GENERAL ANATOMY

Bones:

Types of bones:

According to position:	Ac/ to ossification:	Ac/to shape:
1. Axial bones: skull bones, vertebrae, ribs, sternum 2. Appendicular bones: bones of the limbs	a) Intra membranous ossification: *clavicle*[Q], pareital b) Endochondral ossification: femur, tibia, humerus ***c)*** Mixed type: ***mandible***[Q]	Long bones: femur, tibia, metacarpals, metatarsals Short bones: carpals, tarsals Flat bones: *ribs, sternum*[Q] Irregular: hip bome, vertebrae *Pneumatic:* ***frontal, ethmoid****, temporal, sphenoid****, maxilla*** Sesamoid: *patella, pisiform, fabella*[Q]

Joints

Joints with cavity: diathrosis(synovial) & joints without cavity: synarthrosis(fibrous & cartilaginous)

Immovable joints/synarthrosis:

I. Fibrous joints:

1) **Sutures:** found between skull bones. Separated by fibrous tissue. Types are dentate, serrate, limbic, schindylesis, beveled. Bones found in sutures are Wormian bones/ Inca bones/ sutural bones- most commonly seen in lambdoid suture.
Interfrontal suture is called METOPIC suture.
2) **Syndesmosis:** the two bones need not come in contact, but are connected by ligaments or interosseous membranes. E.g. middle radio-ulnar joint, inferior tibiofibular joint, interlaminar joints of vertebrae.
3) **Gomphosis:** between the teeth and the alveolar sockets of maxilla and mandible.

II. Cartilaginous Joints:

Primary cartilaginous joint	Secondary cartilaginous joint
The bones are united by a plate or bar of hyaline cartilage:E.g. • ***Union between the epiphysis and the diaphysis of a growing bone*** [Q] • **Between the first rib and the manubrium sterni** [Q]	The bones are united by a plate of fibrocartilage and the articular surfaces of the bones are covered by a thin layer of hyaline cartilage. E.g. • Joints between the vertebral bodies (inter-vertebral joints) • Symphysis pubis [Q] • Sacroiliac joint [Q]

Movable joints/ Diarthrosis: have a synovial joint cavity and are surrounded by an articular capsule

I. classified according to number of bones forming the joint

1) **Simple:** two bones forming a joint
2) **Compound:** more than two bones forming a joint
3) **Complex:** where the bones are separated by an articular disc, which divides the joint into multiple cavities. E.g. knee, sternoclavicular, acromioclavicular, temporomandibular.

II. classified according to degree of movement of the joint

1) **Uniaxial:** where there is only one set of movement possible- (flexion/extension, adduction/abduction, medial rotation/lateral rotation, protraction/retraction---circumduction is a combination of the first three sets) e.g. Pivot, hinge
2) **Biaxial:** two degrees of freedom. E.g. **saddle** (sternocalvicular, first carpo-metacarpal, incudo-malleolar); **ellipsoid** (wrist, metacarpophalangeal)
3) **Multiaxial:** three or more degrees of freedom. E.g. **ball and socket** joints (hip, shoulder)

III. Classification according to shape of articulating surface

1. **plane synovial joint**
2. **ellipsoid synovial joint**
3. **condylloid synovial joint**
4. **saddle/sellar synovial joint**
5. **ball and socket synovial joint**
6. **pivot synovial joint**

Type of Synovial Joints:

Type	Movement	Example
1. Plane joint	**Gliding movement is possible**	**Acromioclavicular, intercarpal and intertarsal joint, 1st chondrosternal joint (between 1st rib and sternum)**
2. Uniaxial joint: Movement is possiblein one axis		
a) Hinge (Gingymus) joint	**Movement around transverse axis allows flexion and extension**	**Elbow, ankle and interphalangeal joints**
b) Pivot (trochoid) joint	**Movement on a vertical**	**Superior radioulnar, inferior radioulnar**

	axis. The bone acts as a pivot, which is encircled by an osseoligamentous ring.	**and median atlanto-axial joints.**
c) Condylar joints Also known as modified hinge joint.	**Movement mainly on transverse axis and partly on vertical axis.**	**Knee joint and temporomandibular joint**
3. Biaxial Joint: Movement occurs in two axes		
a) Ellipsoid joint	**Movement around transverse and anteroposterior axes.flexion, extension, adduction and abdu**	**Wrist Joint, metacarpophalangeal,metatarsophalangeal and atlanto-occipital joint.**
b) Saddle joint	**Movement around transverse and anteroposterior axes, conjunct rotation is also possible.**	**1st carpometacarpal joint Sternoclavicular joint Calcaneo-cuboid joint incudo stapedial joint**
4. Polyaxial joints they have three degrees of freedom. Movement occurs aroud three independent axes; transverse, anteroposterior, vertical		
a) Ball and socket (spheroidal) joint	**Movement around anteroposterior, transverse, and vertical axes. Flexion extension, adduction, abduction, rotation and circumduction**	**Hip joint, shoulder joint Talo-calcaneo-navicular joint incudo stapedial joint.**

NERVES

Order of nerves emerging from spinal cord:

- Ventral and dorsal rootlets—>spinal nerve-→rami(1. dorsal primary ramus- supplies skin and paravertebral muscles of back) (2. ventral primary ramus- supplies the rest of the body- forms all the plexuses- cervical, brachial, intercostals nerves, lumbosacral)
- **Sympathetic system** has a thoracolumbar outflow (T1 to L1/L2). Preganglionic neurons in lateral grey column of spinal cord. Postganglionic neurons in various peripheral ganglia (in sympathetic chain, celiac plexus, suprarenal medulla etc)
- **Parasympathtic system:** has a craniosacral outflow (cranial nerves 3, 7, 9 and 10 and S2, 3 and 4). The postganglionic neurons are present close to the viscus supplied. E.g. ciliary ganglion, aurbach's plexus, meissner's plexus.
- All preganglionic fibers are usually myelinated hence appear white, and all postganglionic fibers are unmyelinated and therefore appear grey.

UPPERLIMB

CUTANEOUS NERVES

CUTANEOUS NERVES

Cutaneous nerves of the upper limb:

Dermatomal innervation of the upper limb

- C3 and C4 nerves supply the region at the base of the neck extending laterally over the shoulder
- C5 nerve supplies the arm laterally (i.e. superior aspect of the outstretched limb).
- C6 nerve supplies the forearm laterally and the thumb
- C7 supplies the middle and ring fingers and middle of the posterior surface of the limb
- C8 nerve supplies the little finger, the medial side of the hand, and the forearm

- T1 supplies the middle of the forearm to the axilla
- T2 supplies a small part of the arm and the skin of the axilla
- The cutaneous nerves to the shoulder are derived from the cervical plexus – a network of nerves arising from the anterior primary rami of the C1-4.
- Most cutaneous nerves of the upper limb are derived from the brachial plexus formed by the anterior rami of C5-T1

Nerve	Origin	Distribution
Supraclavicular	Cervical plexus	Supplies skin over clavicle and superolateral aspect of the pectoralis major
Posterior cutaneous nerve of arm	Branch of radial nerve	Supplies the skin on the posterior surface of the arm
Posterior cutaneous nerve of the forearm	Brach of radial nerve	Supplied the skin on the posterior surface of the forearm
Superior lateral cutaneous nerve of arm	Terminal branch of the axillary nerve	Supplies skin over the lower part of deltoid and on the lateral side of midarm
Inferior lateral cutaneous nerve of arm	Branch of radial nerve; it is frequently a branch of the posterior cutaneous nerve of the forearm.	Supplies skin over the inferolateral aspect of the arm
Lateral cutaneous nerve of forearm	Terminal branch of the musculocutaneous nerve	Supplies the skin on the lateral side of the forearm
Medial cutaneous nerve of arm	Arises from the medial cord of the brachial plexus, often uniting in the axilla with the lateral cutaneous branch of the 2nd intercostal nerve	Supplies the skin on the medial side of the arm
Intercostobrachial nerve	Lateral cutaneous branch of the 2nd intercostal nerve from T2	Contributes to the innervation of the skin on the medial surface of the arm
Medial cutaneous nerve of the forearm	Arises from the medial cord of the brachial plexus	Supplies the skin on the anterior and medial surfaces of the forearm

Brachial Plexus:

Supraclavicular Branches		
Dorsal Scapular	Anterior *ramus* of C5 with a frequent contribution from C4	Innervates rhomboids and occasionally supplies levator scapulae
Long thoracic	Anterior *rami* of C5-7	Innervates serratus anterior
Nerve to subclavius	*Superior trunk* receiving fibers from C5, C6 and often C4	Innervates subclavius and sternoclavicular joint
Suprascapular	*Superior trunk* receiving fibers from C5, C6 and often C4	Supraspinatus, infraspinatus, and glenohumeral joint
Infraclavicular branches		
Lateral pectoral	*Lateral cord* receiving fibers from C5-7	Primarily supplies pectoralis major but sends a loop to medial pectorali nerve that innervates pectoralis minor
Musculocutaneous	*Lateral cord* receiving fibers from C5-7	Innervates coracobrachialis biceps brachii, and brachialis, continues as lateral cutaneous nerve of forearm
Median	Lateral root is a continuation of *lateral cord*, receiving fibers from C6 and C7, medial root is a continuation of *medial cord* receiving fibers from C8-T1	Innervates flexor muscles in forearm (except flexor carpi ulnaris, ulnar half of flexor digitorum profundus, and five hand muscles)
Medial pectoral	*Medial cord* receiving fibers from C8-T1	Innervates the pectoralis minor and part of pectoralis major
Median cutaneous nerve of arm	*Medial cord* receiving fibers from C8-T1	Supplies skin on medial side of arm
Median cutaneous nerve of forearm	*Medial cord* receiving fibers from C8-T1	Supplies skin over medial side of forearm
Ulnar	A terminal branch of *medial cord* receiving fibers from C8 and T1 and often C7	Innervates one and ½ flexor muscles in forearm, most small muscles in the hand, and skin of hand medial to a line bisecting the 4th digit
Upper subscapular	Branch of *posterior cord* receiving fibers from C5,6	Innervates superior portion of subscapularis
Thoracodorsal	Branch of *posterior cord* receiving fibers from C6, C7 and C8	Innervates latissimus dorsi
Lower subscapular	Branch of *posterior cord* receiving fibers from C5 and 6	Innervates inferior portion of subscapularis and teres major
Axillary	Terminal branch of *posterior cord* receiving fibers from C5,6	Innervates teres minor and deltoid, glenohumeral joint, and skin over inferior part of deltoid
Radial	Terminal branch of *posterior cord* receiving fibers from C5-8 and T1	Innervates triceps brachii, anconeus, brachioradialis, and extensor muscles of forearm; supplies skin on posterior aspect of arm and forearm via posterior cutaneous nerves of arm and forearm.

Formed by the union of the anterior primary rami of C5 through C8 nerves and the greater part of the anterior ramus of the T1 nerve. The merging of the rami constitute the roots of the brachial plexus, which are located in the posterior triangle of the neck

- **Arterial supply**

- **Subclavian artery** gives rise to the internal thoracic artery, which divides into the superior epigastric and musculophrenic artery; (b) the vertebral artery, which ascends through the upper six transverse foramina of the cervical vertebrae; (c) the **thyrocervical trunk** , which divides into the **suprascapular, transverse cervical** , and **inferior thyroid** arteries; and (d) the **costocervical trunk** , which gives off the deep cervical and superior intercostal arteries.
- **Axillary artery** gives off the **superior thoracic** , **thoracoacromial** (which has pectoral, clavicular, deltoid, and acromial branches), **lateral thoracic** , **subscapular** (which has circumflex scapular and thoracodorsal branches), and **anterior** and **posterior humeral circumflex** arteries.
- **Brachial artery** has the following branches: the **deep brachial** artery runs along with the radial nerve, and the **superior ulnar collateral** artery runs along with the ulnar nerve. The **radial artery** gives off the radial recurrent branch, and the **ulnar artery** gives off the anterior and posterior ulnar recurrent arteries and the **common interosseous artery** , which divides into the anterior and posterior interosseous branches.
- The **superficial palmar arterial arch** is the continuation of the ulnar artery, usually completed by anastomosis with the superficial palmar branch of the radial artery,
- **Deep palmar arch** is the continuation of the radial artery, usually completed by anastomosis with the deep branch of the ulnar artery.

Arteries of the hand

Artery	Origin	Course
Superficial palmar arch	Direct continuation of ulnar artery; arch is complete on lateral side by superficial branch of radial artery or another of its branches	Curves laterally deep to palmar aponeurosis and superficially to long flexor tendons; curve of arch lies across palm at level of distal border of extended thumb
Deep palmar arch	Direction continuation of radial artery; arch completed on medial side by deep branch of ulnar artery	Curves medially deep to long flexor tendons and is in contact with bases of metacarpals
Common palmar digitalis	Superficial palmar arch	Passes distally on lumbricals to webbings of digits
Proper palmar digitalis	Common palmar digital arteries	Runs along sides of digits 2-5
Princes pollicis	Radial artery as it turns into palm	Descends on palmar aspect of 1st metacarpal and divides at the base of proximal phalanx into two branches that run along sides of thumb
Radialis indicis	Radial artery but may arise from princips pollicis artery	Passes along lateral side of index finger to is distal end
Dorsal carpal arch	Radial and ulnar arteries	Arches within fascia on dorsum of hand

NERVES OF UPPERLIMB

The axillary nerve (C5,6)

- **Effect of injury:** the axillary nerve is particularly prone to injury from the downward displacement of the humeral head during shoulder dislocations.
- *Motor deficit*—loss of deltoid abduction with rapid wasting of this muscle. Loss of teres minor function is not detectable clinically.
- *Sensory deficit*—is limited to the 'badge' region overlying the lower half of deltoid.

The radial nerve (C5,6,7,8,T1)

- **Effect of injury**: e.g. humeral shaft fracture resulting in damage to the radial nerve in the spiral groove.
  - *Motor deficit*—loss of all forearm extensors: wristdrop.
  - *Sensory deficit*—usually small due to overlap: sensory loss over the anatomical snuffbox is usually constant.

The median nerve (C6,7,8,T1)

- **Effect of injury** : e.g. compression as in carpal tunnel syndrome.
  - *Motor deficit*—weakness and wasting of the thenar muscles.
  - *Sensory deficit*—involves the skin over the lateral palm and lateral three digits. This is highly variable due to overlap.

The ulnar nerve (C8,T1)

- **Effect of injury** : occurs commonly at the elbow (e.g. fracture of the medial epicondyle) or at the wrist due to a laceration.
  - *Motor deficit*—with low lesions the hand becomes 'clawed'. Owing to the loss of interossei and lumbrical function the metacarpopha- langeal joints of the ring and little fingers hyperextend and their interphalangeal joints flex. The 'clawing' is attributed to the unopposed action of the extensors and flexor digitorum profundus. When injury occurs at the elbow or above, the ring and little fingers are straighter because the ulnar supply to flexor digitorum profun- dus is lost. The small muscles of the hand waste with the exception of the thenar and lateral two lumbrical muscles (supplied by the median nerve).
  - *Sensory deficit*— occurs to the palmar and dorsal surfaces of the hand and medial 11/2 digits. The loss is highly variable due to overlap.

Brachial plexus injuries

Erb-Duchenne paralysis

Excessive downward traction on the upper limb during birth can result in injury to the C5 and C6 roots. This results in paralysis of the deltoid, the short muscles of the shoulder, brachialis and biceps. The combined effect is that the arm hangs down by the side with the forearm pronated and the palm facing backwards. This has been termed the 'waiter's tip' position.

Klumpke's paralysis

Excessive upward traction on the upper limb can result in injury to the T1 root. As the latter is the nerve supply to the intrinsic muscles of the hand this injury results in 'clawing' (extension of the metacarpopha- langeal joints and flexion of the interphalangeal joints) due to the unopposed action of the long flexors and extensors of the fingers. There is often an associated Horner's syndrome (ptosis, pupillary constriction and ipsilateral anhidrosis) as the traction injury often involves the cervical sympathetic chain.

JOINTS

Chief muscles in movements - Glenohumeral joint	
Flexors	Clavicular part of the pectoralis major and anterior part of the deltoid; assisted by the coracobrachialis and the biceps brachii
Extensors	Latissimus dorsi
Abductors	Deltoid (esp. central fibers – following initiation of movement by the supraspinatus)
Adductor	Pectoralis major and latissimus dorsi
Medial rotator	Subscapularis
Lateral rotator	Infraspinatus

Chief muscles in movements about the elbow joint	
Flexors	Brachialis, biceps, brachioradialis; assisted by pronator teres when flexion is resisted
Extension	Triceps, esp. the medial head; assisted by the anconeus

Chief muscles in movements about the radioulnar joints	
Supination	Supinator (when resistance is absent) and by the biceps (when resistance is present); with some assistance from the extensor pollicus longus and extensor carpi radialis
Pronation	Pronator quadratus (primarily) and pronator teres (secondarily); with assistance from the flexor carpi radialis, palmaris longus, and brachioradialis (when the forearm is in the midprone position).

Movement at the Wrist (Radiocarpal) Joint (Condylar or Ellipsoidal Joint)

- Adduction-flexor carpi ulnaris, extensor carpi ulnaris
- Abduction-flexor carpi radialis, extensor carpi radialis longus and brevis
- Flexion-flexor carpi radialis, flexor carpi ulnaris, palmaris longus, abductor pollicis longus
- Extension-extensor carpi radialis longus and brevis, extensor carpi ulnaris

Movement at the Metacarpophalangeal Joint (Condyloid Joint)

- Adduction-palmar interossei (PAD)
- Abduction-dorsal interossei (DAB)
- Flexion-lumbricals and interossei
- Extension-extensor digitorum

Movement at the Interphalangeal Joint (Hinge Joint)

- Flexion-flexor digitorum superficialis (proximal interphalangeal joint), flexor digitorum profundus (distal interphalangeal joint)
- Extension-lumbricals and interossei (when metacarpophalangeal joint is extended by extensor digitorum)
- Extension-extensor digitorum (when metacarpophalangeal joint is flexed by lumbricals and interossei)

Summary of Muscle Innervations of the Upper Limb

Muscles of the Anterior Compartment of the Arm: Musculocutaneous Nerve

- Biceps brachii
- Coracobrachialis
- Brachialis

Muscles of the Posterior Compartment of the Arm: Radial Nerve

- Triceps Anconeus

Muscles of the Posterior Compartment of the Forearm: Radial Nerve

- Superficial layera-brachioradialis; extensor carpi radialis longus; extensor carpi radialis brevis; extensor carpi ulnaris; extensor digitorum communis; extensor digiti minimi

Miscellaneous

- **Rotator cuff** formed by the tendons of the **s** upraspinatus, **i** nfraspinatus, **t** eres minor, and **s** ub-scapularis (SITS).
- The **quadrangular space** is bounded by the teres minor (with subscapularis), teres major, triceps (long head), and the humerus and transmits the **axillary nerve** and the posterior humeral circumflex vessels.
- The **auscultation triangle** is bounded by the trapezius, latissimus dorsi, and scapula and is the most audible site for breathing sound.
- The **cubital fossa** is a bounded by the brachioradialis, the pronator teres, and an imaginary line between the epicondyles of the humerus, with a facial roof and a floor formed by the brachialis and supinator. It contains (from lateral to medial) the radial nerve, biceps brachii tendon, brachial artery, and median nerve.
- The **anatomic snuff box** is bounded medially by the extensor pollicis tendon and laterally by the extensor pollicis brevis and abductor pollicis longus tendons. Its floor is formed by the scaphoid and trapezium bones and crossed by the radial artery.
- The **palmar aponeurosis** is a triangular fibrous layer overlying the tendons in the palm and protects the superficial palmar arterial arch and palmar digital nerves.
- The **flexor retinaculum** forms the **carpal tunnel** through which the median nerve and tendons of the long flexor muscles are transmitted.
- The **extensor expansion** provides the insertion of the lumbrical, interosseous, and extensor muscles of the hand and fingers.

Ape Like Hand

-Paralysis of short muscles of the thumb
-Unopposed action of the extensor pollicis longus
-Thenar eminence is wasted and flattened
-Thumb is adducted and laterally rotated
-First metacarpal lies in the same plane as the other metacarpal

➢ ***PEN TEST:***

Adductor Pollicis Brevis

➢ Lay the hand flat on a table with the palm directed upwards, the patient is unable to touch with his thumb a pen held in front of the palm

JOINTS OF HAND

	Metacarpophalangeal joints	**Interphalangeal joints**	**Wrist joints**	**Carpal (intercapral) joints**	**Carpometacarpal and intermetacarpal joints**
Type	Condyloid synovial joints	Hinge synovial	Condyloid synovial	Plane synovial	Plane synovial; except for carpometa joint of thumb (saddle)
Articulation	Heads of meta with base of proximal phal	Heads of phal with bases of morLEe distal phal	Distal end of radius with proximal row of carpal bones (minus pisiform)	Carpal bones of proximal row with carpal bones of distal row. (the pisiform joint is b/t pisi and triquetrum)	Carpals and meta with each other; carpometacarpal joint of thumb is between trapezium and base of 1st meta
Ligaments	Strong palmar ligs are attached to the phal and meta; deep transverse meta ligs unite 2nd to 5th joints that hold heads of metas together; collateral ligs pass from heads of metas to bases of phals	Ligs are similar to those of the MCP joins, except the unite phalanges	Anterior and post ligs strengthen fibrous capsule; ulnar collateral lig attaches styloid process of ulna and triquetrum; radial collateral lig attaches to styloid process of radius and scaphoid	Carpal bones are united by anterior, posterior, and interosseous ligs	Bones are unites by anterior, posterior, and interosseous ligaments
Movements	Flex/exten, abd/add, and circumduction of 2nd to 5th digits,	Flex/ex	Flex/ex, Abd/add, and circumduction	Small amount of gliding, flexion and abd at midcarpal jnt	Flex/ex and abd/add at jnt for 1st digit; little movement for 2-4, 5 digit mobile

	flex/ex of thumb, but abd/add limited				
Blood supply	Deep digital arteries that arise from superficial palmar arches	Digital arteries	Dorsal and palmar carpal arches	Dorsal and palmar carpal arches	Dorsal and palmar meta arteies and deep carpal and deep palmar arches
Nerve supply	Digital nerves from ulnar and medial nerves	Digital nerves from ulnar and medial nerves	All are supplied by anterior interosseous branch of median nerve, posterior interosseous branch of radial, and dorsal and deep branches of ulnar		

CLINICAL STUFF: FRACTURES AND ENTRAPMENT NEUROPATHIES

SPACE OF PARONA COMPRESSION: Veins are subject to compression when swelling or fluid buildup occurs in any potential space. This causes blood to backflow, which causes the following course of events.

- Ischemia ------ > Necrosis > Fibrosis

FASCIOTOMY: Cutting through the fascia which is causing the compartment syndrome, thereby relieving the pressure and hopefully the compartment syndrome.

SATURDAY NIGHT SYNDROME: Drunk person falling asleep on elbow and hence on ulnar nerve. Wake up the next morning and the ulnar nerve is dead.

CORACOBRACHIALIS SYNDROME : Loss of the **Musculocutaneous Nerve** where it runs through the **Coracobrachial Muscle.**

- *YOU ALSO LOSE:* Biceps, Brachialis, and Lateral Antebrachial Cutaneous Nerve.
- LOST FUNCTION:
  - o Lost flexion at elbow. o Weak supination due to supinator muscle.
  - o Lost sensation over lateral aspect of forearm (cutaneous innervation of medial antebrachial cutaneous N.)

SUPINATOR CHANNEL SYNDROME : *Compression of the* **Deep Branch of the Radial Nerve** *between the* Superficial and Deep Heads of the Supinator, and the Lateral Epicondyle.

- This occurs right at the **lateral epicondyle,** where the Radial Nerve gives off two branches (Deep and Superficial) to innervate the forearm.
- **Arcade of Frohn:** Occurs in 20%-30% of population, where one head of the Supinator is actually a sharp tendon inserting on the lateral epicondyle. This can also lead to Radial N. damage.

SUPRACONDYLAR SYNDROME: Entrapment of the **Median N.** beneath the **Ligament of Struthers,** which connects the *Supracondylar Process* to the *Medial Epicondyle.*

- The Supracondylar Process is a bit of bone sticking out the medial aspect of the humerus. It is only present in a small fraction of population.
- LOSS OF FUNCTION AND SENSATION: Anywhere the median N. innervates.
  - o Lateral 2/3 of palm of hand, lost cutaneous sensation.
  - o Lose motor to the palmar thenar muscles.
  - o Lose motor to the first two lumbricals.

PRONATOR TERES SYNDROME (N420): Entrapment of **Median N.** passing between the Deep and Superficial Heads of the Pronator Teres.

- The Median N. also passes deep to the Flexor Digitorum Superficialis tendon, right after it gets past the Pronator Teres. This can also cause trouble.

- LOSS OF FUNCTION and SENSATION: Again, whatever would happen if you lose the Median N. See above.

MARTIN-GRUBER ANASTOMOSIS: Connection between the Median and Ulnar nerves in the palm of the hand, in about 30% of population. When the connection is there, it is mainly a motor connection.

- Result = people with Ulnar N. damage may still have cutaneous anesthesia, but they may keep some motor function in the hand.

CARPAL TUNNEL SYNDROME: The *Median Nerve* passes deep to the flexor retinaculum. If it is entrapped, carpal tunnel syndrome results.

- Carpus is actually U-Shaped.
- LOSS OF FUNCTION:
  - o Causes numbness and tingling in the lateral part of the hand supplied by the median nerve. o Weakening and wasting of the Thenar muscles.
- TREATMENT: Cut the flexor retinaculum and relieve the pressure.
- **Superficial Palmar Branch of Median N** *does not go through the Carpal Tunnel.* It results in an area of skin in the middle of the palm that is not affected by Carpel Tunnel Syndrome.

CUBITAL TUNNEL SYNDROME: Compression of the **Ulnar Nerve** between the two heads of origin of the *Flexor Carpi Ulnaris.*

- The **Pisiform bone,** distally, acts as a lever in allow the flexor carpi ulnaris to flex the fingers more strongly.
- LOSS OF FUNCTION: Medial two heads of the flexor digitorum profundus and most of the intrinsic muscles of the hand.

GUYON'S CANAL SYNDROME : *Compression of the* **Ulnar Nerve** *in* Guyon's Canal, *between the* Volar Carpal Ligament *and the* Flexor Retinaculum.

- **Volar Carpal Ligament:** Is superficial to the flexor retinaculum. The ulnar artery and nerve pass superficial to the flexor retinaculum but deep to the volar carpal ligament.
- *CUBITAL TUNNEL -VS- GUYON'S CANAL:* In Guyon's Canal, only the intrinsic muscles of the hand are lost, whereas in Cubital Tunnel Syndrome you also lose the innervation of the medial half of the flexor digitorum profundus.

DUPUYTREN'S CONTRACTURE: Progressive shortening of the palmar aponeuroses, from hypertrophy and hyperplasia. Unknown cause.

- Found esp. in those who have done a lot of manual labor.
- SYMPTOM: Tends to bring the medial two fingers in toward the palm and flex them downward a bit.
- LOSS OF FUNCTION: Blood vessels that reach the skin through the palmar aponeurosis are compromised!!!
- TREATMENT: If caught early enough, incise the aponeurosis.

TENOSYNOVITIS: Not to be messed with. Inflammation of the tendons in the synovial joints, which can spread proximally all the way to the elbow.

- INFECTION CAN SPREAD from the **Ulnar Bursa----- > Carpal Tunnel** (with secondary carpal tunnel syndrome) —
  -> Space of Parona-------> Cubital Fossa.
- Tenosynovitis in the index finger flexor tendon can rupture and get into the **Thenar Space,** causing a compartment syndrome there as well.

DEQUERVAIN'S DISEASE: A specific tenosynovitis of the first extensor compartment, which transmits the Extensor Pollicis Longus and Brevis.

- Found in people who use their thumb a lot and are not used to it.
- SYMPTOM: Dull pain around wrist and lack of desire to move the fingers.
- **Dequervain's test:** Make a fist like a child with the thumb inside, and then ulnar deviate (adduct) the wrist. It hurts even without the disease!

SCAPHOID FRACTURE: If the scaphoid is fractured, there is potential for avascular necrosis in 1/3 of all people, because blood comes from only one place -- the distal end.

- This will result in demineralization of the Scaphoid from lack of use, and it will appear dark on the X-Ray as a result.
- When the fracture occurs in the *neck* of the Scaphoid, blood supply is cut off to the proximal part.

TRIGGER FINGER: Swelling of the fibrous sheaths going around the tendons, such that, when the tendon is on one side of the swelling, such that the finger is flexed, it will stay that way and you can't extend it. Then you can pull real hard to get the tendon past the "bottleneck" to the other side of the swelling, such that the finger extends, and then you can't flex it again!

RAYNAUD'S DISEASE: Vascular problem of too high of sympathetic tone, which can cause complications in the hand.

- Spasmodic vasoconstriction at the wrist will cause one or two fingers to become cyanotic and ischemic.
- You could cut the sympathetic nerves at the neck to try and treat it.
- It is a very serious disease.

VARUS: A bone-fracture that creates angulation *toward the midline of the body.* **VALGUS:** A bone-fracture that creates angulation *away from the midline of the body.*

QUESTIONS

BRACHIAL PLEXUS

1..All are branches from roots of brachial plexus except

A. Dorsal scapular nerve
B. Long thoracic nerve
C. Muscular braches to longus colli
D. Nerve to subclavius

2. All are true about lateral pectoral nerve except

A.conveys fibres of C5,C6,C7
B.Pierces clavipectoral fascia
C. Makes a loop of communication with medial pectoral nerve
D.Loop formed by lateral pectoral nerve is in front of second part of axillary artery.

3. All the following are branches from the roots except

A. Dorsal scapular nerve
B. Nerve to subclavius
C. Long thoracic nerve
D. Suprascapular nerve.

SPACES AROUND AXILLA

4. The Content in quadrangular space is

A. Anterior circumflex humeral vessels
B. Posterior circumflex humeral vessels
C. Subscapular vessel
D. Suprascapular vessel

AXILLARY ARTERY

5. True about subscapular artery are all except

A. Subscapular artery is the largest branch
B. Subscapular artery divides into circumflex scapular and thoracodorsal
C. Subscapular artery is a branch from 3rd part of axillary artery
D. It is accompained in lower part by long thoracic nerve of bell

6. Scapular anastomosis involves the following arteries except

A.suprascapular artery
B.acromiothoracic artery
C.superior thoracic artery
D.posterior circumflex humeral artery

NERVES OF UPPERLIMB

7. The pseudoganglion of axillary nerve is located in
A. anterior branch supplying deltoid
B. trunk of axillary nerve supplying shoulder joint
C. posterior branch supplying teres major
D. posterior branch supplying teres minor

8. The nerve that passes through coracobrachialis is
A. Median nerve
B. Radial nerve
C. Axillary nerve
D. musculocutaneous nerve

9. The C7 Fibres of ulnar nerve supply
A. Flexor carpi ulnaris
B. Flexor carpi radialis
C. Flexor digitorum profundus (lateral half)
D. Pronator teres

10. All are true about median nerve except
A. Median nerve crosses brachial artery from medial to lateral in upper part of arm
B. Median nerve leaves cubital fossa between two heads of pronator teres
C. Median nerve appears between superficial and deep group of flexor muscles
D. Anterior interosseous nerve is a branch of median nerve.

11. True about radial nerve are all except
A. Radial nerve divides into superficial & deep branches in front of lateral condyle
B. The superficial branch of radial nerve pierces supinator muscle
C. Deep branch of radial nerve finally presents a terminal pseudo ganglion at wrist
D. Posterior cutaneous nerve of arm is a branch of radial nerve

BRACHIAL ARTERY

12. True about Brachial artery is
A. Is a continuation of axillary artery at the proximal border of teres major
B. Arteria profunda brachii is a large branch of brachial artery that accompany the median nerve
C. Superior ulnar collateral and inferior ulnar collateral are branches of brachial artery
D. Median nerve crosses behind the artery from lateral to medial

CUBITAL FOSSA

13. The floor of cubital fossa is formed by
A. brachialis & supinator
B. supinator & pronator teres
C. brachioradialis & supinator
D. brachioradialis & pronator teres

AXILLARY LYMPHNODES

14. Rotter's node is located
A. near axillary tail of spence
B. on subscapular vessels
C. base of axilla
D. node intervening between pectoralis minor & major

ANASTOMOSIS

15. About anastomosis around elbow true is

A. It is between branches of axillary artery and brachial artery
B. It is between branches of brachial artery and proximal parts of radial and ulnar artery
C. Anastomosis involves in front of medial epicondyle only
D.Cubital anastomosis is not essential anastomosis

AXILLA

16. The Clavipectoral fascia is pierced by following except

A.Cephalic vein
B.Medial pectoral nerve
C.Thoracoacromial artery
D.All the above

17. Best site of drainage of Axillary abscess

A. Anterior wall
B. Posterior wall
C. Base
D. Medial wall

VENOUS DRAINAGE

18. True statement of the following is

A.Cephalic vein is preferred over basilic vein for cardiac catheterisation
B.Ccephalic vein is a content in deltopectoral triangle
C.Basilic vein is formed in anatomical snuff box
D.basilic vein pierces the clavipectoral fascia

NERVES

19. Intercostobrachial nerve is

A.Lateral cutaneous branch of T2
B.Medial cutaneous branch of T2
C.Lateral cutaneous branch of T1
D.Medial cutaneous branch of T1

20. Axillary arch is

A.muscular band
B.vascular band
C.venous band
D.nervous arch

MUSCLES

21. Deltoid muscle is arranged as

A.Multipennate fibres
B.Parallel fibres
C.Cruciform fibres
D.Both A & B

22. The flexors of the wrist are

A.Flexor carpi radialis & Flexor carpi ulnaris
B.Flexor carpi ulnaris & Flexor digitorum supperficialis
C.Flexor digitorum profundus &pronator teres
D.Flexor Digitorum profundus & pronator quadratus

DORSAL DIGITAL EXPANSION

23. Correct statement about Dorsal digital expansion is
A. Formed over Base of metacarpal
B. Base of expansion over head of metacarpal
C. Apex is towards middle phalanx
D. On the medial side of expansion interosseous and lumbricals are inserted.

24. Guyon's canal tranmit
A. median nerve & vessels
B. ulnar nerve & vessels
C. Flexor carpi radialis
D. flexor pollicis longus

25. Structure not related to anatomical snuff box is
A. Cephalic vein
B. superficial branch of radial nerve
C. radial artery
D. deep branch of radial nerve

26. True statement about superficial palmar arch is
A. Superficial terminal branch of ulnar artery with arteria princeps pollicis
B. convexity of arch is directed distally on level with distal border of outstretched thumb
C. A & B
D. None of the above

27. Cleland's Grayson's & Landsmeer's ligaments are:
A. parts of palmar aponeurosis
B. slips of flexor digitorum superficialis
C. Digital fascial complex
D. part of extensor hood

28. The nerve supply to adductor pollicis is
A. Ulnar
B. Median
C. Radial
D. Both a & b

29. Froehse arcade is
A. Arcade between two layers of supinator
B. Arcade between two heads of pronator teres
C. Arterial arcade of radial & ulnar arteries
D. Arcade in deep part of palm formed by median & ulnar nerves

30. True about Vincula is/are
A. Each finger presents two vincula brevia & three vincula longa
B. Vincula brevia are triangular
C. Vincula Longa are filiform
D. All the above

JOINTS

31. The bursae of shoulder joint that does not communicates with joint cavity is
A. Subscapular bursa
B. Subacromial subdeltoid bursa
C. Infraspinatus bursa
D. All the above

32. Anterior Rotator cuff interval is between
A.Supraspinatus tendon & subscapularis tendon
B.Deltoid & infraspinatus tendon
C.Teres minor & supraspinator
D.Subscapularis & infraspinatus

33. The carpometacarpal joint of thumb & metacarpophalangeal joint are
A. Ellipsoid & Pivot joint
B.Plane & ellipsoid joint
C.Ellipsoid & Hinge joint
D.Sellar & ellipsoid joint

34. Cubital tunnel syndrome involve
A. Ulnar nerve
B.median nerve
C.Radial nerve
D.axillary nerve

35. The sites of pronator syndrome are/is
A.Ligament of Struthers
B. Between the two origin of supinator
C. Both a & b
D. None of above

36. The potential sites of compression of radial nerve in radial tunnel syndrome are
A. Spiral groove
B. Medial epicondyle
C.both a & b
D. none of above

37. Martin-Gruber connection is
A.Communication between Radial & Ulnar nerve
B.Communication between Median & Ulnar nerve
C.Communication between Axillary & Ulnar nerve
D.Communication betwen Median & Radial nerve

38. Wartenberg syndrome involve
A. Motor branch of radial nerve
B. Sensory branch of median nerve
C. Motor branch of ulnar nerve
D.Superficial sensory branch of radial nerve

ELBOW JOINT
39. True about pronation & Supination is/are
A.The axis passes through the center of radial head to distal ulnar articular disc
B.The axis of pronation & supination is stationary
C. Power is greater in Pronation
D.None of above

RETINACLUM
40. True about retinaculum is
A. Flexor retinaculum is attached medially to pisiform,hook of hamate and laterally scaphoid,trapezium
B. The extensor retinaculum is attached to anterior border of radius and ulna
C. Both A and B
D. None of above

PALM

41. The following is correctly matched
A.Lumbrical 1&2-bipennate
B.Lumbrical 3 &4-unipennate
C.dorsal interossei-bipennate
D.palmar interossei-unipennate

42. The Surgically important pulleys that prevent bowstringing of flexor tendons
A.A 2 & A4
B. A1 & A5
C. A 3 & A5
D. A 5 & A4

43. Which of the following muscle does not exist
A.adductor pollicis
B.opponens digiti minimi
C.adductor digiti minimi
D.Flexor digiti minimi brevis

44. Hammer thumb is due to
A.Flexor pollicis longus
B.opponens pollicis
C.Abductor pollicis longus
D.extensor pollicis longus

45..Acromioclavicular is a type of
A.Saddle synovial joint
B.Pivot synovial joint
C.plane synovial joint
D.ellipsoid type synovial

46. The normal scapulohumeral rhythm occurs in ratio
A. 2:1
B.3:1
C.4:1
D.1:4

47. A 22-year-old patient received a stab wound in the chest that injured the intercostobrachial nerve. Which of the following conditions results from the described lesion of the nerve?
A. Inability to move the ribs
B. Loss of tactile sensation on the lateral aspect of the arm
C. Absence of sweating on the posterior aspect of the arm
D. Loss of sensory fibers from the second intercostal nerve

48. A 35-year-old man walks in with a stab wound to the most medial side of the proximal portion of the cubital fosssa. Which of the following structures would most likely be damaged?
A.B iceps brachii tendon
B.Radial nerve
C.Brachial artery
D.Median nerve

49. A patient with Bennett's fracture (a fracture of the base of the first metacarpal bone) experiences an impaired thumb movement. Which of the following intrinsic muscles of the thumb is most likely injured?

A. Abductor pollicis brevis
B. Flexor pollicis brevis (superficial head)
C. Opponens pollicis
D. Adductor pollicis

50. A 27-year-old pianist with a known carpal tunnel syndrome experiences difficulty in finger movements. Which of the following intrinsic muscles of her hand is paralyzed?

A. Palmar interossei and adductor pollicis
B. Dorsal interossei and lateral two lumbricals
C. Lateral two lumbricals and opponens pollicis
D. Abductor pollicis brevis and palmar interossei

51. A secretary comes in to your office complaining of pain in her wrists from typing all day. You determine that she likely has carpal tunnel syndrome. Which of the following conditions would help you determine the diagnosis?

A. Inability to adduct the little finger
B. Inability to flex the distal interphalangeal joint of the ring finger
C. Flattened thenar eminence
D. Loss of skin sensation of the medial one and one-half fingers

52. Name the abnormality

A. Arachnodactaly
B. Brachymelia
C. Rhizomelia
D. Floating thumb

ANSWERS & EXPLANATION

1.D

SUPRACLAVICULAR BRANCHES

From roots	1. Nerves to scaleni and longus colli	C5, 6, 7, 8
	2. Branch to phrenic nerve	C5
	3. Dorsal scapular nerve	C5
	4. Long thoracic nerve	C5, 6 (7)
From trunks	1. Nerve to subclavius	C5, 6
	2. Suprascapular nerve	C5, 6

Brachial Plexus: **C5-T1** → Trunks→Divisions→Three cords

1. Lateral Cord

Musculocutaneous branch
Lateral root of the median nerve
Lateral pectoral nerve

2. Medial Cord

Medial root of median nerve
Ulnar nerve
Medial pectoral nerve
Medial cutaneous nerve of forearm & arm

3. Posterior Cord

Axillary nerve
Radial nerve
Upper subscapular nerve
Lower subscapular nerve
Thoracodorsal nerve

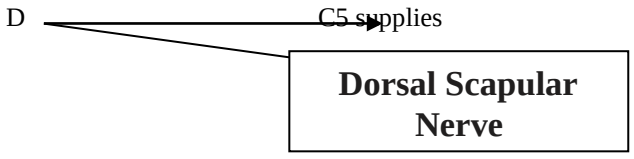
2.D

- Lateral pectoral nerve

The lateral pectoral nerve is larger than the medial, and may arise from the anterior divisions of the upper and middle trunks, or by a single root from the lateral cord. Its axons are from the fifth to seventh cervical rami. It crosses anterior to the axillary artery and vein, pierces the clavipectoral fascia and supplies the deep surface of pectoralis major. It sends a branch to the medial pectoral nerve, forming a loop in front of the first part of the axillary artery , to supply some fibres to pectoralis minor.

3. D

Arises from the upper trunk in the lower part of the posterior triangle.



i. Rhomboids
ii. Levator Scapulae

S – Nerve to subclavius C5 C6 where they join to form the upper trunk, from which it is often classified as arising.
L- Long thoracic nerve C5 C6 C7
Supplies serratus anterior. Segmentally

4.B
Triangular Space
Superior: Teres Minor
Lateral: Long head of Triceps Brachii
Inferior: Teres Major
Structure passing :circumflex scapular and subscapular vessels

Quadrangular Space
Superior: Teres minor
Inferior: Teres major
Lateral: Surgical neck of humerus
Medial: Long head of triceps brachii
Structure passing: Posterior circumflex humeral artery/vein, Axillary nerve
Lower triangular space
Above: teres major
Medially: long head of triceps
Laterally :shaft of humerus
Structure passing: radial nerve & profunda brachii vessels

5.D

- The subscapular artery is the largest branch of the axillary artery. It usually arises from the third part of the axillary artery at the distal (inferior) border of subscapularis, which it follows to the inferior scapular angle, where it anastomoses with the lateral thoracic and intercostal arteries and the deep branch of the transverse cervical artery. It supplies adjacent muscles and the thoracic wall.
- It is accompanied distally by the nerve to latissimus dorsi. Approximately 4 cm from its origin the artery divides into circumflex scapular and thoracodorsal artery.

6.C
The collateral anastomosis is observed between first part of subclavian artery and the third part of axillary artery

Suprascapular
Deep branch of transverse cervical arteries
Circumflex scapular artery
ACROMIAN PROCESS
Acromial branch of suprascapular
Thoracoacromial
Posterior circumflex humeral artery

7. D
The anterior branch curves round the neck of the humerus with the posterior circumflex humeral vessels, deep to deltoid. It reaches the anterior border of the muscle and supplies it, and gives off a few small cutaneous branches which pierce deltoid and ramify in the skin over its lower part. The posterior branch courses medially and posteriorly along the attachment of the lateral head of triceps, inferior to the glenoid rim. It usually lies medial to the anterior branch in the quadrangular space. It gives off the nerve to teres minor and the upper lateral cutaneous nerve of the arm at the lateral edge of the origin of the long head of triceps. There is often an enlargement or pseudoganglion on the branch to teres minor. The axillary trunk supplies a branch to the shoulder joint below subscapularis.

8.D

The musculocutaneous nerve arises from the lateral cord (C5–7), opposite the lower border of pectoralis minor. It pierces coracobrachialis and descends laterally between biceps and brachialis to the lateral side of the arm.

9.A

Some fibres from C7 often leave the lateral root in the lower part of the axilla and pass distomedially posterior to the medial root, and usually anterior to the axillary artery, to join the ulnar nerve. They may branch from the seventh cervical ventral ramus. Clinically they are believed to be mainly motor and to supply flexor carpi ulnaris.

The ulnar nerve, which arises from the medial cord of the brachial plexus (C8 and T1), gives off no cutaneous or motor branches in the axilla or in the arm. As it enters the forearm from behind the medial epicondyle, it supplies the flexor carpi ulnaris and the medial half of the flexor digitorum profundus. In the distal third of the forearm, it gives off its palmar and posterior cutaneous branches. The palmar cutaneous branch supplies the skin over the hypothenar eminence; the posterior branch supplies the skin over the medial third of the dorsum of the hand and the medial one and a half fingers. Not uncommonly, the posterior branch supplies two and a half instead of one and a half fingers. It does not supply the skin over the distal part of the dorsum of these fingers.

Having entered the palm by passing in front of the flexor retinaculum, the superficial branch of the ulnar nerve supplies the skin of the palmar surface of the medial one and a half fingers including their nail beds; it also supplies the palmaris brevis muscle. The deep branch supplies all the small muscles of the hand except the muscles of the thenar eminence and the first two lumbricals, which are supplied by the median nerve.

The ulnar nerve is most commonly injured at the elbow, where it lies behind the medial epicondyle, and at the wrist, where it lies with the ulnar artery in front of the flexor retinaculum. The injuries at the elbow are usually associated with fractures of the medial epicondyle. The superficial position of the nerve at the wrist makes it vulnerable to damage from cuts and stab wounds

10.A

Median nerve crosses in front of brachial artery from lateral to medial.

The median nerve , which arises from the medial and lateral cords of the brachial plexus, gives off no cutaneous or motor branches in the axilla or in the arm. In the proximal third of the front of the forearm, by unnamed branches or by its anterior interosseous branch, it supplies all the muscles of the front of the forearm except the flexor carpi ulnaris and the medial half of the flexor digitorum profundus, which are supplied by the ulnar nerve. In the distal third of the forearm, it gives rise to a palmar cutaneous branch, which crosses in front of the flexor retinaculum and supplies the skin on the lateral half of the palm (Fig. 9-102). In the palm the median nerve supplies the muscles of the thenar eminence and the first two lumbricals and gives sensory innervation to the skin of the palmar aspect of the lateral three and a half fingers, including the nail beds on the dorsum.

From a clinical standpoint, the median nerve is injured occasionally in the elbow region in supracondylar fractures of the humerus. It is most commonly injured by stab wounds or broken glass just proximal to the flexor retinaculum; here it lies in the interval between the tendons of the flexor carpi radialis and flexor digitorum superficialis, overlapped by the palmaris longus

11.B

The deep terminal branch of radial nerve pierces supinator.

The radial nerve, which arises from the posterior cord of the brachial plexus, characteristically gives off its branches some distance proximal to the part to be innervated.

In the axilla it gives off three branches: the posterior cutaneous nerve of the arm, which supplies the skin on the back of the arm down to the elbow; the nerve to the long head of the triceps; and the nerve to the medial head of the triceps.

In the spiral groove of the humerus it gives off four branches: the lower lateral cutaneous nerve of the arm, which supplies the lateral surface of the arm down to the elbow; the posterior cutaneous nerve of the forearm, which supplies the skin down the middle of the back of the forearm as far as the wrist; the nerve to the lateral head of the triceps; and the nerve to the medial head of the triceps and the anconeus.

In the anterior compartment of the arm above the lateral epicondyle it gives off three branches: the nerve to a small part of the brachialis, the nerve to the brachioradialis, and the nerve to the extensor carpi radialis longus.
In the cubital fossa it gives off the deep branch of the radial nerve and continues as the superficial radial nerve. The deep branch supplies the extensor carpi radialis brevis and the supinator in the cubital fossa and all the extensor muscles in the posterior compartment of the forearm. The superficial radial nerve is sensory and supplies the skin over the lateral part of the dorsum of the hand and the dorsal surface of the lateral three and a half fingers proximal to the nail beds. (The ulnar nerve supplies the medial part of the dorsum of the hand and the dorsal surface of the medial one and a half fingers; the exact cutaneous areas innervated by the radial and ulnar nerves on the hand are subject to variation.)
The radial nerve is commonly damaged in the axilla and in the spiral groove.

12.C
Brachial Artery
Begins at inferior teres major)
Arm Branches of Brachial Artery
Deep Artery of Arm: Courses with radial nerve
Superior/Inferior Ulnar Collateral Artery
Cubital Fossa Branches of Brachial Artery
Radial artery→Radial Recurrent Artery
Ulnar Artery→Anterior/Posterior Ulnar Recurent Arteries
Common Interosseous Artery→Anterior/Posterior Interosseous Arteries
Palmar Branches
1. Ulnar Artery (and Radial Artery) → Superficial Palmar Arch→Three Common Palmar Digital Arteries→Two Proper Palmar Digital Arteries

13.A

- The cubital fossa forms a triangular depression in the middle of the upper part of the anterior aspect of the forearm . The superior border of the fossa is an imaginary line, which joins the two epicondyles of the humerus.
- The fleshy elevation which constitutes its medial border is formed by the lateral margin of pronator teres and the elevation which forms the lateral border is the medial edge of brachioradialis. The roof of the fossa is formed by the deep fascia of the forearm, reinforced by the bicipital aponeurosis on the medial aspect.
- The median cubital vein lies on this deep fascia crossed superficially (or sometimes deeply) by the medial cutaneous nerve of the forearm.
- Brachialis and supinator form the floor of the fossa.

14.D

- There are between 20 to 30 axillary nodes, which may be divided into five not wholly distinct groups, namely, lateral, anterior (pectoral), posterior (subscapular), central and apical. Four of the groups are intermediary, and only the apical group is terminal. Collectively they drain the entire upper limb, breast and trunk above the umbilicus.
- The lateral group of four to six nodes is posteromedial to the axillary vein, its afferents drain the whole limb except the vessels accompanying the cephalic vein .
- Efferent vessels pass partly to the central and apical axillary groups, and partly to the inferior deep cervical nodes. The anterior group of four or five nodes spreads along the inferior border of pectoralis minor near the lateral thoracic vessels. Their afferents drain the skin and muscles of the supraumbilical anterolateral body wall and breast, and efferents pass partly to the central and partly to the apical axillary nodes. The posterior group of six or seven nodes lie on the inferior margin of the posterior axillary wall, along the subscapular vessels

15.B
The arterial anastomosis is between the branches of brachial artery and proximal parts of radial and ulnar artery
It is an essential anastomosis

16.B

The fascia becomes thin, splits around pectoralis minor and descends to blend with the axillary fascia and laterally with the fascia over the short head of biceps. The cephalic vein, thoraco-acromial artery and vein, and lateral pectoral nerve pass through the fascia.

17.C

- When axillary suppuration occurs the local fascial arrangement affects the spread of pus. Suppuration may be superficial or deep to the clavipectoral fascia, either between the pectoral muscles or behind pectoralis minor. In the former, an abscess would appear at the edge of the anterior axillary fold or the groove between deltoid and pectoralis major; in the latter, pus would tend to surround vessels and nerves and ascend into the neck, the direction of least resistance. Pus may also track along vessels into the arm.
- When an axillary abscess is incised, the knife should enter the axillary 'base', midway between the anterior and posterior margins and near the thoracic side to avoid the lateral thoracic, subscapular and axillary vessels on the anterior, posterior and lateral walls respectively.

18.B

The superficial veins of the arm lie in the superficial fascia.
The cephalic vein ascends in the superficial fascia on the lateral side of the biceps and, on reaching the infraclavicular fossa, drains into the axillary vein.

The basilic vein ascends in the superficial fascia on the medial side of the biceps . Halfway up the arm, it pierces the deep fascia and at the lower border of the teres major joins the venae comitantes of the brachial artery to form the axillary vein

19.A

Nerve	Origin	Distribution
Supraclavicular	Cervical plexuses	Supplies skin over clavicle and superolateral aspect of the pectoralis major
Posterior cutaneous nerve of arm	Branch of radial nerve	Supplies the skin on the posterior surface of the arm
Posterior cutaneous nerve of the forearm	Brach of radial nerve	Supplied the skin on the posterior surface of the forearm
Superior lateral cutaneous nerve of arm	Terminal branch of the axillary nerve	Supplies skin over the lower part of deltoid and on the lateral side of midarm
Inferior lateral cutaneous nerve of arm	Branch of radial nerve; it is frequently a branch of the posterior cutaneous nerve of the forearm.	Supplies skin over the inferolateral aspect of the arm
Lateral cutaneous nerve of forearm	Terminal branch of the musculocutaneous nerve	Supplies the skin on the lateral side of the forearm
Medial cutaneous nerve of arm	Arises from the medial cord of the brachial plexus, often uniting in the axilla with the lateral cutaneous branch of the 2nd intercostal nerve	Supplies the skin on the medial side of the arm
Intercostobrachial nerve	Lateral cutaneous branch of the 2nd intercostal nerve from T2	Contributes to the innervation of the skin on the medial surface of the arm
Medial cutaneous nerve of the forearm	Arises from the medial cord of the brachial plexus	Supplies the skin on the anterior and medial surfaces of the forearm

20.A

- Muscular band extends from latisssimus dorsi to pectoralis major
- Compress upon axillary vessels causing venous thrombosis

21.A
Deltoid is a multipennate muscle
The acromial fibres are mutipennate that get inserted to humerus deltoid tuberosity

22.A
- Flexors of wrist-FCR & FCU
- Flexors of middle phalanges-FDS
- Flexors of distal phalanges-FDP & FPL
- Pronator of forearm-PT & PQ

23.B
- The extensor hood is triangular in shape with:
- The apex attached to the distal phalanx;
- The central region attached to the middle phalanx (index, middle, ring, and little fingers) or proximal phalanx (thumb); Each corner of the base wrapped around the sides of the metacarpophalangeal joint-in the index, middle, ring, and little fingers, the corners of the hoods attach mainly to the deep transverse metacarpal ligaments; in the thumb, the hood is attached on each side to muscles.
- In addition to other attachments, many of the intrinsic muscles of the hand insert into the free margin of the hood on each side. By inserting into the extensor hood, these intrinsic muscles are responsible for complex delicate movements of the digits that could not be accomplished with the long flexor and extensor tendons alone. In the index, middle, ring, and little fingers, the lumbrical, interossei, and abductor digiti minimi muscles attach to the extensor hoods. In the thumb, the adductor pollicis and abductor pollicis brevis muscles insert into and anchor the extensor hood.

24.B
Guyon's canal: canal for the ulnar nerve and vessels; defined medially by the pisiform, and posteriorly by the flexor retinaculum. As the deep branch of the ulnar nerve passes across the palm, it lies in a fibro-osseous tunnel
(Guyon's canal) between the hook of the hamate and the flexor tendons. Occasionally, small outpouchings of synovial membrane (ganglia) from the joints of the carpus compress the nerve with in this canal, producing sensory and motor symptoms

25.D
Anatomical snuffbox
The 'anatomical snuffbox' is a term given to the triangular depression formed on the posterolateral side of the wrist and metacarpal by the extensor tendons passing into the thumb . Historically, ground tobacco (snuff) was placed in this depression before being inhaled into the nose. The base of the triangle is at the wrist and the apex is directed into the thumb.
The impression is most apparent when the thumb is extended:
The lateral border is formed by the tendons of the abductor pollicis longus and extensor pollicis brevis;
The medial border is formed by the tendon of the extensor pollicis longus;
The floor of the impression is formed by the scaphoid and trapezium, and distal ends of the tendons of the extensor carpi radialis longus and extensor carpi radialis brevis.
The radial artery passes obliquely through the anatomical snuffbox, deep to the extensor tendons of the thumb and lies adjacent to the scaphoid and trapezium. Terminal parts of the superficial branch of the radial nerve pass subcutaneously over the snuffbox as does the origin of the cephalic vein from the dorsal venous arch of the hand

26. C
The ulnar artery enters the hand anterior to the flexor retinaculum on the lateral side of the ulnar nerve and the pisiform bone. The artery gives off a deep branchand then continues into the palm as the superficial palmar arch.
The superficial palmar arch is a direct continuation of the ulnar artery. On entering the palm, it curves laterally behind the palmar aponeurosis and in front of the long flexor tendons. The arch is completed on

the lateral side by one of the branches of the radial artery. The curve of the arch lies across the palm, level with the distal border of the fully extended thumb.

27.C

- Digital fascial complex
- The superficial fascia within the finger is fibrofatty in the palmar and dorsal aspects, but more sheet-like laterally, where it is termed the lateral digital sheet. Within the core of the finger the fascia is thickened in areas, forming the flexor sheath, Cleland's, Grayson's and Landsmeer's ligaments.
- Cleland's ligaments extend from the sides of the phalanges, pass dorsal to the neurovascular bundles and insert into the lateral digital sheet.
- Grayson's ligaments are more delicate, may even be discontinuous and pass from the lateral sides of the phalanges volar to the neurovascular bundles to insert into the lateral digital sheet.
- Landsmeer's ligaments are inconsistent anatomical structures made up of transverse and oblique retinacular ligaments .The transverse retinacular ligament passes from the A3 pulley of the fibrous flexor sheath at the level of the proximal interphalangeal joint to the lateral border of the lateral extensor band. The oblique retinacular ligament lies deep to the transverse retinacular ligament. It originates from the lateral aspect of the proximal phalanx and flexor sheath (A2 pulley) and passes volar to the axis of rotation of the proximal interphalangeal joint in a dorsal and distal direction to insert into the terminal extensor tendon.

28.A

Abductor pollicis brevis	Scaphoid, trapezium, flexor retinaculum	Base of proximal phalanx of thumb	Median nerve	**C8;** T1	Abduction of thumb
Flexor pollicis brevis	Flexor retinaculum	Base of proximal phalanx of thumb	Median nerve	C8; T1	Flexes metacarpophalangeal joint of thumb
Opponens pollicis	Flexor retinaculum	Shaft of metacarpal bone of thumb	Median nerve	**C8;** T1	Pulls thumb medially and forward across palm
Adductor pollicis	Oblique head; second and third metacarpal bones; transverse head; third metacarpal bone	Base of proximal phalanx of thumb	Deep branch of ulnar nerve	C8; **T1**	Adduction of thumb

29.A

Froehse, arcade of: arcade between the two layers of supinator; it transmits the posterior interosseous nerve

30.D

- The phenomenon of tendon gliding within a fibrous sheath requires a very specialized arrangement of the vascular supply. Folds of synovial membrane containing a loose plexus of fascial fibres carry blood vessels to the tendons at certain defined points.

- These folds, vincula tendinum, are of two kinds. Vincula brevia, of which there are two in each finger,are attached to the deep surfaces of the tendons near to their insertions. There is thus one vinculum brevium attaching flexor digitorum profundus to the region of the distal interphalangeal joint, and a more proximal vinculum deep to flexor digitorum superficialis at the proximal interphalangeal joint. Vincula longa are filiform: usually two are attached to each superficial tendon, one to each deep tendon.

31.B

The most consistent of these is the subtendinous bursa of subscapularis, which lies between the subscapularis muscle and the fibrous membrane. The synovial membrane also folds around the tendon of the long head of the biceps brachii muscle in the joint and extends along the tendon as it passes into the intertubercular sulcus. All these synovial structures reduce friction between the tendons and adjacent joint capsule and bone.

In addition to bursae that communicate with the articular cavity through apertures in the fibrous membrane, other bursae are associated with the joint but are not connected to it. These occur:

l between the deltoid and supraspinatus muscle and the joint capsule (the subacromial bursa);

l between the acromion and skin;

l between the coracoid process and the joint capsule;

l in relationship to tendons of muscles around the joint (coracobrachialis, teres major, long head of triceps brachii, and latissimus dorsi muscles).

32.A

- Posterior rotator interval : between the fusion of the supraspinatus tendon and infratendon
- The long head of biceps passes through ARCI

33.D

There are five carpometacarpal joints between the metacarpals and the related distal row of carpal bones . The saddle joint, between metacarpal I and the trapezium, imparts a wide range of mobility to the thumb that is not a feature of the rest of the digits.Movements at this carpometacarpal joint are flexion, extension, abduction, adduction, rotation, and circumduction.

Metacarpophalangeal joints

The joints between the distal heads of the metacarpals and the proximal phalanges of the digits are condylar joints, which allow flexion, extension, abduction, adduction, circumduction, and limited rotation . The capsule of each joint is reinforced by the palmar ligament and by medial and lateral collateral ligaments.

34.A

- Cubital tunnel syndrome
- Typically the ulnar nerve can be compressed in the tunnel formed by the tendinous arch connecting the two heads of flexor carpi ulnaris at their humeral and ulnar attachments. Other local causes of compression and neuritis at this site include trauma, inflammatory arthritis, compression by the medial head of the triceps, osteophytes, recurrent subluxation of the nerve across the medial epicondyle of the humerus and abnormal muscular variants such as the anconeus epitrochlearis.

35.A

Pronator syndrome

- This is an uncommon entrapment neuropathy of the median nerve occurring in the elbow region. Entrapment can occur typically at four sites. The first occurs at the site of the ligament of Struthers. This ligament represents an anatomical variant and when present connects a small supracondylar spur of bone to an accessory origin of pronator teres. The median nerve can be compressed as it passes under this ligament. The nerve may also be trapped as it passes deep to the bicipital aponeurosis; the aponeurotic edge of the deep head of pronator teres muscle; or the tendinous aponeurotic arch forming the proximal free edge of the radial attachment of flexor digitorum superficialis.

36.D

- Radial tunnel syndrome
- Radial tunnel syndrome is an entrapment neuropathy of the radial nerve near the elbow, where four structures can potentially cause compression of the nerve.

- These are fibrous bands (which can tether the radial nerve to the radiohumeral joint); the sharp tendinous medial border of extensor carpi radialis brevis; a leash of vessels from the radial recurrent artery as it passes to supply brachioradialis and extensor carpi radialis longus.
- The arcade of Frohse, which is the free aponeurotic proximal edge of the superficial part of supinator .

37.B

Multiple communicating branches between the median nerve (and sometimes the anterior interosseous nerve) arise proximally and pass medially between flexors digitorum superficialis and profundus, deep to the ulnar artery, and join the ulnar nerve. This motor fibre communication (commonly referred to as the Martin–Gruber connection) is estimated to be present in 17% of individuals. It results in a median nerve innervation of a variable number of intrinsic muscles of the hand , and presumably explains why isolated ulnar and median nerve lesions can sometimes be unpredictable in terms of the pattern of intrinsic muscle paralysis.

38.D

- Radial sensory nerve entrapment (Wartenberg's disease)

Entrapment of the superficial radial nerve can occur as the nerve emerges from beneath the edge of the brachioradialis tendon about 6 cm proximal to the radial styloid; it is probably pinched by the scissoring effect of brachioradialis and extensor carpi radialis brevis tendons.

The condition is frequently associated with previous trauma in this region. The symptoms are pain and paraesthesia over the radial aspect of the dorsum of the wrist and hand.

39.A

The distal end of the ulna is not stationary during movements; it moves a variable amount along a curved course, posterolaterally in pronation, anteromedially in supination. **The axis of movement,** as defined above, is therefore displaced laterally in pronation, medially in supination. Hence the axis for supination and pronation of the whole forearm and hand passes between the bones at both the superior and distal radio-ulnar joints when ulnar movement is marked, but through the centres of the radial head and ulnar styloid when it is minimal. The axis may be prolonged through any digit, depending on the medial or lateral displacement of the distal end of the ulna.

The hand will rotate further than the forearm because of the sliding–rotatory movement which occurs between the carpal bones and the bases of the metacarpals and, to a very minor degree, at the radiocarpal joint.

40.A

- The extensor retinaculum is a strong, fibrous band which extends obliquely across the back of the wrist. It is attached laterally to the anterior border of the radius, medially to the triquetral and pisiform bones, and, in passing across the wrist, to the ridges on the dorsal aspect of the distal end of the radius. It prevents bowstringing of the tendons across the wrist joint.

41.C

- The palmar interossei 1-3 & lumbrical 1 & 2 unipennate
- The dorsal interossei 1-4 & lumbrical 3 & 4 bipennate

42.A

- The A1 pulley is situated anterior to the palmar cartilaginous plate of the metacarpophalangeal joint and may extend over the proximal part of the proximal phalanx.
- The A2 overlies the middle third of the proximal phalanx. It is the strongest pulley and arises from well-defined longitudinal ridges on the palmar aspect of the phalanx. Its distal edge is well developed. A pouch or recess of synovium extends superficial to the free edge of the pulley fibres so that the free edge forms a lip protruding into the synovial space.
- A3 is a narrow pulley lying palmar to the proximal interphalangeal joint.
- A4 overlies the middle third of the middle phalanx,
- A5 overlies the distal interphalangeal joint.
- The cruciate fibres are numbered in a slightly different manner.

- C0 is palmar to the metacarpophalangeal joint. There are two cruciate zones, C1 and C2, at the proximal interphalangeal joint and they lie just proximal and distal respectively to A3. At the distal interphalangeal joint there is one pronounced cruciate system, C3, which lies between A4 and A5.
- Surgically the most important pulleys which prevent bowstringing of the flexor tendons are the A2 and A4 pulleys.

43.C
The adductor digiti mini is not there as little finger is adducted

44.A
Hammer thumb due to FHL Tendon that is attached to terminal phalanx

45.C
ACJ is a plane type synovial
SCJ is a saddle type joint

46. A
The scapula and upper limb are suspended from the clavicle by the strong coracoclavicular ligament assisted by the tone of muscles. When the scapula rotates on the chest wall so that the position of the glenoid fossa is altered, the axis of rotation may be considered to pass through the coracoclavicular ligament.
Abduction of the arm involves rotation of the scapula as well as movement at the shoulder joint. For every 3Â° of abduction of the arm, a 2Â° abduction occurs in the shoulder joint and a 1Â° abduction occurs by rotation of the scapula. At about 120Â° of abduction of the arm, the greater tuberosity of the humerus comes into contact with the lateral edge of the acromion. Further elevation of the arm above the head is accomplished by rotating the scapula.

47.D
Intercostobrachial nerve comminucates with medial cutaneous nerve of arm and supply the medial side of arm

48.D
Medial to lateral –The contents are median nerve,brachial artery,biceps tendon,radial nerve.

49.C
Opponens pollicis insert on first metacarpal. All the other muscles insert to proximal phalanx

50.C
The median nerve innervates abductor pollicis brevis,opponens pollicis,two lateral lumbricals

51.C
Median nerve supplies the thenar muscles.

52.D
Floating thumb-Absence of first metacarpal

LOWER LIMB

LIMB ROTATION:

- Initially, the limbs extend caudally, then later they extend back ventrally. But initially they are both facing the same direction (bent and facing forward).
- *Then rotation occurs, such that the* knees point cranially and the elbows point caudally. THE ROTATION IS IN OPPOSITE DIRECTIONS. *This creates the* **fetal position.**
  - **o** The upper limbs rotate 90 laterally, so that the elbows point down.
  - **o** The lower limbs rotate 90 medially, so that the knees point up.
- This rotation explains the twisted dermatomal arrangement in the limbs -- due to the rotation of the limbs.

VEINS, NERVES, MISCELLANEOUS

SUPERFICIAL VEINS OF LOWER LIMB

- Great Saphenous Vein

o On the anterior thigh, it travels through the **Fossa Ovalis,** after which it merges with the Femoral Vein.
o As you go down the leg, it wraps medially around to the posterior aspect of the knee.
o Then it comes back anteriorly to the medial malleolus of the ankle, where it anastomoses with the Short Saphenous Vein.

Short Saphenous Vein: Runs up the posterior leg.
o It anastomoses with the Great Saphenous Vein around the ankle.

DEEP VEINS OF LOWER LIMB:

- For the most part, the deep veins run with the deep arteries.
- **Popliteal Vein:** Around the back of the knee, this vein is very important clinically.
  - *o BLOOD CLOT in POPLITEAL VEIN*----------> Femoral Vein ----- > External Iliac ------ > IVC.....> Right Heart------ > Lungs------> Pulmonary Embolism! -- not good.
  - *o* The short Saphenous Vein feeds into the Popliteal Vein around the posterior aspect of the thigh. o The Popliteal Vein feeds into the Femoral Vein.

SCIATIC NERVE and Branches : Largest peripheral nerve in body.

- Innervates the posterior thigh. Divides into two principle branches at the *Popliteal Fossa usually, but may occur a foot proximal to it.*
- Common Peroneal Nerve, **which divides into**
  - o **Deep Peroneal Nerve** -- Motor to medial leg
  - o **Superficial Peroneal Nerve** -- Motor to lateral leg
  - o **Lateral Sural Cutaneous** -- Cutaneous innervation to lateral leg.
- **Tibial Nerve** -- Posterior leg
- It may arise above, through, or below the Piriformis muscle in the hip.

FEMORAL NERVE and Branches:

- **Anterior Cutaneous Branches** -- Anterior Cutaneous innervation of thigh
- **Saphenous Nerve** -- Anteromedial innervation of leg

LUMBAR PLEXUS : L2, L3, L4 primarily.

- Lateral Femoral Cutaneous Nerve
- Femoral Nerve
- Obturator Nerve

SACRAL PLEXUS : L4, L5, S1, S2, S3 primarily.

- Superior and Inferior Gluteal Nerves
- Sciatic Nerve
  - o Tibial
  - o Common Peroneal
- Nerve to the Piriformis

MULTIPLE SPINAL LEVELS: Generally we should know that different movements of the same limb utilize different spinal levels.

- Generally the anterior compartment has a slightly higher spinal level than the posterior compartment, in the lower limb. DERMATOME PATTERN OF LOWER LIMB :
- We almost get a *Barber-Pole Effect* with the different spinal levels as you travel down the lower limb.
- LUMBAR generally covers the anterior leg.
- SACRAL generally covers the posterior leg.

CUTANEOUS INNERVATION OF THIGH and LEG:

- Posterior Femoral Cutaneous Nerve **innervates the posterior thigh.**
  - o It comes directly off the Sacral Plexus.
- **Branches of the Femoral** innervate the anterior thigh.
- **Saphenous Nerve:** Innervates the medial part of the leg and foot.
  - o It comes off the Femoral Nerve.
  - **o It** only travels with the Saphenous Vein in the Leg -- not in the thigh!! **In the thigh, the Saphenous Nerve has a** *different path than the corresponding vein. o It gives* residual innervation to the foot. *If you lose the Tibial Nerve (from the Sciatic), you* won't lose all of your sensation in the foot -- because of the Saphenous.

CLINICAL -- Cutaneous innervation of the *Deep Peroneal Nerve* is assessed at the *web of skin between the first and second toes.* This is a common way to assess lower-damage from an injury.

HERNIATED SPINAL DISKS: Pinching a nerve in the nerve-root of the spinal chord, due to an outward herniation of the **nucleus pulposus** in the spinal column.

THE HIP AND THIGH

THE ILIUM:

External surface of Ileum has three Gluteal lines for the Gluteus muscles, from superior to inferior in the following order: o **Posterior Gluteal Line** o **Anterior Gluteal Line** o **Inferior Gluteal Line**

THE FEMUR :

- **Linea Aspera:** Important ridge on the *posterior surface* of the femur, while the anterior surface is smooth. Hence this is a good way to tell the difference between the two surfaces.
- Greater and Less Trochanter:
  - **o** Intertrochanteric Line **connects them anteriorly. o** Intertrochanteric Spine **connects them posteriorly.**

COLLATERAL CIRCULATION AROUND THE NECK OF THE FEMUR :

- Lateral and Medial Circumflex Femoral Arteries -- **supply the head and neck of the femur.**
  - o As well they supply the **intertrochanteric region,** regions between the greater and lesser trochanter.
- **INTERTROCHANTERIC FRACTURE:** Fracture right across the intertrochanteric line, at the bottom of the neck.
  - o You retain blood supply to the head and the neck of the femur, so this has a good chance of healing.
    - **Head Blood Supply:** Retinacular Arteries
    - Neck Blood Supply: Circumflex Femoral Arteries
- **SUBCAPITAL FRACTURE:** Fracture right beneath the head, at the top of the neck.
  - o You LOSE BLOOD SUPPLY TO THE HEAD, resulting in **Avascular Necrosis (AVN) of the head of the femur!**

Cruciate Anastomosis: In a significant percentage of the population, anastomoses between the following vessels:

o Inferior Gluteals

o 1st perforating branch of the Femoral Profunda artery o Medial and Lateral Femoral Circumflex.

- In the event of a Femoral Artery Occlusion, there will still be some blood supply to the leg, because of this collateral circulation.

ISCHIAL SPINE: Is the bony protuberance that marks the separation between the Greater and Less Sciatic Foramina. ANTERIOR COMPARTMENT OF THE THIGH:

- Action = flexion of thigh and extension of leg.
- Innervation = Femoral Nerve

POSTERIOR COMPARTMENT OF THE THIGH:

- Action = Extension of thigh and flexion of leg
- Innervation = Sciatic Nerve
- CLINICAL -- WHERE TO GIVE A SHOT: The **Upper Outer Quadrant,** which is an *intramuscular injection* into the Gluteus Medius and Minimus.
    - o The object: *avoid the Sciatic nerve*, which is in the lower medial quadrant.
- CLINICAL -- **PULLED HAMSTRINGS** -- A common injury to this area.
    - o Can occur at common origin (ischial tuberosity) or common tendon (medial condyle of tibia, or head of fibula for biceps femoris)

MEDIAL (ADDUCTOR) COMPARTMENT OF THE THIGH:

- Action = Adduction of thigh
- Innervation = Obturator Nerve

QUADRICEPS: These four muscles, which insert on the Quadriceps tendon on the Patella, have a crucial role in knee stability.

GAIT / WALKING / PELVIC TILT:

- When walking, you have to tilt up your pelvis on the side of the body not planted. This involved contraction of *Gluteus Minimus andMedius* muscles.
    - o Slightly Abducting the thigh and medially rotating it.
- **CLINICAL -- GLUTEAL GAIT:** If you lose the superior gluteal nerve, you will no longer be able to list the hip. When walking, this looks like a gluteal gait.
    - o To compensate for this, the leg swings out laterally so that the foot can move forward, so walking kind of looks like a shuffle.
    - o This can be caused by loss of two different nerves:
        - **Superior Gluteal Nerve** (no abduction of thigh)
        - **Obturator Nerve** (no adduction of thigh)

SUPERIOR GLUTEALS: The vein, artery, and nerve travel:

- Superior to the Piriformis muscle.
- *Then* between the gluteus minimus and medius muscles.

FASCIA LATA : The fascia on the thigh is very dense.

- Superior Limit: The Inguinal Ligament and Iliac Crest, it is a continuation of the Transversus Abdominis.
- Inferior Limit: It merges with the Iliotibial Tract, which is around the lateral of the leg.

ILIOTIBIAL TRACT : Inserts onto the tibia, around the lateral aspect of the knee. It is continuous superomedially with the fascia lata.

- When standing upright, it holds the knee in place.

GRACILIS MUSCLE: A GOOD SPARE PART. This weak adductor has a nice nerve and artery that are dispensable and can be grafted to other locations.

N.A.V.E.L.: The order of femoral vessels entering through the obturator foramen into the medial thigh, starting from the ASIS and working inferomedially to the pubic tubercle.

- N: Nerve
- A: Artery
- *V: Vein* -- the femoral nerve is not a part of the femoral sheath, while the others are.
- E: Empty Space
- L: Lacunar Ligament

FEMORAL TRIANGLE: Region of medial thigh, where the **Femoral Sheath** *ends* and lets out the Femoral Artery and Vein.

- Floor of the Femoral Triangle is composed of the following muscles:
- Borders of Femoral Triangle:

- **Sartorius:** Inferior base of triangle
- **Inguinal Ligament:** Superior limit of triangle
- **Adductor Longus:** More or less the lateral limit

- **CLINICAL -- FEMORAL HERNIA:** Abdominal contents can spill through the Femoral Sheath into the Femoral Triangle.
  - How to distinguish it from inguinal hernias: A femoral hernia is completely inferior to the inguinal ligament and lateral to the pubic tubercle.

Femoral Vessels : Travel through the thigh between the anterior and medial compartments in the upper thigh.

Femoral Nerve: Enters the thigh by traveling just deep to the **Inguinal Ligament,** on the anterior surface of the **Psoas Muscle.** This creates a nerve-sandwich!

- This entry-point is just medial to that of the lateral femoral cutaneous nerve.
- **Nerve Entrapment** can occur between the Psoas Muscle and the Inguinal Ligament.

Lateral Femoral Cutaneous Nerve: Enters the thigh by traveling under the **Inguinal Ligament** at the very lateral aspect of the Inguinal Ligament.

- **Nerve Entrapment:** Hence the nerve can get pinched, especially in overweight folks.
- That would result in paresthesia in the lateral region of the thigh.

FEMORAL ARTERY: The continuation of the External Iliac Artery, beyond the Inguinal Ligament.

- BRANCHES
  - **Deep Femoral Artery** -- goes around the posterior side of the knee and hugs the back of the knee joint.
    - Sends 3 **Perforating Branches** to posterior compartment.
    - Gives off **Lateral Circumflex Artery** that anastomoses both at the head of the femur and at the knee (via lateral superior genicular)
  - **Popliteal Artery --** around posterior of knee, gives off three branches:
    - **Anterior Tibial Artery** -- main blood supply down anterior leg
    - **Posterior Tibial Artery** -- main blood supply down posterior leg.
    - **Peroneal Artery** -- it may play a significant role if one of the above is absent or damaged.
  - CLINICAL -- a knee injury around the back of the knee can injure the popliteal artery, but that usually doesn't happen because the popliteal is very deep.
- The Femoral Artery becomes the Popliteal after it has traveled through the **Adductor Hiatus** on the medial distal thigh.
  - **At the same time it pierces the** Adductor Magnus tendon.
- **CLINICAL --** *FEMORAL CATHETER.* The Femoral Artery lies halfway in-between the ASIS and the Pubic Tubercle, as it runs beneath the Inguinal Ligament.
  - *o* This is the location where you would put a catheter into the Femoral Artery. This is a common place to inject dye for arteriographs.
- **CLINICAL --** FEMORAL ARTERY OCCLUSION:
  - Commonly occurs at two points:
    - Just as the Femoral Artery enters anterior thigh under the Inguinal Ligament., at the Femoral Triangle.
    - As the Femoral Artery goes through the Adductor Hiatus, going back into the Popliteal Fossa.

GLUTEAL MUSCLES: The order of muscles below the gluteus maximum and minimum, going from superior to inferior:

- Piriformis
  - *o* Sciatic Nerve comes out right below the Piriformis
- Superior Gemellus
- Obturator Internus
- Inferior Gemellus
- Quadratus Femoris

THE KNEE AND LEG

FIBULA: Lateral, smaller bone.

- The proximal part can be used as a spare part for bone grafts. The Fibula has no articulation at the knee but some articulation at the ankle joint.

TIBIA: Medial, larger bone.

- The anterior part of the tibia has almost no tissue associated with it. So it is the most common place to see an open fracture.

THE KNEE-JOINT : Three groups of ligaments.

- Collateral Ligaments
  - **o** Fibular (lateral) Collateral Ligament **-- longitudinal ligament on lateral aspect of Patella. o** Tibial (medial) Collateral Ligament
- Cruciate Ligaments: They span the **Intercondylar Fossa** and insert onto the **Intercondylar Eminence** of the Tibia. They are crucial to knee stability.
  - **o** Anterior Cruciate Ligament
  - **o** Posterior Cruciate Ligament
- Cartilaginous Ligaments: They provide more articulation space for the condyles of the femur.
  - **o** *Medial Meniscus* does connect to the Tibial (medial) Collateral Ligament
    - So if the Tibial Collateral Ligament is damaged, the Medial Meniscus could easily be damaged with it.
    - o **Lateral Meniscus does not connect to the Fibular (lateral) Collateral Ligament**
- The LATERAL MENISCUS IS MORE MOBILE THAN THE MEDIAL MENISCUS.
  - o The **Popliteus Muscle** (posterior leg) has an insertion between the lateral meniscus and the joint, creating more room on the lateral side.

COLLATERAL CIRCULATION AROUND THE KNEE :

- Superolateral Genicular Artery
  - o Anastomoses with the **Lateral Circumflex Artery,** all the way from the femur.
- Inferolateral Genicular Artery
- Superomedial Genicular Artery
- Inferomedial Genicular Artery

POPLITEAL ARTERY : Posterior artery around the knee, the continuation of the Femoral Artery, right after it passes though the Adductor Hiatus. It is the *basic blood supply to everything below the knee.*

- BRANCHES
  - o **Posterior Tibial Artery:** Comes around the *medial malleolus* (ankle) and perfuses the sole of the foot.
    - CLINICAL -- you can test the integrity of the posterior tibial by palpating for a pulse on the sole of the foot.
  - o **Anterior Tibial Artery:** Comes down through the anterior leg and onto the dorsum of the foot.
    - **Dorsalis Pedis Artery** is the continuation of the Anterior Tibial onto the dorsum of the foot. o **Common Peroneal Artery**
  - o **Sural Artery:** Terminal branches of the Popliteal Artery, supplying the heads of the gastrocs. They are *the exclusive supplier of the Gastrocnemius.*
    - **It contains no collateral circulation.** If you lose your blood supply there, a lot of cramping of the leg will result.
    - It can be affected by a femoral artery occlusion, and it is not necessarily fixed by bypass surgery.

- CLINICAL -- **SUPRACONDYLAR FRACTURE** of the distal femur can harm the popliteal artery.
    - o **Gastrocnemius Muscle** can threaten the popliteal artery at its origin, where it flexes the distal femur. Tearing of the artery would cut blood supply to entire leg essentially.
    - o *A Cast for this fracture should be made with the leg in the flexed position*, so pull from the Gastrocnemius on the femur is minimal.

POPLITEAL VEIN: May **thrombose,** for example, during pregnancy, when the External Iliacs are pinched. The thrombus has potential to break lose and make its way back to the lungs. Not good as usual.

POPLITEAL FOSSA : The area behind the knee.

- Borders:
    - o Lateral border: Biceps Femoris
    - o Medial border: Semimembranosus and semitendinosus muscles. o Inferior border: The lateral and medial head of the gastrocnemius.
- CONTENTS:
    - o The origin of the **Popliteal Artery** and terminus of the **Popliteal Vein**
    - o The **Lesser Saphenous Vein** dumps into the popliteal vein at the Popliteal Fossa.
    - o **Sciatic Nerve** can bifurcate into the Tibial and Common Peroneal as far inferiorly as the popliteal fossa.
- The order of things going through Popliteal Fossa, from medial to lateral
    - o ARTERY (popliteal artery) o VEIN (popliteal vein) o NERVE (sciatic or tibial nerve)

ANTERIOR COMPARTMENT OF THE LEG:

- Action = Dorsiflexion of foot and some extension of digits
- Innervation = Deep Peroneal Nerve

COMMON PERONEAL NERVE:

- You can feel it over the head and neck of the fibula.
- It divides into:
    - **o** Deep Peroneal Nerve **-- Anterior leg o** Superficial Peroneal Nerve **-- Lateral leg**
- CLINICAL -- IT CAN BE INJURED where it lies against the head of the fibula (a fracture of the proximal fibula) or around the lateral knee (the lateral collateral ligament).
    - o The telling sign for this injury is **"foot drop",** resulting from damage to the Deep Peroneal Nerve (anterior compartment -- no dorsiflexion of foot).
    - o You will also **Varus** with this injury, due to injury to the Superficial Peroneal Nerve (lateral compartment -- no eversion of foot)

POSTERIOR COMPARTMENT OF THE LEG:

- Action = Flexion of knee, plantarflexion of foot, some flexion of digits.
- Innervation = Tibial Nerve.
- **Sural artery:** Sole supplier of the Gastrocnemius, and it has no collateral circulation.
- **Sural nerve:** A SPARE PART. It does *not innervate* the gastrocs -- the Tibial Nerve does.
- **Transverse Intermuscular Septum:** Separates the superficial and deep compartments of the posterior leg.
- **Gastrocnemius and Soleus:** Both of these muscles are essential for you to push off when you walk, and to change direction.
    - o They are the primary plantar flexors of the foot -- let you stand on your toes.

LATERAL

COMPARTMENT OF THE LEG:

- Action = eversion of foot
- Innervation = Superficial Peroneal Nerve.
- **JONES' FRACTURE:** Pulling off or breaking a piece of the fibula distally, as often occurs with a sprained ankle.

- This often results in damage to the **Peroneus Brevis** muscle, as its origin is on the fibula, which in turn means no eversion of the leg.

THE ANKLE AND FOOT

THE ANKLE LIGAMENTS

- Lateral Collateral Ligament
  - **o** Anterior and Posterior Talofibular Ligaments **(Talus <====> Fibula)**
  - o **Calcaneofibular Ligament** (Calcaneous <====> Fibula) -- it crosses the Subtalar joint to help support it.
- SPRAINED ANKLE:
  - o Often happens by an *inversion* injury, where the foot is inverted, placing too much pressure on the **Anterior Talofibular Ligament,** which you can sometimes see ball up.
- **Deltoid (Medial) Ligament:** Group of four ligaments composing the medial ankle. Various tibiotarsal ligaments.
- **Transverse Tarsal Joint / Ligament:** aka **Chopart's Joint.** Allows for pronation and supination of the foot. A common point of amputation.
- **LISFRANC'S JOINT: TARSOMETATARSAL JOINT** -- very important joint. Injuries to this area are common.
  - o *Fractures of the* **2nd metatarsal** *are common*, because the 2nd metatarsal is less mobile because it is inset from the 2nd cuneiform.
- Cervical Ligament
- Bifurcate Ligament
- **Long Planter Ligament:** Helps maintain the arch of the foot.
- Calcaneonavicular (Spring) Ligament: **Helps maintain the arch of the foot.**

PLANTAR APONEUROSIS: Similar to the palmar aponeurosis, it keeps the skin on the sole of your foot immobile, so you can walk on it.

- Origin from Calcaneous Tuberosity.
- Inserts on much of the skin of the sole of the foot.

RETINACULA:

- PERONEAL RETINACULUM: **Lateral side of foot**
  - o Contents: Peroneus Longus and Peroneus Brevis tendons. o Continuous with the inferior part of the extensor retinaculum
- EXTENSOR RETINACULUM: **Along dorsum of foot**
  - o It is Y-Shaped, dividing into a superior and inferior portion on the lateral side of the foot. The stem of the Y is on the medial side and is continuous with the Peroneal Retinaculum. o Contents:
    - Extensor Digitorum Longus tendon
    - Extensor Hallucis Longus tendon
    - Peroneus Tertius tendon
    - Dorsalis Pedis Artery **and** Deep Peroneal Nerve **pass underneath.**
- **FLEXOR RETINACULUM:** On the medial side of the foot, from the medial malleolus to the calcaneous. All of the flexor tendons pass through it as they wrap around to the plantar aspect of the foot.
  - o Contents: Tom Dick ANd Harry
    - Tibialis Posterior **tendon**
    - Flexor Digitorum Longus **tendon**
    - Posterior Tibial Artery
    - Posterior Tibial Nerve
    - Flexor Hallucis Longus **tendon**

TARSAL TUNNEL SYNDROME: Similar to Carpal Tunnel syndrome, compression of the **tibial nerve** under the **flexor retinaculum.**

BONES OF THE FOOT :

- **Calcaneous:** The heel. The inferior-most aspect of the foot.
  - o Made primarily of cancellous bone
  - o Has three articular surfaces that articulate with the Talus at the Subtalar joint.
    - Posterior Articular Surface
    - Middle Articular Surface
    - Anterior Articular Surface
- **Talus:** The ankle-region, which articulates with the Tibia.
  - o Articulates with the Tibia, the Fibula, and the Navicular bone.
  - o *There are no blood vessels going to the Talus. There are no muscle attachments to the Talus.* o A lot of the Talus blood supply comes from the **Sinus Tarsi.** o Has three facets that articulate with the Calcaneous
    - Posterior Facet
    - Middle Facet
    - Anterior Facet
- **Tarsal Bones:** The analog to the carpal bones in the wrist:
  - o **Cuboid Bone:** Most lateral, near the 5th digit
  - o **Navicular Bone:** Most medial and proximal, articulating with the Talus and Calcaneous.
    - Most prominent of the Tarsal bones.
    - **It has a palpable** Navicular Tuberosity.
  - o **Lateral, Intermediate, Medial Cuneiform Bones:** Most distal and on the lateral side, articulating with the metatarsals.
- Metatarsal Bones
- Proximal, Middle, Distal Phalanges

ARCHES OF THE FOOT :

- The arches:
  - **o** Medial Longitudinal Arch: **Talus is primary connection here. o** Lateral Longitudinal Arch:
  - o **Transverse Arch:** The **Peroneus Longus Tendon** helps support the Transverse arch of the foot (on the lateral side of the foot).
- What keeps the foot arched?
  - o Shape of the bones o Ligaments o Some muscular support
- Three Plantar Ligaments help to maintain the **Longitudinal Arch:**
  - o **Calcaneonavicular (Spring) Ligament:** Connect navicular bone to the Calcaneus.
  - o **Long and Short Plantar Ligaments:** Along bottom of foot, help to maintain its arch.
- Muscles that help the arch: *Flexor Hallucis Longus Tendon* connects from the heel to the big toe, holding the two ends of the Medial Arch together.
- Flat-Foot Deformity:
  - o The longitudinal arch is lost in some flat-foot deformities.

SUBTALAR JOINT: The joint between the Talus and Calcaneus.

- This joint helps you walk on unlevel ground. It accommodates with eversion and inversion of the hindfoot.
- **Subtalar Arthritis** would prevent a person from being able to walk on unlevel ground easily -- no eversion and inversion of hindfoot.

QUADRATUS PLANTAR MUSCLE (2nd layer): **CLAW-TOE** Deformity results from scarring of this muscle. The Flexor Digitorum longus tendons are just superficial to this muscle, and they will contract with scarring of this muscle.

- This is a common symptom of a *compartment syndrome* in this compartment in the foot.

Master's Knot of Henry : The crossing of the Flexor Digitorum Longus and Flexor Hallucis Longus tendons, on the medial side of the foot.

- The two run together down the medial leg, behind the medial malleolus. After they pass the medial malleolus, they cross.
- **BUNION:** Over-pull and contraction of the Adductor Hallucis (3rd layer) Muscle.'
- First toe bends in medially (in valgus)

- In surgery, bunions are often fixed by releasing the muscle in the first web-space.
- ARTERIES OF THE FOOT
- POSTERIOR TIBIAL ARTERY: Follows the posterior tibial nerve, to supply the plantar aspect of the foot
    - **o** Medial Plantar Artery
    - **o** Lateral Plantar Artery
    - o **PLANTAR ARCH:** Is formed by the medial and lateral plantar arteries.
    - o **Perforating Branches** are sent up *between first and second metatarsals*, to provide anastomosis between posterior tibial and dorsalis pedis arteries.
        - If one of the above arteries is cut off, therefore, you can still get blood supply to the foot.
- ANTERIOR TIBIAL ARTERY: Turns into the Dorsalis Pedis
    - o **Dorsalis Pedis Artery** -- supplies the dorsum of the foot. It passes underneath the extensor retinaculum.
        - This is a good place to feel for pulses, as the artery is very superficial.
        - **Gives off an** Arcuate Artery **which forms a** Dorsal Superficial Arch **and in turn gives off** Dorsal Metatarsal Arteries.
- PERONEAL ARTERY: Normally small, unless one of the above is absent. It normally peters out on top of the calcaneous.

NERVES OF THE FOOT:

- TIBIAL NERVE -- Divides into
    - o **Medial and Lateral Plantar Nerves** -- the primary motor innervation of the foot.
- SAPHENOUS NERVE
- DEEP PERONEAL NERVE
- SUPERFICIAL PERONEAL NERVE
- SURAL NERVE

COMPARTMENTS OF THE FOOT:

- Medial Compartment
- Central Compartment
- Lateral Compartment
- Interosseus Compartment

CLINICAL -- **CALCANEOUS FRACTURES** are common with falls.

- The calcaneous is largely cancellous rather than cortical bone, which makes it subject to breaking.
- Common mode of action: The Talus gets driven inferiorly into the calcaneous.
    - o **Boehler's Angle** = the angle between the calcaneous and talus. It becomes flattened. o Fractures are most common through the Posterior Facet of the Talus.
- If you don't operate you can lose the *height of the foot*, making it so shoes don't fit very well!

LISFRANC (TARSOMETATARSAL) JOINT FRACTURES -- most commonly occur at the 2nd metatarsal bone, because it is inset next to the 2nd cuneiform.

- This is the location of the transverse arch of the foot.
- You can get pain in this fracture because the superficial peroneal nerve is directly dorsal to the joint, too.
- Chronic pain and arthritis is common with this, and the joint must be fixated to restore anatomical normality.

STRESS FRACTURE: A fracture that doesn't result from trauma, but results from fatigue in a bone. The fracture is usually small and/or diffuse.

CLASS DISCUSSION QUESTIONS

VENOUS DRAINAGE & FASCIA LATA

1. True about venous drainage of lowerlimb is
   A. Great saphaneous represent the post axial vein of lowerlimb
   B. Great saphaneous vein is accompained by saphenous nerve
   C. The anteromedial vein is sometimes called accessory saphenous vein
   D. None of above

2. False of the following
   A. Iliotibial tract is a modification of deep fascia
   B. Iliotibial tract is attached to Gerdy's tubercle
   C. Upper end of the tract splits to enclose Gluteus medius
   D. Blends with aponeurotic expansion of vastus lateralis

FEMORAL TRIANGLE

3. Floor of femoral triangle is not formed by
   A. Iliacus
   B. Psoas major
   C. Pectineus
   D. Adductor brevis

4. The branch of femoral artery that does not pierce cribriform fascia is
   A. Superficial epigastric
   B. Superficial circumflex iliac zartery
   C. Superficial external pudental
   D. None of above

5. Arteria comitans nervi ischiadici is a branch of
   A. Femoral artery
   B. Profunda femoris
   C. Popliteal artery
   D. Internal iliac artery

6. True about femoral sheath is
   A. Anterior wall is formed by fascia iliaca
   B. Posterior wall is formed by fascia transversalis
   C. Femoral sheath is shorter in newborn
   D. Both A & B

7. The Branches of femoral nerve are all except
   A. Medial femoral cutaneous nerve
   B. Lateral femoral cutaneous nerve
   C. Intermediate femoral cutaneous
   D. Saphaneous nerve

ADDUCTOR TRIANGLE

8. The contents of adductor canal are all except
   A. Femoral vein
   B. Phaneous nerve
   C. Posterior division of Obturator nerve
   D. Nerve to vastus lateralis

OBTURATOR & FEMORAL NERVES

9. True of the following
   A. Posterior division of obturator nerve supply hipjoint
   B. Posterior division of obturator nerve pierces oblique popliteal ligament
   C. obturator nerve is formed by ventral branches of ventral rami of L3,L4,L5
   D. All the above

10. Subsartorial plexus is not formed by
   A. Saphaneous nerve
   B. Medial femoral cutaneous nerve
   C. Ant.division of obturator nerve
   D. Lateral femoral cutaneous nerve

11. The extracapsular "arterial ring of femoral neck" is formed by
   A. Trochantric anastomosis
   B. Cruciate anastomosis
   C. Anastomosis around back of thigh
   D. None of above

POPLITEAL FOSSA

12. Floor of popliteal fossa is formed which of the following
   A. Oblique popliteal ligament
   B. Fibular collateral ligament
   C. Tibial collateral ligament
   D. Popliteal fascia

MUSCLES –GLUTEAL REGION

13. The positive Trendelenberg sign is associated with injuries to which of the following
   A. Piriforms
   B. Adductors
   C. Abductors of thigh
   D. Hamstrings

14. Which of the following muscle is a part of triceps coxa
   A. Obturator externus
   B. Gemelli muscle
   C. Gluteus medius
   D. Piriformis

15. Piriformis syndrome involve which of the following nerves
   A. Femoral nerve
   B. Sciatic nerve
   C. Ilioinguinal nerve
   D. Obturator nerve

JOINTS & LIGAMENTS

16. The following genicular branch supply the cruciate ligaments
   A. Femoral artery
   B. Popliteal artery
   C. Anterior recurrent branch of anterior tibial recurrent
   D. Posterior recurrent branch of anterior tibial recurrent

17. False about cruciate ligament is
   A. Congenital absence of anterior cruciate ligament is Rare
   B. Posterior cruciate ligament ruptures less commonly than anterior cruciate ligament
   C. Anterior cruciate ligament is stronger than Posterior cruciate ligaments

D. None of above

18. Ligament of wrisberg & Ligament of humphry belong to
   A. Ankle joint
   B. Knee joint
   C. Hip joint
   D. Small joints of foot

19. Find the odd match
   A. Deep peronel nerve-Lateral compartment
   B. Superficial peroneal nerve-posterior compartment
   C. Tibial nerve-anterior comparment
   D. All the above

20. All the following are lateral rotators except
   A. Obturator externus
   B. Superior gemelli
   C. Piriformis
   D. Gluteus minimus

21. Which of the following three ligaments are injured in "unhappy triad" of knee injuries
   A. ACL,Tibial collateral ,Medial meniscus
   B. PCL,Fibular Collateral ,Lateral meniscus
   C. ACL,Fibular Collateral, Medial meniscus
   D. PCL, Tibial Collatteral,Medial Meniscus

22. The oblique popliteal ligament is an expansion of
   A. Semitendinosus
   B. Semimembranous
   C. Popliteus
   D. Plantaris

23. Hallux saltans due to
   A. Thickening of tendon of FDL
   B. Thickening of tendon of FHB
   C. Thickening of tendon of FHL
   D. Thickening of tendon of EDL

24. The hyperextension of hip joint during standing is prevented by
   A. Iliofemoral
   B. Ischiofemoral
   C. Pubofemoral
   D. Ligament of Head of femur

MUSCLES OF LEG

25. Which of the following is a powerful push off muscle
   A. Gastronemius
   B. Soleus
   C. Plantaris
   D. Flexor hallucis longus

26. Nervus hesitans refers to
   A. Superficial Fibular nerve
   B. Deep Fibular nerve
   C. Medial Plantar nerve
   D. Lateral Plantar nerve

27. True about Popliteus is
    A. Supplied by tibial nerve
    B. Nerve to popliteus supply tibialis anterior
    C. Nerve to Popliteus supply inferior tibiofibular joint
    D. Nerve to popliteus gives a medullary branch to tibia

28. Artery of Tarsal Canal is a branch of
    A. Anterior tibial artery
    B. Posterior tibial artery
    C. Dorsalis pedis
    D. Popliteal artery

29. The process of unlocking of extended knee in prepration for flexion requires initial contraction of
    A. Gastronemius, soleus, Plantaris
    B. Quadriceps femoris
    C. Hamstrings
    D. Popliteus

30. A pulse in the dorsalis pedis artery may be palpated in which of the following ways?
    A. Between the tendons of the extensor digitorum longus and fibularis (peroneus) tertius muscles
    B. Between the tendons of the extensor hallucis and extensor digitorum muscles
    C. Between the tendons of the tibialis anterior and extensor hallucis longus muscles
    D. Immediately anterior to the lateral malleolus.

31. Corona mortis refers to
    A. Vascular anastomosis between femoral and popliteal artery
    B. Nervous arcade between femoral & saphaneous
    C. Vascular anastomosis between obturator & external iliac
    D. Nervous arcade between superficial and deep peronel nerves

32. Nutrient artery of tibia is a branch of
    A. A.Posterior tibial artery
    B. Anterior tibial artery
    C. C.Popliteal artery
    D. D.Peroneal artery

ARCHES OF FOOT

33. Jack great toe test is for
    A. Knee joint
    B. Hip joint
    C. Ankle joint
    D. Arch of foot

34. LISFRANC LIGAMENT is
    A. Intermetatarsal ligament
    B. Interosseous cuneometatarsal ligament
    C. Plantar ligament
    D. Palmar ligament

SCIATIC NERVE-DEEP PERONEAL & COMMON PERONEAL NERVES

35. Medial plantar nerve does not supply
    A. Abductor hallucis
    B. Adductor hallucis
    C. First Lumbricals
    D. Flexor digitorum brevis

36. All the following structures pass deep to the flexor retinaculum
   A. Tibialis posterior
   B. Flexor digitorum longus
   C. Posterior tibial artery
   D. Flexor hallucis brevis

38. The strongest dorsiflexor of foot is
   A. Tibialis anterior
   B. Fibularis tertius
   C. Extensor digitorum longus
   D. Gastronemius

38. You have examined a patient and find there is weakness in the ability to flex the knee. This indicates a problem with which of the following nerves?
   A. Femoral nerve
   B. Tibial nerve
   C. Common fibular nerve
   D. Deep fibular nerve

39. Your patient has sustained an external force to the knee. Which of the following ligaments has prevented abduction of the leg at the knee?
   A. Anterior cruciate
   B. Posterior cruciate
   C. Lateral collateral
   D. Medial collateral

40. During an abdominal hysterectomy for a cancerous uterus, the obturator nerve was accidentally severed. This resulted in the patient losing which of the following actions?
   A. Extension of the leg at the knee
   B. Extension of the thigh at the hip
   C. Adduction of the thigh at the hip
   D. Flexion of the leg at the knee

41. A patient comes to you complaining of his inability to stand on his tip toes. Which of the following nerve injuries is most likely to be involved?
   A. Femoral nerve
   B. Tibial nerve
   C. Common fibular nerve
   D. Deep fibular nerve

42. A 32-year-old woman is brought into the emergency department, because she is unable to evert her foot at the ankle. Which of the following nerve injuries is most likely to be involved?
   A. Femoral nerve
   B. Obturator nerve
   C. Tibial nerve
   D. Deep fibular nerve

43. A 54-year-old man has just dislocated his right hip. The physician is concerned about the integrity of the joint's blood supply. Which artery is the main blood supply to the hip joint?
   A. Lateral circumflex femoral
   B. Medial circumflex femoral
   C. Superficial circumflex iliac
   D. Deep circumflex iliac

44. In a patient who has a posterior dislocation of the hip, which of the following ligamentous structures would be torn?

A. Pubofemoral ligament
B. Iliofemoral ligament
C. Ischiofemoral ligament
D. Lacunar ligament

45. A patient with the hip dislocation is also exhibiting weakness of exten sion of the thigh at the hip. This would indicate possible damage to which of the following?

A. Femoral nerve
B. Obturator nerve
C. Common fibular portion of the sciatic nerve
D. Tibial portion of the sciatic nerve

46. As an orthopedic surgeon is operating in the posterior compartment of the thigh, care is taken to preserve the arterial blood supply to the muscles in that region. These are branches of which of the following arteries?

A. Deep femoral artery
B. Femoral artery
C. Superior gluteal artery
D. Inferior gluteal artery

47.A patient has sustained lower limb trauma that has damaged the posterior tibial artery. Therefore, you will be concerned about the blood supply to which of the following?

A. Posterior thigh only
B. Lateral compartment of the leg only
C. Posterior compartment of the leg only
D. Calf & Sole of the foot only

48. Which are the chief deep veins of the leg that are of concern for DVT?

A. Small saphenous vein
B. Great saphenous vein
C. Deep femoral vein
D. Anterior and posterior tibial veins

49. You are concerned that your patient's medial deltoid ligament may have been torn from its proximal attachment. Which of the following would you palpate for tenderness?

A. The medial aspect of the tibial shaft
B. The lateral aspect of the fibular shaft
C. The lateral malleolus
D. The medial malleolus

50. When will a patient's ankle joint have the greatest stability?

A. When the knee is flexed
B. When the foot is dorsiflexed
C. When the foot is plantarflexed
D. When the foot is everted

51.A thoracic surgeon is going to harvest a portion of the greater saphenous vein for coronary bypass surgery. He has observed that this vein runs:

A. Posterior to the medial malleolus
B. Into the Popliteal vein
C. Anterior to the medial condyles of the tibia and femur
D. Superficial to the fascia lata of the thigh
E. Along with the femoral artery

52.A construction worker falls feet first from a roof. He sustains a fracture of the groove on the undersurface of the sustentaculum tali of the calcaneus bone. Which of the following muscle tendons is most likely torn?

A. Flexor digitorum brevis
B. Flexor digitorum longus
C. Flexor hallucis brevis
D. Flexor hallucis longus

53.A 21-year-old man was involved in a motorcycle accident, resulting in destruction of the groove in the lower surface of the cuboid bone. Which of the following muscle tendons is most likely damaged?

A. Flexor hallucis longus
B. Peroneus brevis
C. Peroneus longus
D. Tibialis anterior

54.A 32-year-old carpenter fell from the roof. The lateral longitudinal arch of his foot was flattened from fracture and displacement of the keystone for the arch. Which of the following bones is damaged?

A. Calcaneus
B. Cuboid bone
C. Head of the talus
D. Medial cuneiform

55.A 14-year-old gymnastic silver medalist falls from the parallel bar and complains of pains from the knee and ankle joints. On physical examination, her physician found that the muscle responsible for flexing the leg at the knee joint and plantar flexing the foot is severely weakened. Which of the following muscles involved in both movements was most likely damaged in this accident?

A. Tibialis posterior
B. Gastrocnemius
C. Soleus
D. Peroneus longus

ANSWERS & DISCUSSION

1.B

Superficial Veins

The superficial veins of the leg are the great and small saphenous veins and their tributaries. They are of great clinical importance.

The great saphenous vein drains the medial end of the dorsal venous arch of the foot and passes upward directly in front of the medial malleolus. It then ascends in company with the saphenous nerve in the superficial fascia over the medial side of the leg. The vein passes behind the knee and curves forward around the medial side of the thigh. It passes through the lower part of the saphenous opening in the deep fascia and joins the femoral vein about 1.5 in. (4cm) below and lateral to the pubic tubercle.

The great saphenous vein possesses numerous valves and is connected to the small saphenous vein by one or two branches that pass behind the knee. Several perforating veins connect the great saphenous vein with the deep veins along the medial side of the calf .At the saphenous opening in the deep fascia, the great saphenous vein usually receives three tributaries that are variable in size and arrangement: the superficial circumflex iliac vein, the superficial epigastric vein, and the superficial external pudendal vein. These veins correspond with the three branches of the femoral artery found in this region.

An additional vein, known as the accessory vein, usually joins the main vein about the middle of the thigh or higher up at the saphenous opening.

2.C

The ‘fascial skeleton' (deep fascia) of the lower limb is well-defined and forms a tough circumferential ‘stocking-like' structure that constrains the musculature. Septa pass from the deep surface of this fascial sheath to the bones within, confining the functional muscle groups within osteofascial compartments. The tough fascia gives additional areas of attachment to the muscles and ensures that they work to maximal effect. Thickenings in the ensheathing layer may act as additional tendons (e.g. iliotibial tract). Elsewhere, thickenings in the fascial skeleton form fibrous retinacula where tendons cross joints. Although they are particularly prominent in the embalmed cadaver, these fascial layers are also readily demonstrable in the living, and are of considerable functional significance.

3.D

The floor of triangle is formed by iliacus,psoas major,pectineus and adductor longus

4.B

Superficial epigastric artery

The superficial epigastric artery arises anteriorly from the femoral artery approximately 1 cm distal to the inguinal ligament and traverses the cribriform fascia to ascend anterior to the ligament and run in the abdominal superficial fascia almost to the umbilicus. It supplies the superficial inguinal lymph nodes and superficial fascia and skin, and anastomoses with branches of the inferior epigastric artery and its contralateral fellow.

Superficial circumflex iliac artery

The superficial circumflex iliac artery is the smallest superficial branch of the femoral artery and arises near or with the superficial epigastric artery. It usually emerges through the fascia lata, lateral to the saphenous opening, and turns laterally distal to the inguinal ligament towards the anterior superior iliac spine. It supplies the skin, superficial fascia and superficial inguinal lymph nodes, anastomosing with the deep circumflex iliac, superior gluteal and lateral circumflex femoral arteries. The superficial circumflex iliac artery is the basis for the important axial-pattern pedicled groin skin flap. Free flaps based on the vessel may also be raised.

Superficial external pudendal artery

The superficial external pudendal artery arises medially from the femoral artery, close to the preceding branches. Emerging from the cribriform fascia, it passes medially, usually deep to the long saphenous vein, across the spermatic cord (or round ligament) to supply the lower abdominal, penile, scrotal or labial skin, and anastomoses with branches of the internal pudendal artery.

5.D

- Arteria comitans nervi ischiadici (artery to sciatic nerve)

The arteria comitans nervi ischiadici is a branch of the internal iliac artery, and runs on the surface of, or within, the sciatic nerve. It represents the primitive axial artery of the lower limb. The artery is usually a very small vessel; occasionally it persists as a large vessel, in which case the femoral artery is correspondingly reduced in size. The artery may participate in collateral circulatory pathways.

6.C

The femoral sheath is a funnel-shaped distal prolongation of extraperitoneal fascia, formed of transversalis fascia anterior to the femoral vessels, and of the iliac fascia posteriorly. It is wider proximally and its tapered distal end fuses with the vascular adventitia 3 or 4 cm distal to the inguinal ligament. At birth the sheath is shorter; it elongates when extension at the hips becomes habitual. The femoral branch of the genitofemoral nerve perforates its lateral wall. The medial wall slopes laterally and is pierced by the long (great) saphenous vein and lymphatic vessels. Like the carotid sheath, the femoral sheath encloses a mass of connective tissue in which the vessels are embedded. Three compartments are described: a lateral one containing the femoral artery, an intermediate one for the femoral vein, and a medial compartment, the femoral canal, which contains lymph vessels and an occasional lymph node embedded in areolar tissue.

7.B

Lateral cutaneous nerve of the thigh.

The lateral cutaneous nerve of the thigh arises from the dorsal branches of the second and third lumbar ventral rami and emerges from the lateral border of psoas major, crossing the iliacus obliquely towards the anterior superior iliac spine

8.D

The adductor canal (Hunter's canal; subsartorial canal) is a trough-shaped intermuscular tunnel occupying the distal two-thirds of the medial aspect of the thigh (Fig. 80.2). It starts at the apex of the femoral triangle and extends distally as far as the distal attachment of the tendon of adductor magnus. It is triangular in section, and is bounded anterolaterally by vastus medialis, posteromedially by adductor longus, and distal to adductor longus, by adductor magnus. Its anteromedial boundary (often referred to as the roof) is a strong and dense fascia that extends from the medial surface of vastus medialis to the medial edge of the adductors longus and magnus, overlapping in its stride, the femoral vessels in the adductor canal. This fascia, on account of being overlain by sartorius, is termed the subsartorial fascia.

The adductor canal contains the femoral artery and vein, the descending genicular and muscular branches of the femoral artery and their corresponding venous tributaries, the saphenous nerve, and the nerve to vastus medialis (until it enters its muscle). The femoral vessels pass from the adductor canal into the popliteal fossa via the adductor hiatus, an opening in the tendon of adductor magnus adjacent to the femoral shaft, two-thirds of the way down the adductor canal

9.D

Obturator nerve

The obturator nerve arises from the ventral branches of the second to fourth lumbar ventral rami. The branch from the third is the largest while that from the second is often very small. It then descends forwards along the lateral wall of the lesser pelvis on obturator internus, anterosuperior to the obturator vessels, to the obturator foramen, entering the thigh by its upper part. Near the foramen it divides into anterior and posterior branches, separated at first by part of obturator externus and lower down by adductor brevis.

10.D

- Subsartorial nerve plexus
- The medial cutaneous nerve of the thigh forms a subsartorial plexus with branches of the saphenous and obturator nerves, deep to the fascia lata, at the lower border of adductor longus. When the communicating branch of the obturator nerve is large and reaches the leg, the posterior branch of the medial cutaneous nerve is small, and ends in the plexus from which it gives rise to a few cutaneous filaments.

11.A

- Trochanteric anastomosis
- The trochanteric anastomosis lies near the trochanteric fossa of the femur and is an anastomosis between the ascending branch of the medial circumflex femoral artery and descending branches of the superior and inferior gluteal arteries. The lateral circumflex femoral artery and the first perforating artery from the profunda may also contribute, creating an extracapsular 'arterial ring of the femoral neck'. Branches from this ring, the retinacular vessels, pierce the capsule and ascend along the femoral neck to give the main blood supply to the head of the femur.

12.A

- Popliteal fossa
- The popliteal fossa is a narrow intermuscular space posterior to the knee joint, with a diamond-shaped outline that is rendered more apparent when its boundaries are artificially separated during dissection. The boundaries are biceps femoris proximolaterally; semimembranosus and the overlying semitendinosus proximomedially; the lateral head of gastrocnemius with the underlying plantaris distolaterally, and the medial head of gastrocnemius distomedially. The anterior boundary (or Floor) of the fossa is formed, in proximodistal sequence, by the popliteal surface of the femur, the oblique popliteal ligament (overlying the posterior surface of the capsule of the knee joint), and the posterior aspect of the proximal tibia covered by popliteus and the fascia overlying popliteus. The fossa is covered posteriorly by the popliteal fascia, which is referred to as the roof of the fossa. The popliteal fascia is continuous with the fascia lata proximally and with the fascia cruris distally. It is a dense layer that is strongly reinforced by transverse fibres and is often perforated by the short saphenous vein and sural nerve; these two structures are useful landmarks in the direct posterior approach to the knee joint.

13.C

The supportive effect of the glutei (medius and minimus) on the pelvis when the contralateral foot is raised depends on the following conditions. The two muscles, and their innervation, must be functioning normally. The components of the hip joint, which forms the fulcrum, must be in their usual relation. The neck of the femur must be intact, with its normal angulation to the shaft. When any one of these conditions is not fulfilled, e.g. in paralysis of the glutei, congenital dislocation of the hip, or coxa vara, the supporting mechanism is upset and the pelvis sinks on the unsupported side when the patient tries to stand on the affected limb. This is known clinically as Trendelenburg's sign. Individuals with paralysis of gluteus medius and minimus have a characteristic lurching gait. Provided that these two muscles are intact, paralysis of other muscles acting on the hip joint produces remarkably little deficit in walking, or even in running

14.B

- The obturator internus, Superior & inferior Gemelli form tricepital tendon called triceps coxa.

15.B

- Structures emerging from upper border of piriformis

Superior Gluteal nerves & vessels

- Structures emerging lower border of piriformis

Sciatic nerve
Post.femoral cutaneous nerve
Inferior gluteal nerve & vessels
Nerve to obturator internus
Internal pudendal vessels
Pudendal nerve

16.B

- Middle genicular artery
- The middle genicular artery is small. It arises from the popliteal artery near the midpoint of the posterior aspect of the knee joint. It pierces the oblique popliteal ligament to supply the cruciate ligaments and synovial membrane.

17.C

- Anterior cruciate ligament
- The anterior cruciate ligament is attached to the anterior intercondylar area of the tibia, just anterior and slightly lateral to the medial tibial eminence, partly blending with the anterior horn of the lateral meniscus. It ascends posterolaterally, twisting on itself and fanning out to attach high on the posteromedial aspect of the lateral femoral condyle. The average length and width of an adult anterior cruciate ligament are 38 mm and 11 mm respectively. It is formed of two, or possibly three, functional bundles that are not apparent to the naked eye, but can be demonstrated by microdissection techniques. The bundles are named anteromedial, intermediate, and posterolateral, according to their tibial attachments.
- Absent anterior cruciate ligament
- Congenital absence of the anterior cruciate ligament is rare. The condition is usually associated with lower limb dysplasia, and may be a cause of instability of the knee.
- Posterior cruciate ligament
- The posterior cruciate ligament is thicker and stronger than the anterior cruciate ligament, the average length and width of an adult posterior cruciate ligament being 38 mm and 13 mm respectively.

18.B

- Meniscofemoral ligaments
- The two meniscofemoral ligaments (MFLs) connect the posterior horn of the lateral meniscus to the inner (lateral) aspect of the medial femoral condyle. The anterior MFL (aMFL; ligament of Humphry) passes anterior to the posterior cruciate ligament. The posterior MFL (pMFL; ligament of Wrisberg) passes behind the posterior cruciate ligament and attaches proximal to the margin of attachment of the posterior cruciate

19.D

- The nerve supply of the muscles in the compartments follows the ‘one compartment – one nerve‘principle: the deep fibular nerve supplies the anterior compartment, the superficial fibular nerve supplies the lateral compartment, and the tibial nerve supplies the posterior compartment. Most of the muscles in the anterior compartment are supplied by the anterior tibial artery, with an additional contribution from the fibular artery to extensor hallucis longus. Muscles in the posterior compartment are supplied by the popliteal, posterior tibial and fibular arteries. Muscles in the lateral compartment are supplied by the anterior tibial and fibular arteries and to a small extent proximally by a branch from the popliteal system.

20.D

Medial rotators of the hip joint include anterior fibers of the gluteus medius, gluteus minimus, and tensor fascia lata; lateral rotators include the obturator externus, obturator internus, superior gemellus, piriformis, quadratus femoris, and gluteus maximus

21.A

- ACL may tear when tibial collateral ligament is ruptured .First the Tibial Collateral ligament ruptures opening the joint on medial side possibily tearing Medial meniscus and ACL

22.B

The oblique popliteal ligament is an expansion of semimembranous

23.C

- Hallux saltans is due to thickening of tendon of FHL

24.A

- Iliofemoral ligament
- The iliofemoral ligament is very strong and shaped like an inverted Y, lying anteriorly and intimately blended with the capsule. Its apex is attached between the anterior inferior iliac spine and acetabular rim, its base to the intertrochanteric line. Fuss & Bacher describe a relatively weaker central portion, the greater iliofemoral ligament, with thicker and stronger marginal portions which they refer to as the lateral and medial iliofemoral ligaments. The obliquely

disposed lateral ligament is attached to a tubercle at the superolateral end of the intertrochanteric line, while the vertically oriented medial ligament reaches the inferomedial end of the line.

25..D

- FHL is a powerful push off muscle during walking,Running
- Muscle called “beef to calf”

26.B

Deep fibular nerve is called nervus hesitans

27.B

The nerve to popliteus supplies popliteus, tibialis posterior.

28.B

The artery of tarsal canal is a branch of posterior tibial artery

29.D

Conjunct medial rotation of the femur on the tibia in the later stages of extension is part of a ‘locking' mechanism, the so-called ‘screw-home movement', which is an asset when the fully extended knees are subjected to strain.

Full extension results in the close-packed position, with maximal spiralization and tightening of the ligaments. The roles of the articular surfaces, musculature and ligaments in generating conjunct rotations remain controversial, but the following points can be made. The lateral combined meniscotibial ‘receiving surface' is smaller, more circular and more deeply concave. Since the articular surface is virtually convex in sagittal section the depth of the receiving surface is largely due to the presence of the lateral meniscus. The lateral femoral articular surface is also smaller. Consequently, the lateral femoral condyle approaches full congruence with the opposed surface some 30° before full extension (well before the medial condyle). Simple extension cannot continue, but medial rotation of the femur occurs on a vertical axis through its head and medial condyle: the medial femoral condyle moves very little in the sagittal plane and is stabilized by the ‘upslope' of the anterior half of the medial tibia, while rotation of the lateral femoral condyle and meniscus brings the anterior horn of the latter onto the anterior ‘downslope' of the lateral tibial condyle. Rotation and extension follow simultaneously and smoothly until final close packing of both condyles is accomplished. At the beginning of flexion from full extension (with the foot fixed) lateral femoral rotation occurs, which ‘unlocks' the joint. While joint surfaces and many ligaments are involved, electromyographic evidence reveals that contraction of popliteus is important, and that it pulls down and backwards on the lateral femoral condyle, lateral to the axis of femoral rotation. It also retracts the posterior horn during lateral rotation and continuing flexion, via its attachment to the lateral meniscus, and so prevents traumatic compression.

30.B

- The dorsal pedal artery, a continuation of the anterior tibial artery, passes onto the dorsum of the foot between the tendons of the extensor hallucis longus and extensor digitorum longus muscles. The dorsal pedal pulse may be palpated here before the artery passes beneath the extensor hallucis brevis muscle. The posterior tibial artery passes behind the medial malleolus, where the posterior tibial pulse is normally palpable..

31.C

It is a vascular anastamosis between obturator and external iliac system.It is called crown of death.

32.A

Nutrient artery of tibia is a branch of posterior tibial artery.
It is one of the largest nutrient artery that enter tibia below the soleal line.

33.D

- Dorsiflexion, especially of the hallux, draws the two pillars together, thus heightening the arch: the so-called ‘windlass' mechanismThe term pes planus denotes an excessively flat foot. There is no

precise degree of flatness that defines pes planus, but it may be either physiological or pathological. In physiological pes planus, the feet are flexible and rarely problematic. In marked contrast, pathological pes planus is often associated with stiffness and pain.

- The windlass (or 'Jack's great toe') test involves passively dorsiflexing the hallux at the metatarsophalangeal joint. This tightens the plantar aponeurosis and, in flexible pes planus, results in accentuation of the medial longitudinal arch. In pathological pes planus, no accentuation of the arch is seen. This test can also be carried out by asking the individual to stand on tiptoe and viewing the hindfoot from behind.

34.B

- Interosseous cuneometatarsal ligaments
- There are three interosseous cuneometatarsal ligaments. One (the strongest) passes from the lateral surface of the medial cuneiform to the adjacent angle of the second metatarsal. Known as Lisfranc's ligament, it is crucial to the stability of the tarsometatarsal joint complex. Disruption of this ligament can lead to instability and deformity and subsequent Degenerative changes. A second ligament connects the lateral cuneiform to the adjacent angle of the second metatarsal: it does not divide the joint between the second metatarsal and lateral cuneiform and is inconstant. A third ligament connects the lateral angle of the lateral cuneiform to the adjacent fourth metatarsal base.

35.A

- Medial plantar nerve supply-abductor hallucis,flexor digitorum brevis,flexor hallucis brevis , first lmbricals

36.D

The structures passing deep to flexor retinaculm:
Tibialis posterior
FHL
FDL
Posterior tibial artery
Tibial nerve

37.A

- Dorsiflexor-tibialis anterior,EDL,EHL,PT
- Plantar flexion-gastronemius,soleus,TP,FDL,FHL,PL &PB

38.B

- The muscles that flex the knee are innervated by the tibial portion of the sciatic nerve.

39.D

- Abduction of the leg at the knee is limited by the medial or tibial collateral ligament

40.C

- The obturator nerve innervates the muscles of the medial compartment of the thigh which adduct the thigh at the hip

41.B

The plantarflexors are located in the posterior compartment of the leg and innervated by the tibial nerve.

42.D

- The muscles of the lateral compartment of the leg evert the foot and are innervated by the superficial fibular nerve.

43.B

- The chief blood supply to the hip is the medial circumflex femoral artery.

44.C

- Posterior dislocation of the hip would tear the ischiofemoral ligament, which reinforces the capsule of the hip posteriorly.

45.D

Most of the extensor muscles of the hip (the hamstrings) are innervated by the tibial portion of the sciatic nerve. The gluteus maximus muscle, innervated by the inferior gluteal nerve, could still weakly extend the thigh at the hip.

46.A

- The blood supply to the posterior compartment of the thigh is from perforating branches of the deep femoral artery

47.D

- The posterior tibial artery provides the blood supply to the calf and sole of the foot

48.D

- The deep veins of the leg are the anterior and posterior tibial veins that accompany the arteries of the same name

49.D

The four components of the deltoid ligament arise from the medial malleolus.

50.B

- The talocrural or ankle joint proper has the greatest stability in dorsiflexion.

51.D

GSV ascends superficial to fascia lata.

52.D

FHL First occupies the groove of talus and then the undersurface of sustentaculum tali.

53.C

The groove on lowersurface of cuboid is occupied by peroneus longus tendon.

54.B

The KEY stone of lateral longitudinal arch is cuboid.

55.B

He gastronemius can flex the knee joint and also plantar flex the foot .
Tibialis posterior can plantar flex and invert foot
Peroneus longus can plantar flex and evert foot

THORAX

STERNAL ANGLE: The junction between the Manubrium and the Sternum body.

- At the level of T4 and T5 posteriorly.
- Anteriorly, it articulates with the 2nd Costal Cartilage.
- The **Bifurcation of the Trachea** occurs directly posterior to the Sternal Angle.

SUPERIOR MEDIASTINUM: Defined as the region of the thorax above the sternal angle (above T4-T5).

- Contains the Aortic Arches and the Thymus.

INFERIOR MEDIASTINUM: Defined as the region of the thorax below the Sternal Angle. Divided into Anterior, Middle, and Posterior Mediastinum.

- Middle Mediastinum: The pericardial sac, holding the heart.
- Posterior Mediastinum: The esophagus and trachea.
- Anterior Mediastinum: Not much is there.

THE MID-AXIAL LINE: The side of the thorax. The line running from the armpits to the hips.

THE SUPERIOR THORACIC APERTURE: Surrounded by the clavicle, the superior border of the thorax, above which is the base of the neck.

THE BORDERS OF THE THORAX:

- Superior Border: Superior Thoracic Aperture.
- Inferior Border: Diaphragm.
- Anterior Border: The sternum.
- Posterior Border: Thoracic Vertebrata, T1-T12
- Lateral Border: Mid-Axial Line.

THE RIBS:

- They articulate with the Thoracic Vertebrata. As they come anteriorly, they move inferiorly and then stop. Then, the **Costal Cartilage** comes back a little superiorly.
  - o That means, in the back along the spinal column, the level is *up higher* than the same level in the front along the sternum.
- **True Ribs:** T1-T7. They have their own Costal Cartilage on the anterior side.
- **False Ribs:** T8-T10. They all share one common costal cartilage (which mends into each other)
- **Floating Ribs:** T11 and T12. They have no Costal Cartilage.
- 1st Rib:
  - o It has no angle.
  - o It is the shortest and flattest of all ribs. o It has grooves for the subclavian veins and arteries.

COMPONENTS OF A RIB:

- **Head:** Connected to the Vertebrata.
- Neck
- **Tubercle:** Contains the **articular facet,** which articulates with the **transverse process** of the vertebrata.
- Angle
- **Shaft,** containing the Costal Groove.
- **Costochondral Joint:** The joint where bone ends and cartilage begins. The bone extends anteroinferiorly, whereas the cartilage extends back posterosuperiorly.
- **Costal Groove:** Groove for intercostal arteries, veins, and nerves, on inferior aspect.

COMPONENTS OF THORACIC VERTEBRATA:

- The **body** is the anterior portion of Thoracic Vertebrae.
- The **Spinous Process** articulates posteriorly.
- The **Transverse Process** articulates laterally and contains the facet for each rib, at the **costovertebral joint.**
- The **Pedicle** is the short, thicker section that connects the transverse process to the body.

- The **Lamina** is the longer, thinner section that connects each transverse process to the spinous process.

THE BREAST

BREASTS / MAMMARY GLANDS:

- **Cooper's Ligaments:** Suspensory Ligaments, or connective tissue that connects the skin to the underlying fat.
- **Lactiferous Sinuses:** Place where the milk is stored.
  - o Deep to the areola.
  - o The dilated portion of the lactiferous ducts.
- **Lactiferous Ducts:** The ducts into which milk is secreted. Directly deep to the nipple.
- **Areola:** Darkened region around nipple. Appears lighter in women who have not born a child.
  - o Contains sebaceous glands which secrete protective substance (not milk) during pregnancy.
- **Mammary Glands:** Lobules of glandular tissue which arise from the lactiferous ducts. Any deep tissue that is not fatty is the glandular stuff.

BREAST CARCINOMA: Lymphatic drainage of the breast explains the danger of breast cancer.

- **Principle Axillary Lymph Node** (in region of armpit) takes about 75% of lymph drainage from breast.
- Path of this node: Axillary Lymph Node -----> Subclavian Trunk ----- > Jugular Vein. Hence cancer can easily metastasize to all parts of the body from the breast.

MUSCULATURE OF THE THORAX

Muscles Associated with Movement of Arm and Neck: These muscles are relevant to movement of upper limbs.

- **Pectoralis Major:** Most anterior portion.
- **Pectoralis Minor:** Deep to pectoralis majora.
- Scalenus Muscles

Muscles of the Thorax Proper: All of these muscles are associated with respiration.

- **Serratus Posterior** (Outer Muscles): Originate from the vertebrata and insert on the ribs on the posterior.
  - o **Serratus Posterior Superior:** Insert on superior ribs posteriorly. When they contract, they raise the ribs.
  - o **Serratus Posterior Inferior:** Insert on inferior ribs posteriorly. When they contract, they lower the ribs.
    - Inserts on the anterior surface (body) of the vertebrata and the anterior surface of the ribs.
- **Levatores Costarum** (Outer Muscles): Small muscles that pass all along the vertebral column. Raise the ribs upon contraction.
- **Intercostal Muscles:** Inner Muscles that pass between the ribs.
  - **o** External Intercostals:
    - Pass from Lateral to Medial
    - Originate at Vertebrata and travels along intercostal space.
    - Stops before it gets to the sternum.
    - **External Intercostal Membrane:** Connects the muscle to the sternum on the anterior side. o **Internal Intercostals:** Deep to the external intercostals.
    - Run from medial to lateral, crossing the external intercostals.
    - Start at the sternum, pass laterally and posteriorly, and stop around the mid-axial line.
    - The **Internal Intercostal Membrane** connects the muscles to the vertebrata at that point.

  o **Innermost Intercostals:** Start at the angle of the ribs, and move anteriorly and stop before the sternum.
    - They only cover the lateral region of the thorax.

o The anterior aspect of thoracic wall: you can see the pectorals (shallow) and the internal intercostals (deep).
o The lateral aspect of the thoracic wall: you can see mostly the innermost intercostals.
o The posterior aspect of the thoracic wall: you can see the external intercostals and the serratus posteriors.

- **Transversus Thoracis:** Can be seen from innermost aspect of thorax. Connected to innermost intercostals through a membrane.
- **Subcostals:** Located on the posterior aspect, internally. Slips of muscle that pass between the posterior ribs.

NERVE AND BLOOD SUPPLY TO THE INTERCOSTALS

V.A.N: Going from superior to inferior, the order of each intercostal space is vein, artery, nerve. Origin of Intercostal Nerves:

- **Mixed Nerve:** Sensory Nerves come from the Dorsal Root of the spinal chord. Motor nerves come from the ventral root of the spinal chord. These two merge together to become one nerve.
  - o The nerve also received fibers from the Sympathetic Chain Ganglia, the sympathetic part of the ANS.
- The mixed nerve branches into Doral Ramus and Ventral Ramus.
  - o **Dorsal Ramus:** Innervates the back muscles. o **Ventral Ramus:** Innervates the intercostal muscles.

Arterial Blood Supply to the intercostal muscles: **Intercostal Arteries.** The vasculature branches as follows: Subclavian Artery --------- > Internal Thoracic Artery > Intercostal Artery.

- **Internal Thoracic Artery:** Travels Superoinferiorly, lateral to the sternum, deep to the costal cartilages.
- **Costal Groove:** Intercostal arteries, veins, and nerves run along this path, on the inferior aspect of the ribs.

Clinical Application: To place a needle through the ribs, it should be placed in the center of the intercostal space, because the vessels and nerves (VAN) run along each rib on the costal groove.

THE LUNGS

Respiration: The thoracic cavity is enlarged, decreasing pressure, resulting in air being sucked into the lungs. Negative pressure breathing.

- Expansion of rib-cage.
  - o Ribs 1-7 rotate from respiration. They undergo the pail-handle effect. As they are raised, they increase volume in two dimensions:
    - Anterior-posterior dimension.
    - Medial-Lateral dimension (because they are bowed)
  - o Ribs 9-12 bow out laterally, increasing volume in both dimensions described above.
- Vertical Increase (superior-inferior) is the most significant: It results from contraction of the diaphragm, displacing it inferiorly.

PLEURAL CAVITY: The two separate cavities in which the lungs are contained.

- **Visceral Pleura:** The inner membrane of the pleural cavity, or the membrane immediately surrounding the lung.
- **Parietal Pleura:** The outer membrane of the pleural cavity.
  - o The **Costal Pleura:** That portion of the parietal pleura bordering the rib-cage.
  - o The **Mediastinal Pleura:** That portion of the parietal pleura bordering the mediastinum.
  - o The **Diaphragmatic Pleura:** That portion of the parietal pleura bordering the diaphragm.

Costodiaphragmatic Recess: The inferior cavity between the bottom (base) of the lung and the diaphragm.

- Whenever fluid accumulates in the pleural cavity (pleuritis), this is a good place to put a drain tube.

Costomediastinal Recess: The recess created by the junctions **(reflections)** between the mediastinal pleura and costal pleura.

- On the anterosuperior portion of both lungs.
- The **left** costomediastinal recess is larger than the right, due to the **cardiac notch** -- the impression left on the left lung from the heart.

Borders of the Lungs:

- Inferior Border: The 6th rib (anteriorly), and T-10 (posteriorly)
- Lateral Border: The mid-axillary line.
- Superior Border: The lungs extend through the Thoracic Aperture

into the base of the neck.

Apex of the Lung: The top of the lung, just superior and deep to the clavicle.

- The **Subclavian Artery** crosses the apex of the lung.

Base of the Lung: The concave inferior border of the lung, having the same curvature as the convex surface of the diaphragm.

Root of the Lung: The center of the lung at its attachment point, wherein lies the hilus.

Hilum of the Lung: Where the root is attached. Contains all the arteries, vessels, nerves, and lymph vessels of the lung. The hilum contains the following.

- Pulmonary Arteries.
- Middle and Lower Lobe Bronchi
- Lymph Nodes
- Superior and Inferior Pulmonary Veins

DEPRESSIONS IN LUNGS: Both lungs have the following depressions in the superior region of the lungs

- Brachiocephalic vein.
- Subclavian artery
- Trachea (may be seen on right lung more than left, as trachea is more toward the right side).
- Esophagus

THE RIGHT LUNG: The larger of the two lungs. The heart extends into the left lung (at the cardiac notch). The right lung has no cardiac notch. Has three lobes.

- Horizontal Fissure: **separates the** Upper Lobe **from the** Middle Lobe..
- **Oblique Fissure:** Separate both of the other lobes from the **Lower Lobe.**
- Hilus: The pulmonary artery is between the bronchi and pulmonary veins.
  - o Bronchi are most posterior.
  - o Pulmonary artery is between bronchus and pulmonary vein. o Arteries and bronchi are in relatively the same superior/inferior plane.
- **Eparterial Bronchus:** The bronchus closely associated with the **superior pulmonary artery** in the right lung. It ventilates the upper lobe.
- Depressions: Right Lung has depression for superior vena cava.

THE LEFT LUNG: The smaller of the two lungs, containing a recess for the **Cardiac Notch.**

- **Oblique Fissure:** Separates the **Upper Lobe** and **Lower Lobe.** There is no middle lobe.
- Hilus:
  - o Bronchi are still most posterior. The left bronchus is posterior to the pulmonary arteries.
  - Pulmonary artery is most superior.
- Depressions: Left Lung has big groove for Aortic Arch.
- **Cardiac Impression:** In addition to the cardiac notch, the left lung has an impression where the heart is, anterior to the hilus.

Bronchopulmonary Segments: An arterial supply to the lungs develops along with the bronchi, resulting in different parts of the lungs being perfused by different blood supplies.

- **Bronchopulmonary segment involved in**
- Aspiration supine-apical seg of right upper lobe
- Carcinoma-ant.seg of right upper lobe
- Frequent site of TB,septic pneumonitis-Post basal seg. of left lower lobe

- Right lung has **10 bronchopulmonary segments and left 9 bronchopulmonary segment**; each one is aerated by a tertiary bronchus and supplied by a single branch of the pulmonary artery

PERICARDIUM AND POSITIONING OF THE HEART

Base of the Heart: The superior border of the heart, where the great vessels converge. On the anterior surface of the heart, near the Right Atrium.
Apex of the Heart: The inferior border of the heart, at the anterior portion of the Left Ventricle. **Fibrous Pericardium:** The outer membrane (parietal membrane) of the **Pericardial Sac.**

- **Sternal Pericardial Ligaments** connect the fibrous pericardium to the sternum. These ligaments help hold the heart in place.
- The **Phrenic Nerve** is embedded in the fibrous pericardium.
  Serous Pericardium: The inner membrane (visceral membrane) of the Pericardial Sac.
- It secretes a fluid into the pericardium to lubricate the heart when it is beating.
- Membrane plus fluid becomes a whole surface layer called the **Epicardium.**

Transverse Pericardial Sinus: The hole created between the Aorta and Pulmonary Trunk, and the Fibrous Pericardium, on the Anterior Surface of the Heart at its base. Fluid can accumulate there.
Oblique Pericardial Sinus: The hole created by the four Pulmonary Veins, and fibrous pericardium, on the Posterior Surface of the heart near the Left Atrium. Fluid can accumulate there.
External Location of Heart Valves: 3, 3.5, 4, 4.5 Rule. This is *not* the best place to hear the valves, but simply where they are located.

- 3rd Costal Cartilage: Location of Pulmonary Valve.
  - o (Right Ventricle <====> Pulmonary Trunk)
- 3rd Intercostal Space: Location of Aortic Valve.
  - o (Left Ventricle <====> Aorta)
- 4th Costal Cartilage: Location of Mitral Valve
  - o (Left Atrium <====> Left Ventricle)
- 4th Intercostal Space: Location of Tricuspid Valve.
  - o (Right Atrium <====> Right Ventricle)

Valve Sounds: The sounds are reflected to other places externally. The best place to hear each valve is as follows:

- Pulmonary Valve: 2nd Sternocostal Joint
- Aortic Valve: Position of the right 2nd Costal Cartilage.
- Bicuspid Valve: Best heard at the Apex of the Heart: 8 cm to the left of the 5th Intercostal space.
- Tricuspid Valve: Best heard in the lower left quadrant of the sternum.

INNERVATION OF THE HEART:

- **Sino-Atrial (SA) Node:** Located on the anterior surface of the Superior Vena Cava.
  - o Innervated by both sympathetic and parasympathetic fibers. o Nervous impulse originates at the SA Node.
- **Atrio-Ventricular Node:** Located on the right side of the intra-atrial septal wall.
  - o **Moderator Band:** Visible in the Right Ventricle, represent fibers of the AV-Node that go into the Right Ventricle.

THE HEART
EXTERNAL ANATOMY

- **Sulcus:** Depressions on the anterior surface of the heart, used as demarcations for external anatomy. They may be hard to see if fat is present.
  Interventricular Sulcus: The demarcation between the left and right ventricles. The Anterior Interventricular Artery is often embedded in this sulcus.
  - o **Coronary Sulcus (Aorticoventricular Sulcus):** The border between the Right Atrium and Aorta. The Right Coronary Artery often travels along this sulcus.
- **Coronary Sinus:** The Great Coronary Vein empties into the Coronary Sinus, which in turn Empties into the Pulmonary Artery into the Right Atrium.
  - o The Coronary Sinus is located deep to the great vein, on the posterior wall of the Right Atrium.

- **Coronary Arteries:** Originate from the right and left sides of the Ascending Aorta. There are many variations, but common theme is below.
- **Coronary arteries** originate from the **ascending aorta**
- LEFT coronary artery comes from Post aortic sinus/left coronary cusp: **circumflex branch** and **anterior interventricular** (LAD, left anterior descending)
- RIGHT coronary artery comes from the Ant.aortic sinus/right coronary cusp: **atrial branch → sinuatrial (SA) nodal branch,** then later **marginal branch and posterior interventricular**
- SA node supplied by RCA in 60% of cases

o **Right Coronary Artery:** Travels along the Atrioventricular Sulcus (Coronary Sulcus). Then it travels posteriorly around the heart and anastomoses (joins) with the left Coronary Artery on the posterior side. o **Left Coronary Artery:** Is itself very short. It bifurcates into two more arteries:

- **Circumflex Branch:** Goes posteriorly and joins with the Right Coronary Artery.
- **Anterior Interventricular Branch:** Travels along the Interventricular Sulcus on the anterior side.

- **Cardiac Veins:** Most Cardiac veins empty into the Coronary Sinus, but not all.
  o **Great Cardiac Vein:** Passes along the Interventricular Sulcus, with the Anterior Interventricular Coronary
  Artery. It empties anteriorly into the Coronary Sinus. o **Middle Cardiac Vein:** Travels with the posterior (right) interventricular coronary artery and empties into the Coronary Sinus posteriorly. o **Anterior Cardiac Vein:** An exception. It empties right into the wall of the Right Atrium. o **Thebesian Veins:** Small venous structures within the heart tissue. Only histological structures and not visible in lab.
- Vessels of the Heart:
  o Anterior Aspect, from Right to Left: Superior Vena Cava, Aorta, Pulmonary Trunk. o Posterior Aspect: Four Pulmonary Veins, the Inferior Vena Cava.
- **Right Auricle:** The primitive Right Atrium.
- **Left Auricle:** The primitive Left Atrium.

THE RIGHT ATRIUM:

- **Musculi Pectinate:** A rough area on the superior inner wall of the Right Atrium, left over from the embryonic heart.
- **Sinus Venarum:** A smooth area in the Right Ventricle, remaining from the Right Horn of the embryonic Sinus Venosus.
- **Cristae Terminalis:** Ridge on superior anterior border, demarcating the embryonic heart (auricle) from the adult heart. It is at the border of the Right Auricle.
- **Fossae Ovalis:** Depression in the Septal wall, remaining from the embryonic Foramen Ovale.
- **Membranous Septum:** A membranous remnant of the embryonic heart, smaller than the Fossae Ovalis. It may not form, resulting in a "hole" in the septal wall of the heart.
- **Triangle of koch**-bounded by septal leaflet,coronary sinus,tendon of todaro contain AV node

THE RIGHT VENTRICLE:

- **Chordae Tendineae:** The ligaments that connect the tricuspid cusps to the Papillary muscles, allowing them to open when the papillary muscles are contracted.
- **Papillary Muscles:** The muscles which control the cusps of the tricuspid valve. They are contracted *before* the contraction of cardiac muscle, to close the valves, to prevent backflow of blood into the Right Atrium.
- **Trabeculae Carnea:** The muscles of the Right Ventricular Wall.
- **Conus Arteriosus:** Superior left surface of the right ventricle, smooth.
- **Tricuspid Valve:** Connected to the papillary muscles via the chordae tendineae. Composed of three cusps:
  o Anterior cusp o Posterior cusp o Septal cusp

- **Pulmonary Valve:** Composed of three **semilunar cusps.** The valve which controls backflow back into the right ventricle from the pulmonary trunk.

➢ **Septomarginal trabecula (moderator band)** stretches from the interventricular septum to the base of the anterior papillary muscle

THE LEFT ATRIUM:

- **Fossa Ovalis** Should be visible on the septal wall.
- **Bicuspid (Mitral) Valve** should also be visible.

THE LEFT VENTRICLE: The largest of the chambers, with the thickest walls. The Posterior part of the hart. Generally similar to Left Ventricle.

- Mitral Valve: Has Posterior and Anterior Cusps, and Chordae Tendineae and Papillary Muscles, like the Right Ventricle.
- **Aortic Valve:** Composed of three **semilunar valves:** right, left, posterior.
- **Coronary Sinuses:** Just superior to Aortic Valve, openings for the Left and Right Coronary Arteries.

SUPERIOR MEDIASTINUM / NERVES AND ARTERIES OF MEDIASTINUM

Thymus: Anterior most structure in posterior mediastinum. Atrophied in adults but prominent in children.
Ligamentum Arteriosum: Connective tissue connecting the Aorta to the Pulmonary Trunk, helping to hold both structures in place. Left side of heart, superior to the Pulmonary Trunk.

- Developmentally, it is the former Ductus Arteriosus (Left 6th Aortic Arch) in the embryonic heart. The Great Veins: Anterior to the great arteries, in the superior mediastinum.
- **Superior Vena Cava:** Formed by the combining of the right brachiocephalic vein and left brachiocephalic vein.
  - o Combination of Right and Left Brachiocephalic Vein occurs at the articulation of the 1st rib.
- **Right Brachiocephalic Vein:** Right branch of Superior Vena Cava.
  - o **Right Internal Jugular Vein:** Converges on the Right Brachiocephalic Vein.
  - o **Right Subclavian Vein:** Converges on the Right Brachiocephalic Vein, and runs anterior to the Subclavian Artery.
- **Left Brachiocephalic Vein:** Left branch of Superior Vena Cava.
  - o **Left Internal Jugular Vein:** Converges into the Left Brachiocephalic just lateral to the Common Carotid Artery.
  - o **Left Subclavian Vein:** Converges into the Left Brachiocephalic Vein and runs anterior to the Subclavian Artery.

The Great Arteries: Posterior to the great veins.

- **Aorta:** Ascending Aorta curves posteriorly and a bit to the left. It has three branches:
  - o **Brachiocephalic Trunk:** Right-most branch off of the Aortic Arch.
    - ■ **Right Subclavian Artery:** Branches off the brachiocephalic trunk.
  - o **Left Common Carotid Artery:** The center of the three branches off the Aortic Arch.
  - o **Left Subclavian Artery:** The left-most branch off the Aortic Arch.

- ARCH OF AORTA
  - o **Aortic arch** begins and ends at same level, anteriorly at sternal angle and posteriorly at intervertebral disc T4 – T5, passes anterior to posterior; arches superior to (over) left main bronchus and then becomes the **descending aorta**
  - o Concavity of the aortic arch is connected to the left pulmonary artery by a stout, obliquely set cord, the **ligamentum arteriosum**
  - o Following structures are closely related to aortic arch: **left pulmonary artery**, **ligamentum arteriosum**, **left recurrent laryngeal nerve**, and **left main bronchus** (w/ lymph nodes) and **esophagus**
  - o **Cardiac nerves** cross the aortic arch, but are hard to visualize; they also contain sensory fibers that carry the sensation of pain

Internal Thoracic Arteries: Continue off of each of the Subclavian Arteries. They move down the Thorax into the abdomen, lateral to the Sternum.

Phrenic Nerves: Both originate from C3, C4, C5. Both Phrenic Nerves are more lateral than the Vagus nerves.

- Right Phrenic Nerve:
  - o Runs laterally along the Right Internal Jugular Vein. o Continues lateral to the Superior Vena Cava. o Then rungs along the Fibrous Pericardium. o Finally into the diaphragm.
- Left Phrenic Nerve:
  - o Rungs laterally along the Left Internal Jugular Vein. o Anterior to the Arch of the Aorta o Then along the Fibrous Pericardium o Into the diaphragm.
- Both Phrenic Nerves:
  - o They run *anterior* to the roots of the lungs

Vagus Nerves: Both Vagus Nerves are more medial than the Phrenic Nerves.

- Left Vagus Nerve:
  - o Runs lateral to the Aortic Arch.
  - o Gives off a branch for the Left Recurrent Pharyngeal Nerve.
  - o Runs anterior to the subclavian, then posterior to vena cava and brachiocephalic veins. o Continues medially and runs toward the diaphragm lateral to the Esophagus. In the thorax, it tends to go to the anterior portion of the esophagus.
- Right Vagus Nerve:
  - o Runs lateral to the Right Common Carotid Artery (medial to Phrenic Nerve). o Gives off a branch for the Right Recurrent Laryngeal Nerve. o In the thorax, it tends to go to the posterior part of the esophagus.
- Both Vagus Nerves:
  - o Run *posterior* to the roots of the lungs.
    - o Both give off branches for the **Pulmonary Plexus, Cardiac Plexus,** and **Eosphageal Plexus.** ■ Right and left fibers mix to form the eosphageal plexus.

Recurrent Laryngeal Nerves: Both branch off the Vagus nerves and go back superiorly toward the larynx.

- Left Recurrent Laryngeal Nerve: **Off of the Left Vagus.**
  - o Runs back up, lateral to the Trachea, into the Larynx.
  - o Is different in position than the Right Laryngeal, due to the degeneration of the right 6th Aortic Arch (see below),
- Right Recurrent Laryngeal Nerve: **Off of the right vagus.**
  - o Passes back up posterior to the Right Subclavian. o Runs back up, lateral to the Trachea, to the Larynx.
- CLINICAL: Carcinoma of the Lungs can affect the Recurrent Pharyngeals, causing a hoarse voice. They must be watched in surgery.

Pericardiacophrenic Artery and **Vein:** Run on either side of the Phrenic nerve all along its path in the Thorax. **Cardiac Plexus:** Grouping of Vagal nerves innervating the heart. **Pulmonary Plexus:** Grouping of Vagal nerves innervating the lungs.

Bifurcation of the Trachea:

- **Carina:** The cartilage that sticks out at the bifurcation.
- **Right Bronchus:** Fatter and shorter than the left bronchus. It branches off at a straighter angle, so things tend to lodge in the right Bronchus as opposed to the left.
- **Left Bronchus:** Branches off at a sharper angle than the right bronchus.\

Esophagus: Displaced to the right in the Thoracic Cavity. It returns to the left after it crosses the diaphragm and goes into the abdomen.

- **Eosphageal Plexus:** Formed of Vagus nerve, innervates the esophagus.
  - o When the plexus enters the abdomen, it coalesces back into two Vagus Nerves.

Thoracic Duct: The largest lymph vessel in the body.

- To the right of the Thoracic Vertebrata, posterior to the esophagus.
- It empties into Left Brachiocephalic and Internal Jugular veins.
- This duct drains the lower half of the body and the left side of the upper body.
- **Right Subclavian Lymphatic Duct** empties the right half of the upper body.

Azygos Vein: Posterior to Esophagus, to the right of the Thoracic Duct.

- It is an alternate route for the return of venous blood to the heart, rather than through the inferior vena cava.
- Intercostal veins empty into the azygos system, from both left and right (via Hemiazygous system) sides.
- Azygos vein connects to the inferior vena cava at the level of the kidneys.

Hemiazygos Vein System: Posterior to the descending Aorta on the left side of the vertebral column.

- It drains the left intercostal veins.
- It drains into the Azygos Vein.

Sympathetic Chain Ganglia: Lateral to the spinal column, from Cervical to Sacral.

- **Intercostal Nerves:** Come off of the Sympathetic Chain Ganglia in the thorax.
- Splanchnic Nerves:
  - o **Greater Splanchnic Nerve:** Comes off of the sympathetic chain at T5 to T9.
  - o **Lesser Splanchnic Nerve:** Comes off of the sympathetic chain at T10 and T11.
  - o **Least Splanchnic Nerve:** Comes off of the sympathetic chain at T12.
- Autonomic Nervous System: Location of cell bodies
  - o **Sympathetic Nerves:** The cell body is close to the spinal column. The synapse between pre-ganglionic and post-ganglionic nerves occurs in the Chain Ganglia near the spinal chord. o **Parasympathetic Nerves:** The cell body is close to the target organ. The synapse occurs near the target organ, with short axons innervating the target.
- **Rami Communicans:** The junctions where the pre-ganglionic nerves synapse with the post-ganglionic nerves, in the sympathetic chain ganglia.
- **BRONCHOPULMONARY SEGMENT DIAGRAM**
- **Thorax figures**

CLASS DISCUSSION QUESTIONS THORAX

LUNGS

1. True about bronchopulmonary segments
   A. The portion of lung aerated by single bronchus
   B. Each segment is a not separate respiratory unit
   C. Medial basal segment is absent in left lung
   D. B & C

2. The Structure not related to medial surface right lung is
   A. Arch of azygos Vein
   B. Brachiocephalic trunk
   C. Thoracic aorta
   D. Superior venacava

MEDIASTINUM

3. The posterior mediastinum contains the following structure
   A. Thymus
   B. Arch of aorta
   C. Brachiocephalic veins
   D. Azygos vein

4. Azygos vein has the following characters except
   A. Straight in course
   B. Veins are provided with valves
   C. Accompained by corresponding arteries
   D. Paravertebral in position

5. The hemiazygos vein is often connected with
   A. Left Renal vein
   B. Right renal vein
   C. Left suprarenal vein
   D. Right suprarenal vein

THORACIC DUCT

6. All are true about thoracic duct except
   A. It is flexous & beaded in character
   B. Its length is 45 cms
   C. At root of neck it arches laterally opposite to C7
   D. The arch of thoracic duct is 3-4 cm above right clavicle

7. The tributaries of thoracic duct
   A. Left Bronchomediastinal lymph trunk
   B. Bilateral descending thoracic lymph trunk
   C. Both a & b
   D. None of above

HEART

8. The interior of right atrium contains all the following except
   A. Opening of superior vena cava
   B. Tendon of todaro
   C. Foramina veneraum minimarum
   D. Trabeculae carnea

9. Tendon of Todaro is a
   A. Subepicardial tendon
   B. Interventicular ridge
   C. Defines the boundary of Triangle of Koch
   D. None of above

10. Thebesian valve
   A. Located in inferior vena cava
   B. Located in superior vena cava
   C. Located in Coronary sinus
   D. None of above

11. Central fibrous body of heart is formed by
   A. Left fibrous trigone with membranous part of ventricular septum
   B. Right fibrous trigone with membranous part of ventricular septum
   C. Tendon of infundibulum
   D. Both B and C

CORONARY ARTERIES & VEINS

12. True of following is
   A. A.The degree of anastomosis of the coronary arteries is variable but significant
   B. B.The Dominence refers to the coronary artery the gives of anterior interventricular artery
   C. C.The anastomosis between right & left coronary arteries is abundant in fetal life
   D. D.The diameter of the coronary arteries may decreses up to age 30 years

13. The "Third Coronary Artery" refers to
   A. Arteria coni arteriosi from anterior aortic sinus
   B. Left Conus branch from left coronary artery
   C. Anastomosis between right and left coronary artery conus branch
   D. None of above

14. Annulus of vieussen's is located around
   A. Apex of heart
   B. Crux of heart
   C. Left ventricular outflow tract
   D. Right Ventricular outflow tract

15. All are true except
   A. The sinu-atrio nodal artery arises from left circumflex branch of left coronary artery in 80% of cases
   B. Right marginal artery is the longest ventricular rami
   C. Posterior interventricular artery passes along with middle cardiac vein
   D. A & B

16. True about venous drainage of heart is
   A. Great cardiac vein passes along the Posterior interventricular groove
   B. Middle cardiac vein passes along the anterior interventricular groove
   C. All tributaries of cavernous sinus are provided with valves except oblique vein of left atrium
   D. All the above

CARDIAC PLEXUS

17. Superficial cardiac plexus is located
   A. Above aortic arch
   B. Below tracheal bifurcation
   C. Above tracheal bifurcation
   D. Below aortic arch

18. True about coronary plexus
    A. Right coronary plexus larger than left
    B. Right coronary plexus formed of superficial & deep cardiac plexus
    C. Left coronary plexus is formed of superficial cardiac plexus
    D. Both B & C

PHRENIC NERVE & DIAPRAGM

19. True about Phrenic nerve
    A. Right phrenic nerve crosses the first part of subclavian artery
    B. Left phrenic nerve crosses the second part of subclavian artery
    C. Right crus is supplied by both phrenic nerves
    D. Right phrenic nerve is crossed by thoracic duct

20. The incision preferred to avoid iatrogenic phrenic nerve injury is
    A. Radial incision extending from the costal margin to oesophageal hiatus
    B. Thoracoabdominal incision in circumferential manner in periphery
    C. Incision of central tendon
    D. Both b and c

21. Correct of the following is
    A. .Inferior venacaval opening is a quadrilateral opening
    B. Thoracic duct & Azygos vein pass through operature located at T12
    C. Oesophageal opening is a osseoaponeurotic opening
    D. A & B

22. The interventricular septum contains which of the following structures?
    A. Anterior papillary muscle
    B. Fossa ovalis
    C. Sinus venarum
    D. Conus arteriosus

23. Which of the following passes through the caval opening of the diaphragm?
    A. Terminal branches of the right phrenic nerve
    B. Thoracic duct
    C. Greater thoracic splanchnic nerve
    D. Sympathetic trunk

INTERCOSTAL SPACE

24. The musculophrenic arteries give rise to which of the following?
    A. Anterior intercostal arteries for intercostal spaces 7-9
    B. Posterior intercostals arteries for intercostal spaces 3-11
    C. Subcostal artery
    D. Inferior phrenic artery
    E. Lumbar arteries

25. Anterior and posterior intercostals arteries pass between which two layers?
    A. Skin and external intercostal muscles
    B. External and internal intercostal muscles
    C. Internal and innermost intercostals muscles
    D. Innermost intercostal muscles and trans- versalis fascia

26. The thymus is supplied by which of the following?
    A. Anterior intercostal branches of the internal thoracic artery
    B. Brachiocephalic artery
    C. Posterior intercostal arteries
    D. Left common carotid artery

27. The pulmonary plexus contains which of the following?
    A. Cell bodies of visceral afferent fibers
    B. Cell bodies of postsynaptic sympathetic fibers
    C. Cell bodies of postsynaptic parasympathetic fibers
    D. Somatic efferent fibers passing on to diaphragm

28. Vasoconstriction is sympathetically stimulated with the exception of which arteries?
    A. Bronchial arteries
    B. Coronary arteries
    C. Esophageal arteries
    D. Adrenal arteries
    E. Renal arteries

29. Parasympathetic fibers stimulate secretion by all glands except which of the following?
    A. Sweat glands
    B. Lacrimal glands
    C. Salivary glands
    D. Nasal glands

30. Which of the following is NOT a branch of the aorta in the thorax?
    A. Posterior intercostal arteries
    B. Inferior phrenic artery
    C. Bronchial arteries
    D. Esophageal arteries
    E. Superior phrenic arteries

ANSWERS & DISCUSSION

1.C

Right lung	
Superior lobe:	I, apical; II, posterior; III, anterior
Middle lobe:	IV, lateral; V, medial
Inferior lobe:	VI, superior (apical); VII, medial basal; VIII, anterior basal; IX, lateral basal; X, posterior basal
Left lung	
Superior lobe:	I, apical; II, posterior; III, anterior; IV, superior lingular; V, inferior lingular
Inferior lobe:	VI, superior (apical); VIII, anterior basal; IX, lateral basal; X, posterior basal

2.C

Impressions on the lung surface

In addition to these pulmonary features, cadaveric lungs that have been preserved *in situ* can show a number of other impressions that indicate their relations with surrounding structures .

On the right lung the cardiac impression is related to the anterior surface of the right auricle, the anterolateral surface of the right atrium and partially to the anterior surface of the right ventricle. The impression ascends anterior to the hilum as a wide groove for the superior vena cava and the terminal portion of the right brachiocephalic vein. Posteriorly this groove is joined by a deep sulcus which arches forwards above the hilum and is occupied by the azygos vein. The right side of the oesophagus makes a shallow vertical groove behind the hilum and the pulmonary ligament. Towards the diaphragm it inclines left and leaves the right lung, and therefore does not reach the lower limit of this surface. Posteroinferiorly the cardiac impression is confluent with a short wide groove adapted to the inferior vena cava. Between the apex and the groove for the azygos, the trachea and right vagus are close to the lung, but do not mark it.

On the left lung the cardiac impression is related to the anterior and lateral surfaces of the left ventricle and auricle. The anterior infundibular surface and adjoining part of the right ventricle is also related to the lung as it ascends in front of the hilum to accommodate the pulmonary trunk. A large groove arches over the hilum, and descends behind it and the pulmonary ligament, corresponding to the aortic arch and descending aorta. From its summit a narrower groove ascends to the apex for the left subclavian artery. Behind this, above the aortic groove, the lung is in contact with the thoracic duct and oesophagus. In front of the subclavian groove there is a faint linear depression for the left brachiocephalic vein. Inferiorly, the oesophagus may mould the surface in front of the lower end of the pulmonary ligament.

3.D

Posterior mediastinum

The posterior mediastinum is bounded anteriorly by the bifurcation of the trachea, pulmonary vessels, pericardium and the posterior part of the upper surface of the diaphragm. Posteriorly, it is bounded by the vertebral column, from the lower border of the fourth to the twelfth thoracic vertebrae, and on each side by the mediastinal pleura. It contains the descending thoracic aorta and the azygos, hemiazygos and accessory azygos veins; the right and left sympathetic chains, the splanchnic nerves and the right and left vagi; the oesophagus; the thoracic duct and posterior mediastinal lymph nodes.

4.C

The azygos vein (Gr. *azygos* = ‘unpaired') typically starts from the posterior aspect of the inferior vena cava, at or below the level of the renal veins, although the origin is not constant . When present, the lumbar azygos ascends anterior to the upper lumbar vertebrae. It may pass behind the right crus of the diaphragm or pierce it, or it may traverse the aortic hiatus to the right of the cisterna chyli. Anterior to the twelfth thoracic vertebral body, the azygos is joined by a large vessel formed by the right ascending lumbar and subcostal veins that passes forward and to the right of the twelfth thoracic vertebra behind the right crus: in

the absence of a lumbar azygos, this common trunk may form the azygos vein itself. Whatever its origin, the azygos vein ascends in the posterior mediastinum to the level of the fourth thoracic vertebra, where it arches forward above the right pulmonary hilum. It ends in the superior vena cava, before the latter pierces the pericardium.The azygos vein lies close to the right posterolateral aspect of the descending thoracic aorta: aortic pulsations may assist venous return in the azygos and hemiazygos veins.

5.A

Hemiazygos vein

The hemiazygos vein is formed on the left side from the lower three posterior intercostal veins, a common trunk formed by the left ascending lumbar and subcostal veins, and by oesophageal and mediastinal tributaries . It ascends anterior to the level of the vertebral column to the eighth thoracic level then crosses the vertebral column posterior to the aorta, oesophagus and thoracic duct, and ends in the azygos vein . Its lower end is often connected to the left renal vein.

6.D

The summit of the arch of thoracic duct is 3-4 cms above left clavicle.

At its abdominal origin, the thoracic duct is usually 5 mm in diameter, diminishing in calibre at midthoracic level, and then in approximately half of individuals is again slightly dilated before its termination. It is slightly sinuous, constricted at intervals and appears varicose. It may divide in its mid course into two unequal vessels that soon reunite, or into several small branches that form a plexus before continuing as a single duct. At a higher level it occasionally bifurcates, the left branch ending as usual, the right branch diverging to join one of the right lymph trunks or, when present, a right lymphatic duct. The combined vessel usually opens into the right subclavian vein. The thoracic duct has several valves corresponding to sites exposed to pressure. At its termination a bicuspid valve faces into the vein to prevent or reduce reflux of blood: post mortem, blood regurgitates freely into the duct. Anomalies of the thoracic duct may be delineated by dissection into the inguinal lymphatics followed by cannulation and subsequent injection of an oily contrast medium (lipiodol) followed by plain films or CT

7.C

The tributaries of thoracic duct

A pair of descending lymph trunk

A pair of ascending lymph trunk

Bilateral descending thoracic lymph trunk

Left jugular lymph trunk

Left bronchomediastinal lymph trunk

8.D

The interior of right atrium contains

Opening of SVC, Opening of IVC and Coronary sinus.

Openings into the Right Atrium

The superior vena cava opens into the upper part of the right atrium; it has no valve. It returns the blood to the heart from the upper half of the body. The inferior vena cava (larger than the superior vena cava) opens into the lower part of the right atrium; it is guarded by a rudimentary, nonfunctioning valve. It returns the blood to the heart from the lower half of the body.

The coronary sinus, which drains most of the blood from the heart wall , opens into the right atrium between the inferior vena cava and the atrioventricular orifice. It is guarded by a rudimentary, nonfunctioning valve.

9.C

- A tendinous structure, the tendon of Todaro, runs from this commissure into the sinus septum, which is the septum between the coronary sinus and the fossa ovale. The tendon of Todaro runs forwards to insert into the central fibrous body and is one of the landmarks of the triangle of Koch

10.C

The coronary sinus opens into the venous atrial component between the orifice of the inferior vena cava, the fossa ovale and the vestibule of the atrioventricular opening . The coronary sinus is often guarded by a

thin, semicircular valve that covers the lower part of the orifice (Thebesius' valve, also known as the Thebesian valve)

11.B

The central fibrous body right fibrous trigone with membranous part of ventricular septum

The fibrous skeleton is strongest at the junction of the aortic, mitral and tricuspid valves, the so-called central fibrous body . Two pairs of curved, tapering, collagenous prongs, fila coronaria, extend from the central fibrous body. They are stronger on the left, passing partially around the mitral and tricuspid orifices, which are almost co-planar and incline to face the cardiac apex. The aortic valve, in contrast, faces up, right and slightly forwards. It is anterosuperior and to the right of the mitral orifice. Two of the cusps of the aortic valve are in fibrous continuity with the aortic cusp of the mitral valve: this aortic-mitral or subaortic curtain is also an integral part of the fibrous skeleton . The two ends of the curtain are strengthened as the right and left fibrous trigones, which are the strongest part of the skeleton. The right trigone, together with the membranous septum, constitutes the central fibrous body, which is penetrated by the bundle of His, or atrioventricular bundle, i.e. by the mechanism for atrioventricular conduction. The membranous septum is crossed on its right aspect by the attachment of the tricuspid valve, which divides the septum into atrioventricular and interventricular components.

12.C

- The term ‘dominant' is used to refer to the coronary artery giving off the posterior interventricular (descending) branch, which supplies the posterior part of the ventricular septum and often part of the posterolateral wall of the left ventricle. The dominant artery is usually the right (60%). Anastomoses between right and left coronary arteries are abundant during fetal life, but are much reduced by the end of the first year of life. Anastomoses providing collateral circulation may become prominent in conditions of hypoxia and in coronary artery disease. An additional collateral circulation is provided by small branches from mediastinal, pericardial and bronchial vessels.
- The calibre of coronary arteries, both main stems and larger branches, based on measurements of arterial casts or angiograms, ranges between 1.5 and 5.5 mm for the coronary arteries at their origins. The left exceed the right in 60% of hearts, the right being larger in 17%, and both vessels being approximately equal in 23%. The diameters of the coronary arteries may increase up to the 30th year.

13.A

Branches of the right coronary supply the right atrium and ventricle and, variably, parts of the left chambers and atrioventricular septum. The first branch (arising separately from the anterior aortic sinus in 36% of individuals) is the arteria coni arteriosi or conus artery. This is sometimes termed a ‘third coronary' artery, but as a similar vessel comes from the left coronary, it is more correctly named the right conus artery. It ramifies anteriorly on the lowest part of the pulmonary conus and upper part of the right ventricle. It may anastomose with a similar left coronary branch from the left anterior descending artery to form the ‘anulus of Vieussens', which is a tenuous anastomotic ‘circle' around the right ventricular outflow tract.

14.D

- The right conus branch ramifies anteriorly on the lowest part of the pulmonary conus and upper part of the right ventricle. It may anastomose with a similar left coronary branch from the left anterior descending artery to form the ‘anulus of Vieussens', which is a tenuous anastomotic ‘circle' around the right ventricular outflow tract.

15.A

The artery of the sinoatrial node is an atrial branch, distributed largely to the myocardium of both atria, mainly the right. Its origin is variable: it comes from the circumflex branch of the left coronary in 35%. However, more commonly it arises from the anterior atrial branch of the right coronary artery, less often from its right lateral part, least often from its posterior atrioventricular part. This ‘nodal' artery thus usually passes back in the groove between the right auricular appendage and aorta. Whatever its origin, it usually branches around the base of the superior vena cava, typically as an arterial loop from which small branches supply the right atrium. A large ‘ramus cristae terminalis' traverses the sinu-atrial node; it would seem more

appropriate to name this branch the 'nodal artery', as most of the currently named vessel actually supplies the atria and serves as the 'main atrial branch'.
Septal branches of the right coronary artery are relatively short, and leave the posterior interventricular branch to supply the posterior interventricular septum. They are numerous, but do not usually reach the apical parts of the septum. The largest posterior septal artery, usually the first, commonly arises from the inverted loop which is said to characterize the right coronary artery at the crux. It supplies the atrioventricular node in 80% of hearts.

16.C
The large majority of cardiac veins drain into the wide coronary sinus, 2 or 3 cm long, lying in the posterior atrioventricular groove between the left atrium and ventricle . The sinus opens into the right atrium between the opening of the inferior vena cava and the right atrioventricular orifice; the opening is guarded by an endocardial fold (semilunar valve of the coronary sinus; Fig. 56.4A). Its tributaries are the great, small and middle cardiac veins, the posterior vein of the left ventricle and the oblique vein of the left atrium; all except the last have valves at their orifices.

17.D
- Superficial (ventral) part of the cardiac plexus
- The superficial (ventral) part of the cardiac plexus lies below the aortic arch and anterior to the right pulmonary artery. It is formed by the cardiac branch of the left superior cervical sympathetic ganglion and the lower of the two cervical cardiac branches of the left vagus. A small cardiac ganglion is usually present in this plexus immediately below the aortic arch, to the right of the ligamentum arteriosum. This part of the cardiac plexus connects with the deep part, the right coronary plexus and the left anterior pulmonary plexus.

18.B
- Left coronary plexus
- The left coronary plexus is larger than the right, and is formed chiefly by the prolongation of the left half of the deep part of the cardiac plexus and a few fibres from the right. It accompanies the left coronary artery to supply the left atrium and ventricle.
- Right coronary plexus
- The right coronary plexus is formed from both superficial and deep parts of the cardiac plexus, and accompanies the right coronary artery to supply the right atrium and ventricle

19.C
The diaphragm receives its motor supply via the phrenic nerves (Fig. 58.3). Sensory fibres are distributed to the peripheral part of the muscle by the lower six or seven intercostal nerves. The right crus of the diaphragm, the fibres of which divide to the right and left of the oesophageal opening, is innervated by both right and left phrenic nerves. There is some evidence that the crural fibres contract slightly before the costal part, and this may be functionally significant for non-respiratory tasks

20.B
- Lesions of the phrenic nerve
- An appreciation of the location of the main branches of the phrenic nerves is important to avoid iatrogenic surgical damage. Radial incisions in the diaphragm from the costal margin to the oesophageal hiatus lead to diaphragmatic paralysis, whereas thoracoabdominal incisions in a circumferential manner in the periphery of the diaphragm do not involve any significant branches of the phrenic nerves and preserve diaphragmatic function. Similarly, incisions of the central tendon are safe.

21.D
The aortic aperture is the lowest and most posterior of the large openings, and is found at the level of the lower border of the twelfth thoracic vertebra and the thoracolumbar intervertebral disc, slightly to the left of the midline. It is an osseo-aponeurotic opening defined by the diaphragmatic crura laterally, the vertebral column posteriorly and the diaphragm anteriorly. Strictly speaking, it lies behind the diaphragm and its median arcuate ligament (when present). Occasionally, some tendinous fibres from the medial parts of the

crura also pass behind the aorta, converting the opening into a fibrous ring. The aortic opening transmits the aorta, thoracic duct, lymphatic trunks from the lower posterior thoracic wall and, sometimes, the azygos and hemiazygos veins

The vena caval aperture, the highest of the three large openings, lies at about the level of the disc between the eighth and ninth thoracic vertebrae. It is quadrilateral, and located at the junction of the right leaf with the central area of the tendon, and so its margins are aponeurotic. It is traversed by the inferior vena cava, which adheres to the margin of the opening, and by some branches of the right phrenic nerve.

22.B

- The interventricular septum is composed of membranous and muscular parts. The conus arteriosus leads into the pulmonary trunk. A thick muscular ridge, the supraventricular crest, separates the ridged muscular wall of the inflow part of the right ventricle from the smooth wall of the conus arteriosus or outflow part.

23.A

- The inferior vena cava, terminal branches of the right phrenic nerve, and lymphatics pass through the caval opening of the diaphragm

24.A

- The musculophrenic artery gives rise to anterior intercostal arteries for intercostal spaces 7-9

25.C

Anterior and posterior intercostal arteries pass between the internal and innermost intercostal muscles

26.A

- The thymus is supplied by the anterior intercostal and anterior mediastinal branches of the internal thoracic artery

27.C

- The pulmonary plexus contains cell bodies of postsynaptic parasympathetic fibers

28.B

- With the exception of coronary arteries, vasoconstriction is sympathetically stimulated

29.

- With the exception of sweat glands, glandular secretion is parasympathetically stimulated

30.B

Branches of the aorta in the thorax include the posterior intercostal, bronchial, esophageal, and superior phrenic arteries

HEAD AND NECK

- Osteology
- The Face
- Spinal Cord and Suboccipital Region
- Scalp and Cranial Fossa
- Eye and Orbit
- Triangles of the Neck
- Nose and Paranasal Sinuses
- The Mouth
- The Pharynx
- The Larynx
- The Ear
- Lymphatics

STRUCTURES PASSING THROUGH VARIOUS FORMINA, CANALS & FISSURES OF SKULL

FORAMINA IN THE INTERIOR OF BASE OF SKULL

(A) ANTERIOR CRANIAL FOSSA

FORAMEN	STRUCTURES PASSING
1. Foramen caecum	**Emissary vein connecting superiorsagittal sinus with veins of nose.**
2. Foramina in cribriform plate of ethmoid	• **Olfactory nerve** • **Anterior ethmoidal nerve** • **Anterior ethmoidal vessels**
3. Anterior ethmoidal canal	**Connects anterior cranial fossa with medial wall of orbit.** • **Anterior ethmoidal nerve** • **Anterior ethmoidal vessels**
4. Posterior ethmoidal canal.	**Connects anterior cranial fossa with medial wall of orbit.** • **Posterior ethmoidal nerve** • **Posterior ethmoidal vessels**

(B) MIDDLE CRANIAL FOSSA

1. Optic canal or foramen	**Connects orbit with middle cranial fossa.** • **Optic nerve surrounded by meninges** • **Ophthalmic artery** • **Central vein of retina**
2. Superior orbital fissure	**Connects orbit with middle cranial fossa.Common tendinous ring divides it into three parts.** **Medial pat:** • **Inferior Ophthalmic vein** **Middle part within the ring :** • **Upper & Lower divisions of III N.** • **Nasociliary N.** • **Abducent N.** **Lateral Part :** • **Trochlear nerve** • **Frontal nerve** • **Lacrimal nerve** • **Superior Ophthalmic vein**
3. Foramen Rotundum	**Connects middle cranial fossa with Pterygopalatine fossa.** • **Maxillary nerve**
4. Emissary sphenoidal foramen (of Vesalius)	**Connects middle cranial fossa with Infratemporal fossa ; Sometimes present**

	• Emissary vein connecting Cavernous sinus with pterygoid venous plexus
5. Foramen Ovale	**Communicates with infratemporal fossa** • **Motor root of Trigeminal nerve** • **Mandibular nerve** • **Accessory meningealartery** • **Lesser Petrosal nerve** • **Emissary vein connecting cavernous sinus with pterygoid venous plexus**
6. Foramen Spinosum	**Communicates with infratemporal fossa.** • **Middle meningeal artery** • **Nervus spinosum** • **Parietal trunk of middle meningeal vein**
7. Canaliculus innominatus	**Sometimes present communicating with infratemporal fossa.** • **Lesser Petrosal nerve**
8. Foramen Lacerum	• **Meningeal branch of ascending pharyngeal artery** • **Emissary veins connecting cavernous sinus with pterygoid venous plexus & pharyngeal veins.** **Carotid canal transmitting Internal carotid artery with its sympathetic plexus opens into its posterior wall.** **Pterygoid canal opens into its anterior wall and communicates the foramen lacerum with pterygopalatine fossa and transmits Nerve of Pterygoid Canal (Vidian nerve)**
9. Carotid canal	• **Internal Carotid artery** • **Sympathetic plexus** • **Venous plexus connecting cavernous sinus with Internal jugular vein.**

(C) POSTERIOR CRANIAL FOSSA

NAME OF THE FORAMEN	STRUCTURES PASSING THROUGH
1. Internal acoustic meatus	• **Motor root of Facial Nerve** • **Nervus intermedius (Sensory root of facial nerve)** • **Vestibulocochlear nerve** • **Labyrinthine vessels**
2. Jugular Foramen	**Opens on the base of skull ; divided into three parts.** **Anterior Part :** • **Inferior Petrosal Sinus** **Middle Part :** • **Glossopharyngeal nerve** • **Vagus nerve** • **Accessory nerve** **Posterior Part:** • **Sigmoid sinus continues as Internal Jugular Vein** • **Meningeal branches of Occipital & Ascending pharyngeal arteries.**
3. Hypoglossal (Anterior Condylar) Canal	• **Hypoglossal Nerve** • **Meningeal branch of ascending pharyngeal artery** • **Emissary vein**
4. Foramen Magnum	**Anterior Part :**

	• Apical ligament of dens • Superior longitudinal band of cruciform ligament • Membrana tectoria **Posterior Part :** • Medulla oblongata • Single Anterior Spinal artery • Right & Left Posterior Spinal arteries • Right & Left Vertebral arteries • Right & Left Spinal Part of Accessory nerves. • Veins connecting Basilar venous plexus with Internal Vertebral venous plexus • Tonsils of cerebellum

FORAMINA ON THE EXTERIOR OF SKULL

NAME OF FORAMEN	STRUCTURES PASSING THROUGH
1. Supraorbital foramen	• Supraorbital nerve • Supraorbital artery
2. Infraorbital foramen	• Infraorbital nerve – continuation of Maxillary nerve • Infraorbital vessels
3. Zygomatico-facial foramen	• Zygomaticofacial nerve • Zygomaticofacial vessels
4. Zygomatico-temporal foramen	• Zygomaticotemporal nerve • Zygomaticotemporal vessels
5. Pterygomaxillary Fissure	• Maxillary nerve • III part of Maxillary artery
6. Sphenopalatine Foramen	Connects nasal cavity with pterygopalatine fossa. • Sphenopalatine vessels • Nasopalatine nerve
7. Petrotympanic fissure	• Chorda tympani branch of VII N. • Anterior tympanic artery • Anterior ligament of Malleus
8. Greater Palatine foramen	• Greater Palatine nerve • Greater Palatine vessels
9. Incisive Fossa	Lateral Incisive Foramina :Lead to floor of nasal cavity from the lateral wall of the incisive fossa. • Greater Palatine vessels • Nasopalatine nerve – when median foramina are absent. Median Incisive Foramina : Two in number, in the anterior and posterior walls of incisive fossa. • Left Nasopalatine nerve – Pass through anterior foramen. • Right Nasopalatine nerve – pass through posterior foramen
10. Stylomastoid foramen	• Facial nerve • Stylomastoid artery

VERTEBRAE

AXIS: Second Cervical Vertebrae.

- It has an odontoid process or **dens** sticking up through the Atlas above it, and forming the Atlanto-Axial Joint. WHIPLASH: Hyperextension of the neck, common in car accidents. Anterior Longitudinal Ligament is stretched or torn. Features of Each Type of Vertebrae:
- **CERVICAL VERTEBRAE:** 7 vertebral bones, but 8 intervertebral spinal levels.

- They have **Foramina Transversaria** going through their transverse processes, which allow passage of the paired *Vertebral Arteries* up and down the spinal column. o *Good Flexion and Extension:* Their superior articular facets are more *horizontal*. They are shaped to allow good flexion and extension. o This again is mobility at the sacrifice of stability.
- They all have *small spinous processes* EXCEPT C7. The large spinous process (bump in back of neck) at **C7** is called the **Vertebra Prominens.**
  - C7 is the transition with the Lumbar Vertebrae and has many ligaments, and thus has a larger spinous process.

o Each intervertebral cervical spinal level is **above** its corresponding vertebrae.

- C1 spinal level is above the Atlas, C2 is above the Axis, and so on.
- **C8** cervical spinal level is above the first Thoracic Vertebrae. There is no eight cervical vertebrae.

- **THORACIC VERTEBRAE:** 12 Vertebrae and 12 spinal levels.
  - o Articular facets are more *vertical,* allowing very little flexion and extension.
  - o They have additional articular facets for the ribs. The two costal articulation at the head and neck of ribs are both synovial joints.
  - *o* Each intervertebral thoracic spinal level is **below** its corresponding vertebrae
- **LUMBAR VERTEBRAE:** 5 Vertebrae and 5 spinal levels.
  - o Bodies are larger, to support more weight.
  - o Articular Facets are almost completely *vertical,* to allow a great amount of**flexion and extension** but very little rotation.
  - *o* Each intervertebral lumbar spinal level is **below** its corresponding vertebrae.

LIGAMENTS OF THE SPINAL COLUMN:

1. **Anterior Longitudinal Ligament:** Anterior to the vertebral body, straight up and down the entire column.
   - It *limits extension* -- it prevents hyperextension.
2. **Posterior Longitudinal Ligament:** Posterior to the body, within the vertebral arch, straight up and down the entire column.
   - So, this ligament is the anterior border of the vertebral arch -- anterior to the spinal cord itself.
   - It *limits flexion* -- it stretches when you bend forward.
   - Because of the posterior ligament, herniated disks go *laterally* -- not straight anteriorly.
3. **Supraspinous Ligament:** Long, thick ligament running along with posterior borders of the spinous processes.
   - It *limits flexion* -- it stretches when you bend forward.
4. **Interspinous Ligaments:** Short fibers that run between adjacent spinous processes.
   - It *limits flexion* -- it stretches when you bend forward. It is the most important ligament that *prevents hyperflexion.*
5. **Ligamentum Flavum:** Elastic, thick, dense ligament that runs vertically between adjacent lamina along their interior aspects.
   - You can see part of it peering through intervertebral levels. INTERVERTEBRAL DISC:

Helps to provide stability to the vertebral column.

1. **Annulus Fibrosus:** Outer part of the disc, fibrous ring.
2. **Nucleus Pulposus:** Central part of the disc.
   - It is derived from notochord. It acts as a shock absorber and semifluid ball bearing.

SPINAL TAP:

- To draw a spinal tap, enter just *lateral to the spinous processes*, and penetrate the *ligamentum flavin* and then the dura levels.
- It is taken **between** Lumbar Vertebrae **L3 and L4** or between **L4 and L5.**

- Layers of Penetration to get to the CSF: Skin ---- > Subcutaneous Tissue ------> Supraspinous Ligament (tough) ..... >
  Interspinous Ligament----- > Ligamentum Flavum (perhaps tough)------> Extra Dural Space (fatty) ---------- > Dura Mater --
  --- > Arachnoid Mater (tough) ----- > Subarachnoid Space

CERVICAL ENLARGEMENT: A bulge in the spinal chord due to the extra fibers necessary to supply the Brachial Plexus for the upper limb.

LUMBAR ENLARGEMENT: A similar bulge in spinal chord due to the extra fibers necessary to supply the Lumbar Plexus for the lower limb.

CONUS MEDULLARIS: The end of the spinal chord, **after L1.** There are no more *cell bodies* past this point.

- **CAUDA EQUINA =** The "Horse's Tail," the long axons that run down the vertebral canal and supply the spinal levels past the Conus Medullaris. It is a collection of dorsal and ventral roots.
- This means that Thoracic and Lumbar nerves descend quite a bit before they exit their respective vertebral levels. Cervical nerves come out almost horizontally.
- The Dura Mater layer of the vertebral column ends between S1 and S2.

SPINAL CORD and SPINAL NERVES:

1. **Grey Matter:** Central butterfly-shaped portion containing cell bodies.
2. **White Matter:** On either side of the Grey-Matter. It is white because it contains myelinated nerve axons.
3. **Neural Horn:** The edges of the grey matter *within the spinal column.* There are two horns: dorsal and ventral.
   - Dorsal Horn: Relays mostly sensory signals, but it does not house the sensory cell bodies.
   - Ventral Horn: **Houses the majority of the** motor cell bodies.
4. **Neural Root:** The beginning of each spinal nerve as it exits the spinal column, *while it is still within the vertebra arch.* There are two roots: dorsal and ventral.
   - **Dorsal Root Ganglion:** *The* **sensory cell bodies** *are located within the Dorsal Root Ganglion,* which is in the Dorsal Root of the spinal column.
     - If we clip a dorsal root, we lose sensation but retain motor ability.
   - Ventral Root: Contains outgoing motor neurons, but not the cell bodies.
     - If we clip a ventral root, we only lose motor control but retain sensory ability.

MENINGES: "Membranes" -- layers of the brain and spinal chord covering. There are three membranous layers, maters, covering the CNS.

1. **Epidural Space:** Space between the dura mater and periosteum of the skull and vertebrae.
   - It contains fat, arteries, and lots of veins -- which can promote metastases.
   - **OB-GYN EPIDURAL:** Anesthetic commonly given for pain during childbirth. Given at the *sacral hiatus,* about 1 to 2 inches above the tip of the coccyx, to numb all the spinal nerves at that level.
   - Epidural Blocks will anesthetize every rootlet that passes distal to the block.
   - In the brain, the Epidural Space is a *potential space.* In the spinal chord, it is a real space.
2. **Dura Mater:** Tough layer lying *free* within the vertebral column. It is continuous with the cranial dura mater.
   - This is continuous with Dura Mater of brain and *Sclera of the eye.*
3. Subdural Space: A potential space not present under nonpathological conditions in the brain or spinal chord.
4. **Arachnoid Mater:** Thin, watertight layer, "spider-web-like"
5. Subarachnoid Space: **Contains the** CerebroSpinal Fluid (CSF)!
   - It also contains **Denticulate Ligaments,** structures that support the spinal column and keep it centered within the meninges.
6. **Pia Mater:** Unicellular layer directly adherent to the spinal chord.

BLOOD SUPPLY TO SPINAL CORD:

1. **Vertebral Artery:** Paired arteries that come off the subclavian, travel within the Foramina Transversaria, and travel through the Foramen Magnum into the brain.

2. **Anterior Spinal Artery:** A single artery given off from the vertebral artery at the brain stem. Supplies anterior 2/3 of spinal chord.
3. **Posterior Spinal Artery:** Two paired arteries.
   - Supplies posterior 1/3 of spinal chord.
4. **Radicular Arteries:** Branch off to local arteries at many spinal levels, providing *extensive collateral circulation* to the spinal column.[ARTERIA RADICULARIS MAGNA]

Internal Vertebral Venous Plexus: **Valveless venous drainage system, lying outside of the dura.**

- Drains superiorly into occipital sinus.
- Drains inferiorly into intervertebral veins and the *Azygos Venous System.*
- Some cancers (e.g. Prostate) tend to metastasize to the spinal chord via these venous plexuses.

SUBOCCIPITAL TRIANGLE: Formed by three muscles: Rectus Capitis Major, and Obliquus Capitis Inferior and Superior. It contains the **Vertebral Artery** and **Suboccipital Nerve,** which is the dorsal ramus of C1.

FACE:

THE FACIAL ARTERY supplies blood to the superficial structures of face.

1. The facial artery is one of the principle branches given off the *External Carotid.*
2. PATHWAY of Facial Artery:
   1. It is given off just deep to the angle of the mandible.
   2. It crosses the inferior border of the mandible *just anterior to the masseter muscle.*
   3. Once its on the anterior surface of the face, it goes up the cheek, past the angle of the mouth, and heads toward the *inner canthus* (medial corner) of the eye.
3. A **Facial Artery Pulse** can be palpated as the artery crosses the mandible just anterior to the masseter muscle.
4. BRANCHES of the Facial Artery:
   1. Superior Labial Branch **above mouth**
      - Has anastomoses with the Infraorbital Artery
   2. Inferior Labial Branch **below mouth**
   3. **Angular Artery** heads up to the nose
      - Has anastomoses with the Ophthalmic Artery
   1. Lateral Nasal Branch

SUPERFICIAL TEMPORAL ARTERY: **The terminal branch of the External Carotid.**

1. Goes straight up the temporal region of the skull.
2. Branches:
   1. Frontal Branch
   2. Parietal Branch.
   3. **Transverse Facial Artery** crosses Masseter muscle
3. Anesthesiologists use it to take a pulse. It is found just anterior to the ear, superficial to the zygomatic arch.

VEINS OF THE FACE:

1. Venous Channels:
   1. **Facial Vein** provides the major venous drainage ------> **Internal Jugular Vein.**
      - Facial vein is formed *from* the Supraorbital + Supratrochlear Veins -----> Angular Vein (comes down from medial canthus of eye) ------> Facial Vein.
      - Facial vein then joins with the Submental Vein to *lead to* the Internal and External Jugular Veins.
   2. **Retromandibular Vein** is formed by the union of the Superficial Temporal Vein and Maxillary Vein.
      - It then joins with the Posterior Auricular Vein to form the **External Jugular Vein.**
      - It also gives off a branch back to the facial vein------> Internal Jugular.

LYMPHATIC DRAINAGE:

1. **Parotid Nodes:** Superficial and deep set.
2. Submandibular Nodes
3. Retroauricular Nodes

- **Alar Ligament:** Hooks the dens process of C2 directly to the Occipital Condyles, and serves to *limit the rotation of the joint.*

THE SCALP AND CRANIAL FOSSA

SCALP: Cutaneous cranium superficial to the skull. Its layers fit the acronym SCALP:

1. **S**kin
2. **C**onnective tissue -- highly vascular
3. **A**poneurosis -- *Galea Aponeurotica* = dense connective tissue
   - This is continuous with the **Epicranius** muscle from all sides, consisting of *Frontalis* and *Occipitalis* muscles.
4. **L**oose connective tissue, upon which the aponeurosis glides
5. **P**eriosteum -- adherent to bony skull

SCALP LESION: The outermost connective tissue is highly vascular, and the loose connective tissue tends to hold cuts open, resulting in profuse bleeding of scalp. It is easily fixed with stitches

DANGER ZONE: If you get past the aponeurosis (i.e. from a cut), then you have hit the danger zone. Bacteria likes to breed in the loose connective tissue beneath the Galea Aponeurotica.

1. **Diploic Veins:** Veins in the cancellous bone of the skull. These are superficial veins. The Emissary Veins flow into them.
2. **EMISSARY VEINS:** *Communicate with the diploic veins superficially.* They run through the Loose-Connective Tissue Layer -- the DANGER ZONE.
   - If an infection gets in this area, it can easily be carried to the Cerebrospinal fluid via the Emissary Veins.
   - The general blood flow of these veins is *outward* -- out of the cranium.

ARTERIAL SUPPLY TO SCALP:

- From the EXTERNAL CAROTID, we have, from anterior to posterior:
  - Superficial Temporal Artery **anterior to ear o** Posterior Auricular Artery **posterior to ear o** Occipital Artery **back of neck**
- From the INTERNAL CAROTID, we have two branches, which anastomose with the External Carotid via both Facial Artery and Superficial Temporal:
  - **Supratrochlear Artery:** Frontal region medially o **Supraorbital Artery:** Frontal region laterally

CRANIAL FOSSA: The cranium is divided into three regions (fossae), according to the cranial lobes that each region houses.

1. **Anterior Cranial Fossa:** Houses frontal lobes.
   - Includes all of Frontal and Ethmoid bones, and the Lesser Wing of the Sphenoid.
2. **Middle Cranial Fossa:** Houses temporal lobes.
   - Includes the Greater Wing of the Sphenoid, Sella Turcica, and the majority of Temporal Bones.
3. **Posterior Cranial Fossa:** House occipital lobes, cerebellum, and medulla
   - Includes the Occipital bone.

DURAL FOLDS: Extensions of Dura Mater that subdivide the cranial cavity and give support to the brain, such as when bungee- jumping.

- **FALX CEREBRI:** Dural fold going sagittally between the cerebral hemispheres.
  - It connects anteriorly to the **Crista Galli** of the Ethmoid Bone and the **Internal Occipital Protuberance** posteriorly.
  - The *Superior Sagittal Sinus* is the superior limit of the Falx Cerebri, within the dura. o The *Inferior Sagittal Sinus* is the inferior limit of the Falx Cerebri, within the dura.
- **TENTORIUM CEREBELLI:** Lateral dural fold separating the cerebrum from the cerebellum.

- The Falx Cerebri holds it down posteriorly, where they intersect. o The *Transverse Sinus* runs through it posteriorly. - The *Superior Petrosal Sinus* runs through it anteriorly.

- **INCISURA TENTORIA:** The hole in the Tentorium Cerebelli that allows the cerebrum to communicate with the cerebellum.

- **DIAPHRAGMA SELLAE:** Small donut-shaped dural fold covering the Pituitary Gland, at the *Sella Turcica* of the Sphenoid Bone.

DURAL SINUSES: Venous sinuses which drain all blood from the brain. They are formed within the **dura mater** layer of the meninges. The Dura Mater splits into two layer in the cranium: A Periosteal (outer) Layer and a Meningeal (inner) Layer. **The dural sinuses form between them.**

1. **SUPERIOR SAGITTAL SINUS:** Runs within superior aspect of the Falx Cerebri.
   - **ARACHNOID VILLI:** Granulations from the Arachnoid Mater project into this sinus, providing a way to **empty CerebroSpinal Fluid into the Superior Sagittal Sinus.** *This is how we recycle cerebrospinal fluid (CSF).*
   - It drains into the CONFLUENCE OF SINUSES----- > TRANSVERSE SINUS
2. **INFERIOR SAGITTAL SINUS:** Runs within the inferior aspect of the Falx Cerebri.
   - It joins the GREAT VEIN OF GALEN to form the Straight Sinus.
   - From there Blood Drainage is as follows: STRAIGHT SINUS----- > TRANSVERSE SINUS
   - The Sigmoid Sinus also communicates with the Internal Vertebral Venous Plexus.

o All of Cranial Nerves III - VI, except V3

■ All of the above run, in numerical order, along the *lateral wall of the cavernous sinus* from superior to inferior, EXCEPT for the **Abducens Nerve (VI)** which runs directly through the cavernous sinus. o **The Internal Carotid Artery.** This is also completely surrounded within the Cavernous Sinus.

- The Sphenoidal Paranasal Sinus, in the sphenoid bone, is inferior and medial to the cavernous dural sinus.
- SPHENOID FRACTURE: A fracture at the base of the sphenoid could produce a bone fragment that could sever the internal carotid in cavernous sinus > dural hematoma.

MENINGEAL ARTERIES: Arteries that *supply the meninges and bone* -- not the brain per se.

1. **Middle Meningeal Artery** is a branch off the first part of the Maxillary. It is the principle supplier to the dura.
2. Anterior Meningeal Artery
3. Posterior Meningeal Artery

HEMATOMA: Bleeding within and around the meningeal layers

1. **EPIDURAL HEMATOMA:** Middle Meningeal Artery is easily cut with a skull fracture. This will put pressure in the epidural space and smush the brain.
   1. Flow of blood will go through dura superficially. The extent of the hematoma is limited by suture lines.
2. **SUBDURAL HEMATOMA:** Blood flow will not stop at the skull sutures in this case. However, hematoma usually will not cross the midline.
3. **SUBARACHNOID HEMATOMA:** Blood in this space intermixes with CSF and can lead to headache, stiff neck, and loss of consciousness.
   1. Unlike the ones above, *these are very painful.*
4. **INTRACEREBRAL HEMORRHAGE:** Results in death or paralysis by stroke.

INTERNAL CAROTID ARTERY: Major supplier of blood to the brain.

1. PATHWAY: Common Carotid ------- > Internal Carotid------> Into the **Foramen Lacerum------**> medially to Carotid canal ---------- > then Anteriorly *through Cavernous Sinus*----------> Then superiorly again.

CIRCLE OF WILLIS: The anastomotic arterial connections supplying the cranial cavity. The two main supplies to the brain are the *Internal Carotid* and *Vertebral Arteries*, and they communicate through the Circle of Willis

- Branches of the VERTEBRAL ARTERY

- Both Left and Right Vertebrals give off **Posterior Inferior Cerebellar** arteries
- Then the two Vertebral Arteries converge to form the singular **Basilar Artery**
- Basilar Artery gives off the **Anterior Inferior Cerebellar** and **Superior Cerebellar** arteries.
  - The Basilar Artery then becomes the **Posterior Cerebral Artery.**

- **POSTERIOR COMMUNICATING ARTERY** connects the Posterior Cerebral (from Basilar) to the Internal Carotid Artery. This is the **major anastomosis between the Carotid and Vertebral arterial channels.**
- Branches of the INTERNAL CAROTID
  - Middle Cerebral Artery
  - Anterior Cerebral Artery
- *ANTERIOR COMMUNICATING ARTERY:* **Connects the Anterior Cerebral Arteries to each other. This is the** major anastomosis of the Right and Left Internal Carotids with each other.

THE EYE AND ORBIT

Gross Morphology Eyeball:

1. External Features:
   - **CONJUNCTIVA:** Outermost membranous layer covering both the eye and eyelid.
     - **Palpebral Conjunctiva:** Conjunctiva covering eyelid.
     - **Bulbar Conjunctiva:** Conjunctiva covering eyeball.
     - **Superior Conjunctival Fornix:** Superior limit of conjunctival layer, between eyelid and eyeball.
     - **Inferior Conjunctival Fornix:** Inferior limit of conjunctival layer, between eyelid and eyeball.
   - **CANTHUS:** Medial and Lateral. The two corners of the eye, where the upper and lower eyelids meet.
2. Outer Layer of Eyeball
   - **BULBAR SHEATH (TENON'S CAPSULE):** A connective-tissue capsule enclosing the eye, right outside the sclera of the eye.
     - **Medial and Lateral Check Ligaments:** These ligaments are extensions of the Bulbar Sheath. They connect to the medial and lateral *periorbita* (periosteum) of the orbit, to hold the eyeball in place.
   - **SCLERA:** *Dense white connective tissue* continuous with the dura mater of the optic nerve and brain.
     - *o* The oculomotor muscles insert into the sclera.
   - **CORNEA:** The clear central part of the sclera, anterior to the pupil and iris. The cornea is continuous with the sclera.
     - The cornea is avascular, but there are pain fibers from the Ophthalmic N. (V^1)
     - The cornea receives O_2 from the air, thus contact lenses should be gas permeable.
     - Cornea transplants can be done successfully, because the cornea is an *immunologically privileged* site.
   - **ANTERIOR CHAMBER** between the cornea and the iris, filled with **Aqueous Humor.**
   - **CANAL OF SCHLEMM:** Drains the aqueous humor out of the anterior chamber into the venous blood.
3. Middle Layer of Eyeball
   - **CHOROID:** Highly vascular compartment (containing ciliary arteries), sitting between the sclera and the retina proper.
   - **PUPIL:** The opening of the iris, which allows light into the eye.
   - **IRIS:** Pigmented part of the eyeball, surrounding the pupil.
     - Contains the two intrinsic ciliary muscles: *Dilator Muscle* (sympathetic) and *Sphincter Muscle* (parasympathetic)
   - **LENS:** The lens is deformable and has a **natural curvature** which is modulated by zonular fibers and ciliary muscle.
     - **Presbyopia:** The loss of the ability of accomodation. The lens becomes less elastic with old age, resulting in far-sightedness.

- The more the lens is rounded up, the closer up it can focus, in a gist.

- **CILIARY BODY:** *Produces aqueous humor,* which is secreted into the anterior chamber.
- **CILIARY MUSCLE:** It surrounds the lens and is connected to the lens through **zonular fibers.**
  - It contracts zonular fibers---------> allow lens to increase its natural curvature ------> **accomodation** for near- vision.
- **ZONULAR FIBERS:** Also known as *Suspensory ligaments of the lens,* they connect the lens to the ciliary bodies on either side.
  - Tension of zonular fibers make the lens slightly **flattened,** to allow it to gaze at distant objects. o **ACCOMMODATION:** Contraction of the ciliary muscle to view close-up objects.
    - ■ Ciliary muscle contracts--------- > Zonular fibers *lose tension* by pulling toward the anterior chamber of the eye -------> the lens *increases its curvature* due to its natural inherent elasticity--------> light is more highly refracted ------ > **close-up objects** come into focus.

4. Inner Layer of Eyeball:
   - **VITREOUS BODY:** Filled with gelatinous proteoglycans, vitreous humor, in the posterior chamber of the eye.
   - RETINA
     - NEURAL RETINA **o** PIGMENTED RETINA

Gross Morphology of the Eyelid:

1. CILIA: Eyelashes.
   - CILIARY GLANDS: *Sebaceous Glands* that lubricate the eyelashes.
     - o **Sty:** Infection of the sebaceous ciliary glands, usually resulting from obstruction.
2. TARSAL PLATE: Connective tissue core of the eyelid.
   - Two muscles insert on the tarsal plate to control the eyelid:
     - *o* Tarsal Muscle (smooth) o Levator Palpebrae Superiores
   - *Palpebral part of Orbicularis Oculi* also helps to raise the eyelid, but its insertion is superior to the tarsal plate.
   - **Medial and Lateral Palpebral Ligaments:** Connect the tarsal plate to each wall of the orbit.
   - TARSAL GLANDS: Secrete fatty lubricants the keep the eyelids from sticking to each other.
     - **Chalazion:** An infection of the tarsal glands.

THE ORBIT:

1. Borders:
   - Superior: Frontal bone and small part of Lesser Wing of the sphenoid
   - Lateral: Greater wing of the sphenoid and frontal process of the Zygomatic bone
     - o Lateral walls ae almost 90 from each other.
   - Medial: Orbital lamina of the ethmoid bone and lacrimal bones.
     - o Medial walls approximately parallel to each other.
   - Inferior: Maxillary bone.
2. FORAMINA associated with the orbit:
   - **SUPERIOR ORBITAL FISSURE:** Between the lesser and greater wings of the sphenoid bone.
     - *o It transmits the* Superior Ophthalmic Vein.
     - o It transmits *all innervation to the orbit, EXCEPT the Optic Nerve (II):* Oculomotor (III), Trochlear (IV), Opthalmic (V^1), and Abducens (VI)
   - **OPTIC CANAL:** In the Lesser Wing of Sphenoid, superomedial to the superior orbital fissure.
     - o It transmits the *Optic Nerve (II)*
     - *o* It transmits the *Ophthalmic Artery*, a branch from the Internal Carotid.
   - **INFERIOR ORBITAL FISSURE:** Carries the *Maxillary Nerve (V^2)* along the bottom surface of the orbit.

- **INFRAORBITAL FORAMEN:** The lower medial corner of the orbit, in the orbital part of the maxillary bone.
  - *It transmits the* Infraorbital Nerve (V^2) out of the orbit.
  - It transmits the *Infraorbital Artery* -- an anastomotic branch between the Angular and Maxillary Aa. (both of which are off the External Carotid).
- **ETHMOID FORAMEN:** Anterior and posterior foramina in the medial wall, transmitting structures that are going from orbit to the ethmoid air sinuses and nose:
  - Anterior and Posterior Ethmoid Arteries, *from Opthalmic Artery o* Anterior and Posterior Ethmoid Nerves, *from Nasociliary Nerve (V^1)*

COMMON ANNULAR TENDON: The common ring-shaped origin of the extrinsic eye muscles. It surrounds both the Optic Canal and Superior Orbital Fissure.

- The common tendon actually sits *medial* and not exclusively posterior to the eyeball.
- All four rectus muscles originate from the tendon itself.
- The two oblique muscles have origins near the tendon but not in it.

THE H-TEST: Explains the function of the extrinsic eye-muscles. To test for functionality of all muscles (and therefore cranial nerves III, IV, and VI), have the patient look to the left and right, and then up and down.

FUNDUS OF THE EYE: What you see looking through an ophthalmoscope.

Arterial Supply to the Eye: **OPHTHALMIC ARTERY** provides almost all blood supply to the eye. It is the first branch off the Internal Carotid, and it enters through the Optic Canal. It's branches:

1. **Posterior Ciliary Arteries**------ > choroid layer behind the eye, but not the retina.
2. Supraorbital Artery
3. Supratrochlear Artery
4. Lacrimal Artery
5. Anterior and Posterior Ethmoidal Arteries
6. **CENTRAL RETINAL ARTERY:** The *only blood supply to the neural retina.* It pierces the dura mater of the optic nerve to supply the neural retina.
   - It branches at the optic disc of the retina.
   - Loss of blood supply from the central retinal results in blindness.

VENOUS DRAINAGE: **Superior and Inferior Opthalmic Veins** drain the eye. They join *before* the Superior Orbital Fissure — -- > through the superior orbital fissure > facial vein AND cavernous sinus / Pterygoid Plexus.

- Thus once again the ophthalmic veins provide a crucial (and dangerous) anastomosis between the face and cranial cavity.

CLINICAL PROBLEMS ASSOCIATED WITH THE EYES:

- **Stye:** Sebaceous glands of the eyelashes become blocked and infected.
- **Chalazion:** Blockage of one of the tarsal glands, resulting in a lump in the eyelid.
- **Conjunctival Hyperemia:** Bloodshot eyes. Local irritation yields high perfusion in the *bulbar conjunctiva* of the eye.
- **Conjunctivitis:** Pink-eye. Inflammation of the conjunctiva.
- **Glaucoma:** Excessive pressure within the eye.
  - o *Closed-Angle Glaucoma* is due to blockage of fluid from the Canal of Schlemm (aqueous humor can't drain).
  - o Intraocular pressure is tested by blowing a high-pressure jet of air on the eyeball and measuring the deformity of the cornea.
- **Exophthalmos:** Bulging eyes, usually resulting from Grave's Disease. This is due to extra body in extrinsic eye muscles.
  - o It can also result from internal carotid rupture in the cavernous sinus.
- **Cataract:** A loss of transparency of the lens, common in old age.
- **Papilledema:** *Excessive CSFpressure* causing the optic disc to swell, causing venous blood to pool on the surface of the retina.
  - *o This can be diagnosed* with an ophthalmoscope.
- **Venous Nicking:** *High blood pressure* causes opthalmic arteries to swell, which in return restricts venous return.

o The arteries and veins "cross" each other, so swelling of the arteries impedes on the veins. o This again can be seen *with an ophthalmoscope.*

- **Horner's Syndrome:** Loss of sympathetic innervation to the head. Its effects on the eyes are as follows:
  - o *Ptosis* -- Upper eyelid droops.
  - o *Anhydrosis* -- No sweat above the neck.
  - o *Miosis* -- Constriction of pupil from unchecked parasympathetics.

THE TRIANGLES OF THE NECK

BONY LANDMARKS OF NECK:

- **HYOID BONE:** Suspended in space by the hyoid muscles. Right below the floor of the mouth.
- **THYROID CARTILAGE:** It forms the **Laryngeal Prominence,** or Adam's Apple, overlying the Thyroid Gland and Larynx.
- **CRICOID CARTILAGE:** Cartilaginous ring right below the Thyroid Cartilage.

FASCIAL LAYERS OF THE NECK:

1. **Investing Fascia:** Outermost layer below skin. Encloses the *Sternocleidomastoid* and *Trapezius* muscles.
2. **Pretracheal Fascia:** Anterior to the spine, completely enclosed within investing fascia. Contents:
   - Thyroid Gland
   - Trachea
   - Esophagus
3. **Prevertebral Fascia:** Enclosing the musculature surrounding the spine.
4. **Carotid Sheath:** Completely enclosed within investing fascia, on either side of the pretracheal fascia. Contents:
   - Common Carotid Artery
   - Internal Jugular Vein
   - Vagus Nerve
5. **Retropharyngeal Space:** Potential space between the pretracheal fascia and prevertebral fascia.

POSTERIOR TRIANGLE OF THE NECK: That region posterior to the Sternocleidomastoid muscle, and anterior to the Trapezius.

1. *DANGER ZONE:* That part of the posterior triangle inferior to the Spinal Accessory Nerve. It contains:
   - The Spinal Accessory Nerve (XI)
   - Brachial Plexus
2. **VEINS OF POSTERIOR TRIANGLE:** EXTERNAL JUGULAR VEIN = **The union of the** Retromandibular **and** Posterior Auricular Veins
   - Eventually pierces investing fascia but not prevertebral fascia.
   - It can fill and become visible from holding breath, or from congestive heart failure.
   - Most of the facial veins drain into the external jugular.
   - **Transverse Cervical** (from back of danger zone) and **Suprascapular veins** drain into External Jugular.

CERVICAL PLEXUS. Formed from ventral primary rami of cervical vertebral levels. All of below come off of Cervical Plexus and *penetrate investing fascia of the posterior triangle,* but not superficial fascia.

1. A set of cutaneous nerves from this plexus **penetrate the investing fascia** in this region, to innervate the posterior triangle.
2. Lesser Occipital Nerve:
   - *The Greater Occipital Nerve is* not from the Cervical Plexus, as it is from the Dorsal Primary Ramus *of C1.*
   - It runs along the posterior of the Sternocleidomastoid muscle.
3. **Great Auricular Nerve** -- runs along the External Jugular.
4. Transverse Cervical Nerve
5. Supraclavicular Nerve
6. **Phrenic Nerve:** *Runs* on top of (adhered to) the anterior scalene muscle
7. **ANSA CERVICALIS:** Originates from C1-C3. Supplies motor innervation to the strap muscles.
   - *It* surrounds the Carotid Sheath.

Superior Root: Some branches of the **Hypoglossal Nerve (XII)** get mixed up with Ansa Cervicales C1 fiber ..... > innervate the Geniohyoid muscle.

o As a result, parts of the *superior root tag along the Hypoglossal to get to the strap muscles. o* These muscles tag along as the nerve enters back through the Hypoglossal Canal.

- **Inferior Root,** containing lower cervical levels.

BRACHIAL PLEXUS: *Travels* between the Anterior and Middle Scalene muscles *to reach the axilla.*

• CERVICAL RIB: The presence of a "cervical rib" coming out above T1 at C7 can impinge on the Brachial Plexus and/or the Subclavian Artery, causing problems.

ANTERIOR TRIANGLE OF THE NECK: The anterior region of the neck, between the two heads of the Sternocleidomastoid.

1. SUBMANDIBULAR TRIANGLE
   - Borders:
     o Posterior belly of Digastric: *Lateral border*
     o Anterior belly of Digastric: *Medial border*
     o Mandible: *Superior border*
   - Contents:
     o Facial Artery
     o Hypoglossal Nerve (XII)
     o Submandibular Salivary Glands
     o Muscles: Digastric, Mylohyoid, Hyoglossus
2. CAROTID TRIANGLE
   - Borders:
     o Superior Belly of the Omohyoid: *Medial Border*
     o Posterior Belly of the Digastric: *Superior Border*
     o Sternocleidomastoid: *Lateral Border*
   - Contents: This triangle overlies the **Bifurcation of the Carotid.** It contains the Carotid Sheath, as well as the external jugular vein outside of the carotid sheath.
   - Layers: As you cut through the Carotid Triangle, you find the following in order from superficial to deep:
     - **External Jugular Vein,** outside of investing fascia o Investing Fascia o **Carotid Sheath:**
       - **Internal Jugular Vein** is *superficial and lateral* to the common carotid.
       - Common Carotid Artery
3. SUBMENTAL TRIANGLE
4. MUSCULAR TRIANGLE:
   - Borders:
     o Superior Bellies of the Omohyoid *Lateral borders o* Midline of the neck: *Medial borders*
   - Contents: **The Strap Muscles** -ARTERIES OF THE NECK:

• BRANCHES OF THE EXTERNAL CAROTID: Following is a complete list of principle branches off the External Carotid.

o 3 anterior branches
- **Superior Thyroid Artery** -- Thyroid gland and part of anterior neck
- Lingual Artery **-- to tongue**
- **Facial Artery** o 1 medial branch
- **Ascending Pharyngeal Artery** -- to pharynx o 2 posterior branches
- **Occipital Artery** -- back of neck and behind ear
- Posterior Auricular Artery **-- behind and around ear o 2 terminal branches -- External Carotid ends as these two terminal branches**
- **Maxillary Artery** -- goes onto palate, nose, infraorbital region
- **Superficial Temporal Artery** -- blood supply to temporal scalp

- **THE THYROCERVICAL TRUNK:** Comes directly off the Subclavian.
  o Inferior Thyroid Artery **-- not the Superior Thyroid! o** Transverse Cervical Artery **o** Ascending Cervical
- COSTOCERVICAL TRUNK -- Comes off Subclavian and gives off a Deep Cervical Artery which goes to anastomose with the Occipital Artery.

THE NOSE AND PARANASAL SINUSES

External Features:

- Septal Cartilage: Continuation of the vertical plate of the ethmoid bone.
- Lateral Nasal Cartilage: Spawning laterally from each side of the septal cartilage.
- Great Alar Cartilage: **U-shaped, each with a** lateral and nasal crus, **defining the** nares **(nostrils).**

BONES OF NASAL CAVITY:

- ETHMOID BONE
  - o **Perpendicular Plate** forms the superior part of nasal septum and articulates with **septal cartilage.**
  - o **Cribriform Plate:** Transverse plate forming the superior border of the nasal cavity, and containing **cribriform foramina** through which Olfactory nerves pass.
- VOMER: The posteroinferior border of the nasal septum.
  - o It articulates with the **Nasal Crests** of the Maxilla and Palatine bones.
- LACRIMAL BONES: Paired bones forming part of the Middle Meatus of each nostril. The *lacrimal sacs* are opposite these bones.

OLFACTORY APPARATUS: There is a *ciliated mucous membrane* at the *top* of the nasal cavities, along the lateral and medial walls.

- The cell bodies of the **Olfactory Nerves (I)** actually sit *within the* **Olfactory Mucosa** on the superior part of nasal cavity.
- The nerves go through foramina in the **Cribriform Plate** to **Olfactory Tracts** on the other side.

CONCHAE BONES (TURBINATES) and NASAL OPENINGS: All openings come out of the *lateral wall* of each septum. Conchae provide for *increased surface area and turbulence* for humidifying and "mixing" the air we breathe.

- **Sphenoethmoidal Recess:** Superior to the Superior Conchae, in the posterosuperior portion of the nasal cavity.
  - **o It contains the opening of the** Sphenoid air sinus.
    - The Sphenoid Air Sinus drains into two bilateral *Sphenoid Ostia* on either side of the recess in the nasal cavity.
- SUPERIOR CONCHAE: An extension of the ethmoid bone coming out of the lateral wall of the nasal cavity.
- SUPERIOR MEATUS: Recess between superior conchae and middle conchae.
  - **o It contains the opening of the** Posterior Ethmoid air sinus.
- MIDDLE CONCHAE: An extension of the ethmoid bone coming out of the lateral wall of the nasal cavity.
- MIDDLE MEATUS: Recess between middle conchae and inferior conchae.
  - o **Ethmoid Bulla:** Raised portion of ethmoid bone in middle meatus.
    - It contains the *opening of the* **Middle Ethmoidal air sinus,** but this is variable.
      - These "air cells" are a series of little openings for the Ethmoid Sinus going through the Ethmoid Bulla of the ethmoid bone. o **Semilunar Hiatus:** The opening just anteroinferior to the Ethmoid Bulla.
    - **It contains the opening of the** Maxillary Sinus.
    - It contains the *opening of the* **Anterior Ethmoidal air sinus** *o* **Infundibulum:** At the anterosuperior end of the semilunar hiatus.
    - It contains the *opening of the* **Frontal Sinus.**
  - *o* **Uncinate Process:** The anteroinferior edge of the semilunar hiatus.
  - o **Sphenopalatine Foramen:** It is located directly behind the middle meatus, in the posterosuperior part of nose, right in front of Sphenoid air sinus.
- INFERIOR CONCHAE: A *separate bone* attached to the lateral wall of the nasal cavity.

- INFERIOR MEATUS: Recess between inferior conchae and *palatine process* (hard palate) of Maxilla.
  - **o It contains the opening of the** Nasolacrimal Duct.

ARTERIAL SUPPLY TO THE NOSE and NASAL CAVITY:

- ANTERIOR AND POSTERIOR **ETHMOID ARTERIES:**
  - o Both of them come from the Internal Carotid via the Ophthalmic Artery.
  - o The Ethmoid Arteries leave the orbit through anterior posterior ethmoid foramina in the cribriform plate of the ethmoid bone.
  - **o After leaving the orbit, they travel** through the anterior cranial fossa, underneath the dura before going through the Ethmoid Foramina.
  - *o* That means that overall blood supply from the internal carotid is as follows:

Internal Carotid Artery ----------- >

Middle Cranial Fossa ---- > Optic Canal ---- > **Opthalmic Artery ------> Ethmoid Arteries** ---------- > through anterior posterior ethmoid foramina in cribriform plate --- > *Anterior Cranial Fossa* ---- > *Anterior and* Posterior Ethmoid Foramen -------> *Nasal Cavity*

- o Both of the Ethmoid Arteries divide into *septal and lateral branches,* to supply the medial and lateral walls of the nasal cavity.
- Principle Blood Supply to NOSE:
-
  - o INFERIOR 1/3 OF NOSE -- External Carotid:
    - Facial Artery------> Angular Artery ----- > **Lateral Nasal Artery**
    - **Sphenopalatine Artery -- >** Posterior Lateral Nasal Arteries
    - Sphenopalatine Artery -----> **Posterior Septal Artery**
    -
  - o SUPERIOR 1/3 OF NOSE -- Internal Carotid: Ophthalmic Artery ------- > **Dorsal Nasal Artery** > bridge of the nose.

- Additional Blood Supply to NOSE: This covers the INFERIOR 2/3 OF NOSE with additional blood supply.

o Internal Carotid----------> Ophthalmic Artery ----- > Anterior Ethmoidal Artery ------> Lateral Branch of Anterior **Ethmoid Artery ----->** External Nasal Artery

o External Carotid----------> Maxillary Artery ----- > **Infraorbital Artery**

- Principle Blood Supply to the NASAL CAVITY:
  - o **Anterior Ethmoidal Artery,** from Opthalmic, is the largest contributor.
  - o **Posterior Ethmoidal Artery** contributes a little less in the posterior region.
  - o **Sphenopalatine Artery** is a terminal branch of the Maxillary Artery: Maxillary ------- > **Sphenopalatine Foramen** ------>Sphenopalatine Artery------> Lateral and Septal branches
- INTERNAL/EXTERNAL CAROTID ANASTOMOSES IN THE NOSE:
-

o **Angular Artery** (from Facial) **<====> Dorsal Nasal (aka Infratrochlear) Artery** (from Ophthalmic) o Lateral and Septal Branches of **Ethmoid Arteries** (from Ophthalmic) <====> Lateral and Septal Branches of **Sphenopalatine Artery** (from Maxillary)

SPHENOPALATINE FOSSA: The sphenopalatine fossa houses the sphenopalatine ganglion. Underneath the Zygomatic Arch, from lateral to medial, we have:

- Temporal Fossa: Home of the Temporalis muscle.
- Infratemporal Fossa: Home of the principle branches of the Maxillary Artery
- Sphenopalatine Fossa: Home of the Sphenopalatine Ganglion. Boundaries of Sphenopalatine

Fossa is as follows:
- Posteriorly: Lateral plate of Pterygoid o Anteriorly: Maxillary bone o Medially: Palatine bone o Laterally: open

INNERVATION OF THE NASAL CAVITY:

- **Nasopalatine Nerve:** From Maxillary (V2).

o It is given off at the Sphenopalatine Ganglion.
o It carries sympathetics from the **Deep Petrosal Nerve** and parasympathetics from the **Greater Petrosal Nerve** o It enters the nose through the **Sphenopalatine Foramen,** where it gives off lateral and septal branches to provide *visceral motor (GVE)* innervation to the nasal mucosa.

- Sympathetic (deep petrosal) = inhibition of nasal mucosa
- Parasympathetic (greater petrosal) = secretomotor stimulation of nasal mucosa

o It will continue down **Septal Wall** of nose, through the **Incisive Foramen,** right behind the incisors (front teeth). There it will provide sensory innervation to the anterior portion of the hard palate.

- **Anterior Ethmoid Nerve:** Provides sensory innervation to internal nose, plus some innervation to external nose.
  - **o It divides into** Medial and Lateral Internal Nasal Nerves.
- **Infraorbital:** From Maxillary (V2), provides some sensory innervation to inferior part of external nose via External Nasal branches.
  - o The Infraorbital may anastomose with the **Infratrochlear,** from Ophthalmic (V1), over the surface of the nose. o So, the external surface of the nose potentially has dual innervation.

THE PARANASAL SINUSES:

- DEVELOPMENT:
  - o Sinuses develop as evaginations of the nasal mucosa. Consequently they have mucous membrane that is continuous with the nasal mucosa. o Newborns generally do not have sinuses.
- NASAL MUCOUS:
  - o Mucous can buildup in the sinuses from swelling, this tends to plug the area around the opening of the sinuses into the nose (i.e. the Middle Meatus) and impede on the passage of air through the nose as well. o **Cilia** of mucosal cells will trap particles in the air as it passes through the turbinates (conchae).
    - The cilia push the mucous toward the nasopharynx, and we end up swallowing the stuff.
    - If there is overload, the cilia can't push all of it and we get a runny nose.
- The Four Sinuses:

O Frontal Sinus
o Sphenoid Sinus
o Ethmoid Sinus
o Maxillary Sinus

- **Maxillary Sinus** is the "Achilles Heel" -- the only sinus whose *opening is superior to the sinus itself,* such that it can't easily drain into the nose due to gravity itself.
  - o This is why, when you lay on one side of your body with a cold, you tend to clog the "downhill" side of your nose.

CLINICAL STUFF ABOUT THE NOSE AND PARANASAL SINUSES:

- **Nose Bandages:** Worn across the bridge, they are supposed to help the nasal aperture open, to aid the intake of air.
- **KIESSELBACH'S (LITTLE'S) PLEXUS: Nose Bleeds.** The plexus is located in the vestibule of the nose, on the nasal septum. It is an anastomotic network of four blood vessels, and nosebleeds are especially common in the area:
  - **o Septal Branch of the** Superior Labial Artery **o Septal Branch of the**

Anterior Ethmoid Artery **o**
Sphenopalatine Artery
o **Greater Palatine Artery** branched which sneak up through the incisive canal.

- **Runny Nose:** Overload or backflow of mucous in the nose, resulting basically from too much mucous.
- **SINUSITIS:** Inflammation of the sinuses. Very common.
  - o Typically a bacterial infection. o Diagnostic Findings with sinusitis:
    - **Transillumination** = x-ray technique to visualize the sinuses and see whether they are filled with mucous.
    - Purulent Nasal Discharge
    - Sinus Tenderness
  - o Symptoms: Typical of a cold -- runny nose, headache, facial pain, cough.
  - o REFERRED PAIN: Where the pain is can indicate which sinus is inflamed:
    - Maxillary Sinus: Upper teeth or alveolar pain (this could also be a dental problem, however)
    - Frontal Sinus: Headache in forehead and around eyes
    - Sphenoid Sinus: Headache on forehead and on top of head
    - Ethmoidal Sinus: Headache in lateral portion / temporal region.
  - o A *deviated septum* or *misplaced turbinates* may cause **chronic sinusitis.** Endoscopic surgical intervention is one form of treatment.
- **Rhinorrhea:** Leakage of CSF out of the nose. Most typically the result of severe trauma.
  - o Probably from a ruptured cribriform above the ethmoid air sinus, exposing dura of the anterior cranial fossa.
  - o You can do a lumbar puncture and inject flourescent dye into the CSF, to localize source of the leakage.
- **Broken Nose:** Generally a fracture of the nasal bones (the bridge), or the articulation of the nasal bones with the nasal cartilage.
  - o Treatment: Anesthetize and insert a speculum into the nose to push to septum over while finger is used to push the nasal bones over. It may be painful no matter what due to rich nerve supply.

THE MOUTH AND ORAL REGION

Stratified Non-Keratinized Epithelium: Is on the inner surface of the lip.
Stratified Keratinized Epithelium: Is the gingiva attached to the teeth, more tightly bound than that of the lip, but continuous with it.
Ducts into the Mouth:

- **Submandibular Duct:** Two openings sublingually on either side of the lingual frenulum.
- **Sublingual Duct:** A series of openings under the tongue, spreading laterally from the submandibular ducts.
- **Parotid Duct:** *Opens on the side of the mouth,* opposite the second molar tooth.

THE MANDIBLE:

- **Mylohyoid Line:** On inner surface of mandible, a point of attachment of the Mylohyoid muscle. It runs from Symphysis Menti to the area around third molar.
- **Submandibular Fossa:** The region below the mylohyoid line, containing the submandibular salivary gland.
- **Mental Spines:** Attachments of geniohyoid muscle.
- **Lingula:** Overhanging the mandibular foramen, it is the attachment of the sphenomandibular ligament.
- **Mandibular Foramen:** Transmits inferior alveolar nerve, artery, and vein, just under the lingula.

TEMPOROMANDIBULAR JOINT: **The articulation of the head of the** condylar process of mandible **with** zygomatic process of temporal**..**

- Two types of movement at TMJ Joint:

o **Hinge Movement:** Occurs between the head (condyle) of the mandible and the **inferior surface** of articular disc.

o **Gliding Movement:** Occurs between temporal bone and the **superior surface** of the articular disc.

- **DISLOCATED JAW:** The condylar process of mandible slides anterior to the articular tubercle of the temporalis, locking the jaw open.
  - o Treatment: Protect the teeth (and your fingers) and push down on the mandible, and it will forcefully snap back into place.
- Ligaments:
  - o **Lateral Temporomandibular Ligament:** More or less just a thickening of the articular capsule. o **Sphenomandibular Ligament:** Goes from spine of sphenoid bone to lingula of the mandible. Helps limit the forward motion of the mandible. o **Stylomandibular Ligament:** Styloid Process <====> Angle of Mandible Helps limit the forward motion of the mandible.

MANDIBLE & TEMPOROMANDIBULAR JOINT

- Formed by intramembranous ossification of membranous tissue around Meckel's cartilage (cartilage of I pharyngeal arch). The ossification center appears near mental foramen about 6 th.week in utero.Condyle of mandible and anterior border of coronoid process may ossify in cartilage.

- FRACTURES OF MANDIBLE :
  In order of frequency
  1. Most common site is Neck of the condyle.
  2. Angle of mandible through last molar tooth.
  3. Body of mandible in the region of socket for canine tooth –parasymphyseal region
  4. Coronoid process
  5. Ramus of mandible

Most often fractures occur at two of these sites frequently on opposite sides; isolated fractures are relatively unusual.

- TEMPOROMANDIBULAR JOINT :

Synovial, bicondylar joint ;fibrocartilaginous articular disc separates joint cavity into two compartments.

Ligaments :-

1. Lateral or temporomandibular ligament
2. Sphenomandibular ligament – remnant of I pharyngeal arch cartilage (Meckel's cartilage)
3. Stylomandibular ligament – thickened part of investing layer of deep cervical fascia which separates the submandibular & parotid glands.
4. Articular disc –No blood supply and no nerve supply except the posterior bilaminar extension of the disc which has a venous plexus .

Movements & Muscles producing them :-

Movement	Muscles
DEPRESSION	Lateral pterygoids, Digastrics, Geniohyoids, Mylohyoids and Gravity.
ELEVATION	Masseter, Temporalis and Medial pterygoid of both sides.
PROTRUSION	Lateral pterygoid & medial pterygoid of both sides acting together
RETRACTION	Posterior fibers of Temporalis and deep fibers of Masseter.
SIDE TO SIDE, CHEWING	Lateral & medial pterygois acting alternatingly

MANDIBULAR FORAMEN: Inferior Alveolar Nerve, Artery, and Vein enter it to gain access to lower teeth. Located on inner surface of mandible, right under the Lingula.

- Dentists will often inject anesthesia right here, to numb the inferior alveolar nerve.
- They find the location of the mandibular foramen by using visual cues to locate the *lingula* on the interior of the mandible.

INFRATEMPORAL FOSSA: The region between the zygomatic arch of the temporalis and the lateral pterygoid plate of the sphenoid.

BOUNDARIES :

ROOF : - Infratemporal surface of greater wing of sphenoid bone
A small part of squamous temporal

MEDIAL:-Lateral pterygoid plate
Pyramidal process of palatine bone

LATERAL :- Inner surface of ramus of mandible

ANTERIOR:- Posterior surface of body of maxilla

- The fossa is open inferiorly and posteriorly.

COMMUNICATIONS :

Middle cranial fossa _ Foramen Ovale , Foramen Spinosum
Temporal fossa _ Gap between zygomatic arch & side of skull
Pterygopalatine fossa – Pterygomaxillary fissure
Orbit – Upper part of pterygomaxillary fissure & inferior orbital fissure

CONTENTS : Mandibular nerve & its branches, Chorda tympani nerve, Otic ganglion , I & II parts of maxillary artery and branches, Pterygoid venous plexus, lower end of temporalis, lateral & medial pterygoid muscles and a part of parotid gland.

PTERYGOPALATINE FOSSA is medial to the Infratemporal Fossa, in the region of the pterygoid plates. The following structures can be found there:
Pyramidal shaped space below the apex of the orbit and medial to infratemporal fossa.

COMMUNICATIONS :-

Middle Cranial Fossa – Foramen Rotundum
Infratemporal fossa – Pterygomaxillary fissure
Orbit – Inferior orbital fissure
Nasal cavity – Sphenopalatine foramen
Foramen Lacerum – Pterygoid canal
Roof of oral cavity – Greater palatine canal
Roof of pharynx – Palatovaginal canal
CONTENTS :- Maxillary Nerve, Pterygopalatine ganglion, Third part of maxillary artery

MAXILLARY ARTERY: From the region of the infratemporal fossa, it has three principle components.

- *FIRST PART* mainly supplies structures in cranium and middle ear.
  - **o** Anterior Tympanic Artery **to middle ear o** Deep Auricular Artery **to inner ear**
  - o **Middle Meningeal Artery** goes through **Foramen Spinosum** in the spine of the sphenoid to reach the middle cranial fossa.
  - o **Inferior Alveolar Artery:** Sort of an exception because it doesn't supply cranial fossa.
    - It will eventually go through **Mandibular Foramen** to supply lower teeth.
    - Then it continues through **Mental Foramen** to supply chin and lower teeth.
- *SECOND PART* mainly supplies the muscles of mastication.
- *THIRD PART* supplies hard to reach areas anteriorly.
  - o **Posterior Superior Alveolar Artery** to the upper posterior teeth o **Infraorbital Artery** will eventually come out the **Infraorbital Foramen.**
  - o **Sphenopalatine Artery** goes through **Sphenopalatine Foramen** to supply blood to lateral nasal wall and then paranasal sinuses.
    - o **Descending Palatine Artery:** To hard and soft palate.
    - o **Artery of the Pterygoid Canal:** Runs with Nerve of Pterygoid Canal.

PTERYGOID PLEXUS: Venous plexus surrounding medial and lateral pterygoid muscles.

- Communicates with Cavernous Sinus.

- Communicates with Facial and Angular veins via the Infraorbital Vein.
- It will also communicate with **retromandibular vein.**

TEETH:

- 10 deciduous teeth and 32 permanent teeth.
- **Enamel** = hard outer surface.
- **Cementum** = the inner aspect of the hard enamel.
- **Dentin** is deep to the enamel and cementum.
- **Pulp** is deep to the dentin and contains the nerves and vessels.

TONGUE:

- **Filiform Papillae:** Taste receptors on anterior 2/3 of tongue
- **Fungiform Papillae:** Mushroom-like taste receptor on the anterior 2/3 of tongue.
- **Circumvallate Papillae:** Taste buds on the posterior 1/3 of tongue.
- **Sulcus Terminalis:** Divides posterior from anterior parts.
- **Foramen Cecum:** Depression in the midline of tongue, remnant of primitive **thyroglossal duct.**

BLOOD SUPPLY TO TONGUE: **Lingual Artery,** Branch off the External Carotid, usually the second branch. Its principle branches in the mouth:

- **Dorsal Lingual Artery** -- remember dorsum of tongue is the top part that can be seen easily.
- **Deep Lingual Artery** to anterior 2/3 of tongue
- Sublingual Artery **to floor of mouth**

THE PHARYNX

Layers of the Pharynx:

- Oral mucosa and submucosa
- Pharyngobasilar Fascia
- Muscular Layer -- the pharyngeal muscles
- **Buccopharyngeal Fascia:** A tough external fascia that allows pharynx to move relative to neighboring structures (i.e. vertebral column, esophagus, carotid sheaths)

MEDIAN RAPHE: Common muscle attachment of pharyngeal constrictors. Located on the posterior of the pharynx.

PHARYNGEAL MUSCLES: What emerges between each of the pharyngeal constrictors.

- SUPERIOR PHARYNGEAL CONSTRICTOR
  - **o** Stylopharyngeus Muscle
  - o **Glossopharyngeal Nerve** -- this is a good landmark for identifying this nerve. o **Lingual Artery**
- MIDDLE PHARYNGEAL CONSTRICTOR
  - **o** Superior Laryngeal Nerve (Internal Branch)
  - **o** Superior Laryngeal Artery and Vein
- INFERIOR PHARYNGEAL CONSTRICTOR
  - **o** Recurrent Laryngeal Nerve
  - **o** Inferior Laryngeal Artery

PTERYGOMANDIBULAR RAPHE: Tendinous connection between the hamulus of the lateral pterygoid plate and the mylohyoid line of the mandible.

- It serves as the origin of two important muscles: **buccinator muscle** and **superior pharyngeal constrictor**
- *It is also the* division between the oral cavity and oropharynx.

EUSTACHIAN TUBES: They equilibrate pressure between the middle ear and atmosphere, via the throat.

- Openings of the eustachian tubes are found in the Nasopharynx, at the *posterolateral aspect.*
- **Torus Tubarius:** The tissue surrounding the eustachian tube.

TONSILS: **WALDEYER'S RING** -- a "ring" of tonsils surrounding the naso and oropharynx.

- **Pharyngeal Tonsil** -- *Single lymph "node" on posterior of nasopharynx. It* samples antigens breathed in through the air and triggers an immune response.
-

o **ADENOID TONSILS:** When enlarged or inflamed, it is termed an adenoid tonsil. This makes it block the nasopharynx in children, forcing them to breathe through their mouth, termed **Adenoid Breathing.**

- **Palatine Tonsil** -- between the palatoglossal and palatopharyngeal arches, on the posterior of the roof of the mouth.
- **Lingual Tonsil** -- on posterior third of tongue
- **Tubular Tonsil:** Tonsils near the opening of the Eustachian tubes.
- **INFLAMED TONSILS:** *Glossopharyngeus Nerve* can pick up referred pain from inflamed tonsils and send the sensory pain to the middle ear.
- **DEEP CERVICAL LYMPH NODES:** All tonsils of Waldeyer's Rim drain into deep cervical lymph nodes. ARCHES: The **palatine tonsil** is located between the two arches.
- **Palatoglossus Arch:** More anterior and more visible.
- Palatopharyngeal Arch: **More posterior.**

SOFT PALATE: *The muscles of the soft palate* separate the nasopharynx from the oropharynx.

- Raising the soft palate prevents food and liquid from getting in nose and middle ear.
- **SLEEP APNEA:** Can be due to drooping of the tongue or soft palate into the oropharynx, blocking off air to the nose. BLOOD SUPPLY TO PHARYNX: Mostly from External Carotid
- **Ascending Pharyngeal Artery** directly off the External Carotid.
- **Maxillary** ---- > Descending Palatine Artery
- Facial Artery branches:

o Ascending Palatine Artery **o** Tonsillar Branch **going to tonsils**

- Lingual Arteries and Ascending Pharyngeal arteries -- minor contributions.

SWALLOWING:

STAGE 1

o Sensory nerves from Lingual (V3) allow you to monitor the position of food in the mouth, to make sure you don't choke.

o As it moves back down to oropharynx, CN IX starts to sense its position.

o **Raise the Hyoid Bone** by Stylohyoid and Stylopharyngeus muscles.

STAGE 2

o **Soft palate** *is elevated and tightened* to seal off the nasopharynx from the oropharynx.

o **Superior Constrictor** then "grabs" the bolus of food and constricts it down pharynx in peristaltic motion.

o Larynx and pharynx are drawn up and forward.

STAGE 3

o The Arytenoid cartilages are drawn forward.

o Food goes through **piriform fossae**

o **Epiglottis** is drawn backward to guard tracheal opening. Trachea closes when *Epiglottis moves down and epiglottal folds move together.*

STAGE 4

o Inferior Constrictor sends the food down the esophagus.

THE LARYNX

GLOTTIS: Aperture of the larynx, which serves to separate the larynx from the pharynx during swallowing.

- The glottis overlays the respiratory tract (trachea).
- Closing it allows for increase in thoracic / abdominal pressure, for coughing, peeing, pooping, etc.
- **RIMA GLOTTIS:** The opening between the vocal cords, overlying the glottis. The **Lateral Cricoarytenoid Muscle** contracts to open the vocal cords to allow inspiration.

LARYNGEAL CARTILAGES:

- **Thyroid Cartilage** overlies the thyroid gland and composes the Adam's Apple.
  - o **THYROHYOID MEMBRANE:** Attaches the thyroid cartilage superiorly to the hyoid bone.
    - Internal Laryngeal Nerve (X) **and** Superior Laryngeal Artery **pierce this membrane.**
- **Cricoid Cartilage:** It is the lower edge of the larynx.
  - o **Cricothyroid Membrane** attaches cricoid superiorly to thyroid cartilage. It is thickened anteriorly and called the

Cricothyroid Ligament.

o The edge of the Cricothyroid Ligament is the **Vocal Ligament**

- **Epiglottic Cartilege** (Epiglottis) -- directly posterior to thyroid cartilage, and overlying the hyoid bone.
  - o Attaches to Thyroid Cartilage via **Thyroepiglottic Ligament**
  - o Attaches to Hyoid Bone via **Hyoepiglottic Ligament**
  - o **Quadrangular Membrane:** Attaches to Arytenoid Cartilages
    - Aryepiglottic Fold is its superior limit
    - Vestibular Ligament (false vocal cord) is its inferior limit
- **Arytenoid Cartilage** -- small paired cartilages on top of the cricoid cartilage
  - o There are the *site of attachment of the vocal cords and the muscles that move the vocal cords.*
  - o Muscular Process: For muscle attachment o Vocal Process: For attachment of **vocal ligaments**
- **Corniculate Cartilage** -- right on top of the apex of the arytenoid cartilage.
- **Cuneiform Cartilage** -- help form the posterior part of the epiglottic fold, along with the corniculate cartilages **VOCAL LIGAMENT:** Goes from the Vocal Process of the Arytenoid Cartilage to the inner aspect of the Thyroid Cartilage.
- **CONUS ELASTICUS:** The name of the vocal ligament together with the Cricothyroid ligament.
- **LARYNGEAL MUCOSA:** Lined by respiratory epithelium, but it *converts to stratified epithelium over the vocal cords.*
- This change in cell-type lends itself to cancer, hence **laryngeal cancer** is the most common form of head-and-neck cancer.

BLOOD SUPPLY TO THYROID GLAND:

- **External Carotid** --- > Superior Thyroid Arteries
- **Thyrocervical Trunk** ---> Inferior Thyroid Arteries

VENOUS DRAINAGE OF THYROID GLAND:

- Superior Thyroid Vein ---------> **Internal Jugular**
- **Middle Thyroid Vein** ------> Internal Jugular
- **Inferior Thyroid Vein** ------> Right and left brachiocephalic veins

PARATHYROIDS:

- They receive blood from the **inferior thyroid arteries**

Removing them can lead to inadequate blood calcium----------> **Tetany** ----------> death. Give artificial calcium and PTH as therapy if they are removed.

- o Adults can live without the Thyroid gland itself. Children can't --------> Development disorders and retardation.

THE EAR

EXTERNAL EAR: Consisting of the ear canal and Tympanic Membrane

- **External Features:** Helix, Antihelix, Tragus, Antitragus, lobule, Concha, Incisure, Triangular Fossa
- BLOOD SUPPLY TO EXTERNAL EAR
  - **o External Carotid** ------> Posterior Auricular
  - **o External Carotid** ------> Superficial Temporal
- EAR CANAL:
  - o Outer Ear Canal contains Ceruminous (wax) glands and hair
  - o Inner ear canal is covered with skin
- **TYMPANIC MEMBRANE:** Cone-shaped, the size of a dime. It received the mechanical sound waves and transmits them to the middle ear.55 degree orientation with horizontal plane.
  - o The Tympanic Membrane is very thin, composed of three cellular layers:
    - Squamous Epithelium on the outer (lateral) surface

- Fibrous layer, mostly consisting of **pars tensa.** In about 15% of the membrane surface area this layer is missing, yielding **pars flaccida.**
- Inner mucous membrane

EXTERNAL ACOUSTIC MEATUS: The Tympanic component of the mastoid bone is immediately posterior to the *condyle of the mandible* (i.e. the TMJ joint). So watch it with jaw dislocations.
MIDDLE EAR: Consisting of the Eustachian Tube, Middle Ear Ossicles, and Middle Ear Muscles

- It can be divided into three regions:
  - o **Epitympanum** -- above the rim of the tympanic membrane.
    - It contains the main parts of the malleus and incus.
  - o **Mesotympanum** -- just medial (deep) to tympanic membrane
    - It contains the main part of the stapes.
    - o **Hypotympanum** -- Below tympanic membrane
    - It contains carotid artery and jugular bulb
- **EUSTACHIAN TUBE:** It should be considered the *only opening* of the middle ear. It equilibrates pressure between middle ear and atmosphere.
  - o Pressure is equilibrated *only when swallowing*, by the action of salpingopharyngeus and tensor palatini
  - o CLINICAL -- don't give an infant a bottle when the infant is lying down. This can cause leakage into the Eustachian tubes > Middle Ear Infection **(Otitis Media)**
- Borders:
  - o Medial (deep) Limit of Middle Ear:
    - **Promontory** of the cochlea (the first turn)
    - **Vestibular (Oval) Window** -- will move fluid as a result of vibrations of the stapes.
    - **Cochlear (Round) Window** -- relieves pressure from the vestibular window.
  - o Lateral (Superficial) Limit of Middle Ear: **Tympanic Membrane,** or eardrum.
- *Middle Ear Ossicles: Their purpose is to* transmit the mechanical sound wave from air to fluid.
  - *o* **Malleus** attaches to the tympanic membrane
    - The **Tensor Tympani Muscle** attaches to the neck
    - It is housed within the epitympanic recess
    - **The** *Chorda Tympani* **passes just** medial to the malleus **and** superior to the tensor tympani.
  - o **Incus** Articulates with the head of the Stapes
    - It is housed within the epitympanic recess.
  - o **Stapes**
    - The **Stapedius Muscle** attaches to its neck
    - It is housed within the mesotympanic space.
- BLOOD SUPPLY to Middle Ear: Lots of arteries, primarily from External Carotid but also from Internal
  - o Stylomastoid A. o Inferior and Anterior Tympanic Aa. o Petrosal A.
  - o Caroticotympanic A. (from internal)

TRANSMISSION OF SOUND WAVE: Ear Canal ---- > Eardrum (Tympanic Membrane)------> Malleus ----------> Incus----------> Stapes----- > Promontory ----- > Cochlea ------> Organ of Corti
MASTOID AIR CELLS: Linked to the middle ear by the **Antrum** of the middle ear.

- These air cells primarily lie in the squamosal and petrous portions of the temporalis bone, those portions overlying the middle ear.
- There is a correlation between middle ear infections and aeration of the mastoid air cells. *The more sclerotic (non- aerated)* the mastoid cells, the higher the incidence of infection.

INNER EAR: The Cochlea and Semicircular Canals. The Inner Ear is in the deepest part of the Temporal Bone -- the Petrous Part.

- **Cochlea:** Final receptor of sound-information, containing the **Organ of Corti** in the **Cochlear Duct.**
- **Vestibule:** Common chamber which contains:

o **Utricle** -- static balance o **Saccule** -- static balance

- **Semicircular Canals:** Three semicircular canals in the three dimensions of space, for dynamic balance and detection of *angular velocity*.
  - o **Endolymph Fluid** moves in order to detect angular velocity.
- **Osseus Labyrinth:** The outermost encasement of the Cochlea.
- **Membranous Labyrinth:** A labyrinth within the osseus labyrinth. A tube within a tube.
  - o **Perilymph Fluid:** Flows on the outside of the membranous labyrinth. Endolymph fluid flows on the inside.

OTOLOGICAL PATHOLOGIES: Generally, infection tends to creep into the *supratympanic* (upper) region of the middle ear.

- Eustachian Tube Dysfunction:
  - o Common in children, due to shorter, straighter tube.
  - o Insert a **PE-Tube** into the tympanic membrane to equilibrate pressure. The tube is placed in lower part of eardrum.
- **Cholesteatoma:** Like a benign tumor, squamous epithelium from the eardrum builds up in the pars flaccida and invades the middle ear. It must be removed.
- **Otosclerosis:** A bone metabolism disorder that leads to conductive hearing loss via stapes fixation (i.e. stapes doesn't vibrate correctly).
  - o Treatment: It can be treated surgically with implantation of a prosthetic stapes bone.
- **Acoustic Neuroma:** A tumor in the Vestibulocochlear (VII) Nerve. It can impinge upon Facial (VII) at the same time, at the internal auditory meatus.

LYMPHATICS

Waldeyer's Rim: See Pharynx

SUPERFICIAL LYMPH NODES: All of these eventually drain into the Deep Cervical Lymph Nodes.

- They include the following:
  - **o** Occipital
  - **o** Postauricular (Mastoid, Retroauricular) **o** Preauricular (Superficial Parotid) **o** Submandibular **o** Submental
- **Below the head and neck junction:** Superficial Cervical **and** Supraclavicular Nodes
- DEEP CERVICAL LYMPH NODES: External to the carotid sheath.
- All of them ultimately drain into **Right Lymph Duct** on right side and into **Thoracic Duct** on left side.
- SUPERIOR GROUP

o Jugulo-Digastric

o Jugulo-Omohyoid

- INFERIOR GROUP
- TONGUE:
  - o Anterior 2/3 -------- > **Submandibular and Sublingual Nodes** --- > Jugulo-Omohyoid Nodes ultimately
  - *o Posterior 1/3* -------- > Directly into Superior Deep Cervical Nodes
- THYROID GLAND, TONGUE: These two organs drain into the opposite side of the head and neck, somewhat. All other organs drain into the same side.

GENERAL ARRANGEMENT OF THE CRANIAL NERVES

MOTOR INNERVATION: The cell bodies for the motor fibers of all cranial nerves are located in the respective **brainstem nuclei** (lower motor neurons).

SENSORY INNERVATION: The cell bodies for the sensory fibers of all cranial nerves are located in the **parasympathetic ganglia** *(see below) or* **special sensory organs.**

SYMPATHETIC INNERVATION: The sympathetic fibers mostly run along the internal and external carotid arteries to get to their target organs.

3. Internal Carotid Artery: Larger portion of sympathetics run along internal carotid, forming the internal carotid plexus.
4. INTERNAL CAROTID PLEXUS: In cavernous sinus (probably).
    1. Deep Petrosal Nerve: Given off of the internal carotid plexus within the cavernous sinus.
        - From there it goes to Pterygopalatine Fossa and onto nose, palate, and lacrimal glands.
    2. Sympathetic Root of Ciliary Ganglion: The internal carotid plexus also sends a sympathetic branch to the Ciliary Ganglion, where it then goes on to form the Long Ciliary Nerve, which will innervate the dilator pupillae muscle of the eye.

PARASYMPATHETIC INNERVATION: All Parasympathetic motor innervation to the head synapses exactly once, in one of the four cranial ganglia listed below. All of these ganglia are distributed along branches of the Trigeminal Nerve (V).

1. CILIARY GANGLION: Carries parasympathetics from Oculomotor Nerve (III)
    - Located in the posterior of the orbit.
    - GVE (Parasympathetic) innervation is to:
        1. Ciliary Muscles (for Accommodation)

THE FACE

SECOND BRANCHIAL ARCH: All muscles of facial expression are derived from the second branchial arch and are innervated by branches of the Facial Nerve (VII).

Fractures that affect the facial skeleton:

1. La Fort 1: A horizontal fracture through the maxilla, at the base of alveolar process (i.e. at the top of the upper teeth).
    - The alveolar process of the maxilla and upper teeth come of as a unit.
    - The rest of the maxilla remains attached to the zygomatic bone.
2. La Fort 2: Complete separation of the maxilla. Essentially, the nose is separated from the facial skeleton.
    - Zygomatic bone remains intact and separated from Maxilla.
3. La Fort 3: Zygomatic bone separates from the frontal bone. Essentially, the entire face breaks lose from the cranium.
    - The orbits drop down, causing double vision.

FACE LACERATIONS: Because facial skin is loose, lacerations in the face tend to gape. Injuries in the face tend to swell more than other tissues.

GALEA APONEUROTICA: Superficial fascia of the scalp. The frontalis muscle inserts into the Galea Aponeurotica.

2. ANASTOMOSES WITH CRANIAL FOSSA: Clinically important collateral circulation with the dural sinuses occurs at two places:
    1. Deep Facial Vein is a communication between the Facial Vein and the Pterygoid Plexus.
    2. Superior Ophthalmic Vein is a communication between the Facial Vein and the Cavernous Sinus.
3. DANGER TRIANGLE OF THE FACE: A triangle approximately covering the nose and maxilla, and going up to the region between the eyes. Superficial Veins communicate with dural sinuses in this region.
    1. *The Facial Vein has no valves. Backflow can cause* **infection to get into the dural sinuses,** through the Deep Facial Vein (via pterygoid plexus) and Superior Ophthalmic Vein (via Cavernous Sinus)

THE SPINAL CORD AND SUBOCCIPITAL REGION

PARTS OF THE VERTEBRAL COLUMN:

1. BODY: Faces anteriorly. From C2 on down, they become progressively larger.
2. VERTEBRAL ARCH: A complete circle formed by two pedicles and two lamina
    - PEDICLE is between the body and transverse process

- LAMINA is between the transverse and spinous process

3. VERTEBRAL FORAMEN is the hole enclosed by the vertebral arch, containing the spinal chord
4. INTERVERTEBRAL FORAMEN is the hole formed between the pedicles at each vertebral level.
   - It is composed of the SUPERIOR VERTEBRAL NOTCH of the lower level and
   - INFERIOR VERTEBRAL NOTCH of the upper level.
5. SPINOUS PROCESSES point posteriorly.
   - Laminectomy is a resection between the transverse and spinous processes.
6. TRANSVERSE PROCESSES point laterally. There are two of them.
7. Articular Facets: Shape varies according to location.
   - INFERIOR ARTICULAR FACETS are on either side of spinous process, pointing inferiorly and laterally, and articulating with the superior articular facets of the next level down.
   - SUPERIOR ARTICULAR FACETS point upward and laterally.

ATLANTO-OCCIPITAL JOINT: Joint between Atlas and Occipital Condyles. It allows for great flexion and extension and almost no rotation.

- The articular facet is horizontal, facilitating flexion and extension.
- It is the "yes" joint -- the joint you use when you nod your head.
- It is stabilized by Anterior and Posterior Atlanto-Occipital Membranes.

ATLAS: First Cervical Vertebrae.

- Superior Articular Facet articulates with the Occipital Condyles of the Occipital bone.
- *It has* no body or spinous process.
- It has a vertebral groove for the vertebral artery, which has already passed through the foramina transversaria. ATLANTO-AXIAL JOINT: Between Atlas and Axis. It allows for great rotation but almost no flexion and extension.
- Joint is between the Atlas and the dens of the Axis.
- It is the "no" joint -- the joint you use when you rotate head from side to side.
- Cruciform Ligament: Extends out from atlas and holds the atlas to the dens of the axis.
  1. It has Superior, Transverse, and Inferior portions.

5. Spinal Nerve: The fusion of the dorsal and ventral roots, right outside the vertebral arch, at each intervertebral level.
3. OCCIPITAL SINUS: Lies in the Falx Cerebellia. It drains blood as follows: OCCIPITAL SINUS------ > CONFLUENCE OF SINUSES -----> TRANSVERSE SINUS
4. CONFLUENCE OF SINUSES: The junction between the Superior Sagittal, Straight, and Transverse Sinuses. It leads into the Transverse Sinus. The occipital sinus is caudal to it.
5. TRANSVERSE SINUS: It receives blood from all three sinuses above: Superior and Inferior Sagittal, and Occipital. It drains blood as follows:
   - TRANSVERSE SINUS----- > SIGMOID SINUS------ > INTERNAL JUGULAR VEIN

6. **SUPERIOR PETROSAL SINUS:** Drains the Cavernous Sinus----- > *OCCIPITAL SINUS*

7. INFERIOR PETROSAL SINUS: Drains the Cavernous Sinus-------- > INTERNAL JUGULAR VEIN directly.

CAVERNOUS SINUS: VERY IMPORTANT because it contains lots of nerves and vessels running through it.

- It is located at the Sella Turcica of the Sphenoid, surrounding the Pituitary Gland, within the Diaphragma Sella dural fold.
- It receives blood from:
  o Superior and Inferior Ophthalmic Veins o Superficial Middle Cerebral Vein o Sphenoparietal Sinus
- It drains blood into:
  o Inferior and Superior Petrosal Sinuses. *o* Pterygoid Plexus.
- It has the following running through it:

3. ORBITAL SEPTUM: Extends up from tarsal plate and hooks onto the bony border of the orbit on either side. It effectively separates the front of the orbit (very anterior part) from the rest of the orbit.
4. BLINKING: The UPPER EYELID does all the work in opening and closing the eyelid. The lower eyelid is not controlled by an muscles, but only by gravity.

Lacrimal Apparatus:

- Lacrimal Gland: The superior and lateral part of the orbit, consisting of two parts: An orbital and palpebral part.
  1. They secrete tears into the superior conjunctival fornix of the eye.
  2. Tears go over the cornea of the eye every time you blink or close your eyelid.
- Lacrimal Caruncle: Medial Canthus of the eye, the location of the Lacrimal Lake, where tears accumulate after they have coated the surface of the cornea.
- Lacrimal Puncti: Two openings in the Lacrimal Papilla (bumps), on either side of the Lacrimal Caruncle. These holes take up tears by a vacuum motion every time you blink.
- Lacrimal Canaliculus: The canal that conducts tears from the Lacrimal Puncti to the Lacrimal Sac.
- Lacrimal Sac: Directly proximal to the Nasolacrimal Duct. Tears pool up here until they are ejected into the nasolacrimal duct and onto the nose.
- Nasolacrimal Duct: The duct which allows tears to conduct from the eye to the nose. Crying and tearing causes sniffling due to overflow of the nasolacrimal duct.
- Overall flow of tears:
- Lacrimal Gland ----------> 8 to 10 lacrimal ducts ----- > Superior Conjunctival Fornix ------> surface of cornea------> Lacrimal Lake------> Lacrimal Puncti----- > Lacrimal Canaliculi------ > Lacrimal Sac ----------
  > Nasolacrimal Duct ----- > Nasal Cavity, under the Inferior Turbinate.

CLASS DISCUSSION QUESTIONS

SCALP,FACE,OSTEOLOGY

1. The fascial layers recognised on face superficial to the plane of facial nerve are
   A. Subcutaneous fibroadipose tissue
   B. SMAS
   C. Parotidomassetric system
   D. All the above
2. The atypical cervical vertebrae are
   A. 1,2,6
   B. 1,3,7
   C. 1,2,7
   D. 1,5,7
3. The common carotid artery bifurcates at the level of
   A. C4
   B. C6
   C. C2
   D. C7
4. INCA bone is
   A. Sphenoid bone
   B. Interparietal bone
   C. Interfrontal bone
   D. Small parietotemporal bone
5. Pterion is an important anthropometric landmark as it overlies
   A. Posterior branch of middle meningel artery & lateral fissure of cerebral hemisphere
   B. Anterior branch of middle meningel artery & lateral fissure of cerebral hemisphere
   C. Anterior branch of middle cerebral artery & central fissure of cerebral hemisphere
   D. Anterior branch of middle cerebral artery & central fissure of cerebral hemisphere
6. Joints involved in regulation of growth in length of Skull are
   A. Basiocciput with Basisphenoid joint
   B. Joint between jugular process and petrous temporal bone
   C. Sutural joints at peripheral margin of occipital bone
   D. All the above
7. Petrotympanic tympanic fissure transmits
   A. Emissary vein
   B. Lesser petrosal nerve
   C. Anterior ligament of malleus
   D. Greater petrosal nerve
8. Which of them are of full adult size at birth
   A. Orbital volume
   B. Internal ear
   C. Nasal aperature
   D. Facial canal
9. Maxillary hiatus is not formed by
   A. Inferior nasal concha
   B. Perpendicular plate of palatine bone
   C. Lacrimal bone
   D. superior nasal concha
10. In Old age the mental foramen is located
   A. Near the lower border
   B. Midway between upper and lower border
   C. Near the upper border
   D. Close to the mandibular foramen

PTERYGOPALATINE FOSSA

11. The openings in the wall of pterygopalatine fossa are all except
    A. Foramen ovale
    B. Palatinovaginal canal
    C. Pterygoid canal
    D. Greater palatine canal
12. Which is not a content of superior orbital fissure
    A. Superior ophthalmic vein
    B. Inferior ophthalmic vein
    C. Maxillary nerve
    D. Nasociliary nerve
13. Arcuate eminence overlies the
    A. Posterior semicircular canal
    B. Anterior semicircular canal
    C. Lateral semicircular canal
    D. Both A and C

FORAMINA OF SKULL

14. Abducent nerve passses through
    A. Inferior orbital fissure
    B. Dorello's canal
    C. Canaliculus innominatus
    D. Foramen vesalius
15. Which of the following foramina does not transmit emissary vein
    A. Condylar canal
    B. Parietal foramen
    C. Mastoid foramen
    D. Anterior ethmoidal foramen
16. Common facial vein is formed by
    A. A.Facial vein & post division of retromandibular vein
    B. Facial vein & ant. division of retromandibular vein
    C. C.Posterior auricular vein & post division of retromandibular vein
    D. D.ant & post division of retromandibular vein
17. All the following transmit an arterial branch to the meninges except
    A. Mastoid foramen
    B. Foramen rotundum
    C. Groove of greater petrosal nerve
    D. Foramen Ovale

TRIANGLES OF NECK

18. Lesser supraclavicular fossa is between
    A. Two heads of omohyoid
    B. Two bellies of digastric
    C. Two heads of sternocleidomastoid
    D. Between right and left sternomastoid
19. Carotid tubercle is situated on
    A. Body of C7
    B. Transverse process of C7
    C. Body of C6
    D. Transverse process of C6
20. False about Lesser Occipital nerve
    A. Hooks around greater auricular nerve
    B. Conveys fibres of C2
    C. Derived from cervical plexuses
    D. Runs on post border of sternomastoid
21. The highest and genuine content of occipital triangle is
    A. Dorsal scapular nerve

B. C3 &C4 cervical nerves
C. Spinal accessory nerve
D. Upper trunk of brachial plexuses

MUSCLES OF FACE

22. Which of the following is not true of buccinator
A. Excepls the air from oral cavity
B. Is a muscle of mastication
C. Innervated by facial nerve
D. Draws the mouth to one side acting unilaterally

23. Which of the following does not insert to the angle of mouth
A. Platysma
B. Risorius
C. Buccinator
D. Depressor septi

24. Phrenic nerve can be identified by the following
A. Content in Anterior triangle
B. Lies on scalenus anterior
C. Hooked by lesser occipital nerve
D. Lies on scalenus medius

25. Carotid Sheath is around the following
A. External carotid artery,common carotid artery,internal jugular vein & Vagus nerve
B. Internal carotid artery,common carotid artery,internal jugular vein & Vagus nerve
C. Internal carotid artery,common carotid artery,internal jugular vein & accessory nerve
D. External carotid artery,common carotid artery,internal jugular vein & accessory nerve

26. The following dorsal rami of spinal nerve do not give cutaneous branches
A. C1,C3,C7,C8,L4 & L5
B. C1,C3,C7,C8,L3 & L5
C. C1,C2,C7,C8,L4 & L5
D. C1,C6,C7,C8,L4 & L5

27. The only pair of muscle attached to the posterior Tubercle of atlas is
A. Rectus capitis posterior minor
B. Rectus capitis posterior major
C. Obliquus capitis inferior
D. Obliquus capitis superior

28. The Ventral rami of C1 supply
A. Rectus capitis lateralis
B. Rectus capitis posterior major
C. Semispinalis Capitis
D. Rectus capitis posterior minor

VERTEBRAL ARTERY

29. Which of the following is not a branch of vertebral artery system
A. Basilar artery
B. Posterior cerebral artery
C. Anterior cerebral artery
D. Posterior communicating artery

30. Which nerve emerges between labyrinthine artery and anterior inferior cerebellar artery
A. Oculomotor
B. Abducent
C. Trochlear
D. Phrenic

PAROTID GLAND&TONGUE

31. Parasympathetic fibres from CN IX travel to the parotid gland via which of the following nerves
    A. Greater auricular nerve
    B. Auriculotemporal nerve
    C. Directly from Glossopharyngeal nerve
    D. External carotid nerve plexus
32. The Safety muscle of tongue is
    A. Styloglossus
    B. Genioglossus
    C. Hyoglossus
    D. Geniohyoid
33. Which of the following is the most direct route for spread of infection from paranasal sinus to cavernous sinus of duramater
    A. Pterygoid venous plexus
    B. Superior ophthalmic vein
    C. Basilar venous plexus
    D. Parietal emissary vein
34. Structures between hyoglossus and mylohyoid are all except
    A. Styloglossus
    B. Lingual nerve
    C. Hypoglossal nerve
    D. Genioglossus

MIDDLE EAR CAVITY

35. Which of the following is not contained in the tympanic cavity
    A. Auditory ossicles
    B. Chordatympanic cavity
    C. Tympanic plexus
    D. Lesser petrosal nerve

INFRATEMPORAL FOSSA

36. The communication routes of infratemporal fossa are all except
    A. Inferior orbital fissure
    B. Pterygopalatine fissue
    C. Foramen spinosum
    D. Foramen rotundum
37. All are true except
    A. Massetric nerve is a branch of maxillary nerve
    B. Nervus spinosus is a branch of mandibular nerve
    C. Auriculotemporal nerve is a branch of mandibular nerve
    D. Inferior alveolar nerve is a branch of mandibular nerve

TMJ & GANGLIONS

38. The temporomandibular joint is a
    A. Fibrous joint
    B. Saddle type synovial
    C. Pivot type synovial
    D. Modified hinge type synovial
39. The nerve of pterygoid canal is composed of which of the following
    A. Greater petrosal & Lesser petrosal
    B. Greater petrosal & Deep petrosal
    C. Lesser petrosal & Deep petrosal
    D. Greater petrosal & Maxillary nerve
40. Maxillary nerve gives branches to which of the following ganglia
    A. Otic ganglia
    B. Pterygopalatine ganglia

C. Submandibular ganglia
D. Geniculate ganglia

41. Which of the following is not a branch of facial nerve
A. Temporal
B. Zygomatic
C. Mental
D. Cervical

42. All are true except
A. Stylomandibular ligament is a thickening of deep cervical fascia
B. Sphenomandibular ligament is thickening of investing layer of deep cervical fascia
C. Mylohyoid nerve pierces sphenomandibular ligament
D. Sphenomandibular ligament stretches from spine of sphenoid to lingula of mandibula

43. Lateral pterygoid muscle is attached to
A. Pterygoid fovea
B. Petrous part
C. Scaphoid fossa
D. Spine of sphenoid

DURAL VENOUS SINUSES

44. Which of the following is a not contained in the cavernous sinus
A. Oculomotor nerve
B. Abducent nerve
C. Maxillary nerve
D. Mandibular nerve

45. The cavernous sinus receives blood from all the following except
A. Superficial cerebral vein
B. Superior ophthalmic vein
C. Inferior ophthalmic vein
D. Great cerebral vein

46. Which of the following palate muscle not innervated by cranial part of accessory through pharyngel plexus
A. Levator veli palati
B. Tensor veli palati
C. Palatoglossus
D. Palatopharyngeus

47. A Carcinoma of medial portion of lower lip most likely to metastasize to via which of the following nodes
A. Submandibular
B. Superficial cervical
C. Submental
D. Parotid

48. Which of the following structures contribute to the formation of confluence of sinuses in the interior of occipital bone
A. Sigmoid and Transverse sinuses
B. Cavernous and Inferior sagittal sinuses
C. Straight and Occipital sinuses
D. Transverse and inferior Petrosal sinus

49. In dislocation of jaw, displacement of articular disc beyond the articular tubercle of TMJ from spasm or excessive contraction of which of the following muscles
A. A.Masseter
B. B.Medial pterygoid
C. C.Lateral pterygoid
D. D.Temporalis

50. Which of the following is not a branch of 2nd part of maxillary artery
A. A.Deep temporal
B. B.Pterygoid
C. C.Massetric
D. D.Labyrinthine

51. Which of the following is not present at birth
    A. A.Styloid process
    B. B.Mastoid process
    C. C.External occipital protuberance
    D. D.Thymus

PHARYNX

52. Which of the following pass through the gap inferior to inferior constrictor
    A. Internal laryngeal nerve
    B. Superior laryngeal nerve
    C. Inferior laryngeal artery
    D. Superior laryngeal vein
53. The Ciliary ganglion is located between
    A. Optic nerve & medial rectus
    B. Optic nerve & lateral rectus
    C. Medial rectus & inferior oblique
    D. Medial rectus & superior oblique
54. Stapedius is a
    A. Symmetric bipennate muscle
    B. Asymmetric bipennate muscle
    C. Symmetric unipennate muscle
    D. Asymmetric unipennate muscle
55. Facial vein makes clinically important connections with cavernous sinus through
    A. Superior ophthalmic vein
    B. Meningeal
    C. Great cerebral vein
    D. Lingual vein
56. Great cerebral vein of Galen is formed by union of
    A. Two basal vein
    B. Internal cerebral vein & basal vein
    C. Two internal cerebral vein
    D. Internal cerebral vein & occipital vein
57. Which of the following abducts the vocal cord
    A. Lateral cricoarytenoid
    B. Posterior cricoarytenoid
    C. Cricothyroid
    D. Thyroarytenoid
58. Frankfort plane refers to
    A. Orbitofrontal plane
    B. Frontopolar plane
    C. Orbitomeatal plane
    D. Naso-occipital plane
59. Which of the following arteries in not a branch of ophthalmic artery
    A. Supraorbital artery
    B. Lacrimal artery
    C. Infraorbital artery
    D. Anterior ethmoidal artery
60. The muscle that arises from Pterygomandibular raphae is
    A. Lateral pterygoid
    B. Inferior constrictor
    C. Medial pterygoid
    D. Superior constrictor

61. Tumors of the head may grow from one region of the head to another by passing through fissures and foramina. Knowing this, if you found a tumor in the pterygopalatine fossa, it may have developed there primarily or it may have grown into the fossa from any of the following EXCEPT:
   A. Infratemporal fossa
   B. Cranial cavity by way of the foramen ovale
   C. Cranial cavity by way of the foramen rotundum
   D. Oral cavity by way of the greater palatine canal

62. The tympanic plexus of nerves is found on the:
   A. Floor of the middle ear cavity
   B. Pyramid of the middle ear
   C. Medial surface of the tympanic membrane
   D. Promontory of the middle ear cavity

63. The thyrohyoid membrane is pierced by the:
   A. Hypoglossal nerve
   B. Internal branch of the superior laryngeal nerve
   C. External branch of the recurrent laryngeal nerve
   D. Ansa cervicalis

64. The submandibular ganglion contains preganglionic parasympathetic axons from which cranial nerve?
   A. III
   B. V
   C. VII
   D. IX

65. Loss of lacrimation (dry eye) can be due to an injury to which nerve?
   A. Nasociliary
   B. Greater petrosal
   C. Anterior ethmoid
   D. Lesser petrosal

66. Which of the following muscles is innervated by the glossopharyngeal nerve?
   A. Tensor tympani
   B. Superior constrictor of the pharynx
   C. Tensor veli palatine
   D. Stylopharyngeus

67. Which nerve innervates the muscle for tight closure of the eyelids?
   A. Facial
   B. Oculomotor
   C. Sympathetic
   D. Trigeminal

68. The facial nerve
   A. Exits the cranium through the foramen ovale
   B. Provides the primary parasympathetic supply to the parotid gland
   C. Supplies taste fibers to the posterior 1/3 of the tongue
   D. Supplies motor fibers to the stapedius muscle

69. The sensory supply to the skin over the lower eyelid comes from the
   A. Maxillary division of the trigeminal
   B. Auriculotemporal nerve
   C. Buccal branch of the trigeminal nerve
   D. Ophthalmic division of the trigeminal

70. The skin of angle of mandible is supplied by
   A. Ophthalmic division of trigeminal
   B. Maxillary division of trigeminal
   C. Great auricular nerve
   D. Lesser occipital nerve

71. Which muscle is innervated by the external branch of the superior laryngeal nerve?
    A. Lateral cricoarytenoid
    B. Cricothyroid
    C. Posterior cricoarytenoid
    D. Transverse arytenoid
72. The best landmark to identify the inferior alveolar nerve is
    A. Lingula of mandible
    B. Ramus of mandible
    C. Symphsis menti
    D. Mylohyoid line
73. Regarding vertebral artery true is
    A. Vertebral artery does not enter foramen transversarium C7
    B. Vertebral artery is a branch from thyrocervical trunk
    C. Vertebral artery is found in the supraclavicular triangle
    D. Internal thoracic artery is a branch from vertebral artery
74. Elevation of eye is caused by
    A. Inferior rectus & superior oblique
    B. Superior rectus & inferior oblique
    C. Medial & lateral rectus
    D. Superior & inferior rectus
75. Which of the following nerves arise by two roots that surround middle meningeal artery
    A. Zygomaticofacial
    B. Nervus spinosus
    C. Nerve to medial pterygoid
    D. Auriculotemporal
76. The Langely's ganglion is located on
    A. Genioglossus
    B. Palatoglossus
    C. Hyoglossus
    D. Stylopharyngeus
77. Piriform recess mucosa receives innervation from
    A. External laryngeal nerve
    B. Internal laryngel nerve
    C. Glossopharyngeal nerve
    D. Spinal accessory
78. Tritiate cartilage true is
    A. Located on cricothyroid membrane
    B. Located on thyrohyoid membrane
    C. Lies on vocal fold
    D. Lies on vestibular fold
79. Ansa subclavia
    A. Is a loop around 2nd part of subclavian artery
    B. Is a branch from subclavian artery
    C. Is a cord connecting middle and inferior cervical ganglion
    D. Is a cord connecting superior and middle cervical ganglion
80. Inferior alveolar nerve gives the following branches except
    A. Mental nerve
    B. Incisive branch
    C. Mylohyoid branch
    D. Lingual branch
81. The temporal branch of CN VII does not innervate the following
    A. Frontal belly of occipitofrontalis
    B. Auricularis anterior
    C. Orbicularis oculi (lower part)
    D. Orbicularis oculi (upper part)

82. The vidian nerve does not innervate which of the following
   A. Lacrimal gland
   B. Palatine gland
   C. Mucosal gland of nasal cavity
   D. Submandibular gland

83. What innervates tensor tympani
   A. Vestibulocochlear nerve
   B. Mandibular nerve
   C. Maxillary nerve
   D. Chordatympanic nerve

84. Of the following, which muscle receives innervation from dorsal rami
   A. Splenius capitis
   B. Posterior scalene
   C. Levator scapulae
   D. Anterior scalene

85. Which of the following has insertion on pharyngeal tubercle
   A. Middle constrictor
   B. Superior constrictor
   C. Thyropharyngeus
   D. Palatopharyngeus

86. Which of the following is not an anterior vertebral muscle
   A. Longus colli
   B. Longus capitis
   C. Rectus capitis lateralis
   D. Splenius capitis

87. The floor of the sella turcica is also the
   A. Site of attachment of the superior pharyngeal constrictor muscle
   B. Roof of the sphenoid sinus
   C. Medial wall of the temporal fossa
   D. Roof of the nasal cavity

88. The atlanto occipital joint is
   A. Ellipsoid type synovial
   B. Saddle type synovial
   C. Pivot type synovial
   D. Plane type synovial

89. False about accessory phrenic nerve
   A. Is a branch of phrenic nerve
   B. Descends lateral to phrenic nerve and posterior to subclavian vein
   C. It joins with phrenic nerve
   D. Carry fibres from C5 to supply diaphragm

90. Masticator space contains the following except
   A. Muscles of mastication
   B. Mandibular nerve
   C. Buccal pad of fat
   D. Facial artery

91. A 15 yr old boy is eating s fish dinner and inadvertently has a bone caught in is throat.He complains of significant pain above the vocal cords.Which of the following nerve is responsible for carrying the sensation of his pain.
   A. Hypoglossal nerve
   B. Accessory nerve
   C. Superior laryngeal nerve
   D. Recurrent laryngeal nerve

92.A surgeon is performing an carotid endarterectomy on a 55yr old man who has carotid artery occlusion.In approaching the internal carotid artery the surgeon severs a nerve embedded in carotid sheath.Which nerve was severed

A. Vagus
B. Hypoglossal
C. Ansa subclavia
D. Ansa cervicalis

93. A 2yr old girl is diagnosed with torticollis involving the right sternocleidomastoid. Which of the following describes the most likely anatomical change

A. Head flexed forward in midline
B. Head rotated to right
C. Head rotated to left
D. Head extended in midline

94.A 45 yr old man who has diabetes developed shingles involving the right cornea.Which route did the varicella virus most likely travel to the cornea.

A. CN II
B. CN III
C. CN V
D. CN VII

95.Cloison sagittale

A. Separates the parapharyngeal and retropharyngeal space
B. Separates stiles space
C. Separates the space of burns
D. Separates the masticator space

96. The ligament connecting the axis with occipital bone are

A. Cruciform ligament
B. Ligamentum denticulatum
C. Anterior longitudinal ligament
D. Ligamentum flavum

97. In Judicial hanging the ligament ruptured is

A. Transverse ligament of atlas
B. Membrana tectoria
C. Ligamentum flavum
D. Anterior longitudinal ligament

98.Palatine aponeurosis is formed by the

A. Tendon of musculus uvula
B. Tendon of levator veli palatini
C. Tendon of tensor veli palatini
D. From palatopharyngeus

99.Nodes of Rouviere are seen in

A. Retroperitoneum
B. Retropharyngeal region
C. Parapharyngeal
D. Mediastinal region

100.Lesser's triangle contain

A. Occipital artery
B. Facial artery
C. Ascending pharyngeal artery
D. Lingual artery

ANSWERS& DISCUSSION

1.D

Three fascial layers are recognised superficial to plane of facial nerve
Subcutaneous fibroadipose tissue
SMAS
Parotidomassetric system

Superficial musculo-aponeurotic system (SMAS)

This is described as a single tissue plane in the face. In some areas it is composed of muscle fibres, and elsewhere it is composed of fibrous or fibroaponeurotic tissue: it is not directly attached to bone. When traced below the level of the lower border of the mandible it becomes continuous with platysma in the neck. Microdissection has revealed that the SMAS becomes indistinct on the lateral aspect of the face approximately 1 cm below the level of the zygomatic arch. Anteromedially, the SMAS layer becomes continuous with some of the mimetic muscles including zygomaticus major, frontalis and the peri-orbital fibres of orbicularis oculi. In most areas of the face, a distinct sub-SMAS plane can be defined deep to SMAS. It is continuous with the plane between platysma and the underlying investing layer of deep cervical fascia in the neck. However, where it overlies the parotid gland, the SMAS is firmly blended with the superficial layer of the parotid fascia, which means that a clear sub-SMAS plane is difficult, if not impossible, to define in the region of the parotid.

2. C

The typical Cervical vertebrae are C1,C2,C7
Thoracic vertebrae are

3. A

The common carotid artery bifurcates at the level of C3-C4 junction

Vertebral Levels as Reference Points

Vertebral Level	Anatomic Structure
C4	Hyoid bone Bifurcation of common carotid artery
C5	Thyroid cartilage Carotid pulse palpated
C6	Cricoid cartilage Start of trachea Start of esophagus
T2	Sternal notch Arch of the aorta
T4	Sternal angle Junction of superior and inferior mediastinum Bifurcation of trachea
T5—7	Pulmonary hilum
T8	Inferior vena cava hiatus
T9	Xiphisternal joint
T10	Esophageal hiatus
T12	Aortic hiatus
T12—L1	Duodenum
T12	Celiac artery Upper pole of left kidney
L1	Superior mesenteric artery Upper pole of right kidney End of spinal cord in adult (conus medullaris) and pia mater
L2	Renal artery
L3	End of spinal cord in newborn Inferior mesenteric artery Umbilicus
L4	Iliac crest Bifurcation of aorta
S1	Sacral promontory Start of sigmoid colon
S2	End of dural sac, dura, arachnoid, subarachnoid space, and cerebrospinal fluid
S3	End of sigmoid colon

4.B
A large interparietal bone is called Inca bone.

5.B
Pterion-4cm above zygomatic arch & 3.5 cm behind frontozygomatic suture

6.A
Growth of base increases the length of skull.It takes place at the cartilaginous joints between the body of sphenoid and ethmoid bone and between the basi-occiput and basi-sphenoid.

7.C
The petrotympanic Fissure transmits
Chordatympanic nerve, anterior tympanic branch of maxillary artery, anterior ligament of malleus.

8.B
The following are of full adult size at birth-internal ear,tympanic cavity, mastoid antrum,three ear ossicles.

9.D
The maxillary hiatus is formed by uncinate process of ethmoid,descending process of lacrimal bone from above , maxillary process of inferior nasal concha from below, maxillary process of perpendicular plate of palatine bone from behind.

10.C
In old age after loss of teeth, absorption of the alveolar margin brings the mental foramen near the upper border of mandible
In adults the mental foramen lies in the mid way between upper and lower border of bone
Angle of mandible is 110-115º
At birth the mental foramen is close to lower border,angle is 140 º[obtuse]

11.A
V2 Maxillary- foramen rotundum
General sensory-middle of face upper jaw and teeth, palate, maxillary sinus, nasal cavity and part of dura
Branches: Suspends pterigopalatin ganglion, Zygomatic, Superior Aveoler, Infraorbital, Nasal, Palatine (lesser, greater, nasopalatine), pharyngeal.

12.C
Maxillary nerve is not a content of superior orbital fissure
SOF-Lacrimal, frontal, trochlear, nasociliary, abducent, oculomotor nerve and ophthalmic veins

13.B
The arcuate eminence produced by upward bulging of anterior semicircular canal

14.B
Dorello canal:abducent nerve
- Pierces dura where pons and medulla meet
- Travels to superior orbital fissure; enters orbit
- General somatic motor nerve
- Supplies lateral rectus muscle: abducts (turn out) eye from midline

Dorellos canal: Opening sometimes found in the temporal bone through which the abducent nerve and inferior petrosal sinus together enter cavernous sinus.

15.D
The anterior & posterior ethmoidal foramina transmit the anterior & posterior ethmoidal nerves not emissary veins
Also see table

16.B
The anterior division of retromandibular vein joins with facial vein to form common facial vein which drains into IJV

17.B
The foramen ovale transmit accessory meningeal artery
The foramen spinosum transmit MMA
Mastoid foramen transmit meningeal branch of occipital artery.
Jugular foramen transmit meningeal branch of ascending pharyngeal artery

18.C
Lesser supraclavicular fossa is between two heads of sternocleidomastoid.

19.D
The carotid tubercle is on the transverse process of C6 [Chaissagnae tubercle]

20.A
Lesser Occipital nerve hooks around spinal accessory nerve

21.C
The highest and only genuine content of occipital triangle is spinal accessory nerve.

22.B
Buccinators is a mucle of the cheek,it is pierced by parotid duct, buccal branch of mandibular nerve, molar mucous glands

23.D
Depressor septi is a muscle of nasal group. It is not inserted to angle of mouth.

24.B
The phrenic nerve is plastered on scalenus anterior muscle

25.B
The carotid sheath is around CCA,ICA,IJV &Vagus

26.D
The following dorsal rami do not give any cutaneous branches –C1,C6,C7,C8,L4,L5

27.B
The only pair of muscle attached to the posterior tubercle of atlas is R C P Minor
Five pair of mucles attached to spine of axis-RCP Major, Obliquus capitis inferior, Semispinalis cervicis, Multifidus, Rotatores

28.A
Ventral rami of C1 supply Rectus capitis lateralis, Rectus capitis anterior, Thyrohyoid, Geniohyoid, Superior belly of Omohyoid

29.C
Anterior cerebral artery is branch from internal carotid artery.

30.B
The abducent nerve emerge between labyrinthine artery and AICA

31.B
The nerve supply to parotid gland

- **SYMPATHETIC**

PLEXUS AROUND EXTERNAL CAROTID ARTERY

- **PARASYMPATHETIC**

OTIC GANGLION THROUGH AURICULOTEMPORAL NERVE

- **SENSORY**

AURICULOTEMPORAL NERVE AND GREAT AURICULAR NERVE

32.B
The safety muscle of tongue is genioglossus

33.B
The superior ophthalmic vein drains the region of the paranasal sinuses and is directly connected with cavernous sinus although blood flow is normally away from brain.
Pterygoid venous plexus communicate with cavernous sinus via ophthalmic veins
The frontal emissary vein communicate with superior sagittal sinus via foramen caecum
The basilar venous plexus communicate with inferior petrosal sinus
Parietal emissary vein also communicate with superior sagittal sinus

34.D
The structures between mylohyoid and hyoglossus are:
Styloglossus, Lingual nerve, Submandibular ganglion, deep part of submandibular gland, hypoglossal nerve,suprahyoid branch of lingual artery.

35.D
The contents of tympanic cavity are three ossicles, two muscles, four nerves-superior & inferior caro ticotympanic nerves, tympanic branch of glossopharyngeal nerve, chordatytympanic nerve & facial nerve

36.D
- The boundaries of IFT are
- Anterior:
  Maxilla.
- Superior:
  Greater wing of sphenoid.
- Medial:
  Lateral pterygoid plate.
- Lateral:
- coronoid process and ramus of mandible.
- Inferior:
  Continuous with neck.
- Posterior:
  TMJ and styloid process.
- Communicates with:
  Orbit via inferior orbital fissure.
  Pterygopalatine fossa via pterygomaxillary fissure.
  Middle cranial fossa via foramen ovale and foramen spinosum

37.A
Massetric nerve is branch of anterior division of mandibular nerve

38.D
Modified hinge type synovial / Synovial sliding ginglymoid joint

39.B
The nerve of pterygoid canal is formed by greater petrosal [facial] with deep petrosal nerve [dervived from internal carotid plexus of nerves]

40.B
- CN V^2 =maxillary, entirely sensory
  - Goes thru foramen rotundum (a round hole behind the medial angle of the superior orbital fissure, that goes forward in skull)
  - Takes a bent course to go to floor of orbit; travels the infraorbital fissure and thru infraorbital canal and out the infraorbital foramen
  - Sensory innervation of cheek; sensory for everything from floor of orbit to roof of mouth
    - Upper jaw, maxillary sinus, nasal cavity, middle of face, middle ear cavity, auditory tube and dura
  - Branches
    - Supends pteryogopalantine ganglion (CN VII)
      - To reach ganglion, travels vertically along pteryogomaxillary canal
      - Fibers pass thru then go medially along nasal cavity to palate
    - Zygomatic: from cheek
      - Sends sensory thru lateral wall of orbit onto cheek
    - Nasal branches: from mucous membranes of nasal sinuses
    - Palatine branches (lesser, greater, nasopalatine)
      - Fibers pass through pteryogpalatine ganglion

- Descend through palatine canal and exit respective foramen
- Sensory nerves to palate

- nasopalatine nerve
  - supplies nasal septum
  - goes to front of palate and exits out opening behind upper incisors (incisor foramen)
  - sensory to front of palate
- Superior alveolar branches from upper teeth, gums, maxillary sinus
  - Maxillary sinus: hollow cavity from floor of orbit to roof of mouth; lined with mucosa
- infraorbital: terminal branch
- sensory between orbit and mouth
- meningeal: from middle and anterior cranial fossae
  - given off before exiting foramen rotundum
  - supplies dura around area
- pharyngeal: passes thru ganglion
  - from middle ear cavity and auditory tube
  - upper part of pharynx (back of throat)

Connection to middle ear

41.C

The branches of facial nerve are temporal, zygomatic, buccal, marginal mandibular and cervical

42.B

The sphenomandibular ligament is derived from the fibrous envelope of the meckels cartilage

43.A

Pterygoid fovea gives insertion to lateral pterygoid muscle.

44.D

Important Structures Associated With the Cavernous Sinuses

- The internal carotid artery and the sixth cranial nerve, which travel through it .
- In the lateral wall, the third and fourth cranial nerves, and the ophthalmic and maxillary divisions of the fifth cranial nerve .
- The pituitary gland, which lies medially in the sella turcica
- The veins of the face, which are connected with the cavernous sinus via the facial vein and inferior ophthalmic vein, and are an important route for the spread of infection from the face
- The superior and inferior petrosal sinuses, which run along the upper and lower borders of the petrous part of the temporal bone

45.D

The tributaries of cavernous sinus are superior ophthalmic vein, inferior ophthalmic vein, central vein of retina,superficial middle cerebral vein, inferior cerebral vein, sphenoparietal sinus

46.B

It is innervated by mandibular nerve thro otic ganglion without relay carrying fibres from nerve to medial pterygoid

47.C

Lymph from the medial portion of the lower lip preferentially drains through the submental nodes in the chin and metastases may first appear here. Lymph from the upper lip and lateral portions of the lower lip drains preferentially through the submandibular nodes on the inferolateral aspect of the mandible. The parotid nodes receive lymph from upper and lateral regions of the face including the forehead, eyelids, and middle ear. Superficial and deep cervical nodes receive lymph from other nodes including the parotid and retroauricular. Buccal lymph nodes drain the cheeks and sides of the nose.

48. C

The confluence of sinuses is formed by the superior sagittal sinus, both transverse sinuses, the occipital sinus, and the straight sinus. The inferior sagittal sinus and the great cerebral vein join to form the straight sinus. The superior and inferior petrosal sinuses both drain the cavernous sinuses, the former connecting with the ipsilateral transverse sinus. The sigmoid sinus is in between the transverse sinus and the origin of the internal jugular vein.

49.C

The temporalis, masseter, and medial and lateral pterygoid muscles are the muscles of mastication that attach to the mandible. The buccinator muscle which controls the contents of the mouth during mastication, is innervated by the facial CN VII. The lateral pterygoid muscles, acting bilaterally, protract the jaw and, acting unilaterally, rotate the jaw during chewing. Because the fibers of the superior head of the lateral pterygoid muscle insert onto the anterior aspect of the articular disk of the temporomandibular joint as well as onto the head of the mandible, spasm of this muscle, such as in a yawn, can result in dislocation of the mandible by pulling the disk anterior to the articular tubercle. Reduction is accomplished by pushing the mandible downward and back, so that the head of the mandible reenters the mandibular fossa. The temporalis, medial pterygoid and masseter muscles primarily elevate the jaw in molar occlusion.

50.D

The maxillary artery is this divided into three parts by its relation to the lateral pterygoid muscle. **Branches of the first or retromandibular part of the maxillary are**:

- Deep auricular artery to the external acoustic meatus
- Anterior tympanic artery to the tympanic membrance
- Middle meningeal to the dura and calvaria
- Accessory meningeal arteries to the cranial cavity
- Inferior alveolar artery to the mandible, gingivae (gums), teeth, and floor of the mouth

Branches of the second or pterygoid part are:

- Deep temporal, anterior and posterior, which ascend to supply the temporal muscle
- Pterygoid, which supplies the pterygoid muscles
- Masseteric, which passes laterally thru the mandibular notch to supply the masseter muscle
- Buccal artery, which supplies the buccinator muscle and mucosal of the cheek.

Branches of the third or pterygopalatine part are:

- Posterior superior alveolar artery, which supplies the maxillary moral and premoral teeth, the buccal gingiva, and the lining of the maxillary sinus.
- Infraorbital artery, which supplies the inferior eyelid, lacrimal sac, infraorbital region of the face, side of the nose, and the upper lip
- Descending palatine artery, which supplies the mucous membrane and glands of the palate (roof of mouth) and palatine gingival
- Artery of pterygoid canal, which supplies the superior part of the pharynx, the pharyngotympanic (auditory) tube, and the tympanic membrane
- Pharyngeal artery, which supplies the roof of the pharynx, the sphenoidal sinus, and the inferior part of the pharyngotympanic tube.
- Sphenopalatine artery, the termination of the maxillary artery, which supplies the lateral nasal wall, the nasal septum, and adjacent paranasal sinuses.

51.B

Mastoid process is absent at birth and develops after second year

52.C

The overlapping constrictor muscles leave 4 gaps for structures to enter or leave the pharynx:

1. Superior to the superior constrictor, the levator veli palatine, pharyngotympanic tube, and ascending palatine artery pass thru the gap between the superior constrictor and cranium; it is here that the pharyngobasilar fascia blends with the buccopharyngeal fascia to form, with the mucous membrane, the thin wall of the pharyngeal recess.
2. Between the superior and middle is a gap that forms the gateway to the oral cavity thru which pass the stylopharyngeus, glossopharyngeal nerve. And stylohyoid ligament.

3. Between the middle and inferior is a gap for the internal laryngeal nerve and superior laryngeal artery and vein to pass to the larynx.
4. Inferior to the inferior is a gap for the recurrent laryngeal nerve and inferior laryngeal artery to pass superiorly into the larynx.

53.B
The ciliary ganglion located between lateral rectus and optic nerve

54.B
Stapedius is a asymmetric bipennate muscle

55.A
Facial vein makes clinically important connections with cavernous sinus through superior ophthalmic vein

56.C
Formed by union of two internal cerebral veins

57.B
Extrinsic Muscles:
-Suprhyoid muscles (mylohyoid V3, digastrics antV3 post VII, geniohyoid C1 via XII, stylohyoid VII- raise larynx and depress mandible (high notes)
-Infrhyoids- (omohyoid, thyrohyoid (really just C1), sternohyoid, sterothyroid) invervated by ansa cervicalis dpress larynx- low notes
Intrinsic Muscles:
** all innervated by recurrent laryngeal except cricothyroid which is innervated by external laryngeal
-Adductors of Vocal Folds
-Transverse arytenoids
- Oblique arytenoids
- Llateral cricoarytenoids
-Abductor of Voal Folds
- Posterior cricoarytenoids
- Adjustors- adjust tension by pulling down like helmet or sliding fwrd
- Cricothyroid muscles
- Thyroarytenoids and vocalis muscles

58.C
Frankfurt plane is orbitomeatal plane –joining lower margin to upper margin of external acoustic meatus

59.C
Infraorbital artery is a branch of maxillary artery- 3rd part

Artery	Origin	Course and Distribution
Ophthalmic	Internal carotid artery	Traverse optic foramen to reach orbital cavity
Central retinal artery	Ophthalmic	Runs in dural sheath of optic nerve and pierces nerve near eyeball; appears at center of optic disc; suppies neural retina (except rods and cones)
Supraorbital	Ophthalmic	Passes superiorly and posteriorly from supraorbital foramen to supply forehead and scalp
Supratrochlear	Ophthalmic	Passes from supraorbital margin to forehead and scalp
Lacrimal	Ophthalmic	Passes along superior border of lateral rectus muscle to supply lacrimal gland, conjunctiva, and eyelids
Dorsal nasal	Ophthalmic	Courses along dorsal aspect of nose and supplies its surface
Short posterior ciliaries	Ophthalmic	Piece sclera at periphery of optic nerve to supply choroids, which in turn supplies the cones and rods of neural retina

Long posterior ciliaries	Ophthalmic	Pierce sclera to supply ciliary body and iris
Posterior ethmoidal	Ophthalmic	Passes thru posterior ethmoidal foramen to posterior ethmoidal cells
Anterior ethmoidal	Ophthalmic	Passes thru anterior ethmoidal foramen to anterior cranial fossa; supplies anterior and middle ethmoidal cells, frontal sinus, nasal cavity, and skin on dorsum of nose
Infraorbital	Third part of maxillary artery	Passes along infraorbital groove and foramen to face
Anterior ciliary	Ophthalmic artery	Pierces sclera at the periphery of iris and forms network in iris and ciliary body.

60.D

Muscles of pharynx

- External muscles: three constrictors
  - All attach to tendinous midline
  - Circular sphincters for peristalsis
  - Slight overlap b/w superior and middle constrictors and b/w middle and inferior constrictors
  - not well differentiated
  - Laterally : gaps (see more below)
  - Superior constrictor
    - From pterygomandibular raphe and pterygoid hamulus to median raphe and pharyngeal tubercle
      - Pterygomandibular raphe: boundary b/w buccinator and superior constrictor
  - Middle constrictor
    - From hyoid bone and inferior end of stylohyoid ligament to median raphe
  - Inferior constrictor

From thyroid and cricoid cartilages to median raphe

61.B

Only if the tumour is in pterygopalatine fossa it can reach cranial cavity via foramen rotundum

62.D

The tympanic plexuses is formed by the tympanic branch of glossopharyngeal nerve

63.B

Thyrohyoid membrane pierced by internal branch of superior laryngeal nerve

64.C

Parasympathetic ganglion associated with CN III, V, VII, IX:

Ganglion	**Location**	**Parasympathic root**	**Sympathetic Root**	**Main distribution**
Ciliary	Located between optic nerve and lateral rectus, close to apex of the orbit	Inferior branch of oculomotor nerve (CN III)	Branch from internal carotid plexus in cavernous sinus	Parasym postsyn fibers from ciliary ganglion pass to ciliary muscles and sphincter pupillae of iris; symp postsyn ifbers from superior cervical ganglion pass to dilator pupillae and blood vessels of eye

Pterygopalatine	Located in pterygopalatine fossa where it is suspended by pterygopalatine branches of maxillary nerve; located just anterior to opening of pterygoid canal and inferior to CN V2	Greater petrosal nerve from facial (CN VII)	Deep petrosal nerve, a branch of internal carotid plexus that is continuation of postsyn fibers of cervical symp trunk; fibers from superior cervical ganglion pass thru pteryopalatine glangion and enter branches of CN V2	Parasymp postsyn fibers from pterygopalatine ganglion innervate lacrimal gland via zygomatic branch of CN V2; symp postsyn fibers from superior cervical ganglion accompany those branches of pterygopalatine nerve that are distributes to blood vessels of the nasal cavity, palate, and superior part of the pharynx.
Otic	Located between tensory veli palatine and mandibular nerve (CN V3); lies inferior to foramen ovale	Tympanic nerve from CN IX; from tympanic plexus tympanic nerve continues as lesser petrosal nerve	Fibers from superior cervical ganglion come from plexus on middle meningeal artery	Parasymp postsyn fibers from otic ganglion are distributed to parotid gland via auriculotemporal nerve (CN V3); symp postsyn fibers from superior cervical ganglion pass to parotid gland and supply its blood vessles
Submandibular	Suspended from lingual nerve by two short roots; lies on surface of hyoglossus muscle inferior to submandibular duct	Parasym fibers join facial nerve and leave it in its chorda tympani branch, which unites with lingual nerve	Sympathetic fibers from superior cervical ganglion come from the plexus on facial artery	Parasym postsyn fibers from submandibular ganglion are distributed to the sublingual and submandibular glands; sympathetic fibers supply sublingual and submandibular glands and appear to be secretomotor.

65.B
Lacrimation is associated with greater petrosal nerve through PPG

66.D
Glossopharyngeal nerve (CN IX): Provides

- Sensory for taste from the posterior third of the tongue
- Sensory (general) from the mucosa of the pharynx, palatine tonsil, posterior third of the tongue, pharygotympanic (auditory) tube, and middle ear.
- Sensory for blood pressure and chemistry from the carotid sinus and carotid body.
- Motor and proprioceptive to the stylopharygeus muscle.
- Parasymp (secretomotor) to the parotid gland and glands in the posterior third of the tongue.

67.A
Facial nerve innervates the muscle of facial expression from 2 nd arch

68.D
Facial nerve (CN VII): the facial nerve emerges from the junction of the pons and medulla. CN VII has two divisions, the motor root and the intermediate nerve. The larger motor root innervates the muscles of facial expression, and the smaller root carries taste, parasymp, and somatic sensory fibers conveyed distally by the chorda tympani nerve. During its course, CN VII traverses the posterior cranial fossa, internal acoustic meatus, facial canal

in the temporal bone, stylomastoid foramen and parotid gland. At the medial wall of the tympanic cavity, the facial canal bends posterioinferiorly where the genicular ganglion (sensory ganglion of CN VII) is located. Within the facial canal, CN VII gives rise to the greater petrosal nerce, the vers to the stapedius, and the chorda tympani nerve. Then CN VII emerges from the cranium via the stylomastoid faramen, gives off branches to the auricular, facial and occipitofrontal muscles, then enters the parotid gland, forming the parotid plexus of nerves, which gives rise to the following terminal branches:

Posterior auricular
Temporal
Zygomatic
Buccal
Mandibular
Cervical

Brachial motor: Terminal branches innervate the muscles of facial expression, the occipitalis, auricular muscles, posterior belly of digastric, stylohyoid, and stapedius muscles. These are all derivated of the 2nd embryonic pharyngeal arch.
General sensory: Some fibers from the geniculate ganglion supply a small area of skin around the external acoustic meatus. Postsyn fibers from the submandibular ganglion innervate the sublingual and submandibular glands, while those from the pterygopalatine ganglion innervate the lacrimal, nasal, pharyngeal, and palatine glands. Parasym fibers synapse in these ganglia whereas symp and other fibers pass thru them.
Taste (special sensory): The chorda tympani receives fibers from the lingual nerve that convey taste sensation from the anterior two thirds of the tongue and soft palate to the geniculate ganglion.

69.A
I.V1 Opthalmic –superior orbital fissure
General Sensory- cornea, eyeball, forehead, frontal and ethmoid sinuses, lachrymal gland
Branches:
Lacrimal
Frontal (supraorbital, supratrochlear)
Nasociliary- carries cilliary ganglion
Long Cillary carry sympathetics to cilliary body, iris
Ethmoidal and nasal nerve
Infratrochlear
V2 Maxillary- foramen rotundum
General sensory-middle of face upper jaw and teeth, palate, maxillary sinus, nasal cavity and part of dura
Branches: Suspends pterigopalatin ganglion, Zygomatic, Superior Aveoler, Infraorbital, Nasal, Palatine (lesser, greater, nasopalatine), Manyngeal, pharyngeal
V3 Mandibular- foramen Ovale
Branches: mental, auricotemporal, buccal
General sensory- lower jaw and teeth floor of mouth, ANTERIOR 2/3 of tongue
Motor- muscles of mastication (temporalis, massateur, lat/med. pterygoid), mylohyoid, digastrics,* tensor veli palatine*, tensor tympani (via inferior alveolar)
Branches: Buccal (internal and external), auricotemporal (suspends otic ganglion, does tympanic memb, EAM), Lingual (sensory ant. 2/3 and suspends submandibular ganglion), Inferior Alveoler (dental and Mental Nerves), Meningeal Nerve (accompanies mid menig a.)

70.C
Angle of mandible is supplied by greater auricular nerve[c2]

71.B
Intrinsic Muscles:
** all innervated by recurrent laryngeal except cricothyroid which is innervated by external laryngeal
-Adductors of Vocal Folds
-Transverse arytenoids
-oblique arytenoids
-lateral cricoarytenoids

-Abductor of Voal Folds
-Posterior cricoarytenoids
-Adjustors- adjust tension by pulling down like helmet or sliding fwrd
-Cricothyroid muscles
-Thyroarytenoids and vocalis muscles- diff fiber directions allow for fine voice control and fin tuning if you will

Epithelium→ vocal fold gets stiffer
Vocal folds→ Arytenoids and thyroid cartilages gets stiffer
Laryngeal vibrations are not the result of rhythmic contraction of Laryngeal muscles but rather due to changes in air pressure (folds forced apart and sucked back together)→ low pressure (rarefraction) and high pressure (compression)

Changes in amplitude confer loudness
Changes in frequency confer diff pitches
More massive vocal folds→ lower pitches
Infant larynx higher in neck so can breath more easily while suckling
Puberty abrupt change in larynx size leads to pitch control problems
Whispering- leave vocal folds partially open so lots of air comes out

72.A

73.A
The foramen transversarium of C7 Contain only vertebral vein.The vertebral artery enter C6 foramen transversarium in majority of the cases.
Vertebral: travel up via transverse foramena- enter endocranial cavity via foramen magnum→ give off small cerebellar branches then combine to form basilar artery terminating in posterior cerebral arteries

74.B

I. Eye Movements
- **a.** Muscles
  - **i.** Movements: Elevation/Depression, Adduction/Abduction, Extorsion(lateral rotation of eye)/Intorsion(medial rotation of eye)
  - **ii.** **Superior Rectus**
    1. Innervation: CN III
    2. Fxn: Elevation (adduction & intorsion)
    3. muscle axis is ~23 degrees off from visual axis
  - **iii.** **Inferior rectus**
    1. Innervation: CN III
    2. Fxn: Depression (abduction & extorsion)
    3. muscle axis is ~23 degrees off from visual axis
  - **iv.** **Medial rectus**:
    1. Innervation CN III
    2. Fxn: Adduction
  - **v.** **Lateral rectus**:
    1. Innervation: CN VI (abducent nerve)
    2. Fxn: abduction
  - **vi.** **Superior oblique**:
    1. Innervation: CN IV (trochlear nerve)
    2. Fxns: Intorsion (w/ depression & abduction)
    3. muscle axis is ~51 degrees off from visual axis
  - **vii.** **Inferior oblique**:
    1. Innervation: CN III (oculomotor nerve)
    2. Fxns: Extorsion (w/ elevation & abduction)
    3. muscle axis is ~51 degrees off from visual axis

75.D

The auriculotemporal nerve arises by two roots to embrace the middle meningeal artery.

V3 Mandibular- foramen Ovale

Branches: mental, auricotemporal, buccal

General sensory- lower jaw and teeth floor of mouth, ANTERIOR 2/3 of tongue

Motor- muscles of mastication(temporalis, massateur, lat/med. pterygoid), mylohyoid, digastrics,* tensor veli palatine*, tensor tympani (via inferior alveolar)

Branches: Buccal (internal and external), auricotemporal (suspends otic ganglion, does tympanic memb, EAM), Lingual (sensory ant. 2/3 and suspends submandibular ganglion), Inferior Alveoler (dental and Mental Nerves), Meningeal Nerve (accompanies mid menig a.)

76.C

Langley's ganglion / Submandibular ganglion lies on Hyoglossus.

- The facial nerve gives off a branch, the chorda tympani nerve, immediately before exiting the skull at the stylomastoid foramen.
- Chorda tympani recurs back into the middle ear cavity, and then passes anteriorly across the lateral wall of the middle ear, which happens to be the tympanic membrane.
- It crosses the handle of the malleus, and ultimately leaves the middle ear anteriorly to exit at the base of the skull through the petrotympanic fissure. This leads chorda tympani into the infratemporal fossa, in which it passes anteroinferiorly to join the lingual nerve from behind. It then runs with the lingual nerve to the submandibular ganglion, located in the paralingual space near the deep portion of the submandibular gland.

Chorda tympani carries preganglionic parasympathetic fibers that pass to the submandibular ganglion. There, some of these fibers synapse and return to the lingual nerve to travel anteriorly to reach the sublingual gland, to be secretomotor there. Other fibers pass through the submandibular ganglion to reach the submandibular gland, and synapse within the gland on diffuse postsynaptic neurons, to be secretomotor to this gland. Chorda tympani not only carries preganglionic parasympathetic fibers, but it also carries sensory fibers for taste for the anterior two-thirds of the tongue. These fibers travel into the tongue with the lingual nerve to reach the taste buds on the dorsum and sides of the tongue.

77.B

Piriform recess

Medially-Aryepiglottic fold

Laterally-Mucous membrane covering the lamina of thyroid lamina

Internal laryngeal nerve & superior laryngeal vessels pierce the thyrohyoid membrane and traverse outside the mucous lining of the fossa lateral to medial fossa.

78.B

Tritiate cartilage is a cartilage located on the thyrohyoid membrane.

79.C

Ansa subclavia is a cord connecting the middle cervical ganglia with inferior cervical ganglia around the first part of subclavian artery.

80.D

The mandibular division of trigeminal gives the following branches

From the trunk-nervus spinosus, Nerve to medial pterygoid

From anterior division-three motor one sensory-Massetric nerve, Deep temporal nerve, Nerve to lateral pterygoid, BUCCAL NERVE

From posterior division –three sensory and one motor-Auriculotemporal , inferior alveolar and lingual

Fibres from motor root are conveyed by the inferior alveolar nerve as MYLOHYOID Nerve

81.C

The facial nerve divides into temporofacial and cervicofacial branches. The Temporofacial divides into temporal,zygomatic. The cervicofacial divides into buccal, marginal mandibular and cervical branches. The

temporal branches supply the intrinsic muscles of auricle, upper part of orbicularis oculi, frontalis and corrugators supercilli. The zygomatic branch supply the lower part of orbicularis oculi.

82.D
The nerve of pterygoid canal innervate lacrimal gland, palatine gland, mucosal gland of nasal cavity.

83.B
Tensor tympani is supplied mandibular nerve through nerve to medial pterygoid

84.A
The muscle that receives innervations from dorsal rami is splenius capitis

85.B
The constrictors have common insertion to median Raphe ,the superior constrictor gets inserted to the pharyngeal tubercle.

86.D
The anterior vertebral muscles are RCL,RCA,LC,LC

87.B

88.A
Ellipsoid type synovial –atlanto occipital joint

89.A
Phrenic nerve derived from C3,C4,C5
Accessory phrenic nerve derived from C5
Descends lateral to phrenic nerve and posterior to subclavian vein

90.D
The masticator space contains muscles of mastication, mandibular nerve, buccal pad of fat

91.D
Sensory supply Larynx : The mucous membrane above the vocal cord is supplied by internal laryngeal nerve and below the vocal cord by the recurrent laryngeal nerve.
Motor supply: All intrinsic mucles supplied by recurrent laryngeal nerve except cricothyroid.

92.C
Ansa cervicalis is formed by descendens hypoglossi from hypoglossal nerve [C1 fibres] that joins with descendens cervicalis [C2 &C3].

93.C
With torticollis, the SCM is shortened, leading to the head being rotated toward the contralateral side.

94.C

95.A
Fascial slips separating the Parapharyngeal and Retropharyngeal space

96.A
Four set of ligaments bypass Atlas and connect axis with occiput
Apical ligament
Alar ligament
Cruciform ligament
Membrane tectoria

Cruciform ligament consist of a horizontal band and vertical band
Vertical band is attached to the upper surface of basilar part of occipital bone and below it is attached to axis
Horizontal band is the transverse ligament of atlas

97.A
Transverse ligament of atlas extends between the two tubercles on the medial side of lateral mass of Atlas.
A bursae intervene between the transverse ligament of atlas and Dens

98.C
Palatine aponeurosis is formed the tendon of tensor veli palatine
Its is a frame work where all palatal muscles are attached
The tendon of tensor veli palatine windes around the pterygoid hamulus
The Aponeurosis splits to enclose musculus uvulae

99.B
Nodes of Rouvier are Lateral retropharyngeal nodes
Prominent at C1-C2 Level
Medial to internal carotid artery
Drainage of nasopharynx
Rotters nodes-Interpectoral nodes

100.D

The Lessers triangle contain the LINGUAL ARTERY

Codman's triangle a triangular area visible radiographically where the periosteum, elevated by a bone tumor, rejoins the cortex of normal bone.

Farabeuf's triangle one in the upper part of the neck bound by the internal jugular vein, the facial nerve, and the hypoglossal nerve.

Triangle of Koch a roughly triangular area on the septal wall of the right atrium, between the tricuspid valve, coronary sinus orifice, and tendon of Todaro, that marks the site of the atrioventricular node.

Langenbeck's triangle one whose apex is the anterior superior iliac spine, its base the anatomic neck of the femur, and its external side the external base of the greater trochanter.
Lesser's triangle one formed by the hypoglossal nerve above, and the two bellies of the digastricus on the two sides.

Pawlik's triangle an area on the anterior vaginal wall corresponding to the trigone of the bladder.

Petit's triangle the inferolateral margin of the latissimus dorsi and the external oblique muscle of the abdomen

THE ABDOMEN
ANTERIOR ABDOMINAL WALL

Layers of the Abdominal Wall:

- Skin
  - o **Epidermis** -- the part we shed
  - o **Dermis** -- contains nerves, capillaries, sweat glands, hair follicles.
    - ■ Has collagen fibers that tend to be horizontal, forming the creasing of the skin. These are called **Langer's Lines.**
    - ■ In surgery, you should cut with Langer's Line, the direction of the collagen, so as to minimize surgical scars.
- **Superficial Fascia** -- Connective tissue that is not aponeurosis, tendon, or ligament. This is the same thing as the hypodermis.
  - o **Camper's Fascia:** Fatty layer, first of the two layers. It is found throughout.
  - o **Scarpa's Fascia:** Lower layer, found in the lower 1/3 of the anterior abdominal wall. It has a restrictive location, defined by the extent of damage occurring with a **straddle injury.**
    - ■ Limits:
      - ■ The area is restricted to the anterior abdominal wall.
      - ■ Lateral Limit: Basically the inguinal ligament, where it intersects with **fascia lata,** so that fluid does not pass into the thigh.
      - ■ Inferior Limit = the base of the scrotum.
      - ■ Posterior Limit = it goes back to the anus, and fills the pelvis in between.
    - ■ The outlined region is called the **superficial perineal space.**
    - ■ It is called different fascia at different places: *Dartos Fascia* in scrotum / labia majora, and *Colles Fascia* around perineum.
  - o **Fundiform Ligament:** The **false suspensory ligament** of the penis or clitoris. It is an extension of superficial fascia.
- Deep Fascia
  - o A **true suspensory ligament** occurs in the deep fascia layer, which extends into the penis / clitoris. So, we have
    both a true suspensory ligament (deep fascia) and a false one (fundiform ligament / superficial fascia).
  - o Deep fascia encompasses all muscles of the entire body.
- **Muscles** -- Three flat muscles plus the longitudinal rectus sheath muscle.
  - o **External Abdominal Oblique** -- muscle fiber direction is antero-inferior (like external intercostals -- hands in pocket).
    - ■ Originate at border of Thoracic ribs T5 - T12
    - ■ Extends to midline and attaches on linea alba. Also attaches to the iliac crest.
    - ■ Again, the **aponeurosis** portion of the externals form the **inguinal ligaments.**
    - ■ Also forms the **superficial inguinal ring,** which allows passage of the **spermatic cord** (male) or **round ligament** (female).
      - ■ Superficial Inguinal Ring is made up of two components, **lateral crus** and **medial crus. Intercrural fibers** separate the two.
  - **o** Internal Abdominal Oblique
    - ■ Also has fibers that attach along the inguinal ligament to the pubic crest.

- Direction of fibers tends to go outward, from medial to lateral and a little bit inferiorly (inferolaterally).
- Borders on ribs 7 - 12.
- The aponeurosis splits and goes both anteriorly (to merge with external aponeurosis) and posteriorly (to merge with transversus aponeurosis)

o **Transversus Abdominis** Deep most layer of flat muscles.

- Also borders on ribs 7 - 12. Extends down to the pubic crest and medially to the linea alba.
- It creates a diagonal pathway for the spermatic cord or round ligament to pass through.
- Fibers run transversely! -- horizontally from

lateral to medial. o **Rectus Abdominis:** Straight muscle.

- Passes from Xiphoid Process inferiorly to **pubic symphysis** (inferior center of pubic bone).
- **Rectus Sheath** holds this rectus muscle in place. It is directly shallow to it, formed by the aponeuroses of the three flat muscles. It has a posterior and anterior layer, formed from the aponeuroses of the three flat muscles.
  - Upper 3/4 of Abdominal Wall: All three muscle layers converge on rectus sheath, and pass both anteriorly (external aponeurosis) and posteriorly (transversus aponeurosis).
    - This part of the wall is suturable in surgery.
  - Lower 1/4 of abdominal wall is transversalis fascia. Here, all three muscle layers pass anteriorly. Here it is called transversalis fascia.
    - This part of the wall is not suturable in surgery.
- **Arcuate Line:** The line that divides the upper 3/4 of abdomen from lower 1/4, by the differences in the aponeurotic layers.
- **Transversalis Fascia** -- Deep fascia on the interior (deep) surface of the transversus abdominis muscle.
  - Esp. found in the lower 1/4 of the abdomen.

o It has several names, but it is one continuous plane of fascia, just outside the peritoneum.
o As a continuous plane, it is also an avenue for infection.

- Subserous Fascia
- **Peritoneum:** A serous membrane that secretes fluid, thus allowing internal organs frictionless movement.
- **Linea Alba:** The best place to make a surgical cut and not hit any nerves is straight down the linea alba.
- NERVOUS SUPPLY of Anterior Wall: Ventral Rami of T7 - T12, and L1.
- **Dermatomes:** How nerves innervate the anterior abdominal wall -- in sections.
- Referred Pain: Example
  - o T10 goes to umbilical region.
  - o Appendicitis pain will go to sympathetic nervous system ----------> refers back to T10. When rupture occurs, toxins
    are released and irritate the peritoneum, resulting in a localized effect.
- **Ilioinguinal Nerve:** Goes through the inguinal canal, with the spermatic cord (male) or round ligament (female).
  - o Supplies scrotum (or labia majora) and medial aspect of thigh.
- **Iliohypogastric Nerve:** Directly superior to ilioinguinal nerve.
  - o Innervates the suprapubic area.
- Both Ilioinguinal and Iliohypogastric may come off as a single nerve and branch later.

McBurney's Point: The point of surgical incision for an appendectomy.

- Is located on a line along the ASIS. The iliohypogastric nerve is right there, about 1cm superior to the ASIS, so that is the nerve that ya gotta be weary of when doing an appendectomy.

ARTERIAL SUPPLY of Anterior Wall:

- **Superior Epigastric Artery** -- Runs directly over rectus abdominis muscle.
- Inferior Epigastric Artery
- Superficial Epigastric Artery

VENOUS SUPPLY of Anterior Wall: The same as the veins above.

- When using a needle to drain peritoneal fluid, do not hit the Superior or Inferior epigastric veins! The result would be massive bleeding.

INGUINAL REGION

Inguinal Canal: Formed from the aponeuroses of the three flat muscles.

It a **diagonal passage.** Most tubular structures pass through membranes diagonally, as the ureters and fallopian tubes do.

o This provides reinforcement on the wall of the structure being entered.

Contents of Inguinal Canal

o Spermatic Cord **(male) or** Round Ligament **(female)**

o Ilioinguinal Nerve

o Genital Branch of the **Genitofemoral Nerve.**

Inguinal Triangle (Hesselbach's Triangle): An area of weakness in the aponeurosis, where direct hernias can occur.

- Borders:
  - **o The lateral margin of the rectus muscle (linea** semilunaris)
  - **o The** Inferior Epigastric Artery
  - **o The** Inguinal Ligament
- **CONJOINT TENDON:** The space of membrane where the transversus abdominis and internal oblique aponeuroses join into one. It is an *area of weakness* in the abdominal wall.

HERNIAS: The protrusion of intraperitoneal guts outside of the peritoneum (i.e. through the peritoneal wall).

- **DIRECT INGUINAL HERNIA:** Gut goes straight through the inguinal triangle, through the conjoint tendon.
  - *o It will be located* medial to the inferior epigastric artery
- **INDIRECT INGUINAL HERNIA:** Hernia that passes through the inguinal canal and originates *lateral to the inferior epigastric artery*.
  - *o* **Congenital Indirect:** The weakness was present at birth.
    - **Agenesis:** Absence of growth or closure of some part of the abdominal wall.
    - **Dysgenesis:** Incorrect or dysfunctional growth. o **Acquired Indirect:**
    - **Ascites** -- (fluid buildup in peritoneum)
    - Obesity
    - Pregnancy
    - Surgical Incisions
- Diaphragmatic Hernias:
  - o **HIATAL HERNIA:** Distal end of the esophagus can draw itself back into the eosphageal hiatus, pulling part of the stomach with it.
    - Referred pain from a hiatal hernia occurs in Epigastric region, around T7-T8. o **Semilunar Hernias:** Occur along the rectus sheath and arcuate lines, mostly.

PERITONEUM

Spleen: It is actually mesodermal in origin, not endodermal like the rest of the abdominal organs.

Retroperitoneal Space: The area behind (posterior to) the peritoneum. Any organs not completely (or almost completely) covered by peritoneum are considered retroperitoneal organs.

Abdominal Cavity: Everything but the lateral, posterior, and anterior body walls of the abdomen, including both the peritoneal cavity and the retroperitoneal space.

Peritoneal Cavity: That part of the abdomen invaginated by **peritoneum.**

- Peritoneum has visceral and parietal layers, just like the pleural cavity. It is analogous to the organs pushing themselves into the peritoneum, like a fist into a balloon.
  - o **Visceral Peritoneum:** Peritoneum directly on the organs.
  - o **Parietal Peritoneum:** Peritoneum surrounding the interior lining of the abdominal wall.
- MALES: The peritoneal cavity is CLOSED.
- FEMALES: The peritoneal cavity is OPEN. It opens out into the cervix and vagina, making it a potential space for pathogens to enter.
- Peritoneum should be considered a *potential space* for pathogens and fluids to build up.

Subphrenic Recess: The recess where the peritoneum reflects off the liver (right side) on the inferior surface of the diaphragm.

- It contains the **coronary ligament** of the liver. OMENTA: Peritoneum surrounding the stomach
- **Lesser Omentum:** Peritoneum along the lesser curvature of the stomach, covering the pancreas. It is superior and medial to the stomach and posterior to parts of the liver, and anterior to pancreas.
  - o **Lesser Omental Bursa / Lesser Peritoneal Sac:** The space between the stomach and the liver. The space anterior to the lesser curvature of the stomach and posterior to the liver.

- **EPIPLOIC FORAMEN:** A pathway that allows entrance from the lesser peritoneal sac to the greater peritoneal sac.
  - o The Inferior Vena Cava goes directly posterior to it *(retroperitoneal).*
  - *o* The portal triad is directly anterior to it, in the peritoneum, along the lesser curvature of the stomach.
- **Greater Omental Bursa:** The space between the stomach and anterior abdominal wall.
  - o **Greater Omentum:** The space formed by the peritoneum on the anterior surface of the stomach and the anterior abdominal wall.
    - It attaches to the stomach and to the transverse colon.
    - Anterior Layer of Greater Omentum: The parietal peritoneum of the abdominal wall.
    - Posterior Layer of Greater Omentum: The visceral peritoneum along the greater curvature of the stomach.

Superior Recess: Where the Lesser Omentum stops at the **coronary ligament** of the liver and reflects back onto the liver.

Inferior Recess: Along the greater curvature of the stomach, where the greater omentum reflects onto the transverse mesocolon. Essentially, the space between the stomach and transverse colon, inferior to the stomach.

Intra-Peritoneal Organs: Organs completely or almost completely enclosed by peritoneum.

- Stomach
- Liver
- Gall Bladder
- Transverse Colon: completely
- Jejunum
- Ileum
- Cecum (very start of ascending colon)

Retro-Peritoneal Organs: Organs that are located mostly or completely behind the posterior parietal peritoneum.

- Duodenum
- Ascending Colon (only 25-50% covered)
- Descending Colon (only 25-50% covered)
- Sigmoid Colon
- Pancreas
- Kidneys
- Great Vessels and their primary branches: Abdominal Aorta and Inferior Vena Cava, Celiac Trunk, and Superior and Inferior Mesenteric arteries and veins.

Mesentery: Two layers of peritoneum opposing each other. Vessels and nerves often lie in the mesentery, where they can easily reach the organ where the peritoneal layers separate and reflect off the organs.

- **THE Mesentery:** The one that connects the small intestine to the posterior abdominal wall.
  - o The **root** of the mesentery is where the Mesentery connects to the posterior wall.
- **Transverse Mesocolon:** Specific mesentery connecting the transverse colon to the posterior peritoneum.
- **Sigmoid Mesocolon:** Specific mesentery connecting the sigmoid colon to the posterior peritoneum.

The Anterior Surface of the Diaphragm:

- **Vena Caval Foramen:** Hole for the Inferior Vena Cava, where it passes to the liver.
  - o Around **T8**
  - o It is located in the **central tendon** (superior most part) of the diaphragm.
- **Eosphageal Hiatus:** Opening that admits the esophagus, guarded by two muscles **left crus** and **right crus.**
  - o **Left Gastric Artery** and **Left Gastric Vein** also pass through the eosphageal hiatus. o Passes through at **T10.**
- **Aortic Hiatus:** Is actually posterior to the diaphragm -- not really a hole in the diaphragm.
  - o **Thoracic Duct** goes posterior through this opening as well as aorta. o About Level 12, at lower most part of diaphragm.
- **Lumbocostal Arches:** Transversalis Fascia on the posterior wall of the diaphragm. Sympathetic Ganglia come through along these arches.

FOREGUT:

- STRUCTURES:
  - o Stomach
  - o 1st two parts of the duodenum: Duodenal Cap and Descending Duodenum. o Liver
  - o Gall Bladder o Pancreas
- ARTERIAL VASCULAR SUPPLY
  - o Branches of the Celiac Trunk
- LYMPHATIC SUPPLY
  - o Branches of the Celiac Nodes

- REFERRED PAIN: Occurs in the Epigastric Region.
- VENOUS RETURN: The portal vein.
- INNERVATION:
  - o Parasympathetic: From Vagus nerve (C10). It is *perivascular* -- it follows the blood vessels.
  - o Sympathetic: From the Greater Thoracic Splanchnic Nerves (T6-T10)

MIDGUT:

- STRUCTURES:
  - o Third and fourth parts of duodenum: Horizontal and Ascending Duodenum.
  - o Jejunum
  - o Ilium
  - o Cecum
  - o Ascending Colon o First 2/3 of Transverse Colon
- ARTERIAL VASCULAR SUPPLY
  - o Branches of the Superior Mesenteric Artery
- LYMPHATIC SUPPLY: Branches of the Superior Mesenteric Nodes.
- REFERRED PAIN: Occurs in the Umbilical Region
- VENOUS RETURN: The Superior Mesenteric Vein.
- INNERVATION:
  - o Parasympathetic: From Vagus nerve (C10). It is *perivascular* -- from the blood vessels. o Sympathetic: From the Lesser Thoracic Splanchnic (T9-T11,L1)

HINDGUT:

- STRUCTURES:
  - o Distal 1/3 of Transverse Colon o Descending Colon o Sigmoid Colon o Rectum
  - o Upper portion of anal canal.
- ARTERIAL VASCULAR SUPPLY
  - o Branches of the Inferior Mesenteric Artery
- LYMPHATIC SUPPLY: Branches of the Inferior Mesenteric Nodes.
  - o Exception: The upper and lower rectum go to the Right and Left Common Iliac nodes, which then drains straight to the Lumbar Chain Nodes, and then to Thoracic Duct.
- REFERRED PAIN: Occurs in the Hypogastric (Suprapubic) region.
- VENOUS RETURN: The Inferior Mesenteric Vein.
- INNERVATION:
  - o Parasympathetic: From Pelvic Splanchnic Nerves (S2-S4).
  - o Sympathetic: From the Upper Lumbar Splanchnic (L1-L2)

THE STOMACH

DEVELOPMENT:

- Stomach begins as a mere dilation of the primitive gut tube.
- It undergoes two basic processes: differentiation and rotation.
- Initially tube attaches to dorsal and ventral walls via dorsal and ventral mesenteries.
  - o **Ventral Mesentery** eventually becomes lesser omentum.
  - **o** Dorsal Mesentery (Dorsal Mesogastrium) **eventually becomes greater omentum.**
- **Rotation:** Then the whole structure rotates 90 to the right, dragging the mesentery along with it.
  - o The dorsal mesentery becomes the left side of the body, and the posterior of the stomach becomes the left lateral aspect.
- **Differential Growth:** Then differential growth produces the fundus, the greater curvature, and the lesser curvature of the stomach.

LOCATION: The pylorus of the stomach at the level of L1, in the transpyloric plane.

- Generally in the right epigastric region, but the location varies depending on position, weight, physiology, etc.

EXTERNAL MORPHOLOGY:

- **Cardia:** Superior part nearest the esophagus.
- **Fundus:** That part of the stomach that is actually superior to the abdominal esophagus.
  - o Gastric Bubble is located here in radiographs, if person is upright.
  - o Cardiac Notch is a radiographic feature of being able to see the fundus part of the stomach.

- **Body:** The main part of the stomach consisting of the greater and leser curvatures.
  - o **Greater Curvature:** Inferior border of stomach body.
  - o **Lesser Curvature:** Superior border of stomach body.
- **Pyloric Region:** The most distal part of the stomach, at level of L1, leading into duodenal cup.
- **Gastrocolic Ligament:** On greater curvature of stomach, attaching to transverse colon. It is part of the greater omentum. INTERNAL MORPHOLOGY:
- **Gastric Canal:** Impression along the lesser curvature of the stomach, on the interior.
  - o Rugae here are more longitudinal, to guide food to the pylorus.
- **Cardiac Opening:** The opening at the proximal end, aka the **esophogastric junction.**
  - o No true sphincter here.
- **Rugae:** Mucosal folds of internal wall of stomach. They increase the surface area available for digestion.
- Pyloric Antrum:
- **Pyloric Canal:** The distal region of the body, in the pyloric zone, leading to pylorus.
- **Pyloric Sphincter:** At the pylorus, it is a true sphincter controlling flow of chyme into the duodenum.

RELATIONSHIPS:

- The left lobe of the liver overlies the anterior portion of the stomach.
- Spleen is lateral to the stomach, just off the greater curvature.
- The greater omentum is inferior to the stomach (just off greater curvature), and the transverse colon lies directly deep to it.
- Posterior to Stomach:
  - o The lesser peritoneal sac.
  - o The pancreas, with the duodenum surrounding it.
- **Bed of the Stomach:** Those organs upon which the stomach lies.
  - o The pancreas, spleen, transverse colon, and a portion of the kidney and suprarenal glands.

CLINICAL CONSIDERATIONS:

- Gastric Bubble can be seen in stomach on X-rays, in the fundus region.
- Stomach Carcinoma is usually in the pyloric region or lower body, close to the pyloric lymph nodes.
- **Gastric (Peptic) Ulcers:** Acid secretion in stomach.
  - o Gastroduodenal Artery, posterior to pyloric area, can be affected by an ulcer if the wall is eroded.

VASCULAR / LYMPH SUPPLY:

- Pyloric Lymph Nodes drain to the Celiac Nodes.
- **Right and Left Gastric Arteries** supply the lesser curvature of the stomach. They come off of the Celiac Trunk, via the common or proper hepatic arteries.
- **Right Gastroepiploic** supplies greater curvature, from the gastroduodenal, from the proper hepatic.
- **Left Gastroepiploic** supplies greater curvature, from the Splenic Artery, from the Celiac Trunk.

THE SPLEEN

DEVELOPMENT: It is mesodermal -- not derived from gut (i.e. nongut)

- It grows within the two layers of peritoneum going to the posterior wall -- within the two folds defining the dorsal mesogastrium.
- As the stomach rotates, the spleen is moved to the left of the stomach (lateral to stomach)
- The dorsal mesogastrium in this region becomes the **gastrosplenic ligament.**
- Posterior part of mesogastrium adheres to the posterior wall, and the left kidney will then lie directly deep to it. This portion of the mesentery becomes the **splenorenal ligament.**

LOCATION: Upper left quadrant, left hypochondriac region, articulated with ribs 9-11 (laterally).

EXTERNAL MORPHOLOGY: It has three grooves (surfaces)

- Renal Surface
- Gastric Surface
- **Colic Surface:** Anterior / Inferior extremity.
- **Hilus:** Contains the splenic artery and vein, near the splenorenal ligament. INTERNAL MORPHOLOGY:

RELATIONSHIPS:

- Kidney is deep to it, connected by splenorenal ligament.
- Stomach is medial to it, connected by gastrosplenic ligament.

CLINICAL CONSIDERATIONS: VASCULAR / LYMPH SUPPLY:

- Splenic Artery **and** Splenic Vein **come into the hilus.**

THE DUODENUM

DEVELOPMENT: Duodenum is the dividing point between the foregut and midgut.

- It forms in response to the rotation of the stomach.

LOCATION: It is **retroperitoneal.** (The first portion is actually intraperitoneal, but we won't count that).

- Umbilical Region, and Medial parts of the Left and Right upper quadrants. EXTERNAL

MORPHOLOGY: It is a C-Shaped portion of the gut.

- **Duodenal Bulb** (I) (foregut) (at about the level of LV1 -- the transpyloric plane)
  - o **Hepatoduodenal Ligament:** There is a ligament which is part of lesser omentum.
  - o This ligament is the sign of peritoneum surrounding the duodenum, hence we will consider the whole duodenum as retroperitoneal.
- **Descending Duodenum** (II) (foregut) (LV2)
- **Horizontal Duodenum** (III) (midgut) (LV3)
- **Ascending Duodenum** (IV) (midgut) (LV2-3)
  - o **Ligament of Treitz:** Attaches the fourth part of the duodenum to the right crus of the diaphragm. It goes posterior to the pancreas. Essentially attaches duodenum to posterior wall.
    - ■ It is the Suspensory Muscle of the Duodenum -- function to hold duodenum opened / closed for passage of food into Jejunum.

INTERNAL MORPHOLOGY:

- Duodenal Bulb is smooth internally, while the rest of it is rough with mucosal folds.
- **Plicae Circulares:** The name of the folds on the distal three parts of duodenum.
- **Hepatopancreatic Duct:** Anastomose of the common bile duct and pancreatic duct onto the duodenum. It joins at the second part of the duodenum.
- **Major Papilla:** The opening into the common bile and pancreatic ducts.
  - o The pancreatic duct usually joins the common bile duct before it reaches the major papilla.
- **Minor Papilla:** Another duct opening.
- **Ampulla (of Vater):** Ductule right at the major papilla, which holds bile and pancreatic enzymes.

RELATIONSHIPS:

- The pancreas lies in the internal curvature of the C-Shape.
- Duodenal bulb is in transpyloric plane.
- **Superior Mesenteric Artery** usually passes over the horizontal duodenum.
- **Renal Artery and Vein** passes posterior to the ascending (fourth part of) duodenum.
- **Aorta:** The fourth part of the duodenum lies on the Aorta. Aorta is posterior to duodenum.
- **Transverse Mesocolon:** Inferior aspect of transverse colon. It covers the pancreas, and crosses the duodenum at the fourth part (ascending, and most medial part).
- **Portal Triad:** Common Bile Duct, Portal Vein, Proper Hepatic Artery.
  - o They are located posterior to the duodenal bulb.
  - o They are within the free edge of the lesser omentum (hepatoduodenal ligament).
- **Pancreas:** Within the C-Shape of the duodenum. The head of the pancreas lies posterior to the descending and horizontal duodenum.

CLINICAL CONSIDERATIONS:

- **Duodenal Atresia:** Lack of development of duodenum.
- **Duodenal Stenosis:** Clogging of duodenum.
- Vomiting: Look for bile as a sign of where the obstruction occurred. If there is bile, then it was the lower duodenum (distal to duodenal papilla), if not, then it was the proximal duodenum (proximal to papilla).
- **Duodenal Ulcer:** Posterior aspect of the duodenal bulb, if the wall is broken, hemorrhaging can occur as it invades the gastroduodenal artery.
  - o Four times more prevalent than peptic ulcers.
- **Paraduodenal Hernia:** The **Paraduodenal Recess** lies just posterior to the fourth part of the duodenum. A portion of duodenum and ilium can herniate there.
  - o The *inferior mesenteric vein* is right there, and can be ruptured as a result.
- **Enterogastrone:** Is released by duodenum to decrease the peristalsis and acidity of material coming from stomach.
- **Cholecystitis:** Inflammation of gall-bladder, where bile is stored. Duodenum can form adhesions, etc., from what was originally cholecystitis.
- **Referred Pain:** Pain referred in duodenum is generally referred to *umbilical region*, through the **greater thoracic splanchnic nerve.**

VASCULAR / LYMPH SUPPLY:

- Supplied by both the Celiac Artery (foregut parts) and Superior Mesenteric Artery (Midgut parts).
- **Gastroduodenal Arteries:** Come from the celiac trunk ultimately.
  - o Celiac Trunk---------- > Common Hepatic------- > Gastroduodenal.
- **Hepatic Arteries:** Proper Hepatic and Left Hepatic come off of the Common Hepatic Artery.
- **Superior Mesenteric Artery and Vein** passes over last half (midgut portions) of the duodenum.

THE PANCREAS

DEVELOPMENT:

- Starts out with a dorsal and ventral **pancreatic bud** on either side of the duodenum.
- The ventral bud rotates 180 and joins the dorsal bud.
- The stalk to the ventral bud becomes the **major papilla**
- The main pancreatic duct is formed from *both dorsal and ventral buds.*
- **Annular Pancreas:** The pancreatic lobes migrate around duodenum in the wrong direction and fuse with each other, strangling the duodenum.
    - o Can completely block or at best result in **stenosis** of duodenum.

LOCATION: Retroperitoneal.

- Umbilical, Epigastric, and left hypochondriac regions.
- It traverses diagonally from the descending (second) duodenum all the way over to the spleen. EXTERNAL MORPHOLOGY:
- **Head** -- snug up against the second and third parts of duodenum.
    - o Lower portion extending inferiorly from the head is the **uncinate process.**
- **Neck** -- directly anterior to superior mesenteric artery and veins, and the portal vein.
- Body
- **Tail:** The tail of the pancreas extends into the **splenorenal ligament,** associated with the spleen.

INTERNAL MORPHOLOGY:

- There is a main **pancreatic duct** running down the center of the organ. RELATIONSHIPS: Also see external morphology
- The root of the **transverse mesocolon** runs along the longitudinal axis of the pancreatic, directly anterior to it. (So the transverse colon lies on top of it).
- Left Adrenal Gland and Left Kidney are just posterior to the body and tail of the pancras.

CLINICAL CONSIDERATIONS:

- Referred epigastric pain could be the pancreas or the gallbladder. If the pain wraps around the the posterior, too, then the bile duct is probably compressed (stenosis) which could be more serious than just gallbladder.
- Pancreatitis: **causes**
    - o Gallstones can block the major papilla in the duodenum. This would cause *bile* to backflow into the pancreas. o A stenosis in the pancreaticohepatic duct can cause *acid chyme* to backflow into the pancreas. o The stones may block both common bile and pancreatic ducts above, causing both to backflow into pancreas.

VASCULAR / LYMPH SUPPLY:

- **Superior Pancreaticoduodenal Arteries (Anterior and Posterior):** These come off of the common hepatic, in turn off of the Celiac Trunk.
    - o They also anastomose with the Right Gastroepiploic. o They supply the head, generally.
- **Great Pancreatic Artery,** and **Inferior Pancreatic Artery,** come off the Splenic Artery, from the Celiac Trunk.
    - o Supplies body and tail.

THE LIVER

DEVELOPMENT: Foregut, closely associated with primitive cystic and pancreatic ducts.

- **Starts out as the** hepatic diverticulum.
- Hepatic Duct elongates throughout development and joins with cystic duct to form **common bile duct** in the adult.
- The liver elongates into the **septum transversum** during development.
    - o It continues to grow into the diaphragm later, to create the *bare area* of the liver -- the part that has no peritoneum covering it.
- The **omental foramen** is a free border of the lesser omentum. The portal triad travels through this hole.
- The **ventral mesentery** in the embryo reduces to become the **falciform ligament** i the adult.
- PRENATAL CIRCULATION: The liver is basically bypassed.
    - o **Ductus Venosus:** In the embryo, it connects the **umbilical vein** with the hepatic vein and inferior vena cava. It shunts blood going through the liver so that it really doesn't perfuse the liver, but rather bypasses right to the inferior vena cava.
    - o Blood going through much of the embryonic portal vein system is shunted through the ductus venosus.
    - o After birth, the ductus venosus closes and its remnants become the **ligamentum venosum,** the ligament on the inferior, posterior aspect of the liver. o The **Round Ligament** is what remains of the umbilical vein. It hangs down fro the falciform ligament.

LOCATION:

- The liver is not covered in the area of the falciform ligament attachment.

- Highest point is the right lobe. It rises to the 5th intercostal space.

EXTERNAL MORPHOLOGY:

- Ligaments:
  - o **Coronary Ligament:** Reflection of peritoneum off the posterior surface of the liver, with the diaphragm.
    - A **bare area** is created by the reflection of the coronary ligaments on the diaphragm. The bare area touches the diaphragm.
  - o **Right and Left Triangular Ligaments:** Part of the Coronary Ligament. Formed by the two layers of peritoneum extending laterally.
  - o **Falciform Ligament:** Liver's reflection of peritoneum with anterior wall. The primitive ventral mesentery.
  - o **Round Ligament** (Ligamentum Teres Hepatis) hangs down from the falciform ligament, on the anterior side.
  - o **Ligamentum Venosum:** Posterior side of liver, separating the two lobes. It continues superiorly (on the posterior side) all the way to the superior margin of the liver.
- Lobes: The two lobes are separated by the falciform ligament.
  - o **Left and Right Lobes:** The functional lobes of the liver, demarcated by an imaginary line going between the **inferior vena cava** (superior part) and the **gall bladder** (inferior part).
    - The right lobe is the larger lobe, extending superiorly to the fifth ICS when supine.
    - The left lobe is the smaller lobe.
  - o **Caudate and Quadrate Lobes:** Both on the posterior side, surrounding the porta hepatis (i.e. portal triad).
    - **Caudate** Lobe is directly superior to the porta hepatis. Part of the functional left lobe of the liver.
      - It is closest to the vena cava.
    - **Quadrate** lobe is directly inferior to the porta hepatis, also part of the left lobe of the liver.
      - It is closest to the gall bladder.
- Peritoneal Reflections
  - o **Subphrenic Recess:** Recess created by coronary ligament reflecting off the diaphragm.
  - o **Hepatorenal Recess:** Recess between the right lobe of the liver and right kidney.
- Surfaces:
  - o Diaphragmatic Surface: The surface of the liver facing the diaphragm. Smooth.
  - o Visceral Surface: The posterior and left surfaces facing the stomach, duodenum, gall bladder, and pancreas.

INTERNAL MORPHOLOGY:

- **Porta Hepatis:** The hole going through the posterior side of the right lobe, containing the **portal triad** of vessels:
  - **o** Portal Vein **o** Common Bile Duct **o** Proper Hepatic Artery.
- Difference between functional (surgical) and anatomical lobes: anatomic lobes are divided by the falciform ligament. Functional lobes (as above) are divided by the imaginary line between the gall bladder and IVC.
  - o Each functional lobe is supplied by different vessels.

RELATIONSHIPS:

- **Inferior Vena Cava:** Goes over the reflection of the coronary ligament, through the **bare area,** on the superior posterior aspect of the liver.

CLINICAL CONSIDERATIONS:

- **Subphrenic Recess:** Air can collect in there as a result of surgeries.
- **Hepatorenal Recess:** This is the lowest area for fluid to collect in the upper abdominal cavity, *when the patient is in supine position.*

THE GALLBLADDER

LOCATION: Located in the gallbladder fossa of the liver, on visceral (posterior side), medial-left lobe. EXTERNAL MORPHOLOGY: A pear-shaped sac, containing concentrated gallbladder bile.

- Small or large amount of mesentery surrounding sac.
- Composed of:

INTERNAL MORPHOLOGY:

- Duct system on inside is made of spiral grooves. It joins the **common hepatic duct** to form the **common bile duct,** which dumps out on the major papilla of the duodenum.

RELATIONSHIPS:

- The body of the gall bladder is directly superior to the first part of the duodenum.
- It is adjacent to the Quadrate Lobe (lower posterior lobe) of the liver.

CLINICAL CONSIDERATIONS:

- Small or large amounts of mesentery may be present around the sac. The mesentery commonly has vessels. So surgical removal of the gallbladder can cause massive hemorrhaging if a lot of mesentery is present.\
- **Cholecystokinin** is the hormone the stimulates the release of gallbladder bile.
- **Biliary Colic** = expansion of the gall bladder or **cystic duct,** resulting in pain in the right upper quadrant.
- Has many stretch receptors, so it is sensitive to swelling. However, it is relatively insensitive to a direct cut. **Cholecystitis:** The infection of the gall bladder. It is clinically determined by palpating along the right costal margin, along the liver. This is **Murphy's Sign.**

THE SMALL INTESTINE (JEJUNUM / ILIUM)

DEVELOPMENT: Small intestine develops as a herniation into the umbilical region.

- Bowel spins 90 counterclockwise during growth, so that the distal end is to the left of th proximal end.
- Then, in the *Return Phase,* there is a 180 rotation, which places the cecum just inferior the liver. Then the Cecum usually descends somewhat, but in some people and it doesn't, and is thus termed a **subhepatic cecum.**
- **Fixation** occurs lastly: Organs become retroperitoneal secondarily. They start with peritoneum surrounding them, then they implant on the posterior wall, then they lose their peritoneum.
  - o At this point, what was once visceral peritoneum is now parietal.
  - o This secondary fixation occurs with all retroperitoneal organs except the rectum, which never has peritoneum in the first place.

LOCATION: It occupies most of the left upper quadrant and right lower quadrant of the abdomen.

- Jejunum Mostly in the umbilical region. EXTERNAL MORPHOLOGY:
- 18-20 feet in length, but the mesentery holding it is only 4 feet long because it is scrunched up.
- Jejunum Proximal to the Ileum.
- **THE Mesentery** is the peritoneum surrounding the small intestine. INTERNAL MORPHOLOGY:
- Jejunum has many **circular folds** on the inside lining, in the mucosa.
  - o It has a thicker wall.
- The Ileum is smoother and has **solitary lymph follicles** (little spots) on inside lining.
  - o It has a thinner wall.

RELATIONSHIPS:

CLINICAL CONSIDERATIONS:

- **Meckel's Diverticulum:** A portion of the bowel along the Ileum that may be left over from development. o Rule of Twos: In 2% of population, 2 feet from the distal end of the Ileum, and 2 inches long. o It creates a pouch which can collect unwanted waste and materials.

VASCULAR / LYMPH SUPPLY:

- **Arteriae Rectae** come off the superior mesenteric artery and supply the **Jejunum,** throughout the Mesentery. They run perpendicular to the superior mesenteric artery.
- **Arterial Arcades** have a more web-like pattern coming off the Superior Mesenteric Artery, and supple the **Ileum.**

THE LARGE INTESTINE (COLON)

DEVELOPMENT:

- Cecum, Ascending Colon, and Proximal 2/3 of Transverse Colon are midgut.
- Distal 1/3 of Transverse Colon, Splenic Flexure, Sigmoid Colon, Rectum, and Proximal Anal Canal are hindgut.
- **Cloacal Membrane:** At the distal end of the hindgut in the embryo.
- **Allantois:** Posterior part of the yolk sac. It will become the **Urogenital Sinus** and primitive urogenital system.
- Invasion of the Folds:
  - o **Tourneaux's Fold:** A wedge of mesoderm that invades the hindgut region along the midsagittal plane.
  - o At same time, lateral **Rathke's Folds** invade along the frontal plane.
- These two folds come together such that the hindgut is *separated from the primitive urogenital sinus.*
- **Perineal Body:** The tissue in between the two primitive tubes formed by the Rathke's and Tourneax's Folds. It will form the future Urogenital region.
  - o The perineal body divides two tubes, which are:
    - Anorectal Canal
    - **Urogenital Sinus:** This will be future **perineum** of the adult -- the region below the abdomen and superior to the pelvic bones, medial to the thighs.

- o Perineal body is the common attachment site for future muscles in the region:
  - Anal Sphincter.
  - Muscles associated with the pelvic and urogenital diaphragms.
  - In females it provides the primary support for reproductive organs.
- **Proctodeum:** Distal portion of hindgut, still covered by cloacal membrane. The cloacal membrane will eventually perforate, resulting in the anal opening.
- **PECTINATE LINE:** The division of hindgut (endodermal) anal canal, and ectoderm from invagination of the skin. They are both supplied by different vessels, nerves, etc.
  - o Upper Anal Canal, superior to pectinate line, is endodermal hindgut. o Lower Anal Canal, inferior to pectinate line, is ectoderm.
  - o The Pectinate Line can be identified by looking for the **anal columns,** longitudinal folds of mucosa that demarcate the upper anal canal.
- **COLLATERAL CIRCULATION:**
- Due to the pectinate line, there are two alternative circulations in the area.
  - o **Caval System** of vessels supplies the ectodermal lower anus: Rectal Veins ---------- > Iliac Veins--------> Caval System
  - o **Portal System** os vessels supplies the endodermal upper anus: Superior Rectal Veins ---------- > Inferior Mesenteric Vein ------ > Portal Vein System
  - o Because of the anastomosis, if there is an occlusion in one system, blood can get back to the circulation via the *collateral system.*

LOCATION: All four quadrants. In the nine-region system, it is located in the bottom six regions -- not the epigastric / hypochondriac regions.

EXTERNAL MORPHOLOGY:

- Order of Sections:
  - o **Cecum / Ileocecal Junction:** Intraperitoneal, for the most part.
    - **Vermiform Appendix:** Can be intraperitoneal or retro. The appendix extends down over the pelvic brim.
  - o **Ascending Colon:** Retroperitoneal.
  - o **Transverse colon:** Intraperitoneal, covered by transverse mesocolon. Hence it is mobile. o **Descending Colon:** Retroperitoneal
  - o **Sigmoid Colon:** Intraperitoneal, covered by sigmoid mesocolon. Hence it is mobile.
- **Tenia Coli:** Three longitudinal muscles that run the length of the large intestine.
  - o **Rectosigmoid Junction:** A complete expansion of the longitudinal muscles at the end of the colon, where it can have a muscular force.
- **Sulci:** Periodic indentations in the large intestine, on the external surface.
- **Haustra:** The "sections" of intestine created by the semilunar folds.
- **Epiploic Appendices:** The fatty appendages along the length of the large bowel. Their presence or absence is related to the diet of the individual.

INTERNAL MORPHOLOGY:

- There are no mucosal folding, like the small intestine.
- There are **semilunar folds,** the internal markings of the sulci on the outside. They are much further apart than in the jejunum.
- **Diverticula:** Outpocketings of the bowel, at the location of the semilunar folds. Food and popcorn can get stuck in there. RELATIONSHIPS:

- **Transverse Mesocolon:** The mesentery connecting the transverse colon to the pancreas, stomach, and duodenum.
  - o Transverse mesocolon covers the pancreas. Hence pancreatitis can spread to the transverse colon.
- **Sigmoid Mesocolon:** The mesentery connecting the sigmoid colon to the posterior abdominal wall.
- **Hepatic Flexure:** Turning point of the ascending---------> transverse colon on the right side, just inferior to the liver.
- **Splenic Flexure:** Turning point of the transverse --------> descending colon on the left side, just anterior to the left kidney.
- **Phrenicocolic Ligament:** Attaches the transverse colon to the left crus of the diaphragm, at the location of the splenic flexure.
  - o It is right next to the spleen.
  - o It inhibits the passage of fluid into the **left paracolic gutter,** and prevents fluid from getting into the supracolic (above mesocolon) area.

CLINICAL CONSIDERATIONS:

- **Pancreatitis** can spread to the transverse colon, via the transverse mesocolon.
- **Diverticula** can cause problems. See popcorn.
- **Volvulus:** is twisting of the sigmoid colon. It can lead to a strangulation of the vessels and eventual necrosis.

VASCULAR / LYMPH SUPPLY: Colic arteries have variations.

- **Right Colic Artery:** Comes off of the superior mesenteric artery, superior to the **ileocolic artery,** and supplies the ascending colon.
  - o It divides into the Arterial Arcades
- **Middle Colic Artery:** Comes off the superior mesenteric artery and supplies the Transverse Colon. It divides off right anterior to the duodenum.
- **Left Colic Artery:** Comes off the inferior mesenteric artery and supplies the descending colic.
- **Sigmoid Arteries:** Come off the inferior mesenteric and supply the sigmoid colon.

THE ABDOMINAL VASCULATURE

Abdominal Aorta:

- Enters the **Aortic Hiatus** between the **right crus** and **left crus** of the diaphragm at the level of T12.
- Extends retroperitoneally along the anterior surface of the vertebrae (slightly to the left), until the level of L4.
- Bifurcation of the Abdominal Aorta: **It bifurcates at L4, into the** Left Common Iliac **and** Right Common Iliac Arteries.
- RELATIONS:
  - o Goes posterior to the Uncinate Process and Body of the pancreas. o Goes posterior to the horizontal (third portion of) duodenum. o Goes posterior to the Left Renal Vein.
    - ■ The left renal vein passes *over* (anterior to) the Aorta.
    - ■ The left renal vein passes *under* (posterior to) the superior mesenteric artery.
  - o The Inferior Vena Cava is to the right and slightly more anterior than the abdominal aorta.
    - ■ At the bifurcation, the inferior vena cava passes *posterior* to the Aorta.
- Principle Branches:
  - o Celiac Trunk o Superior Mesenteric Artery o Inferior Mesenteric Artery o Renal Arteries
  - o Gonadal Arteries -- gonadal arteries pass to a region in the *upper abdomen*, not lower. **Celiac Trunk:** Located just inferior to Aortic Hiatus.
- Branches:
  - o Splenic
    - ■ Splenic------- > Left Gastroepiploic
  - o Common Hepatic
    - ■ Common Hepatic ------ > Proper Hepatic ----- > Gastroduodenal ------- > Right Gastroepiploic.
    - ■ Right Gastroepiploic-------- > Gastroduodenal Arteries
    - ■ Right Gastroepiploic-------- > Superior Pancreaticoduodenal Arteries
  - o Left Gastric
    - ■ CLINICAL: If the left gastric is occluded, blood can be rerouted through the right gastric. With gastro- eosphageal cancer, the left gastric can be ligated, and the right gastric will still supply blood.

Superior Mesenteric Artery:

- Branches:
  - o SMA ---------- > Inferior Pancreaticoduodenal Arteries
  - o SMA ----------> Middle Colic -------> (transverse colon)
  - o SMA ----------> Right Colic -------> (ascending colon)
  - o SMA ----------> Ileocolic ------ > Ileal and Colic
- **Marginal Artery:** Comes off the Left Colic Artery and can supply the medial aspect of the large intestine in the absence of a middle colic.

Inferior Mesenteric Artery:

- IMA ------ > Left Colic
- IMA ------ > Sigmoid Artery
- IMA ------ > Rectosigmoid
- IMA ------ > Superior Rectal

Pancreaticoduodenal Arcade: An alternative route for blood flow through the branches of the celiac, if there should be an occlusion in the celiac trunk.

- Superior Pancreaticoduodenal Arteries come from the Hepatic branch of the Celiac.
- Inferior Pancreaticoduodenal Arteries come from the SMA.

Lumbar Arteries: Supply the posterior abdominal wall.

- **1st - 4th Lumbar Arteries** come off of the Aortic Trunk directly.
- **5th Lumbar Artery** comes off of the *Median Sacral Artery*, below the bifurcation of the Aorta.

PORTAL VENOUS SYSTEM: Takes blood from the entire abdomen and dumps it into the liver for processing

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> out the
Suprahepatic Inferior Vena Cava.

- Abdominal venous drainage ends in the **hepatic sinusoids** in the liver.
  - o Approx 67% of the liver's blood is venous blood from the portal vein. The other 33% comes from the hepatic arteries.

- BLOOD IN THE LIVER:
  - o *Venous Blood Going into the liver:* portal vein branches to **left portal vein** and **right portal vein,** to go to the respective functional lobes of the liver. Then it further subdivides until it gets to the hepatic sinusoids.
  - **o Venous blood leaving the liver:** Central Vein ----------> Sublobar Veins --------- > Left and right Hepatic Veins
    -> Inferior Vena Cava.
- BRANCHES
  - o *Blood going to the portal vein:* The anastomose of the **splenic vein** and **superior mesenteric vein.** o **Inferior Mesenteric Vein:** Joins with the Splenic Vein, 60% of the time, and with the Superior Mesenteric Vein, 40% of the time.
- RELATIONS
  - o Right at the anastomoses of SMV and Splenic Vein, the portal vein passes *posterior to the neck of the pancreas.*
    (CLINICAL) Hence tumors in the head and neck of the pancreas can occlude the portal vein. o Passes posterior to the common hepatic artery, just south of the liver.
- PORTAL TRIAD: Duh. Portal Vein, Proper Hepatic Artery, and Common Bile Duct, going through the Porta Hepatis on the posterior side of the liver, between the caudate and quadrate lobes.

- **PORTAL HYPERTENSION:** Increased blood flow in hepatic portal system, creating increased pressure in the rest of the venous system.
  - o Occlusion can be **prehepatic, intrahepatic, or posthepatic,** depending on where the occlusion occurs.
  - o THE PORTAL VENUS SYSTEM DOES NOT HAVE VALVES.
    - o Because the portal system has no valves, the blood can flow back on itself, causing an increase in pressure. o Blood tries to get back to the heart and winds up taking collateral channels, which creates a dilation *outside the portal system*, causing **varicose veins.** (this is only one cause of varicose veins).
    - o **CAPUT MEDUSAE:** Varicosity of the paraumbilical veins, due to severe portal hypertension. They look like somewhat like small snakes on the skin. They radiate in a wheel-like fashion. o **Ascites:** Increased fluid in the peritoneal cavity. Can result from the liver's inability to handle increased blood pressure.
  - o **Hemorrhoids:** Varicose veins in the anal regions.
  - o COUGH UP BLOOD: Blood backflow into eosphageal plexus could make you cough up (or vomit) blood from portal hypertension. Important clinical diagnostic sign.

- COLLATERAL VENOUS PATHWAYS: In the event of portal hypertension or portal stenosis.
  - o **Paraumbilical Pathway:** The paraumbilical vein feeds into the portal vein, in the left lobe the liver.
    - These are usually closed off after birth, but in the event of portal hypertension, they can recanalize.
    - Umbilical Veins (recanalized) ------- > Inferior Epigastric Veins ------- > Superficial Epigastric Veins
      > IVA / SVC.
  - o **Eosphageal Pathway:** Blood back flows into the left gastric and eventually makes its way back to the azygos vein.
    - Left Gastric Vein------- > Eosphageal Vein (plexus) --------> Inferior Thyroid Veins (one on each side) —
      --> Azygos system of veins
  - o **Caval/Portal Pathway:** At the pectinate line is another collateral pathway.
    - Upper portion of anal canal drains via **Superior Rectal Vein** --------- > IMV

- **Lower Portion of anal canal drains via** MIddle and Inferior Rectal Veins--------- > Caval System.
- **PECTINATE LINE:** The two venous systems anastomose with each other, so backflow can take the alternative route at that location.

o HEMORRHOIDS:

- **INTERNAL HEMORRHOIDS:** Hemorrhoids in the upper anal canal caused by varicosities of the superior rectal vein. They are innervated by autonomic nerves and hence are not painful.
- **EXTERNAL HEMORRHOIDS:** Varicosities of the inferior and middle rectal veins. They are innervated by somatic nerves and are painful.

Pelvic Splanchnic Nerves: **Hindgut innervation**

- The Pelvic Splanchnic Nerves are parasympathetic Sacral spinal nerves S2-S4.
- They form **Pelvic Plexuses**--------> **Inferior Hypogastric Plexus** --------> Pelvic viscera, and separately, the hindgut.
- These nerves are **Non-Perivascular.** They *do not* follow the arteries, but instead crisscross the arteries. The nerves are still located in mesentery.
- The lower anus (below pectinate line) is innervated by *somatic nerves* -- the **pudendal nerve** -- not parasympathetic pelvic splanchnic.

Greater Thoracic Splanchnics: T6-T9. Sympathetic spinal nerves supplying the foregut and midgut.
Lesser Thoracic Splanchnic: T10-T11. Sympathetic spinal nerves supplying the hindgut, generally. **Least Thoracic Splanchnic:** T12. It supplies the Renal Plexus.

POSTERIOR ABDOMINAL WALL

Three Hiatuses of the Diaphragm:

- **Caval Hiatus:** Passage for Vena Cava, T8. The highest, most central hiatus, in the central tendon.
- Eosphageal Hiatus: **T10.**
- **Aortic Hiatus:** The Descending Aorta passes through the diaphragm most posteriorly and inferiorly. T12.

Diaphragmatic Crura: Left and Right Crus of the diaphragm, on posterior wall.

- **Thoracic Splanchnic Nerves** go through the left and right crura of the diaphragm, to enter the abdomen.

LUMBOCOSTAL ARCHES (ARCUATE LIGAMENTS): The ligaments connecting the diaphragm to the posterior wall. They are condensations of transversalis fascia.

- **Median Arcuate Ligament:** Passes anterior to the Aorta as it goes through the diaphragm. It creates the Aortic hiatus.
  - o CLINICAL: At times it can compress the Celiac trunk, below the diaphragm. In this event blood can still circulate via the pancreaticoduodenal arcade.
- **Medial Arcuate Ligament:** Overlies the psoas muscle, lateral to the median arcuate ligament.
  - o It may also be called the *psoas fascia.*
  - o RELATION: The sympathetic trunks enters the abdomen immediately *posterior* to the medial arcuate ligaments.
- **Lateral Arcuate Ligament:** Ligament around the Quadratus Lumborum muscle. Extends from the transverse fascia of L1 to the 12th rib.

Muscles of the Posterior Abdominal Wall:

- **Psoas Major Muscle:** Chief flexor of the thigh and trunk
  - o Passes all along vertebral column starting at T12.
  - o Passes deep to the inguinal ligament and attaches to the lesser trochanter of the femur. o Innervated by L2-L4.
  - o Contraction: Pulls the body toward the leg, or the thigh toward the body.
- **Iliacus Muscle:** Aids the psoas major in flexing the thigh and trunk
  - o Attaches to the iliac fossa (anterior surface of the iliac bone).
  - o Inserts into psoas tendon, and hence the two muscles together are often called the **iliopsoas muscle.**
- **Quadratus Lumborum:** Stabilizes the 12th (floating) rib during inspiration. Inserts on the 12th rib.

Thoracolumbar Fascia: Actually an extension of the aponeuroses of the transversus abdominis and external abdominal oblique muscles.

- It divides into an anterior plane and posterior plane. It thus serves to compartmentalize the muscles, which lies in between the two planes.
  - o Anterior plane attaches to the transverse process of the lumbar vertebrae. o Posterior plane attaches to joins with the other muscles in the back.

Nerves of the Posterior Wall:

- Things common to all the nerves:
- CLINICAL
  - o They are all related to the psoas muscle. Psoas pathology will irritate those nerves. A patient that relieves pain upon relaxation of the psoas muscle may have retroperitoneal pathology.
  - o All of the nerves pass from the posterior to wall laterally to the anterior wall.
    - Subcostal and lumbar plexus pass through the transversalis fascia and then go in-between the transversus abdominis and internal oblique muscles.
- Subcostal Nerve: **T12**
  - o Associated with the 12th (floating) rib. This nerve is immediately posterior to the kidney and overlies quadratus lumborum muscle.
  - o It is the only nerve of the lower posterior wall not associated with the lumbar plexus.
- **Lumbar Plexus:** L1-L3, and the upper half of L4. These are spinal nerves, so they have somatic and autonomic branches.
  - o Somatic Components: Supply iliopsoas and quadratus lumborum muscles. o Autonomic Components: The lumbar splanchnic nerves. o Location: The plexus itself is located deep within the psoas muscle.
  - o Distribution: Lower abdominal wall, genitalia, upper portion of the lower limb. It contains the following nerves: Nerves of the lumbar plexus:
- Iliohypogastric Nerve: **T12-L1.**
  - o Runs superomedial to the Anterior Superior Iliac Spine.
  - o CLINICAL: Passes over **McBurney's Point** -- the point of surgical entry for an appendectomy (about 1/4 of the way between the ASIS and umbilicus). It can thus be damaged from an appendectomy. o In the suprapubic region, it divides into two portions: Iliac Branch and Hypogastric Branch. o Distribution:
    - Iliac branch gets sensory info from hip.
    - Hypogastric branch innervates the suprapubic region.
      - o Passes posterior to kidney and overlies quadratus lumborum muscle.
  - o Sometimes it will be joined with the ilioinguinal nerve from their origin at L1, and sometimes it won't.
- Ilioinguinal Nerve: **L1**
  - o Same location as the iliohypogastric. It passes through the inguinal canal and emerges out of the inguinal ring. o Distribution:
    - Innervates the anterior scrotum / labia majora, and the upper and medial thigh.
  - o CLINICAL: If you want to anesthetize the pubic area, this is one of the nerves you have to block. Anesthesia would probably be placed in the inguinal canal. o It maybe joined with genitofemoral nerve.
    - o Passes posterior to kidney and overlies quadratus lumborum muscle.
- Lateral Femoral Cutaneous Nerves: **L2-L3**
  - o Assoc with the lateral aspect of the psoas muscle.
  - o Considered to be a part of the posterior division of the plexus. Has nothing to do with the abdominal cavity. o Innervates the posterior and lateral thigh.
- Femoral Nerve: **L2-L4**
  - o By far the largest branch of the lumbar plexus. o Location: Located in the cleft between the psoas and iliacus muscles. o Runs posterior to inguinal ligament and carries fascia with it -- the **femoral sheath.** o Distribution: Motor innervation of psoas and iliacus; innervation of the thigh and lower extremities.
- Genitofemoral Nerve: **L1-L2**
  - o Location: Anterior surface of the psoas muscle. Very fine string, "ribbon." o Distribution: Branches into the genital and femoral branches.
    - Genital branch goes through inguinal nerve to inguinal canal. It innervates the **cremaster muscle.**
    - Femoral Branch: Innervates skin in upper portion of the thigh.
  - o CLINICAL: **Cremaster Reflex:** Gently touch the medial portion of the thigh, and see if the scrotum pulls the testes up. This is a simple way of testing the functionality of the lumbar plexus.

- Obturator Nerve: **L2(?), L3-L4**
  - o Deep, medial border of the psoas muscle. Very tight chord that passes along the lateral part of the pelvic wall.

Lumbosacral Trunk: **L4-L5**

- Deep and medial to psoas and obturator nerve.
- Distribution = sensory, to the gluteal region, thigh, leg.
- Not part of the lumbar plexus.

KIDNEYS AND SUPRARENAL GLANDS

Suprarenal Glands:

- Multiple arterial branches supply it with blood, but only one vein empties it. VENOUS DRAINAGE:
  - o Right Adrenal Gland: **Inferior Vena Cava.** o Left Adrenal Gland: **Left Renal Vein.**
- *NERVE SUPPLY: Only sympathetic (hence adrenaline). They are* only innervated bypre-ganglionic fibers, no post- ganglions.
  - o The fibers originate fro the sympathetic trunk -- **Greater Thoracic Splanchnic Nerves.**

KIDNEYS:

- Location: Retroperitoneum, T12-L4, in the **perirenal space.**
- **Hilus:** Renal Artery, Renal Vein, and Renal Pelvis (ureters) enter at the hilus.
- RELATIONS:
  - o **Right Kidney** related to Morrison's Pouch. o **Left Kidney** related to tail of the pancreas.
- Retroperitoneal Spaces:
  - o **Perirenal Space:** The space containing the kidney's, bordered by Gerota's Fascia. o **Anterior Pararenal Space:** Contains the other retroperitoneal organs -- part of the duodenum, pancreas, ascending and descending colon. o **Posterior Pararenal Space:** Doesn't contain jack shit.
  - o Because of the division of retroperitoneal spaces, pathology escapes down into the pelvis, before it goes right or left.

LYMPHATIC SYSTEM

General stuff about the Lymphatic System:

- Functions:
  - o Return extracellular fluid back to circulation o immunity
  - o Clean up debris, general housekeeping
- Appearance = usually clear but can be cloudy when it contains fat
- Circulation: Percolates through lymph nodes. Lymph nodes are added to the fluid at lymph nodes.
  - o Muscular contraction squeezing lymphatic channels is the primary contributor to its movement. Filtration pressure and arterial pulsing also contribute.

Thoracic Duct: Carries most of the lymph from the abdomen. All things empty into the thoracic duct.
Lymphadenitis: Infections within the lymph node(s).
Lymphangitis: Infections within lymph vessels.

Abdominal Nerves

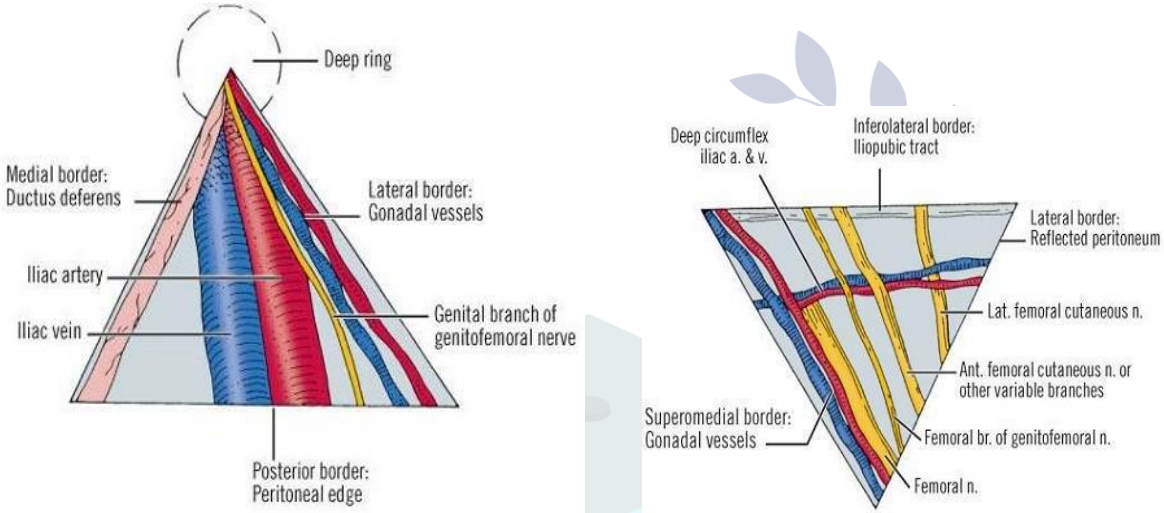
Nerve	Origin	Course	Distribution	Other
Thoracoabdominal (T7-T11)	Continuation of inferior intercostals nerves	Run btwn 2nd and 3rd layers of abdominal muscles	Anterior abdominal muscles and overlying skin; periphery of diaphragm	T7-T9 supply skin superior to umbilicus T10 supplies umbilicus
Subcostal (T12)	Anterior ramus of T12	Runs along inferior border of rib 12	Lowest slip of external oblique m. and skin over anterior superior iliac spine and hip	
Iliohypogastric (L1)	Chiefly from anterior ramus of L1	Pierces transverse abdominal m., branches pierce external oblique aponeurosis	Skin of hypogastric region and over iliac crest; internal oblique and transverse abdominal	
Ilioinguinal (L1)	Anterior ramus of L1	Pass btwn 2nd and 3rd layer of abdominal muscles and passes through ilioinguinal canal	Skin of scrotum/ labium majus, mons pubis, and adj. medial aspect of thigh; internal oblique and transverse abdominal	

Abdominal Arteries

Artery	Origin	Course	Distribution	Other
Superior epigastric	Internal thoracic a.	Descends in rectus sheath deep to rectus abdominus	Rectus abdominis and superior part of anterolateral abd wall	
Inferior epigastric	External iliac a.	Runs superiorly and enters rectus sheath; runs deep to rectus abdominus	Rectus abdominis and medial part of anteriolateral abdominal wall	
Deep circumflex iliac		Runs on deep aspect of ant abd wall, parallel to inguinal ligament	Illiacus muscle and inf part of anterolateral abd wall	
Superficial circumflex iliac	Femoral a.	Runs in superficial fascia along inguinal ligament	Subcutaneous tissue and skin over inferior portion of anterolateral abd wall	

Superficial epigastric		Runs in superficial fascia toward umbilicus	Subcutaneous tissue and skin over suprapubic region	

TRIANGLE OF DOOM & PAIN



THE PELVIS AND THE PERINEUM

Pelvic Diaphragm: It is the inferior border of the pelvis, separating the pelvis from the perineum. It supports the pelvic organs.

- **Genital Hiatus:** A hole in the pelvic diaphragm, where there is no muscle, just fascia. It overlies the superior part of the urogenital diaphragm. The following structures go through it.
  - o Urethra o Vagina (female)
- **Levator Ani Muscles:** Attaches to the tendinous arch (arcus tendineus) of the levator ani. It extends all the way from the pubis back to the ileum, and sweeps medially back to the coccyx.
  - o **Ileococcygeus Muscle:** The posterolateral part of the levator ani muscle, associated with the ilium.
  - o **Pubococcygeus Muscle:** The anteromedial part of the levator ani muscle, associated with the pubis.
  - o **Puborectalis Muscle:** The most medial part of the pubococcygeus muscle, going around the rectum.
  - **Puborectal Sling** are the muscle fibers of the puborectalis that swing around the rectum, holding it in place. o Pubovaginalis / Puboprostatic: There is also a pubovaginalis part in the female, and less prominent puboprostatic part in the male.
  - o Obturator Internus Muscle: The muscle underlying the *obturator membrane*, which covers the obturator foramen.
- **Coccygeus Muscles:** Laterally attaches to the ischial spine, and medially attaches to the lateral aspect of the sacrum.
- **Arcus Tendineus:** The line of attachment between the obturator internus muscle and levator ani. Okay, not a line, but rather a sweep of fascia.

FUNCTION OF THE PUBORECTAL SLING: It creates an angle between the rectum and anal canal, which allows you to retain fecal matter. The angle is almost 90, and the anal canal points down and posteriorly.

Urogenital Diaphragm: The part of the pelvic diaphragm that extends medially, between the **ischiopubic rami.**

- Through and through, it is located *inferior to the pelvic diaphragm.*
- Anteriorly, it encloses the sphincter urethrae muscle.
- Posteriorly, it encloses the deep transverse perianal muscle.
- Anteriorly, it encircles the urethra on either side. The anterior recess of the anal fossae becomes smaller and smaller as you move anteriorly.

- It encloses the **Deep Perineal**

Pelvic Roof / Peritoneum: The pelvis roof is defined by the inferior limit of peritoneum, coming down from the abdomen.

- Peritoneum covers the anterior aspect of rectum, then reflect off the uterus (in female), forming the **Rectouterine Pouch (of Douglas).** That is the inferior most peritoneal recess of the abdomen.
  - o Male analogous structure is **rectovesical recess,** reflection between the rectum and seminal vesicles, which are directly posterior to the bladder.
- The peritoneum then covers the uterus and uterine tubes, before going back up the anterior abdominal wall.
- Peritoneum does *not* cover all of the rectum.
- **Central Tendon of the Perineum** (Male), or **Perineal Body** (female): The junction of most of the musculature of the pelvic diaphragm. *It is the central support for pelvic diaphragm, which in turn supports the pelvis.*
  - *o* If it is damaged, incontinence results.
  - o It is an attachment point for both the perineum and the pelvis. o Point where fibers from pelvis unite with those of external anal sphincter. o It is the posterior attachment point of the urogenital diaphragm. *o* Point where external genitalia (corpora) muscles attach. o Point where superficial transverse perineal muscles attach.

Endopelvic Fascia: The name of the visceral fascia in the pelvis.

OBGYN STUFF:

- **Pelvic Inlet:** Line from upper part of pubic symphysis back to the sacral promontory.
- **Pelvic Outlet:** Line from the lower part of pubic symphysis back to tip of coccyx.
- **True Conjugate Diameter:** Measured along the pelvic inlet.
- **Diagonal Conjugate Diameter:** Measured from the bottom of the pubic symphysis back to the sacral promontory.
- **Obstetrical Conjugate Diameter:** The smallest opening, from the widest part of the pubic symphysis, back to the sacral promontory.

Perineum: The area inferior to the pelvic and urogenital diaphragms.

- Structures in perineum:
  - o External genitalia. o Anal canal and anal sphincters o Ischiorectal and ischioanal fossa.
- **Urogenital Triangle:** Triangle defining urogenital region of th perineum.
  - o Anterior aspect (apex of triangle): pubic symphysis o Lateral aspects: Ischial tuberosities o Posterior aspect: tip of coccyx bone.
- **Anal Triangle:** Triangle defining the anal region of the perineum.
  - o Apex of anal triangle = the tip of the coccyx bone.
  - o Sides of anal triangle = the sacrotuberous ligaments and the gluteus maximus. o Base of anal triangle = the ischial tuberosities.
- Boundaries between the triangles: A line going from one **ischial tuberosity** to the other one defines the border between the two perineal triangles. The perineal body is in the middle of that line.
  - o The line also marks the inferior border of the urogenital diaphragm.
  - o **Superficial Transverse Perineal Muscle** goes between the anal and UG triangles, and converges on the perineal body.

RECTUM / ANAL CANAL / ISCHIOANAL FOSSAE

Ischioanal Fossae: The potential spaces surrounding the anal canal, in the anal triangle region, located between the skin of the anal region and the pelvic diaphragm.

- The spaces are triangle-shaped.
- Borders:
  - o The apex forms superiorly at the lateral border of the levator ani muscles, where they connect to the obturator membrane.
  - o The lateral aspect of the fossae are the obturator internus muscles. o The base of each fossa (triangular base) is the perianal skin. o The medial aspect of each fossa is the anal canal.
  - o The posterior aspect of each fossa is the sacrotuberous ligament and gluteus maximus muscle.
- As you go more anteriorly, the region of the ischioanal fossae becomes thinner, until it converges on the bladder anteriorly. There is very little of the anterior recess left, right next to the pubic symphysis most anteriorly.
- **Anterior Recess of the Ischioanal Fossae** is formed by the reflection of the fossa, anteriorly, with the urogenital diaphragm.
  - o This recess is between the pelvic diaphragm (superior border) and UG diaphragm (inferior border).
  - o If an abscess were to get into the anterior recess, the fluid would be *superior to the UG diaphragm and inferior to the pelvic diaphragm.*

- **Posterior Recess of the Ischioanal Fossae** is just superior to the sacrotuberous ligament, where it reflects on the posterior part of the pelvic diaphragm.
    - o This is inferior to the pelvic diaphragm.
- Contents of Ischioanal Fossae: Fat! -- which allows the expansion of the anal canal and therefore the passage of stored feces.
-

PUDENDAL CANAL: Contains pudendal artery, pudendal vein, and pudendal nerve.

- It runs along the *lateral wall of the ischioanal fossae,* just medial to the obturator internus muscle.
- *It runs along the* medial surface of the ischial tuberosity.
- It goes out at the greater sciatic foramen, then runs laterally along the ischial spine and sacrospinous ligament, and then comes back in through the lesser sciatic foramen, and then runs along the medial aspect of the ischiopubic ramus.
- Internal Pudendal Artery and Vein:
    - o A branch of the anterior division of the internal iliac artery / vein.
- Pudendal Nerve:
    - o The only nerve innervating the perineal region!
- Branches of the Pudendal Canal:
    - o Inferior Rectal Artery, Vein, and Nerve: Goes to the rectal area. o Perineal Artery, Vein, and Nerve: Goes to the Urogenital area.
    - o Deep Dorsal Artery, Vein, and Nerve: Goes to the shaft of the penis (clitoris). ■ It travels along the superior aspect of the UG diaphragm.

RECTUM AND ANAL CANAL:

- Rectosigmoid junction is about the level of **S3** -- third sacral segment.
- **Ampulla:** The distal holding tank for fecal mass, distal part of rectum, before entering the anal canal proper.
    - o The *Pelvic Diaphragm* is associated with the ampullary portion of the rectum. That is where the levator ani muscles are!
    - o As the ampulla fills up, the **anorectal sling** of the puborectalis muscle holds the anal canal at an angle, and support the ampulla superiorly, to prevent defecation. o Defecation occurs when the puborectalis muscle is relaxed and the angle becomes more linear.
- **Anorectal Flexure:** The transition point between the rectum and anus.
- Peritoneum: Gradual disappearance of the peritoneum.
    - o Upper third of rectum: Both anterior and lateral sides (sigmoid mesocolon)
    - o Middle third of rectum: Just anterior side of rectum.
    - o Lower third of rectum: No peritoneum!
- Rectal Folds: Perhaps to hold the shit in place.
    - **o** Superior Rectal Valve **o** Middle Rectal Valve **o** Inferior Rectal Valve
- Rectal Veins:
    - o The **Inferior Rectal Vein:** The **External Rectal Plexus** forms from the inferior rectal vein. This is ectodermal and innervated by somatic efferents (GSE). The external rectal plexus has three sites of drainage:
        - ■ Superior parts dump into the superior rectal vein, then into the IMV. (via anastomoses with portal system.)
        - ■ The middle parts dump into the middle rectal vein and then into the internal iliac.
        - ■ The inferior parts drain into the internal pudendal vein, then into the internal iliac.
    - o The **Superior Rectal Vein:** The **Internal Rectal Plexus** forms from the superior rectal vein. This is endodermal and innervated by visceral efferents (GVE).
        - ■ Takes drainage from two vessels: The middle rectal vein and inferior rectal vein.
    - o The *anastomoses* between the two -- the **pectinate line** is right at the anorectal flexure, where the inferior rectal vein anastomoses with the superior rectal vein.
- **Anal Columns:** They are right *above* the pectinate line, at the distal-most part of the rectum.

- Anal Musculature:
  - o **External Anal Sphincter Muscle:** Striated, voluntary muscle, innervated by the *inferior rectal nerves.* These muscles insert on the Central Tendon of the UG diaphragm.
    - External Anal Sphincter comes in three parts:
      - Subcutaneous External Anal Sphincter **-- circular**
      - **Superficial External Anal Sphincter** -- extends longitudinally to either side of the anal canal.
      - **Deep External Anal Sphincter** -- part of pelvic diaphragm that participate in the puborectal sling.
    - External usually maintain a tonic level of contraction to stop from shitting.
  - o **Internal Anal Sphincter Muscle:** Smooth, involuntary, innervated by the *pelvic splanchnic nerves.*
    - Parasympathetic reflex.
- Innervation of Rectum
  - o A lot of **pelvic splanchnic nerves** come from the posterior of the rectum and pass around the lateral edges.
- Relations:
  - o The rectum can make an impression on the posterior wall of the vagina. It can invade the posterior wall of the vagina such that the vaginal wall extends down toward the vestibulum. o ANTERIOR TO RECTUM: Seminal Vesicles, Prostate, Bladder.
  - o POSTERIOR TO RECTUM: All muscles of pelvis diaphragm, bony elements of skeleton, Pelvic splanchnic nerves and pudendal nerve.
  - o LATERAL TO RECTUM: Ureters, pelvic splanchnic nerves.

EXTERNAL GENITALIA

EXTERNAL MALE GENITALIA:

- **Superficial (Dartos) Fascia:** Goes all the way down into the penis.
- **Deep Fascia:** Directly overlies the penis, deepest layer.
- PENIS CROSS SECTION:
  - o **Corpus Cavernosa:** The two more dorsal bodies of the penile shaft. They fill with blood from the **deep artery** when erect.
  - o **Tunica Albuginea:** The very dense fascia that surrounds the corpus cavernosa.
  - o **Corpus Spongiosum:** The most ventral of the three erectile tubes. o **Urethra:** Travels through the corpus spongiosum.
  - o **Glans Penis:** Extension of the corpus spongiosum, and it overlies (caps) the two corpora spongiosa.
- **The Root of the Penis:** The three bodies (corpora spongiosa and cavernosa) converge on the penis. Conversely, the corpus cavernosa divert as you move down the shaft of the penis, toward the ischiopubic rami.
  - o When they get down to the bottom, they are then called the **left crus** and **right crus** of the penis.
    - Left and right crura attach to both the ischiopubic rami and the fascia of the UG diaphragm.
  - o As you move down the shaft, the corpus spongiosum becomes thicker until it called the **bulb of the penis** at the base. It also attaches to the fascia of the UG diaphragm.
- Communication between Corpora: The corpus bodies do communicate with each other. They are not strictly isolated.
- Penile Stimulation:
  - o Afferent fibers are carried back through the **Pudendal Nerve** as GSA somatic fibers.
  - o At the same time, *parasympathetic fibers* of the ANS travel along the Pudendal Nerve, specifically the **Pelvic Splanchnic Nerves -- S2, S3, S4.**
  - o PATHWAY OF THE PELVIC SPLANCHNICS INTO THE PENIS:
    - They travel down through the **prostatic plexus,** which is deep to the UG diaphragm.
    - Then they pass under the **sub-pubic arch.**
    - Then they pass through a hiatus in the **UG Diaphragm,** where they join the fibers of the pudendal nerve. o The job of the parasympathetic pelvic splanchnics is to induce *vasodilation*, causing corpus cavernosa to fill with

blood from the deep artery. o Sympathetic Stimulation *gets rid of* an erection.

- Muscles: Along the root of the penis that aid in erection, by preventing the backflow of blood back out of the shaft.
  - o **Investing Fascia (Gallaudet's Fascia)** is the penile fascia that surrounds the muscles.
  - o **Bulbospongiosus Muscle:** Penile muscle surrounds the corpus spongiosum and urethra. Aids in the last part of urination and ejaculation.
    - Forms a **herringbone** *pattern*, V-shape on either side of the urethra. Hence when it contracts it compresses the urethra to aid in expulsion of fluids.
    - It inserts on the central tendon of the perineum.
  - o **Ischiocavernosus Muscle:** Penile muscles surround the corpora cavernosa.
    - Upon contraction they restrict the return flow of blood, to maintain erection.
    - *They insert on the Ischiopubic Rami bones -- they* do not insert on the Central Tendon of the Perineum.
- Ejaculation:
  - o **Emission:** Peristaltic wave of contractions through the **ductus deferens,** along with contraction of seminal vesicles and prostate gland, causes fluid to move to the Ejaculatory Duct which leads into the **urethra.**
    - **Emission is a** sympathetic response.
    - Seminal Vesicle add fluid to the urethra at the **ejaculatory duct,** most distally. The ejaculatory duct is where the seminal vesicle joins the ductus deferens.
    - Prostate gland adds fluid to the urethra at the **prostatic utricle,** more proximally.
  - o **Expulsion:** Spastic contraction of the muscles that overlie the corpora cavernosa. and spongiosa. The same type of muscular contraction (though not spastic) will expel the last bit of urine during urination.
    - **Expulsion is a** parasympathetic response.
- MALE URETHRA:
  - o **Prostatic Portion of Urethra:** The part that passes through the prostate gland. Directly inferior to the bladder.
    - The prostate sits directly superior to UG diaphragm.
  - o **Membranous Portion of Urethra:** The part of the urethra that passes through the urogenital diaphragm.
  - o **Spongy (Penile) Urethra:** The part of the urethra that goes up the shaft of the penis, starting from the bulb of the penis at its base.
- **Bulbourethral Gland:** Supplies lubrication to the urethra. It is located *in the urogenital diaphragm.*
  - o Ducts open into spongy portion of urethra.
  - *o* Greater Vestibular Gland (Bartholin's Gland) *is homologous structure in female.*
- Ductus Deferens: **Pathway**
  - o It starts at epididymis, passes *through the inguinal canal,* over the pelvic brim and into the pelvis. o It passes **medial to the ureters** on the posterior aspect of the bladder. o It joins with the seminal vesicles to form the ejaculatory duct.
- **Seminal Vesicles:** Located posterosuperior to the prostate gland. They go into the prostate gland anteriorly and empty into the ejaculatory duct.

FEMALE EXTERNAL GENITALIA:

- **Mons Pubis:** Overlies the pubic bone.
- **Labium Majus:** Outermost region, covered with hair. Composed of skin and elongated tubes of fat.
  - o The distal end of the **ROUND LIGAMENT** of the uterus inserts into the labia majora.
  - o **Anterior Labial Commissure:** Just anterior to the prepuce (hood) of the clitoris. The area where the labia majora meet anteriorly. There is no true posterior labial commissure.
- **Pudendal Cleft:** All structures in between the left and right labia majora. It contains the following:
- **Labia Minora:** Fat-free folds between the labia majora. All structures in between the labia minor are contained in the vestibule.
  - o The labia minora enclose the vestibule.
  - o Anteriorly, the labia minora come together to form the **prepuce of the clitoris.**
  - o **Frenulum of Labia Minora:** The posterior junction of the labia minora. This is also known as the **Fourchette.**
- **Vestibule** = the space + all structures located between the labia minora.
  - o **Clitoris:** Homologous to the penis in the male.
    - The corpora and crura of the clitoris originate in the labia minora.

- **Prepuce** = the anterior convergence of the two labia minora.
- **Frenulum:** The posterior aspect of the clitoris, where the labia minora also converge.
- **Glans Clitoris:** Distal end. Proximal to it is the **body,** or, **shaft** of the clitoris.
- **Angle of the Clitoris:** Still more distal to the body.
- Then the two corpora divert into a left and right crus, that insert into ischiopubic rami, just as in the male.
- **Suspensory Ligament of Clitoris:** An extension of deep fascia, which attaches at the symphysis pubic. Just anterior to the clitoris.

o **Vestibular Bulbs:** Homologous to the corpus cavernosa in the male.
- They are erectile tissue, one on each side.
- They are not officially part of the clitoris.

o Development: Unlike the male, the development of the urethra is independent to that of the external genitalia,
since the urethra does not travel through the clitoris.
o **Greater Vestibular (Bartholin's) Gland:** Inferior fascia of the UG diaphragm, just posterolateral to the vaginal wall.
- Unlike the male counterpart, these glands are superficial to the inferior surface of the UG diaphragm, in the superficial perineal space.
- Glands empty into the posterolateral wall of the vaginal orifice, providing lubrication.
- CLINICAL: Because of close proximity to outside, vestibular glands are susceptible to infection.

VASCULAR / NERVE SUPPLY TO THE EXTERNAL GENITALIA

- **Deep Dorsal Vein:** It carries most of the blood from the penis / clitoris.
  o It has two pathways:
  - Primary Pathway: Passes through the genital hiatus, posterior to the arcuate ligament > to **prostatic**
    venous plexus (only in male)--------> to **Vesicular venous plexus** on the bladder (both sexes)----------> Internal Iliac Vein.
  - Secondary Pathway: Deep Dorsal Vein --------> Internal Pudendal Vein --------> Internal Iliac

  o CLINICAL: **Prostate Cancer** in the male. If the prostatic venous plexus is removed during removal of the prostate, then very little blood will be able to return from the penis. Result = no erection!
- **Internal Pudendal Vein:** It comes off the Aorta ------- > Common Iliac ----- > Internal Iliac -------> Anterior Division of
  Internal Iliac -------> Internal Pudendal.
  o Internal pudendal carries the rest of the blood from the genitalia (the part not carried directly by deep dorsal vein) o Has three primary branches:
  - **Deep Dorsal Vein:** Secondary drainage of penis / clitoris
  - **Perineal Vein:** UG diaphragm and UG viscera
  - Inferior Rectal: **Anal fossa**
- **Pelvic Splanchnic Nerves:** Come from the Prostatic Plexus (in the male) and Vesicular Plexus (both sexes) to give autonomic parasympathetic innervation to the penis / clitoris.
  o **Prostatic Plexus** -- ANS plexus from S2, S3, S4. o **Vesicular Plexus** -- plexus on bladder from ANS S2, S3, S4.
- **Pudendal Nerve:** Somatic innervation. It originates at the **sacral plexus (S1-S4).** It enters the perineal region through the lesser sciatic foramen. It has three primary branches.
  - **Inferior Rectal Nerve** -- innervates, um, the rectum.
  - Perineal Nerve **-- UG viscera**
  - **Deep Dorsal Nerve** -- sexual stimulation, man.
- **Ilioinguinal Nerve:** Innervates the anterior labia majora / scrotum.
  o Originates from the **Lumbar Plexus at L1** -- sympathetic innervation. It enters the perineum through the inguinal canal.

BLOCKAGE OF THE PUDENDAL NERVE: The pudendal nerve is the main nerve you need to deaden, to anesthetize the pelvic region....but there are others.

- To find the nerve, *palpate for the* **ischial spine,** because that is where the nerve exits the pelvis and enters the pudendal canal.
- By anesthetizing right there, you can deaden all the branches in one shot: the inferior rectals, perineals, and deep dorsal.

PERINEUM

TISSUE LAYERS OF THE UROGENITAL TRIANGLE: MALE

- Skin
- Subcutaneous Tissue -- **Camper's Fascia.**
- Superficial Membranous Fascia: Attach to the posterior aspect of the UG diaphragm, just anterior to the central tendon of the perineum.
  - o **Scarpa's Fascia:** Abdominal superficial membranous fascia.
  - o **Colle's Fascia:** Superficial membranous fascia, continuous with Scarpa's, in the region posterior to the scrotum. o **Darto's Fascia:** Superficial membranous fascia of the penis.
- SUPERFICIAL PERINEAL SPACE: All structures between the superficial membranous fascia and the perineal membrane.
  - o **Investing Fascia:** Inferior border of the bulbospongiosus muscle. Converges with Buck's fascia at the base of the penis.
  - o **Buck's Fascia:** Superior (deep) border of the bulbospongiosus muscle. Converges with investing fascia at the base of the penis.
  - o **True Suspensory Ligament of the Penis:** Superior to and continuous with deep fascia, continuous with transversus abdominis fascia of anterior abdominal wall. o MUSCLES / CORPORA / VESSELS / NERVES: All are in the superficial perineal space. ALL OF THE MUSCLES ATTACH TO THE PERINEAL BODY
    - ■ Corpus Spongiosum with **Bulbospongiosus Muscle** covering it.
    - ■ Corpus Cavernosum with **Ischiocavernosus Muscles** covering it; Crura of the Penis (composed of Corpora Cavernosa).
    - ■ **Bulb of the penis** (of the corpus spongiosum)
    - ■ **Superficial Transverse Perineal Muscle:** The posterior border of the UG diaphragm. Attaches to the perineal body and counters the action of the bulbospongiosus muscle.
      - ■ It generally holds the UG structures in place.
    - ■ Perineal Nerves, branches of the pudendal.
- PERINEAL MEMBRANE: Inferior border of the UG diaphragm. It divides the superficial perineal space from the deep perineal space.
- DEEP PERINEAL SPACE
  - o Male Muscles of the UG Diaphragm:
    - ■ Sphincter Urethrae Muscle: **To stop urination.**
      - ■ Primary musculature in the male. They are circular fibers which compress the urethra upon contraction, to stop urination.
    - ■ **Deep transverse perineal muscle:** Muscle located in the posterior aspect of the UG diaphragm. o Deep dorsal vein/artery of the penis (branch of pudendal vein)
  - o Deep dorsal nerve of penis (branch of pudendal nerve) o **Bulbourethral (Cowper's) glands** -- in the Deep Perineal Space. o Urethra passes through it.
- SUPERIOR MEMBRANE OF THE UROGENITAL DIAPHRAGM

STRADDLE INJURY: Blood investing the superficial perineal space will not get into the deep perineal space. It will be stopped at the following borders:

- Superior Border: Arcuate line in the abdominal wall.
- Lateral Borders: Inguinal Ligaments.
- Deep border: Perineal Membrane.

TISSUE LAYERS OF THE UROGENITAL TRIANGLE: FEMALE

- Skin
- Subcutaneous Tissue -- **Camper's Fascia.**
- Superficial Membranous Fascia: Attach to the posterior aspect of the UG diaphragm, just anterior to the central tendon of the perineum.
  - o **Scarpa's Fascia:** Abdominal superficial membranous fascia.
  - o **Colle's Fascia:** Superficial membranous fascia, continuous with Scarpa's, in the region posterior to vagina.
- SUPERFICIAL PERINEAL SPACE: All structures between the superficial membranous fascia and the perineal membrane.
  - o **Gallaudet's (Deep) Fascia:** Inferior border of the bulbospongiosus muscle.
  - o **True Suspensory Ligament of the Clitoris:** Superior to and continuous with deep fascia, continuous with

transversus abdominis fascia of anterior abdominal wall. o MUSCLES / CORPORA / VESSELS / NERVES: All are in the superficial perineal space. ALL OF THE MUSCLES ATTACH TO THE PERINEAL BODY

- Two Vestibular Bulbs with **Bulbospongiosus Muscle** covering it.
- Corpus Cavernosum with **Ischiocavernosus Muscles** covering them; Crura of the clitoris.
- Urethra / Vagina
- **Greater Vestibular (Bartholin's) Gland** -- located at the posterior aspect of the vestibular bulb -- in the superficial perineal space.
  - The analogous structure in the male, the Bulbourethral gland, is in the deep perineal space, while the female homolog is in the superficial perineal space. Note difference.
- **Superficial Transverse Perineal Muscle:** The posterior border of the UG diaphragm. Attaches to the perineal body and counters the action of the bulbospongiosus muscle.
  - It generally holds the UG structures in place.
- Perineal Nerves, branches of the pudendal nerve.

- PERINEAL MEMBRANE: Inferior border of the UG diaphragm. It divides the superficial perineal space from the deep perineal space.
- DEEP PERINEAL SPACE
  - o Female Muscles of the UG Diaphragm:
    - **Compressor Urethrae Muscle** -- passes anterior to the urethra.
    - **Sphincter Urethrae Muscle** -- Passes posterior to the urethra and blends with the compressor urethra.
      - It inserts on the Perineal Body.
    - **Urethrovaginal Sphincter** -- circular, voluntary fibers around the posterior of the urethra. When they contract, both the vagina and the urethra constrict.
      - It inserts on the Perineal Body.
    - Deep Transverse Perineal Muscle

  o Deep dorsal vein/artery of the clitoris (branch of pudendal vein) o Deep dorsal nerve of clitoris (branch of pudendal nerve) o Urethra passes through it.
- SUPERIOR MEMBRANE OF THE UROGENITAL DIAPHRAGM

Genital Hiatus of the UG-Diaphragm:

- Located in between the arcuate ligament and transverse perineal ligament.
- **Arcuate Ligament:** Anterior border of genital hiatus, located just deep to the pubic symphysis.
- **Transverse Perineal Ligament:** Posterior border of the genital hiatus, located just anterior to the muscular part of the UG diaphragm. It is the fusion of the inferior and superior membranes of the UG diaphragm.
- The Deep Dorsal Vein / Nerve of Penis goes below the genital hiatus.
- The **pelvic splanchnic nerves** go through the hiatus to join the dorsal nerve on the other side.

PELVIC VISCERA

URETERS:

- Pathway of the Ureters
  - o They are almost always found at the **bifurcation of the iliacs,** where the left and right each bifurcate into left internal/external and right internal/external, respectively. o The ureters then pass over the pelvic brim along the posterior wall, briefly follow the internal iliacs, and proceed along the lateral pelvic wall. o They are at all times *retroperitoneal* until the peritoneum is lost.
  - o Then they sweep onto the rectum (where the peritoneum is lost), and pass anteroinferiorly to enter the posterior surface of the bladder at a diagonal angle.
- MALE: The ureter is related to the *ductus deferens.* The Ductus Deferens is superior and anterior to the ureter.
- FEMALE: The ureter passes *directly inferior to the uterine artery* as it passes over the pelvis to enter the bladder. This is often termed **water under the bridge** (ureter under the uterine artery) and it is critical to any surgery involving the ureters.
- CLINICAL STUFF:
  - o Innervation of ureters is T11-L1 -- Sympathetic autonomic. Hence referred pain goes back to the umbilical region! o **Ureteric Calculus:** A kidney stone or stone in the ureter.
    - The pain caused by a stone is *colicky pain...* hyperperistalsis in the region superior to the obstruction. This is followed by a dull pain caused by distension of the renal pelvis.
    - The pain is referred to T11-L1

- May cause obstruction of urinary flow. *Most common sites of obstruction are:*
  - Where the ureter passes over the pelvic brim, at the bifurcation of the iliacs.
  - Where the ureter passes obliquely into the posterior bladder wall.
- Stone can be removed with endourology: passing a scope up the urethra.

THE BLADDER:

- Parts of Bladder: Most of the bladder has a rough, loosely associated surface, except the trigone.
  - o **Fundus** -- the posterior and inferior portion of the bladder.
  - o **Neck** -- The part of the bladder that converges down onto the urethra. The inferior third.
    - It forms the **infundibulum** (funnel-like) part of the bladder.
  - o **Trigone** -- the triangle on the posterior bladder wall, defined by the two ureters superiorly, and the urethral opening inferiorly.
    - The trigone has a smooth surface and tightly adhered muscle. o **Body**
  - o **Apex:** The anterior most part of the bladder, posterosuperior to the pubic ramus. The urachus comes off of the apex of the bladder.
  - o **Uvula:** The raised portion of the bladder near the neck.
    - It is raised due to the impression of the middle lobe of the prostate right inferior to it. CLINICAL when the prostate is inflamed it will get raised a lot more and could obstruct the urethral opening.
  - o **Detrusor Muscle:** The smooth muscle of the bladder, carrying ANS innervation. BED OF THE BLADDER: Depends on whether it is empty or full.
  - o When full, it will push against the rectum (in males) or uterus (in females) posteriorly.
  - o Anteriorly, the bladder rests on the symphysis pubis. o Anterolaterally, the bladder rests on the obturator internus muscle.
  - o Inferiorly, the bladder rests on the pelvic diaphragm in females, and on the prostate gland in males.
  - **Vesicular Venous Plexus:** Directly inferior to the bladder (females) or inferior to the prostate (males). MALE Structures:
  - o Seminal Vesicles: On the posterior part of the bladder, near the trigone and fundus of the bladder. o Prostate Gland: Associated with the neck of the bladder. The body of the bladder sits on the prostate. o Ductus Deferens traverses the superior part of the bladder, joining with the seminal vesicles on the posterior part of the bladder. o Rectum is immediately posterior to bladder.
  - o **Rectovesicale Recess:** The space between the rectum and bladder.
  - FEMALE Structures
  - o Uterus is associated with posterior surface of bladder. As the bladder fills, it pushes the uterus in a posterior (retroflexed) position.
  - *o The* anterior wall of the uterus is closely related to the posterior wall of the bladder, *due to the common* developmental origin of the *sinovaginal bulbs.* This is important clinically. o The bladder is anterior to the vagina. Okay?

Ligaments:

- o MALE:
  - **Sacrogenital Ligament:** Supporting ligament. Runs from the sacrum, around the rectum, and attaches on the posterior surface of the bladder.
  - **Puboprostatic Ligament:** Attaches the prostate to the pubis. o FEMALE:
  - **Uterosacral Ligament:** Goes from sacrum, around rectum, and attaches to uterus posterolaterally.
  - **Vesicouterine Ligament:** A continuation of the uterosacral ligament. It attaches the bladder to the uterus. The primary support of the bladder is the pelvic diaphragm!

Median Umbilical Ligament / Urachus: A fibrous chord coming off of the apex of the bladder. Directly anterior to the bladder.

- o This is one of the embryonic median umbilical arteries. There are two others going over the bladder.

CLINICAL: Enlargement of prostate will push it into the bladder. This can cause dribbling of urine (incontinence), due to decreased sphincteric action of the sphincter urethrae muscle in the UG diaphragm.

Autonomic Control of Micturition:

- o Voiding of the bladder is an autonomic response through the parasympathetic system, from the *pelvic splanchnic nerves* (S2-S4), specifically the **inferior hypogastric plexus** which goes to the **vesicular plexus** of the bladder.

- They stimulate the detrusor muscle and inhibit the UG urethral sphincter.

o Overdistension and pain is carried by pre-ganglionic sympathetics, originating from T11-L2. o Somatic voluntary control comes from the **perineal branch** of the pudendal nerve. This can override the parasympathetic voiding reflex -- up to a point. CLINICAL: Fractures of pubic bone can rupture the bladder.

o Rupture of bladder superiorly will send urine to the peritoneal cavity.

o Anterior rupture (rupture of pubic bone) would send urine into the Anterior **Retropubic Space of Retzius.**

- The *Vesicular Venous Plexus* is located in this space. Blood Supply to the Bladder:

o Blood supplied by the **Superior** and **Inferior Vesicular Arteries,** which are branches of the Anterior Internal Iliacs.

o Venous drainage is through the **Vesicular Venous Plexus,** which drains into the Internal Iliac Veins.

o Lymphatics primarily go to external and internal iliac nodes.

PERITONEAL SPACES

Vesicorectal Pouch: Male area between the bladder and rectum. (In the female, there are two such spaces).

Vesicouterine Pouch: Female area between the bladder and uterus.

- **Rectouterine Pouch of DOUGLAS:** The female reflection of peritoneum between the uterus and rectum. It is the *lowest (most dependent) point in the abdominal cavity,* where pathology tends to collect.
- **Pararectal Fossa:** Space created by reflection of peritoneum off of the rectum onto the lateral wall.
  - o As feces fills, the fossa deepens.
- **Paravesical Fossa:** Space created by the reflection of peritoneum off of the bladder onto the lateral wall.
  - o As the bladder fills, the fossa deepens.
- **Space of Retzius:** Space anterior to the bladder.

FEMALE REPRODUCTIVE ORGANS

Origin of the Ovary:

- The uterus and ovary have a diverse origin. They arise from two different places developmentally.
- When the distal ends of the paramesonephric duct contact the urogenital sinus, they fuse and pull the rest of the paramesonephric duct away from the posterior wall, forming the *broad ligament* of the uterus.

OVARIES:

- It is located more on the posterior aspect of the peritoneum -- posterolateral to the uterus and to the broad ligament.
- **Ovulation:** The ovum is actually released *into the peritoneal cavity* and then picked up by the ovarian tubes.
- **Ovarian Fossa:** The location of the ovaries. A depression in the lateral wall of the pelvis.
- NERVE / BLOOD SUPPLY TO OVARIES -- Once again, they come from back around L2 and L2.
  - o Left ovarian vein drains into the left renal. The right ovarian vein drains into the IVC. o Left and Right ovarian arteries drain into the abdominal aorta directly. o Lymph for the ovaries, therefore, is through the *lumbar aortic nodes.*
  - o Parasympathetic supply comes from the *Vagus nerve* rather than the pelvic splanchnic, because of the embryonic origin of the ovaries.
  - o Sympathetics are from T10, the *Lesser Thoracic Splanchnics,* via the hypogastric plexus ---------- > ovarian plexus.

UTERINE TUBES:

- Structures:
  - o **Fimbriae:** The finger-like projections going into the peritoneum, which surround each ovary to aid in the deposition of the ovum.
  - o **Infundibulum:** The neck of the uterine tube, where it turns, nearest the ovary. Funnel-shaped opening.
    - It has a heavily ciliated lining which produces a current which sweeps the ovum in a distal-proximal direction, toward the uterus.
  - o **Ampulla:** The main part of the tube, where fertilization normally takes place. o **Isthmus:** The stretch of tube nearest the proper ovarian ligament, close to the uterine junction. o **Intramural:** The part of the uterine tube within the myometrium of the uterus.
- CLINICAL:
  - o **Ectopic Pregnancy** more common occurs in the uterine tube than in the peritoneum. It is dangerous because the normal cause of pregnancy causes tissues to be digested as the embryo implants in the peritoneal wall somewhere. A tubal pregnancy will eventually cause the tubes to erupt. o **Hysterosalpingogram:** An X-Ray given into the endopelvic space to determine whether or not there is an opening in the fallopian tubes.

- o **Peritonitis / Salpingitis:** Infection in the peritoneum can spread to the fallopian tubes, and infection in the fallopian tubes can spread to the peritoneum.
  - When the fallopian tubes are infected (Salpingitis), a *tubal pregnancy* can easily results due to adhesions in the tube.

- BLOOD SUPPLY:
  - o It has a **dual blood supply** from the **ovarian artery** and **uterine artery.** The ovarian and uterine arteries anastomose with each other at the fallopian tubes.
  - o Veins, nerves, and lymphatics are associated with those of the ovaries.

UTERUS:

- Relations -- Anteriorly related to the bladder and posteriorly related to the rectum. When the bladder is filled, the uterus is more posteriorly located.
- STRUCTURES
  - o **Fundus:** The top portion of the uterus, above the level of the uterine tubes.
  - o **Body:** Main part, with thick wall.
  - o **Isthmic Portion:** The lower one third, which leads down into the cervical canal.
  - o **Myometrium:** Muscular wall of the uterus.
  - o **Perimetrium:** Outer lining of uterine wall.
  - o **Endometrium:** Inner lining of uterine wall.
- POSITIONS
  - o **Anteflexed:** Bent anteriorly with respect to the isthmus of the uterus. The cervix may be pointing posteriorly.
  - o **Anteverted:** Bent anteriorly at the level of the cervix. The cervix and isthmus point anteriorly.
  - o **Retroflexed:** Bent posteriorly with respect to the isthmus.

Ligaments and Peritoneum:

- **Suspensory Ligament of the Ovary:** Connects the ovary to lateral wall. It covers the external iliacs.
  - *It* brings the vessels, nerves, and lymph supply *to the ovaries.*
  - It is not a true ligament, but rather a condensation of endopelvic fascia.
- **Proper Ovarian Ligament:** Remnant of the gubernaculum. The ligament that connects the ovary to the uterus, running inferior to the uterine tubes.
- **Round Ligament:** Remnant of the gubernaculum. It runs from the fundus of the uterus, inferolaterally to the labia major, joining up with the inguinal ligament about halfway through its course.
  - o Carries with it a vascular supply -- the *phrenicular branch of the ovarian artery* or **Samson's Artery.**
- **Broad Ligament:** The sweeping peritoneum that overlies the ovaries and the uterus anteriorly.
- **Mesovarium:** That portion of broad ligament that suspends the ovaries in place. It comes out from the broad ligament, wraps around the ovaries, and goes back to the broad ligament on the posterior wall.
- **Mesometrium:** That portion of broad ligament that is associated with the uterus directly.
- **Mesosalpinx:** That portion of broad ligament that directly overlies the fallopian tubes.
- **Cardinal Ligament:** The ligament connecting to the uterus at the level of the cervix. It provides support to the uterus, but not the primary support -- that comes from the pelvic diaphragm.
  - *o The* ureters pass right underneath the uterine artery at the location of the cervix -- at the cardinal ligament. *"Water under the bridge" -- don't cut that ureter!*
- VASCULAR / LYMPH SUPPLY
  - o Vascular supply is from the **uterine artery** a branch of the anterior internal iliac approaching the uterus at the level of the cervix. The vaginal may branch off it too. o Also gets vascular supply from the Ovarian arteries -- from L1 level! o Also gets vascular supply from Vaginal artery.
  - o LYMPH is on two places too -- Mostly back to the **external iliac nodes,** but a small portion goes back to the *superficial inguinal nodes* because of the presence of the round ligament.
    - Third place -- the lower potion of uterus drains back to the internal iliac nodes, then onto external iliacs. o NERVES -- dual nerve supply, divided approx. upper (lumbar plexus) / lower (pelvic splanchnic).
    - Parasympathetic from the pelvic splanchnics.
    - Sympathetic from the hypogastric plexus, from the lumbar.
    - Pain (GVA) afferent receptors go back to T10-L1!
- CLINICAL:
  - o Pain from uterine contractions goes back to T10-L1. This means that uterine contraction pain is sympathetic.

- But for the lower portion of the uterus and upper vagina (the cervix) -- it is parasympathetic back to the pelvic splanchnics.

VAGINA:

- STRUCTURES:
  - **Rugae:** Muscular folds on internal wall -- unlike the stomach which has mucosal rugae folds.
  - **Cervix:**
    - **Supravaginal Portion:** Portion of the cervix above the vagina.
    - **Vaginal Portion:** Portion of the cervix in the vagina.
  - **Urethral (Skene's) Glands:** They lubricate the urethra, have openings into the urethra.
  - **Vestibular Bulbs:** Two of them, analogous to the corpora cavernosa of the penis.
  - **Clitoris:** The clitoris has no corpus spongiosum, because the urethra does no run through the clitoris. There is a crus in the superficial perineal space, on either side of the clitoris and separated by the vagina.
- PERITONEUM / RECESSES: Only a very small part of the vagina is covered with peritoneum -- the very edge of the *posterior fornix,* just inferior to the rectovaginal pouch of Douglas.
- MUSCLES:
  - **Urethrovaginal Sphincter:** Helps in the compression of the vagina (and urethra) in an *anteroposterior direction.*
  - **Bulbospongiosus muscles** to either side of the vagina, help in the compression of the vagina along the *lateral* axis.
- FORNICES: Spaces surrounding the external vaginal wall.
  - **Lateal Fornices:** *The ureters* run along the lateral aspects of the vagina.
    - Since the ureters are there, we know the uterine vessels are also approx at that location -- near the vaginal cervix.
  - **Posterior Fornix:** Covered with peritoneum, it is just inferior to the Pouch of Douglas and hence clinically important. Directly related to the rectum.
  - **Anterior Fornix:** Very thin space, and the anterior vaginal wall (related to bladder) is far thicker than the posterior vaginal wall. This makes it impractical to pierce that wall clinically.
- CLINICAL
  - **Culdocentesis:** Aspirate fluid out of the rectouterine pouch by passing a needle through the posterior fornix of the vagina.
  - **Culdoscopy:** Pass a fiber-optic scope through the posterior fornix of the vagina to look around.
  - **Rectocele:** With a *weakened pelvic diaphragm,* the anterior wall of the rectum could invade the posterior wall of the vagina, bulging it inward.
  - **Cystocele:** Invasion of the bladder wall, posteriorly, to the anterior vaginal wall.
  - **Enterocele:** Invasion of loops of small intestine into the rectouterine or vesicouterine pouch. This is less common.
- RELATIONS:
  - The anterior wall of the vagina is intimately related to the posterior wall of the bladder, and the lower part to the urethra.

MALE DUCTS AND GLANDS

- **Ductus Deferens:** Travel from the testes, pubic symphysis around the superior aspect of the bladder, and they pass **medial to the ureters,** and enter onto the ejaculatory duct.
  - **Ampullary Portion =** the dilated portion near the seminal vesicles as it converges onto the ejaculatory duct.
- **Prostate Gland:** Located immediately inferior and slightly posterior to the bladder. It surrounds the urethra.
  - Has a very dense, true capsule encompassing it.
  - **Anterior Lobe:**
  - **Posterior Lobe:** Assoc with cancer
  - **Middle Lobe:** The important portion of the prostate between the prostatic urethra and the ejaculatory ducts.
- **Seminal Vesicles:** Located immediately posterior to the posterior bladder wall, and *superior to the prostate gland.* It has a bow-tie configuration.
  - It contributes as much as 80% of the volume to seminal fluid.
- **Ejaculatory Ducts:** The union of the ductus deferens and seminal vesicles. The left and right ducts open into the prostatic portion of the urethra.
- **Seminal Colliculus** (verumontanum): The name of the point where the ejaculatory ducts enter the prostatic urethra.

- **Bulbourethral (Cowper's) Glands:** Inferior to the prostate, it dumps into the spongy urethra and is located *within the deep perineal space* -- in the urogenital diaphragm.
    - o The Female bulbourethral glands (Greater Vestibular Glands) are located in the superficial perineal space, on the superficial surface of the UG Diaphragm.
- CLINICAL:
    - o **Benign Prostatic Hypertrophy:** When it affects the middle lobe (hyperplastic middle lobe), it presses up against the bladder, raising the uvula even further and possibly obstructing the urethral opening, making it difficult to urinate or even painful.
    - o **Prostate Cancer:** Is usually associated with the *posterior lobe.*

Sacrogenital Ligament: In the male, the condensation of endopelvic fascia going from the sacrum around (similar path as rectal sling) and inserting
Puboprostatic Ligament: Strong, tough ligament going from the back of the pubic bone to the prostate gland in the male. It lends true support to the prostate.
Uterosacral Ligament: Female homology to the sacrogenital ligament.
Vesicouterine Ligament: Female homology to the sacrogenital ligament.
Pubovesical Ligament: Female homology to the puboprostatic ligament, lending support to the bladder anteriorly.

VESSELS

POSTERIOR BRANCH OF THE INTERNAL ILIAC:

- **Iliolumbar Artery** -- goes immediately back superiorly after the anterior-posterior division.
    - o **Iliacus Branch** -- supplies iliacus muscle!
    - o **Lumbar Branch**
- Lateral Sacral Artery
- **Superior Gluteal** -- exits the pelvis through the Greater Sciatic Foramen, passing superior to the Piriformis muscle.
    - o This artery is the terminal branch of the posterior division of the internal iliac. You could call the whole posterior division just the Superior Gluteal, really.

ANTERIOR BRANCH OF THE INTERNAL ILIAC

- **Obturator Artery** -- this is first off the anterior branch, or umbilical may be first.\
    - o **Accessory Obturator Artery,** if it is there, may anastomose with the *Inferior Epigastric Artery.* o If it is there and there is no obturator artery, then it is referred to as a **Abnormal Obturator Artery.**
    - o CLINICAL -- in the event of a femoral hernia through the femoral sheath, they must check to see if the pubic branch of the obturator is an accessory or abnormal obturator, so they know whether or not they can cut it. It is i abnormal, then they can't -- it's the only blood supply to the area.
- Umbilical Artery
    - o Can be the first branch off.
    - o It often has a **Superior Vesical Artery** as a branch.
    - o Identify it because it becomes the **medial umbilical ligament** (obliterated umbilical artery) as it courses.
- Uterine / Vaginal Arteries:
    - o Uterine Artery courses through the *cardinal ligament,* at the base of the broad ligament near the cervix. It anastomoses with both the vaginal and with ovarian at the top of the uterus. o Also forms the **Azygous Plexus** of the Vagina.
    - o Water Under the Bridge: Again, the ureters pass right under the uterine artery, at about the level of the cervix.
- **Middle Rectal Artery** -- it passes to the rectum but superior to the pelvic diaphragm.
- **Inferior Vesical Artery** (male only) -- it brings the *primary blood supply to prostate* and to the seminal vesicles.
    - o It is usually a branch of the middle rectal, but it can also come off the umbilical. o You rarely see this in females, but instead see the uterine artery.
- **Inferior Gluteal Artery:** Exits the pelvis through the Lesser Sciatic Foramen, below the Piriformis muscle. This artery is the terminal branch of the anterior division of the internal iliac.
- **Internal Pudendal Artery** -- all three branches come off after the perineal sweeps back around anteriorly. It can be a trunk with either the Middle Rectal Artery or the Inferior Gluteal Artery.
    - o **Inferior Rectal Artery** -- passes to the anal canal, inferior to the pelvic diaphragm.
    - o **Perineal Artery** -- supplies the rest of the perineal region -- all the muscles of the perineum.
    - o **Deep Dorsal Artery** -- supplies penis / clitoris.

LYMPHATIC DRAINAGE:

- **Right and Left Iliac Nodes:** Almost the whole pelvis *eventually* ends up at the Right and Left Iliac Nodes, then goes onto the chain nodes ---------- > lumbar nodes ----- > lumbar trunk > thoracic duct
- **Superficial Inguinal Nodes:** Almost everything in the perineum (inferior to pelvic diaphragm) will drain in part to the superficial inguinal nodes.
  - o The Superficial Inguinals drain to the ----------> **External Iliac Nodes** --------> Common Iliac Nodes.
- Uterus:
  - o The UPPER portion of the uterus follows the OVARIES and OVARIAN VESSELS back to the **lumbar chain nodes.**
  - o The lower portion of the uterus follows the uterine artery back to the External Iliac Nodes----------> Common Iliac Nodes.
- **External Iliac Nodes:** Generally carries most of the pelvic organs, and drains the superficial inguinal nodes.
- **Ovaries / Testes** -- back to the **Lumbar Chain** nodes. Any questions?
- **PROSTATE:** It breaks the rules!
  - o Posterior Surface goes back to the **Internal Iliac Nodes.** This is the lobe most assoc with carcinoma.
  - o Anterior Surface follows the bladder to the external iliacs. o Inferior Surface follows the pudendal to the internal iliacs.
- RECTUM (review)
  - o UPPER RECTUM: Follows the pathway of the Superior Rectal Artery: **Pararectal Nodes**----------> **Inferior** Mesenteric Nodes ---------> **Lumbar Chain Nodes**
  - o LOWER RECTUM: Follows Middle Rectal Arteries to the Internal Iliacs
  - o ANAL CANAL (below PECTINATE line) -- goes back through the Superficial Inguinal Nodes, all the way, dude.

INNERVATION OF THE PELVIS:

- **The Bladder:** An example of where all three nervous systems are acting in concert to control one function.
  - o **Voiding Reflex** is Parasympathetic -- from Pelvic Splanchnic Nerves (S-2,3,4).
  - o **Pain Sensory** from overdistension is sympathetic. o **Voluntary Control** is somatic -- from pudendal.
- **PUDENDAL NERVE:** Carries somatic innervation! If it's somatic, it's pudendal.
  - o Voluntary tonic contraction of external anal sphincter -- to stop from taking a dump.
- GONADS: Follow the **Lesser Thoracic Splanchnic** back to T10-T11. Developmental origin.
- EJACULATION: Mostly a parasympathetic response. Vasodilation of the corpora cavernosa.
  - o However, peristalsis of the ductus deferens is sympathetic.
- UTERUS: Some of the pain in the uterus is actually carried through the parasympathetic system.

Arteries of the pelvis

Artery	Origin	Course	Distribution
Internal Iliac	Common iliac	Passes over pelvic brim to reach pelvic cavity	Main blood supply to pelvic organs, gluteal muscles, and perineum
Anterior division of internal iliac	Internal iliac	Passes anteriorly and divides into visceral branches and obturator artery	Pelvic viscera and muscles in medial compartment of thigh
Umbilical	Anterior division of internal iliac	Short pelvic course and ends as superior vesical artery in females	Superior aspect of urinary bladder in females; ductus deferens in males
Obturator	Anterior division of internal iliac	Runs anteroinferiorly on lateral pelvic wall	Pelvic muscles, nutrient artery to ilium, and head of femur
Superior vesical	Patent part of umbilical artery	Passes superior aspect of urinary bladder	Superior aspect of urinary bladder
Artery to ductus deferens	Superior or inferior vesical artery	Runs retroperitoneally to ductus	Ductus deferens
Inferior vesical	Anterior division of internal iliac	Runs retroperitoneally to inferior aspect of male urinary bladder	Urinary bladder, pelvic part of ureter, seminal gland, and prostate

Middle Rectal	Anterior division of internal iliac	Descends in pelvis to rectum	Seminal gland, prostate, and rectum
Internal pudendal	Anterior division of internal iliac	Leaves pelvis though greater sciatic and enter perineum (ischioanal fossa) by passing thru lesser sciatic	Main artery to perineum including muscles of anal canal and perineum; skin and UG triangle; erectile bodies
Inferior gluteal	Anterior division of internal iliac	Leaves pelvis though greater sciatic	Piriformis, coccygeus, levator ani, and gluteal muscles
Uterine	Anterior division of internal iliac	Runs medially on levator ani; crosses ureter to reach base of broad ligament	Pelvic part of ureter, uterus ligament of uterus, uterine tube, and vagina
Vaginal	Uterine artery	At junction of body and cervix of uterus, it descends to vagina	Vagina and branches to inferior bladder
Gonadal (testicular or ovarian)	Abdominal aorta	Descends retroperitoneally; testicular artery passes into deep inguinal ring; ovarian artery crosses brim of pelvis and runs medially in suspensory ligament to ovary	Testis or ovary
Posterior division of internal iliac	Internal iliac artery	Passes posteriorly and gives rise to parietal branches	Pelvic wall and gluteal region
Iliolumbar	Posterior division of internal iliac	Ascends anterior to sacroiliac join and posterior to common iliac vessesl and psoas major	Iliacus, psoas, quad lumb, and cauda equina in vertebral canal
Lateral sacral (superior and inferior)	Posterior division of internal iliac	Runs on superficial aspect of piriformis	Piriformis and vertebral canal.

Nerves of Sacral and Coccygeal Plexuses:

Nerve	Segmental Origin	Distribution
Sciatic	L4, L5, S1-3	Articular branches to hip join and muscular branches to flexors of knee, and all muscles in leg and foot
Superior gluteal	L4, L5, S1 – leaves thru greater sciatic, superior to pyriformis	Gluteus medius and minimus muscles
Inferior gluteal	L5, S1, S2 – leaves thru greater sciatic inferior to pyriformis	Glueus maximus
Nerve to piriformis	S1, S2	Piriformis
Nerve to quadratus femoris and inferior gemellus	L4, L5, S1	Quadratus femoris and inferior gemellus

Nerve to obturator internus and superior gemellus	L5, S1, S2	obturator internus and superior gemellus
Pudendal	S2, S3, S4 – leaves pelvis thru greater sciatic between periformis and coccygeus muscles.	After leaving pelvis, it hooks around the ischial spine and sacrotuberous ligament and enters the perineum thru the lesser sciatic. Innervates structures in perineum: sensory to genitalia, muscular branches to perineal muscles, sphincter urethrae and external anal sphincter. It ends as dorsal nerve of penis or clitoris.
Nerves to levator ani and coccygeus	S3, S4	Levator Ani and coccygeus muscles
Posterior femoral cutaneous	S2, S3	Cutaneous branches to buttock and uppermost medial and posterior surfaces of thigh
Perforating cutaneous	S2, S3	Cutaneous branches to medial part of buttock
Pelvic splanchnic	S2, S3, S4	Pelvic viscera via inferior hypogastric and pelvic plexus.

Muscles of the Perineum

Muscle	Origin	Insertion	Innervation	Actions
External anal sphincter	Skin and fascia surrounding anus and coccyx via anococcygeal body	Perineal body	Inferior anal (rectal) nerve	Closes anal canal
Bulbospongiousus	**Male:** median raphe, ventral surface of bulb of penis, and perineal body	Corpora spongiosum and cavernosa and fascia of bulb of penis	Deep branch of perineal nerve, a branch of pudendal nerve	Compresses bulb of penis and assists in erection
	Female: perineal body	Fascia of corpus cavernosa	Deep branch of perineal nerve, a branch of pudendal nerve	Reduces lumen of vagina and assists in erection of clitoris
Ischiocavernosus	Ischial ramus and tuberosity	Crus of penis or clitoris	Deep branch of perineal nerve, a branch of pudendal nerve	Maintain erection of penis or clitoris by compression of outflow veins
Superficial transverse perineal	Ischial ramus and tuberosity	Perineal body	Deep branch of perineal nerve, a branch of pudendal nerve	Supports perineal body
Deep transverse perineal	Inner aspect of ischiopubic ramus	Median raphe, perineal body, and external anal sphincter	Deep branch of perineal nerve, a branch of pudendal nerve	Fixes perineal body
External urethral sphincter	Inferior pubic ramus and ischial tuberosity	Surrounds urethra; in females some fibers also enclose vagina	Deep branch of perineal nerve, a branch of pudendal nerve	Compresses urethra; also compresses vagina in females.

Arterial supply of the perineum

Artery	Origin	Course	Distribution
Internal pudendal	Internal iliac	Leaves pelvis thorugh the greater sciatic; hooks around ishial spine and enters perineum by way of lesser sciatic and passes to pudendal canal.	Perineum and external genital organs
Inferior rectal	Internal pudendal	Leaves pudendal canal and crosses ischioanal fossa to anal canal	Distal portion of anal canal
Perineal	Internal pudendal	Leaves pudendal canal and enters superficial perineal space	Supplies superficial perineal muscles and scrotum
Posterior scrotal or labial	Terminal branch of perineal	Runs in subcutaneous tissue of posterior scrotum or labium majus	Skin of scrotum or labium majus
Artery of bulb of penis or vestible	Internal pudendal	Pierces perineal membrane to reach bulb of penis or vestible of vagina	Supplies bulb of penis or vestible and bulbo gland (male) or greater vestibular gland (female)
Deep artery of penis or clitoris	Terminal branch of perineal	Pierces perineal membrane to reach corpora covernosa of penis or clitoris	Supplies erectile tissue or penis or clitoris
Dorsal artery of penis or clitoris	Terminal branch of perineal	Pierces perineal membrane and passes through suspensory ligament of penis or clitoris to run on dorsum of penis or clitoris	Skin of penis and erectile tissue of penis or clitoris
External pudendal, superficial and deep branches	Femoral	Pass medially across the thigh to reach the scrotum or labia majora	External genetalia and superomedial part of the thigh

PERINEAL POUCHES

	Males	Females
Superficial perineal pouch contents	Root (bolb and crura of the penis and associated muscles)	Root (crura) of the clitoris and the muscles associated with it (ischiocavernosus)
	Proximal part of the spongy urethra	Bulbs of the vestible and the surrounding muscle (bulbospongiosus)
	Superficial transverse perineal muscles	Superficial tranverse perineal muscles
	Branches of the internal pudendal vessels	Related vessels and nerves (branches of internal pudendal vessels, perineal nerves)
	Branches of the pudendal nerves (perineal nerves)	Greater vestibular glands
Deep perineal pouch contents	Intermediate part of the urethra	Proximal part of the urethra
	External urethral sphincter muscles	External urethral sphincter muscle
	Bulbourethral glands	Deep transverse perineal muscles
	Deep transverse perineal muscles	Related vessels nerves
	Related vessels and nerves	

CLASS DISCUSSION QUESTIONS ABDOMEN & PELVIS

ABDOMINAL WALL

1. The expansions of Poupart's ligament are all except
   A. Gimbernat's ligament
   B. Cooper's ligament
   C. Innominate fascia of gallaludet
   D. Reflected part of inguinal ligament

2. External oblique,internal oblique,Transverse abdominis can be compared with
   A. Sternocleidomastoid muscle
   B. Digastric muscle
   C. Trapezius muscle
   D. Pterygoids muscle

BLOOD VESSELS ABDOMEN

3. Find the odd match
   A. Coeliac trunk-T12
   B. Superior mesentric artery-L1
   C. Inferior mesentric artery-L3
   D. Abdominal aorta bifurcation-L3

NERVES

4. True about lumbar plexuses
   A. Formed by ventral rami of L1-L5
   B. Smaller part of ventral rami of L2 join with L4 to form lumbosacral trunk
   C. L4 is called nervus furcalis
   D. All the above

OESOPHAGUS,STOMACH,DUODENUM

5. Which of the following structure contain both skeletal and smooth muscle
   A. Stomach
   B. Jejunum
   C. Oesophagus
   D. Rectum
6. Which of the following arteries does not supply the oesophagus
   A. Left gastric
   B. Splenic
   C. Superior thyroid artery
   D. Inferior thyroid artery
7. Which of the following statement is true
   A. The major duodenal papillae is situated 8-10 cm distal to pylorus on anterior wall
   B. Peptic ulceration of second part of duodenum is more common than first part
   C. The accessory pancreatic duct may open 2cm above major duodenal papillae
   D. Duodenum is the least common site of diverticulosis in small intestine

8. The following statement concerning superficial inguinal ring is accurate
   A. It is a defect in external oblique muscle fibre
   B. It is a opening with base formed by pubic crest
   C. It is Present in midway between anterior superior iliac spine and pubic symphsis
   D. All the above

9. The greater and lesser splanchnic nerves pass through the diaphragm via which of the following structures?
   A. Aortic hiatus
   B. Diaphragmatic crus
   C. Vena caval foramen
   D. Medial arcuate ligament

10. The Hepatorenal pouch of Morrison is
    A. Right anterior intraperitoneal recess
    B. Right posterior intraperitoneal recess
    C. Right extraperitoneal space
    D. Left posterior intraperotoneal recess

GALL BLADDER

11. Which of the following is the correct landmark for locating the normal position of the gallbladder during a physical examination?
    A. The lowest point of the left subcostal margin
    B. The junction of the left linea semilunaris with the subcostal margin
    C. The lowest point of the right subcostal margin
    D. The junction of the right linea semilunaris with the subcostal margin

12. During a surgical procedure in which you will remove the gallbladder, you will expect its blood supply, the cystic artery, to arise from which of the following arteries?
    A. Right hepatic artery
    B. Left hepatic artery
    C. Proper hepatic artery
    D. Common hepatic artery

APPENDIX&PANCREAS

13. Which of the following techniques could you use to precisely locate the appendix?
    A. Locate a region devoid of haustra
    B. Trace the right collect artery
    C. Trace the ileocolic artery
    D. Trace the teniae coli on the cecum

14. The junction between head and neck of pancreas is separated by
    A. A.Groove for hepatic artery
    B. B.Groove for superior pancreaticoduodenal artery
    C. C.Gastroduodenal artery
    D. D.Portal vein

15. Arteria cauda pancreatis is a branch of
    A. A.Splenic artery
    B. B.Superior mesentric artery
    C. C.Gastroduodenal artery
    D. D.Inferior pancreaticoduodenal artery

16. You are at surgery and are about to mobilize the second portion of the duodenum and the head of the pancreas. You note an artery and vein passing anteriorly to the uncinate process of the pancreas and the third portion of the duodenum. Which vessels are these?
    A. SMA and SMV
    B. Inferior mesenteric artery and vein
    C. Gastroduodenal artery and vein
    D. Superior pancreaticoduodenal artery and vein

LIVER

17. You are examining the liver during a surgical procedure. The gallbladder will be found in its fossa between which two anatomical lobes?
    A. Quadrate and left lobes
    B. Quadrate and caudate lobes
    C. Right and quadrate lobes
    D. Caudate and right lobes

18. The non-peritoneal areas of liver include all except
    A. Bare of liver
    B. Fossa of gall bladder
    C. Fissure of ligamentum teres
    D. Caudate lobe

19. Fissure of Gans lies on
    A. Caudate lobe
    B. Quadrate lobe
    C. Left lobe of liver
    D. Right lobe of liver

20. If you ligated the right hepatic artery, the arterial supply to which of the following portions of the liver would remain intact?
    A. Left, quadrate, and a portion of the caudate lobe
    B. Right and quadrate lobes
    C. Left lobe only
    D. Left and quadrate lobes only

21. Your patient who had cirrhosis has symptoms of esophageal varices. This is due to dilatation of the anastomosis between which of the following pairs of veins?
    A. Left gastric and the azygous veins
    B. Right gastric and the azygous veins
    C. Right gastric and the hemiazygous
    D. Left gastric and the hemiazygous

22. A surgical incision through the fundus of the stomach would require you to clamp which of the following?
    A. Right gastric artery
    B. Left gastric artery
    C. Right gastro-omental artery
    D. Short gastric arteries

KIDNEY

23. During the removal of a patient's kidney, you would observe which of the following as being most anterior within the renal sinus?
    A. Renal arteries
    B. Renal vein
    C. Major calyx
    D. Minor calyx

24. Bloodless line of Brodels is related to
    A. Spleen
    B. Kidney
    C. Gall bladder
    D. Liver

25. You wish to examine the hilum of the right kidney during surgery. Which of the following structures must be elevated and reflected to do so?
    A. Stomach
    B. Suprarenal gland
    C. Ascending colon
    D. Duodenum

26. To elevate the kidney within the renal fascia and the perirenal fat, the renal fascia must be reflected or incised from the fascia of which of the following muscles?
    A. Diaphragm
    B. Psoas muscle
    C. Quadratus lumborum muscle
    D. Transverses abdominis muscle

27. Renal angle is formed by
    A. 10 thrib with inner border of erector spinae
    B. Angle between ureter and renal sinus
    C. Angle between renal artery and abdominal aorta
    D. 12 thrib with outer border of erector spinae

URETER

28. The narrowest part of ureter is
    A. Pelvi ureteric junction
    B. Point where ureter crosses over pelvic brim
    C. Mid way between abdominal and pelvic part of ureter
    D. At vesicoureteric junction

29. The anatomical land mark to identify left ureter is
    A. Intersigmoid fossa
    B. Close to superior mesentric artery
    C. Covered by second part of duodenum
    D. All the above

30. Inferior epigastric vessels is covered by
    A. Median umbilical fold
    B. Lateral umbilical fold
    C. Medial umblical fold
    D. None of above

ADRENAL

31. As a surgeon about to remove the right adrenal gland, you examine the blood supply of the right adrenal gland and observe which of the following?
    A. It receives its arterial blood supply from the aorta only
    B. Its central vein drains into the IVC
    C. Its central vein drains into the left renal vein
    D. It is in contact with the head of the pancreas
    E. It lies external to the renal fascia

32. The root of mesentry crosses all the following
    A. Right ureter
    B. Left psoas major
    C. Ascending and horizontal parts of duodenum
    D. Right testicular artery

33. Spiral valve is located in which of following
    A. Pylorus
    B. Caecum
    C. Rectum
    D. Neck of gall bladder

34. The artery of ductus deferens arises from
    A. Inferior vesical artery
    B. Inferior epigastric
    C. Superior vesical artery
    D. Aorta

35. Seminal fluid has entered the ejaculatory duct.where the fluid will be next found
    A. Epididymis
    B. Penile urethra
    C. Prostatic urethra
    D. Ductus deferens

36. Fascia transversalis in abdomen corresponds to which layer in scrotum
    A. External spermatic fascia
    B. Internal spermatic fascia
    C. Cremastric fascia
    D. None of above

ISCHIORECTAL FOSSA& URINARY BLADDER

37. True about Ischiorectal rectal fossa is all except
    A. It contains internal pudendal vessels& Pudendal nerve
    B. The fascia related to fossa are anal fascia,lunate fascia.
    C. Pudendal canal is a fascial tunnel situated on the medial wall of ischiorectal fossa
    D. Hiatus of schwalbe is due to failure of origin of levator ani from obturator fascia

38. Space of retzius is related to
    A. Uterus
    B. Liver
    C. Bladder & prostate
    D. Kidney & ureter

39. All are true ligaments of bladder except
    A. Puboprostatic ligaments
    B. Median umbilical ligament
    C. Medial umbilical ligament
    D. Posteriorlgament or Sacrogenital fold

PERINEUM

40. All the following muscles are attached to the perineal body ***EXCEPT***:
    A. Superficial transverse perinei
    B. Deep transverse perinei
    C. Ischiocavernosus
    D. Bulbospongiosus

PROSTATE

41. True about prostatic urethra is all except
    A. Is the widest and most dilatable part of male urethra
    B. Cross section shows a transverse slit
    C. The posterior wall contain verumontanum
    D. Length of prostatic urethra is 3 cm

ANAL CANAL

42. Anal continence is not contributed
    A. Puborectalis
    B. Valves of houston
    C. External anal sphincter
    D. Pudendal nerve

43. The rectosigmoid junction lies anterior to which of the following structure
    A. S3 vertebrae
    B. Prostate
    C. Bladder
    D. Pararectal fossa

PENIS

44. The navicular fossa is situated on which of the following structure
    A. Prostate
    B. Bladder
    C. Seminal vesicle
    D. Glans penis

45. All of the following statements concerning the pectinate line are correct EXCEPT
    A. It is the junction between the superior and inferior parts of the anal canal.
    B. The superior rectal artery supplies the superior part of the anal canal.
    C. Lymphatic vessels from the superior part of the anal canal drain into the internal lymph nodes.
    D. The superior part of the anal canal is drained by the internal rectal venous plexus which drains into tributaries of the caval venous system

46. The internal iliac artery is crossed by which of the following structures at the level of the 4th intervertebral disc between L5 and S1?
    A. Puborectalis muscle
    B. Ureter
    C. Obturator nerve
    D. Umbilical artery

47. Helicine arteries are located in which of the following structures?
    A. Superficial perineal space
    B. Deep perineal space
    C. Corpora cavernosa
    D. Spermatic cord

48. All of the following structures surround the corpora cavernosa and corpus spongiosum EXCEPT
    A. Loose areolar tissue
    B. Deep fascia
    C. Tunica albuginea
    D. Tunica dartos

49. The relationship ("water passing under the bridge") is an especially important one for surgeons ligating which of the following arteries?
    A. Ovarian
    B. Testicular
    C. Uterine
    D. Vaginal

50. The anal columns contain which of the following structures?
    A. Internal pudendal vessels
    B. Pudendal nerve
    C. Superior rectal vessels
    D. Obturator nerve

ANSWERS & EXPLANATION

1.C

The Inguinal ligament is formed by the margin of the aponeurosis of external oblique extending between the anterior superior iliac spine and the pubic tubercle. The deep fibres of the aponeurosis of external oblique are not initially parallel to the long axis of theinguinal ligament: they approach the ligament obliquely at an angle of 10–20°. On reaching the ligament, fibres turns medially, and most run along the ligament to reach the pubic tubercle. The deepest fibres of the aponeurosis spread out posteromedially to insert into the pectineal line.

The inguinal triangle lies in the posterior wall of the canal. It is bounded inferiorly by the medial half of the inguinal ligament, medially by the lower lateral border of rectus abdominis and laterally by the inferior epigastric artery, and overlies the medial inguinal fossa and, in part, the supravesical fossa.

Lacunar ligament

The lacunar ligament is a thick triangular band of tissue lying mainly posterior to the medial end of the inguinal ligament. It measures approximately 2 cm from base to apex and is a little larger in the male. It is formed from fibres of the medial end of the inguinal ligament and fibres from the fascia lata of the thigh, which join the medial end of the inguinal ligament from below. The inguinal fibres run posteriorly and laterally to the medial end of the pectineal line and are continuous with the pectineal fascia. They form a near horizontal, triangular sheet with a curved lateral border which forms the medial border of the femoral canal. The apex of the triangle is attached to the pubic tubercle. A strong fibrous band, the pectineal ligament of Astley Cooper, extends laterally along the pectineal line from the pectineal attachment. The fibres from the fascia lata join the inferior/posterior border of the inguinal ligament; the latter, in combination with fibres from the transversalis fascia, fuses with the pectineal fascia as it joins the thickened periosteum of the pectineal line. This portion of the lacunar ligament forms the lower extension of the medial border of the femoral canal and femoral sheath

2.C

- The external oblique, internal oblique and transversus abdominis muscles can thus be regarded as paired, digastric muscles with a central tendon in the form of the linea alba. These decussating fibres maybe used to identify the midline during surgical incisions, since they can be seen as oblique fibres crossing at right angles.

3.D

The abdominal aorta begins at the median, aortic hiatus of the diaphragm, anterior to the inferior border of the 12th thoracic vertebra and the thoracolumbar intervertebral disc . It descends anterior to the lumbar vertebrae to end at the lower border of the fourth lumbar vertebra, a little to the left of the midline, by dividing into two common iliac arteries. It diminishes rapidly in calibre from above downward, because its branches are large; however, the diameter of the vessel at any given height tends to increase slightly with age. The cadaveric superior and inferior calibres are between 9–14 mm and 8–12 mm, respectively, with little difference between the sexes. The angle of the aortic bifurcation varies widely, particularly in the elderly.

4.D

The posterior abdominal wall contains the origin of the lumbar plexus and numerous autonomic plexuses and ganglia, which lie close to the abdominal aorta and its branchesThe lumbar ventral rami descend laterally into psoas major, and increase in size from first to last. The first three and most of the fourth form the lumbar plexus; the smaller moiety of the fourth joins the fifth as a lumbosacral trunk, which joins the sacral plexus. The fourth ramus is often termed the nervus furcalis, because it is divided between the two plexuses. Occasionally the third ramus is the nervus furcalis, and both third and fourth ventral rami may be furcal nerves, in which case the plexus is termed prefixed. More frequently, the fifth ventral ramus is furcal, and the plexus is then termed postfixed. These variations modify the sacral plexus.

The first and second, and sometimes the third, lumbar ventral rami are each connected with the lumbar sympathetic trunk by a white ramus communicans. All lumbar ventral rami are joined near their origins by long slender grey rami communicantes from the four lumbar sympathetic ganglia. The rami communicantes accompany the lumbar arteries round the sides of the vertebral bodies, behind psoas major. Their arrangement is irregular: one ganglion may give rami to two lumbar ventral rami, or one lumbar ventral ramus may receive rami from two ganglia, or grey rami often leave the sympathetic trunk between ganglia.

5.C

The muscle of the pharynx is striated, while the lower tubular esophagus is smooth. Directly below the pharyngoesophageal junction, isolated smooth muscle bundles appear intermingled with the striated muscles. The

number of smooth muscle bundles increases within the first centimeter of the esophageal tunica muscularis. This occurs somewhat higher in the inner, anterior muscle layer than in the outer, longitudinal layer. No sharp transition lines occur. Instead both muscle types remain interwoven without any apparent anatomic boundary. As they descend, the smooth muscle components simply become more numerous and replace – in the same proportion – the striated muscle). Finally, only isolated fibers or strands of the striated type lodge within the smooth muscles. Caudal to the tracheal bifurcation, the fibers of both layers are exclusively of smooth muscle type. Measurements showed no essential individual variation

6.C
The superior thyroid does not supply the oesphagus

7.C
The common bile duct and pancreatic duct enter the medial wall obliquely and usually unite to form the common hepatopancreatic ampulla. The narrow distal end opens on the summit of the major duodenal papilla (ampulla of Vater), which is situated on the posteromedial wall of the second part, 8–10 cm distal to the pylorus. There are variants of the ductal anatomy. The most common is a second, accessory pancreatic duct which may open 2 cm above the major papilla on a minor duodenal papilla. Peptic ulceration of the second part of the duodenum is less common than that of the first part, and tends to occur on the anterior or lateral wall.

8.
Superficial inguinal ring
The superficial inguinal ring is a hiatus in the aponeurosis of external oblique, just above and lateral to the crest of the pubis. The ring is actually triangular, and its apex points along the line of the deep fibres of the aponeurosis. Although it varies in size, it does not usually extend laterally beyond the medial one-third of the inguinal ligament – the ring is smaller in the female. The base lies along the crest of the pubis and its sides are the crura of the opening in the aponeurosis. The lateral crus is the stronger and is reinforced by fibres of the inguinal ligament inserted into the pubic tubercle. The medial crus is thin.

9.D
- The sympathetic trunks pass deep to the medial arcuate ligament. There are two small apertures in each crus of the diaphragm; one transmits the greater and the other the lesser splanchnic nerve

10.B
Right subhepatic space (hepatorenal recess)
- The right subhepatic space lies between the right lobe of the liver and the right kidney. It is bounded superiorly by the inferior layer of the coronary ligament, laterally by the right lateral abdominal wall, posteriorly by the anterior surface of the upper pole of the right kidney and medially by the second part of the duodenum, hepatic flexure, transverse mesocolon and part of the head of the pancreas. In the supine position the posterior right subhepatic space is more dependent than the right paracolic gutter: postoperative infected fluid collections are common in this location.

11.D
- The gallbladder is normally located at the junction of the right semilunar line with the right subcostal margin.

12.A
- The cystic artery typically is a branch of the right hepatic artery.

13.D
- The three teniae coli converge at the base of the appendix on the caecum.
- The three taeniae coli on the ascending colon and caecum converge on the base of the appendix, and merge into its longitudinal muscle. The anterior caecal taenia is usually distinct and can be traced to the appendix, which affords a guide to its location intra-operatively. The appendix varies from 2–20 cm in length: it is often relatively longer in children and may atrophy and shorten after mid-adult life. It is connected by a short mesoappendix to the lower part of the ileal mesentery. This fold is usually triangular, extending almost to the appendicular tip along the whole viscus.

14.C
The junction between the head and neck of pancreas is separated by groove for gastrodudodenal artery

15.A
The pancreas is supplied by numerous small arterial branches which usually run into the gland directly from their arteries of origin. They are particularly numerous in the region of the neck, body and tail. Most originate from the splenic artery as it runs along the superior border of the gland and supply the left part of the body and tail. A dorsal branch descends posterior to the pancreas, dividing into right and left branches. It sometimes arises from the superior mesenteric, middle colic, hepatic or rarely, the coeliac artery. The right branch is often double and runs between the neck and uncinate process to form a prepancreatic arterial arch as it anastomoses with a branch from the anterior superior pancreaticoduodenal artery. The left branch runs along the inferior border to the pancreatic tail where it anastomoses with the greater pancreatic artery (*arteria pancreatica magna*) and the artery to tail of the pancreas (*arteria caudae pancreatis*).

16.A
- The SMA and SMV emerge from between the head and uncinate process of the pancreas to cross the uncinate process and the third portion of the duodenum

17.C
- The gallbladder is located between the right lobe and the quadrate lobe.
- The gallbladder usually lies in a shallow fossa, but this is variable: it may have a short mesentery or be completely intrahepatic and lie within a cleft in the liver parenchyma. The quadrate lobe lies between the fissure for the ligamentum teres and the gallbladder

18.D
- The non peritoneal areas
- 1.along line of attachment of falciform ligament
- 2.bare area of liver
- 3.groove for IVC
- 4.Fossa for GB
- 5.Floor of fissure for ligamentum teres & venosum

19.D
- Fissure of Gans
- The fissure of Gans lies on the undersurface of the right lobe of the liver behind the gallbladder fossa. It often contains the portal pedicle to the right posterior sector and is thought to correspond to the right fissure as it relates to the separation of the sectors of the liver

20.A
- The left hepatic artery supplies the left and quadrate lobes and a portion of the caudate lobe

21.D
Esophageal veins drain to the left gastric and the hemiazygous veins

22.D
- The short gastric arteries supply the fundus of the stomach.

23.B
- The renal veins lie most anterior within the renal sinus

24.B
The "avascular" line or plane (also known as Brödel's line) is the most avascular area of the kidney. It is located slightly behind the convex border at the posterior half of the kidney at the junction of the area supplied by the anterior and posterior divisions of the renal artery. This is approximately 2/3 of the way along a line from the hilum to the lateral margin of the kidney. Incision in this area will permit removal of a stone within the renal calices with minimal damage.

25.D
The duodenum lies immediately anteriorly to the hilum of the right kidney

26.B
The renal fascia is fused posteriorly with fascia of psoas major muscle

27.D
- Renal angle is formed by 12 th rib with outer border of erector spinae
- Tenderness in perirenal abscess

28.D
- Characteristic Narrowings of the Ureters
- Narrowing of the ureter occurs
- At the ureteropelvic junction
- At the pelvic brim (iliac vessels)
- At the intravesical course (ureterovesical junction)

When both ureters approach the urinary bladder they are Approximately 5 cm apart. Their openings within the full bladder are also approximately 5 cm apart, but in an empty bladder the openings are only 2.5 cm apart.

29.A
- Observations on the abdominal course of the ureter:
- The right ureter is covered by the second portion of the duodenum
- The left ureter is adherent to the mesocolon
- The left ureter is very close to the inferior mesenteric artery, passing under it
- The abdominal part of the ureter is fused to the peritoneum
- The abdominal course of the ureter is the same in male and female
- The anatomic landmark of the left ureter is the intersigmoid fossa . The ureter passes behind the fossa and therefore behind the sigmoid colon at the apex of the capital Greek lambda

30.B
Lateral umbilical fold covers the inferior epigastric vesssels

31.B
- The central vein of the right suprarenal gland drains into the IVC, whereas that of the Left gland drains into the left renal vein.

32.B
- MESENTRY –It crosses following
- Right ureter
- Right psoas major
- Right testicular artery
- Abdominal aorta
- IVC

33.D
Spiral valve is in neck of GB

34.C
- The spermatic cord contains the vas deferens; the testicular artery and veins, cremasteric artery (a branch of the inferior epigastric artery) and artery to the vas deferens (from the superior vesical artery); the genital branch of the genitofemoral nerve and cremasteric nerve and the sympathetic components of the testicular plexus (which are joined by filaments from the pelvic plexus accompanying the artery to the vas deferens); 4–8 lymph vessels draining the testis. All of these structures are conjoined by loose connective tissue

35.C
- Both of the ejaculatory ducts empty sperm from the epididymis by way of the ductus deferens and seminal fluid from the seminal vesicle into the prostatic urethra.
- Seminal fluid then traverses the membranous urethra in the urogenital diaphragm and penile urethra during ejaculation

36.B
Internal spermatic fascia corresponds to fascia transversalis

37.C
Pudendal canal is situated on lateral wall of ischiorectal fossa

38.C
Space of retzius is related to bladder & Prostate
For all practical purposes, the space of Retzius, the so-called prevesical space, extends into both the abdomen and the pelvis, being a division of the entire extraperitoneal space. The space of Retzius is situated in front and to the sides of the urinary bladder. Its boundaries are listed below.
Anterior. Symphysis pubis *Lateral.* Pubic bone, fascia of obturator internus muscle, superior fascia of levator ani muscle, lateral puboprostatic ligament*Medial.* Inferior lateral surface of bladder*Superior.* Peritoneum bridging the upper surface of the bladder and lateral pelvic wall*Posterior.* Vascular stalk of the internal iliac artery and vein with their sheath. Sheath reaches posterolateral border of the bladder. *Inferior.* Puboprostatic or pubovesical ligaments, reflection of the superior fascia of levator ani muscle to the urinary bladder from the arcus tendineus fascia pelvis
Potentially, the space of Retzius is larger than the retropubic space. It extends upward and laterally to form a triangular space between the medial umbilical ligaments (the obliterated umbilical arteries), with its apex at the umbilicus and its base provided by the puboprostatic or pubovesical ligaments. The space is "a continuous bursa-like cleft in the areolar tissue at the sides and front of the bladder which allows the bladder to fill and empty without hindrance."
The space of Retzius is bounded behind by the vesicoumbilical fascia, a mantle of mixed connective tissue that extends upward from the urinary bladder toward the umbilicus and posterolaterally as the lateral pillars of the bladder. The space of Retzius is continuous above with the space of Bogros, the potential space between the extraperitoneal connective tissue and the transversalis fascia

39.D

Ligament	**Location**
True ligaments	
Median umbilical ligament (urachus) (unpaired)	Dome of bladder to umbilicus
Lateral true ligament	Lateral wall of bladder to tendinous arch of pelvic fascia
Medial umbilical ligament (obliterated umbilical arteries)	Inguinal ligament
Medial puboprostatic ligament (male)	Pelvic wall to prostate gland
Lateral puboprostatic ligament	Pelvic wall to prostate gland
False ligaments	
Superior false ligament (unpaired)	Covers the urachus
Lateral false ligament	Bladder to wall of pelvis
Lateral superior ligament	Covers the medial umbilical ligament
Posterior ligament (sacrogenital fold)	Side of bladder, around rectum to anterior aspect of sacrum

40.C
Perineal body
The perineal body is a poorly defined aggregation of fibromuscular tissue located in the midline at the junction between the anal and urogenital triangles. It is attached to many structures in both the deep and superficial urogenital spaces. Posteriorly, it merges with fibres from the middle part of the external anal sphincter and the conjoint longitudinal coat. Superiorly, it is continuous with the rectoprostatic or rectovaginal septum, including fibres from levator ani (puborectalis or pubovaginalis). Anteriorly, it receives a contribution from the deep transverse perinei, the superficial transverse perinei and bulbospongiosus (Fig. 63.4). The perineal body is continuous with the perineal membrane and the superficial perineal fascia. Since the superficial perineal fascia runs forward into the skin of the perineum, the perineal body is tethered to the central perineal skin, which is often puckered over it. In males, this is continuous with the perineal raphe in the skin of the scrotum. In females, the perineal body lies directly posterior to, and is attached to, the posterior commissure of the labia majora and the introitus of the vagina.
The anus can be surgically detached from the perineal body without any clinical consequences. However, spontaneous lacerations of the body sustained during childbirth are often associated with damage to the anterior fibres of the external anal sphincter. The deliberate division of the perineal body to facilitate delivery (episiotomy) is

angled laterally to avoid such injuries. The perineal body is often used for the positioning of radiological markers used to determine the amount the perineum descends during straining in order to assess pelvic floor dysfunction.

41.B

The prostatic urethra is 3–4 cm in length and tunnels through the substance of the prostate, closer to the anterior than the posterior surface of the gland. It is continuous above with the preprostatic part and emerges from the prostate slightly anterior to its apex (the most inferior point of the prostate). Throughout most of its length the posterior wall possesses a midline ridge, the urethral crest, which projects into the lumen causing it to appear crescentic in transverse section.

On each side of the crest there is a shallow depression, the prostatic sinus, the floor of which is perforated by the orifices of 15–20 prostatic ducts. An elevation, the verumontanum (seminal colliculus), is seen at about the middle of the length of the urethral crest: it is used as a surgical landmark for the urethral sphincter during trans-urethral resection for benign enlargement of the prostate. At this point the urethra turns anteriorly by 35° and contains the slit-like orifice of the prostatic utricle. On both sides of, or just within, this orifice are the two small openings of the ejaculatory ducts. The prostatic utricle is a cul-de-sac 6 mm long, which runs upwards and backwards in the substance of the prostate behind its median lobe. Its walls are composed of fibrous tissue, muscular fibres and mucous membrane, the latter pitted by the openings of numerous small glands. The prostatic utricle develops from the paramesonephric ducts or urogenital sinus, and is thought to be homologous with the vagina of the female . It is sometimes called the ‘vagina masculina', but the more usual view is that it is a uterine homologue and hence the term ‘utricle'. The lowermost part of the prostatic urethra is fixed by the puboprostatic ligaments and is therefore immobile

42.B

Internal anal sphincter

The internal anal sphincter is a well-defined ring of obliquely orientated smooth muscle fibres that is continuous with the circular muscle of the rectum, and which terminates at the junction of the superficial and subcutaneous components of the external sphincter. Its thickness varies between 1.5 and 3.5 mm, depending upon the height within the anal canal and whether the canal is distended. It is usually thinner in females and becomes thicker with age. It may also be thickened in disease processes such as rectal prolapse and chronic constipation. The lower portion of the sphincter is crossed by fibres from the conjoint longitudinal coat which pass into the submucosa of the lower canal.

Vascular supply

The internal anal sphincter is supplied from the terminal branches of the superior rectal vessels and branches of the inferior rectal vessels.

Innervation

The internal anal sphincter is supplied by the sympathetic and parasympathetic systems by fibres that extend down from the lower rectum. Sympathetic fibres originate in the lower two lumbar spinal segments, are distributed via the inferior hypogastric plexus, and cause contraction of the sphincter. Parasympathetic fibres originate in the second to fourth sacral spinal segments, are distributed via the inferior hypogastric plexus, and cause relaxation of the sphincter.

External anal sphincter

The external anal sphincter is an oval tube-shaped complex of striated muscle, composed mainly of type 1 (slow twitch) skeletal muscle fibres, which are well suited to prolonged contraction. It has been described as consisting of deep, superficial and subcutaneous parts but the external anal sphincter should be considered as a single functional and anatomical entity although the upper middle and lower thirds show different features and attachments. Endoanal ultrasound and magnetic resonance imaging reveal that the uppermost fibres blend with the lowest fibres of puborectalis. In the upper third some of these upper fibres decussate anteriorly into the superficial transverse perineal muscles and posteriorly some fibres are attached to the anococcygeal raphe. The majority of the fibres of the middle third of the external anal sphincter surround the lower part of the internal sphincter. The middle third is attached anteriorly to the perineal body and posteriorly to the coccyx via the anococcygeal ligament: some fibres from each side of the sphincter decussate in these areas to form a commissure in the anterior and posterior midline. The fibres of the lower third lie below the level of the internal anal sphincter and are separated from the lowest anal epithelium by submucosa.

Vascular supply

The external anal sphincter is supplied from the terminal branches of the inferior rectal vessels with a small contribution from the median sacral artery.

Innervation
The external anal sphincter is innervated mainly by the inferior rectal branch of the pudendal nerve (anterior divisions of the second, third and fourth sacral spinal nerves). It may also receive some direct supply via fibres which leave the ventral rami of these nerves as they exit the sacral foramina and run beneath the fascia over levator ani to reach the anorectal junction

43.A

- The junction between the sigmoid colon and the rectum has been variously described:
- A point opposite the left sacroiliac joint
- Level of the 3rd sacral vertebra
- Level at which the sigmoid mesentery disappears
- Level at which the superior rectal artery divides into right and left branches
- Level of superior rectal fold (inconstant)
- Transition between rugose mucosa of colon and smooth mucosa of rectum (cadaver)

44.D
Navicular fossa is situated in glans penis
45.D

	Below the Pectinate Line	**Above the Pectinate Line**
Embryonic origin	Ectoderm	Endoderm
Anatomy		
Lining	Stratified squamous	Simple columnar
Arterial supply	Inferior rectal artery	Superior rectal artery
Venous drainage	Systemic, by way of inferior rectal vein	Portal, by way of superior rectal vein
Lymphatic drainage	To inguinal nodes	To pelvic and lumbar nodes
Nerve supply	Inferior rectal nerves (somatic)	Autonomic fibers (visceral)
Physiology	Excellent sensation	Sensation quickly diminishes
Pathology		
Cancer	Squamous cell carcinoma	Adenocarcinoma
Varices	External hemorrhoids	Internal hemorrhoids

46.B

- The internal iliac artery begins at the level of the fourth disc between L5 and S1 vertebrae, where it is crossed by the ureter. It is separated from the sacroiliac joint by the internal iliac vein and the lumbosacral trunk

47.C

- The deep arteries of the penis are the main vessels supplying the cavernous spaces in the erectile tissue of the corpora cavernosa and are therefore involved in the erection of the penis. They give off numerous branches that open directly into the cavernous spaces. When the penis is flaccid, these arteries are coiled and therefore are called helicine arteries

48.D

- The penis is composed of three cylindrical bodies of erectile cavernous tissue enclosed by a fibrous capsule, the tunica albuginea. Superficial to the capsule is the deep fascia of the penis (Buck's fascia). Superficial to the deep fascia is the loose areolar tissue, which lies just beneath the skin of the penis. The tunica dar tos is located in the scrotum

49.C

- In its uppermost portion, at the base of the peritoneal broad ligament, the uterine artery runs transversely toward the cervix while the ureters pass immediately beneath them as they pass on each side of the cervix toward the bladder. This relationship ("water passing under the bridge") is an especially important one for surgeons ligating the uterine artery, as in a hysterectomy

50.C

- The superior half of the anal canal contains mucous membrane that is characterized by a series of longitudinal ridges called anal columns. These columns contain the terminal branches of the superior rectal artery and vein

EMBRYOLOGY

Week 1

Day 1: Fertilization, zygote is formed, in fallopian tube
Day 2: Cleavages form blastomeres
Day 3: Morula forms ICM and trophoblast
Day 4: Blastocoel is formed, zona pellucida breaks down
Day 5/6: Implantation into uterine wall

Week 2

- Trophoblast connects with maternal circulation
- Bilaminar germ disc forms (epiblast and hypoblast)
- Amniotic cavity forms

Week 3

- Gastrulation: primitive streak and node, formation of mesoderm and endoderm
- Notochord forms from notochordal plate
- Cloacal membrane and allantois form
- Development in a cranial to caudal direction

Week 4

- Neurulation: neural plate, neural folds, neural plates; proceeds middle to ends
- Neural crest cells form
- Paraxial, intermediate, and lateral plate mesoderm can be distinguished
- Paraxial mesoderm forms somites, cranial to caudal direction; somites differentiate into dermo-, myo-, and sclerotome parts
- Intermediate mesoderm begins to form mesonephros

Lateral plate mesoderm gives rise to somatic and splanchnic mesoderm, intraembryonic coelom forms

- Folding laterally and craniocaudally, which is also important to GI development
- Through Week 8, embryogenesis of all major organ systems

Week 9 to birth

- Fetal development: overall growth, maturation of tissues

Head and Neck Development

a. Critical time for craniofacial development is wk 3-4 (same as gastrulation)
b. Neural crest cells ⇨ bones of face & anterior skull
c. Mesoderm ⇨ posterior bones & base of skull
d. Lateral Plate Mesoderm ⇨ laryngeal cartilage

II. Somitomeres

a. Week 3: paraxial mesoderm differentiates into somitomeres
  i. differentiate in cranial to caudal fashion
  ii. 7 somitomeres
  iii. key in segmenting brain into fore- mid- hind- brain segments by inducing neural tube (via chemogradients)
b. somitomere = incompletely differentiated (in head)
c. somite = completely differentiated (found in lower body)
d. somitomeres form all voluntary muscles in head/neck; but scaffold (patterning) is by connective tissue elements

Origin	Craniofacial muscles	Innervation
Somitomere 1,2	Sup., med., ventral recti	CN III
Somitomere 3	Sup. Oblique	CN IV
Somitomere 4	Jaw-closing mm.	CN V
Somitomere 5	Lat. Rectus	CN VI
Somitomere 6	Jaw-opening mm. Other 2nd arch mm.	CN VII
Somitomere 7	Stylopharyngeus	CN IX
Somites 1,2	Intrinsic laryngeals	CN X
Somites 2-5	Tongue mm.	CN XII

III. Neural Crest Cells and Pharyngeal Arches

a. NCCs: migrate from neural folds in cranial-to-caudal sequence to somitomeres pharyngeal arches (brachial arches)

- **i.** directed by HOX genes ⇨ populate specific regions of head/neck
- **ii.** MSX-2 genes: specific "suicide" signal to NCCs along rhombomeres 3 & 5
  - **1.** produces gaps (brachial grooves)
  - **2.** ensures non-mixing between populations of NCCs
- **iii.** Rhombomere: subdivision of hindbrain (segment of neural tube)
  - **1.** each rhombomere has its own HOX code
  - **2.** NCCs in each rhombomere migrate to brachial arches with compatible HOX code ⇨ *specific link between face & brain development*
- **iv.** NCCs provide link between development of face & brain; key BUT also very sensitive to teratogens

b. Pharyngeal Arches (Brachial Arches)

Arch	Artery	Nerve	Skeletal Elements	Muscles
1	Maxillary	V(V_2 & V_3 only)	(NCCs) Maxilla, mandible, zygomatic portions of temporal,	mm. of mastication (temporalis, masseter, pterygoids) myelohyoid, ant. belly of digastric, tensor tympani, & veli palatini
2	Stapedial (practically degenerates)	VII	(NCCs) Stapes, styloid process, part of hyoid	muscles of facial expression, post. belly of digastric, stylohyoid, stapedius
3	Carotid	IX	(NCCs) Part of hyoid	Stylopharyngeus
4	Right: subclavian, Left: arch of the aorta	X (superior laryngeal br)	(LPM) Laryngeal cartilages	Cricothyroid, levator veli palatine, pharynx constrictors
5	-	-	-	-
6	Pulmonary	X (recurrent laryngeal br)	(LPM) Laryngeal cartilages	Intrinsic larynx mm.

IV. Pharyngeal Pouches & Grooves

a. Pharyngeal Pouches (Glands)

- **i.** First Pharyngeal Pouch
  - **1.** forms the auditory tube (narrow proximal part) & tympanic cavity (distal sac-like structure)
  - **2.** tympanic membrane—forms from lining of tympanic cav.
  - **3.** later comes into contact with epithelial lining of 1st pharyngeal cleft (future EAM)
- **ii.** Second Pharyngeal Pouch
  - **1.** proliferates to form palatine tonsil
- **iii.** Third Pharyngeal Pouch
  - **1.** forms thymus and inferior parathyroid glands
  - **2.** thymus descends during development, pulling superior/ inferior parathyroid glands with it
- **iv.** Fourth Pharyngeal Pouch
  - **1.** forms superior parathyroid glands

2. attach to dorsal surface of thyroid

v. Fifth Pharyngeal Pouch

1. forms ultimobrachial body—regulates Ca^{2+} in body & is embedded in thyroid

b. Pharyngeal Grooves (Clefts)

i. four recognizable clefts; all but one disappear during development

ii. 1st pharyngeal cleft ⇨ external auditory meatus (EAM) & part of tympanic membrane

iii. 2nd pharangeal arch mesenchyme proliferates ⇨ overlapping arch that covers 2-4th pharangeal clefts ⇨ smooth neck

iv. cervical sinus—temporary cavity formed during development; closes later during development

V. Tongue Development

a. Essentially a group of muscles covered by mucosa

b. Mucosa

i. Endoderm derived; from 1-4th pharyngeal arches

ii. Sensory Innervation:

1. anterior 2/3—mostly 1st brachial arch ⇨ CN V
2. Posterior 1/3—3rd & 4th pharyngeal arches ⇨ CN IX & X

iii. Special Sensory (Taste): CNs VII (ant 2/3), IX, & X (post. 1/3)

c. Frenulum—band of tissue underlying tongue that anchors it to floor of mouth; extensively degenerates during development

d. Terminal sulcus—sulcus separating anterior part of tongue from posterior

e. Foramen Cecum—midpoint of sulcus; position of thyroid outgrowth

VI. Thyroid Gland Development

a. Arises from epithelial proliferation (endoderm) in floor of mouth on midline @ foramen cecum

b. Descends along vertical path to above laryngeal cartilages

c. Remains connected to tongue via thyroglossal duct (a narrow canal)

VII. Facial Development

a. Frontonasal Prominences

i. Frontonasal prominence—mesenchyme surrounding forebrain

ii. Nasal Placode—local thickening of surface ectoderm; develops into medial/lateral nasal prominences (develop into nose)

iii. Medial nasal prominence (MNP)

iv. Lateral Nasal Prominence (LNP)

b. Stomadeum—promitive oral cavity located below frontonasal prom.

c. 1st Pharayngeal Arch prominences

i. Maxillary Prominence—(MxP) dorsal

ii. Madibular Prominence—ventral; forms mandible

d. Steps in Development

i. Nasal Placode and 1st pharyngeal arch divide into MNP/MLP & MxP/mandibular prominences respectively

ii. MxP merge with MNP, pushing them closer to the midline

iii. MNPs fuse, forming midline of nose and upper lip (philtrum), and primary palate (part of palate carrying front four teeth)

iv. Nasolacrimal groove (deep furrow) divides MxP & LNP, canalized to form nasolacrimal duct (and lacrimal sac)

v. MxP & LNP fuse with eachother

vi. MxP enlarge to form cheeks and maxillae; LNP enlarge to form sides of nose

e. Secondary Palate

i. Palatine Shelves—grow out from MxP during 6th week; begin directed downward on either side of tongue

ii. Attain horizontal position and fuse with each other once tongue drops ⇨ secondary palate

iii. Incisive foramen—midline landmark between primary/secondary palate fusion point

iv. Soft palate—mucosa posterior to hard palate

VIII. Ear Development

a. External Ear (3 parts)

- **i.** External Acoustic Meatus—der. From 1st pharyngeal cleft
- **ii.** Tympanic Membrane (eardrum)—3 layers: ectodermal epithelial lining from EAM, endodermal epithelial lining of tympanic cavity, & intermediate layer of connective tissue
- **iii.** Auricle (external ear)—dev from 6 mesenchymal proliferations (auricular hillocks) of 1st & 2nd pharyngeal arches
  1. fuse to form definitive auricle; pushed upward, backwards, and rotated 90 degrees to final position
  2. problems w/ auricular development often indicated 1st / 2nd pharyngeal arch problems/defects

b. Middle Ear (2 parts)
- **i.** Tympanic cavity & auditory tube—from 1st pharyngeal pouch
- **ii.** Ossicles—(malleus, incus, & stapes) embedded in mesenchyme during most of development; in 8th month it degenerates & endoderm envelops them & connects them to wall of cavity
  1. malleus—1st pharyngeal arch (tensor tympanin = accompanying m. inn by CN V)
  2. incus—1st pharyngeal arch
  3. stapes—2nd pharyngeal arch (stapedius m = accompanying m. inn by CN VII)

c. Inner Ear (2 parts):
- **i.** Begins as otic placodes ⇨ invaginate to form otic vesicles
- **ii.** Ventral (saccule & cochlear duct)
  1. Cochlear Duct—initiates as outgrowth of saccule; penetrates surr. mesenchyme in spiral fashion
  2. scala vestibule & scala tympani—2 compartments surrounding cochlear duct
  3. Responsible for hearing via CN VIII
- **iii.** Dorsal (utricle/semicircular canals & endolymphatic duct)
  1. Utricle forms 3 flattend outpocketings ⇨ loses central core & semicircular canals form
  2. responsible for balance via CN VIII

d. many craniofacial syndromes are associated w/ ear/hearing deficiencies; ⇨ if pt. presents w/ malformations know what to look for!

IX. Eye Development

a. Process
- **i.** Evagination of forebrain ⇨ optic vesicles; connect to brain via optic stalks
- **ii.** Optic vesicles induce surface ectoderm to become columnar ⇨ lens placode
- **iii.** Invagination of optic vesicles ⇨ bilayered optic cup
- **iv.** Blood supplied to eye via hyaloid artery (feeds growing lens; degenerates later in dev) in groove (known as choroid fissure)
- **v.** Choroid fissure closes ⇨ optic stalk becomes optic nerve

b. Layers
- **i.** Sclera = continuous with dura mater; tough connective tissue
  1. cornea = transparent; anterior 1/6 of eye; continuous w/ sc.
  2. ciliary mm = control size of lens; arise from mesenchyme
  3. papillary mm = control light entry into eye; arise from mesenchyme surrounding eye
- **ii.** Iridopupillary Layer—choroid layer
- **iii.** Retina/Iris
  1. retina—direct derivative of optic cup (3 layers of cells)
  2. Iris—forms via an outgrowth of the anterior body

X. Clinical Correlations

a. Treacher Collins Syndrom—zygomatic Hypoplasia (severe) due to 1st arch deficiencies (maxillary and mandibular)

b. Robin Sequence—mandibular hypoplaxia, cleft palate, posteriorly placed tongue (less severe than treacher Collins) due to 1st arch deficiency

c. Hemifacial Microsomia—hypoplasia of zygomatic, temporal and maxilla bones, small/missing external ear, usually asymmetrical; due to 1st arch (and 2nd sometimes) deficiency

d. Lateral cervical cysts—along anterior border of sternocleidomastoid muscle; result from incomplete closure of cervical sinus
e. Ankyloglossia—(tongue tied) tongue not freed from floor of mouth via degeneration of frenulum ⇨ frenulum extends to tip of tongue
f. Thyroglossal cysts (or fistulas)—anywhere along thyroid migratory path on midline; caused by incomplete closure of duct
g. Lingual Thyroid—thyroid fails to descend; instead develops atop tongue
h. Unilateral/bilateral cleft lip—MxP on 1/both sides fail to fuse with MNP (sometimes associated with lack of primary and/or secondary palate fusion
i. Median cleft lip—rare anomaly; incomplete merging of the 2 MNP on midline; often associated with mental retardation & loss of midline structs
j. Oblique facial clefts—failure of MxP to fuse with LNP; nasolacrimal duct is usually exposed to surface

* Cleft lip=multifactorial in origin; incidence 1:1000, > in ♂; teratogen causes

k. Cleft Palate—no fusion between palatine shelves; multifactoral; 1:2500, > in ♀ (possibly b/c ♀ secondary palate fuses ~ 1wk after ♂)
l. Clefting of Soft Palate—(cleft Uvula) incidence 1:100; non-pathological
m. Coloboma—incomplete iris caused by nonclosure of choroid fissure
n. Synopthalma—fusion of eyes (partial or complete); ALWAYS accompanied by other facial/brain midline defects
o. Holoprosencephaly—continuum of midline malformations => from early loss of midline progenitor cell populations (can be teratogen induced)

UROGENITAL SYSTEM:

Overview

- Urogenital system arises from intermediate mesoderm
- Both systems have common components (processing, ducts, storage, excretion outlet)

I. Urinary System

A. Pronephros

- Most cranial, nonfunctional, and regresses by end of 4th week

B. Mesonephros

- Nephrotomes develop into functional mesonephric units (bulges give UG ridges)
- Mesonephric units contain mesonephric tubules (connected to developing mesonephric duct) and Bowman's capsule (surrounding glomerulus)
- Initially, mesonephric kidney empties into intraembryonic cavity, but after mesonephric duct forms it empties into cloaca
- Mesonephros regresses by 3rd month, leaving behind mesonephric duct

C. Metanephros

1. Collecting system

- Ureteric bud arises from mesonephric duct, and becomes metanephric duct
- Successive bifurcations gives rise to renal pelvis, major and minor calyces, and collecting tubules (of renal pyramids)

2. Excretory system

- Renal vesicles give rise to renal tubules, which establish connection with collecting tubule and give rise to middle part of nephron

D. The kidney ascends in the abdomen during development

E. Development of the bladder and urethra

- Week 6-7, urorectal septum divides cloaca into anorectal canal and urogenital sinus
- UG sinus develops into bladder, prostatic and membranous urethra, and phallic urethra
- Allantois → urachus → median umbilical ligament
- Mesonephric ducts furse to become prostatic urethra
- Ureters fuse at trigone of bladder (originally mesoderm, replaced by endoderm)

F. Congenital disorders urinary system

- Congenital cystic kidney: collecting tubules and renal tubules don't connect

- Renal agenesis: ureteric bud degenerates, no kidney, fatal
- Double or ectopic ureter: early ureteric bud splits, two ureters form
- Pelvic or horseshoe kidney: caudal kidney poles fuse, ascent stopped by IMA
- Urachal fistula: allantois lumen persists

I. Genital System

A. Formation of gonads

0. Indifferent stage (approx. weeks 3-7)

- Coelomic epithelium gives rise to primitive sex cords
- Germ cells arrive at genital ridge week 6, when gonads start to differentiate

1. Male testis

- Primitive sex cords develop into medullary cords, which give rise to rete testis; in 4th month cords made of PGCs and Sertoli cells (make MIS); in puberty, cords develop lumen and become seminiferous tubules
- Tunica albuginea develops between cords and surface epithelium
- Leydig cells (mesenchyme origin, make T) lie between cords
- Testis acquires layers from abdominal wall during descent
- Gubernaculum and abdominal pressure cause testis descent
- No transversus abdominus around testis!

2. Female ovaries

- Medullary cords break up
- Cortical cords develop, they are epithelium (→ follicular cells) around germ cells (→ oogonia)
- Ovary is positioned by cranial and caudal genital ligaments

B. Formation of genital ducts

0. Indifferent stage has both mesonephric and paramesonephric ducts
1. Male genital ducts
   - Mesonephric excretory tubules → efferent ductules
   - Mesonephric ducts → epididymis, seminal vesicle, ductus deferens, ejaculatory duct
   - Paramesoneprhic duct degenerates due to MIS
2. Female genital ducts
   - Paramesonephric ducts fuse to form uterine canal, rest is uterine tubes
   - Broad ligament of uterus → uterorectal and uterovesicle pouches
   - Mesenchyme → myometrium; peritoneum → perimetrium
   - Sinovaginal bulbs → vaginal plate → vaginal fornices and hymen

C. Formation of external genitalia

0. Indifferent stage
   - Cloacal folds divided into urethral and anal folds
   - Genital tubercle, genital swellings
1. Male external genitalia
   - Genital tubercle elongates → phallus; urethral plate → urethral groove → penile urethra (endodermal)
   - In glans, invagination makes lumen of external urethral meatus
2. Female external genitalia
   - Genital tubercle → clitoris; urethral folds → labia minora; genital swellings → labia majora; UG groove → vestibule

D. Congenital disorders

- Congenital inguinal hernia: patent processus vaginalis
- Cryptorchism: undescended testis
- Duplication of uterus: paramesonephric ducts don't fuse
- Duplication of vagina: sinovaginal bulbs don't fuse
- Vaginal atresia: sinovaginal bulbs don't form
- Gondal dysgenesis: PGCs don't form or migrate, no gonads (no T/DHT/MIS implies…)
- Testicular feminization: external genitalia unresponsive to androgens
- Pseudohermaphorditism: male, no T/DHT/MIS; female, congenital adrenal hyperplasia
- Hypospadia: urethral folds not completely fused, openings persist
- Epispadia: anomalous caudal genital tubercle and dorsal urethral meatus
- Micropenis: not enough androgens, name is phenotype
- Bifid penis: genital tubercle splits

FETAL/ADULT HOMOLOGS

Fetal Structure	Function	Adult Homolog
Umbilical vein	Bring oxygen and nutrients from placenta to fetus	Ligamentum teres hepatis
Ductus venosus	Shunts most of blood through liver (already processed by mother's liver)	Ligamentum venosum
Foramen ovale	Shunts blood from right atrium to left atrum, bypassing nonfunctional lungs	Fossa ovalis
Ductus arteriosus	Shunts right ventricular blood from pulmonary trunk to aorta, bypassing nonfunctional lungs	Ligamentum arteriosum
Umbilical arteries	Returns poorly oxygenated blood and metabolic waste to the placenta	Medial umbilical ligaments (Urachus connects apex of bladder with umbilicus)
Truncus arteriosus		Aorta, pulmonary trunk
Bulbus cordis		Superior 1/3=truncus arteriosus (aorta, pulmonary trunk) Middle 1/3=conus arteriosus (outflow tract) Proximal 1/3=right ventricle
Primitive ventricle		Left ventricle
Primitive atrium		Auricles Pectinate muscle walls of L/R atria
Sinus venosus		Right atrium
Gubernaculum		Females: round ligament, ligament of the ovary Males: spermatic cord
Processes vaginalis	Bubble of peritoneum that follows the descending gubernaculum to form the inguinal canal	Tunica vaginalis
Medullary cords (male) Cortical cords (female)	Formed from primitive sex cords	Seminiferous tubules Ovarian tubes
Genital tubercle		Phallus (male) Clitoris (female)

EMBRYOLOGICAL ORIGINS

Endoderm	Mesoderm
Bladder	Ureter (mesenephros) (intermed. mesoderm)
Urethra	Kidney (metanephros) (intermed.)
Prostate	Seminal vesicles (intermed.)
Trigone (bladder)	Trigone (ureteric inlets to bladder)
	Gonads (testes, ovaries; intermed. mesoderm)
	Genital ducts (vas deferens, fallopian tubes)
	External genitalia (penis, scrotum, vagina)

GENITAL DEVELOPMENT

Indifferent stage organ	Male fetal (adult)	Female fetal (adult)
Primitive sex cords	*Testis/medullary cords (⇒ seminiferous tubules)	*Cortical cords (⇒ fallopian tubes)
Genital ridge	*Mesenchyme of genital ridge (⇒ Leydig cells)	___

Mesonephric (Wolffian) duct	*Ductuli efferentes (⇒ ductus deferens ⇒ vas deferens when acquires muscular coat) *epididymis *seminal vesicles Stimulated by testosterone (Leydig cells)	Degenerate (no testosterone)
Paramesonephric (Mullerian) duct	Suppressed (MIS of Sertoli cells)	*Uterine canal (cranial 2/3 ⇒ bilateral uterine tubes, caudal 1/3fusion ⇒ uterus) *Sinovaginal bulbs (⇒vagina)
Abdominal wall	Processus vaginalis (⇒ tunica vaginalis)	
Primitive sex cells	Sperm	Egg
Gubernaculum	Spermatic cord	Round ligament, ligament of the ovary
Genital tubercle	Phallus (penis)	Clitoris
Genital swellings	Scrotum	Labia majora
Urethral folds	Fuse ⇒ urethral plate	Labia minora

LUNG DEVLOPMENT

• With t growth in caudal and lateral directions, the *lung buds expand into the body cavity* and the *primitive pleural cavities* are formed

• The mesoderm covering the outside of the lung develops into *visceral pleura*, the somatic mesoderm lining the body wall from the inside forming the *parietal pleura*

• The space between the visceral and parietal pleura is the *pleural cavity*

• During further development lobar bronchi divide into *segmental bronchi*, creating *bronchopulmonary segments*

• By the end of *six months* approximately *17 generations* of subdivisions have formed

• An additional *6 divisions* form during *postnatal life*

• *Branching* is *regulated* by *epithelial-mesenchymal interactions* between the endoderm of the lung buds and the splanchnic mesoderm surrounding it

• *With growth* the *lungs* occupy a *more caudal position*, the bifurcation of the trachea lying at the level of the 4th thoracic vertebra, at birth

• *Lung development* can be divided into *5 stages:*

a) Embryonic – 26 days to 6 weeks, until the formation of *bronchopulmonary segments*

b) Pseudoglandular – 6 to 16 weeks, until the formation of terminal bronchioles

c) Canalicular – 16 to 28 weeks, *respiratory bronchioles* and respiratory vasculature begins to appear

d) Saccular – 28 to 36 weeks, *terminal sacs* form

e) Alveolar – 36 weeks to term, *mature alveoli* form

• In the *7th month* terminal sacs or primitive alveoli form, which are surrounded by capillaries to ensure adequate gas exchange

• In addition *type two alveolar cells* develop in the *7th month* which produce *surfactant*

• A foetus born in the 7th month may survive because of the above reasons and hence the *7th month* is considered the *viable age of the foetus*

• Only *one sixth* of the adult number of *alveoli* are *present at birth*, the remaining are formed in childhood

SKELETAL SYSTEM

• *Fibroblast growth factors* and their *receptors* play an important role in many *skeletal dysplasias*

• The *vertebral column* is formed from the *sclerotome portion* of the *somite*

• During the *4th week of development*, cells of the sclerotomes shift their position to surround both the spinal cord and the notochord

• Each *sclerotomic segment around the notochord* is subdivided by a linear, horizontal *sclerotomic fissure* into a *dense caudal part* and a *less dense cranial part*
• The caudal part of one segment *fuses* with the cranial part of the succeeding segment to form the *definitive centrum*
• The sclerotomic fissure and the mesodermal condensation around it form the *perichordal disc* which persists in the adult as the *intervertebral disc*• The *notochordal cells* persist in the centre of the *intervertebral disc* as the *nucleus pulposus*, the mesenchymal cells of the perichordal disc give rise to the peripheral *annulus fibrosus*
•

HEART

• The *heart* is the *first organ* of the body to start *functioning*
• The *vascular system* appears in the middle of the *3rd week* , when the embryo when the embryo is unable to satisfy its nutritional requirements by diffusion alone
• *Cardiac progenitor cells* migrate from the epiblast through the primitive streak and come to lie cranial to the buccopharyngeal membrane in the *splanchnic layer of lateral plate mesoderm* later forming myoblasts
• This mesoderm constitutes the *cardiogenic area* and is closely related to the *pericardial cavity*
• With the establishment of the *head fold* the developing heart comes to lie dorsal to the pericardial cavity and ventral to the foregut

THE HEART TUBE

• Initially a *horseshoe shaped endothelial lined tube* is formed by a process of *vasculogenesis*
• Due to *lateral folding* the two cardiac primordia fuse except at their caudal ends
• The tube now invaginates the pericardial cavity from the dorsal side
• The splanchnopleuric mesoderm lining the dorsal aspect of the pericardial cavity proliferates to form the *myoepicardial mantle*
• The *myoepicardial mantle* completely surrounds the heart tube and gives rise to the *myocardium* and *epicardium*
• Thus the heart tube has three layers the *endocardium*, the *myocardium* and the *epicardium or visceral pericardium*
• The *parietal layer of pericardium* is derived from *somatopleuric mesoderm*
• The heart tube shows series of dilatations:
a) Bulbus cordis
b) Ventricle
c) Atrium
d) Sinus venosus
• The ventricle and the atrium are connected by a narrow *atrioventricular canal*
• The *sinus venosus* has *right and left horns*
• The *bulbus cordis* lies at the *arterial end* of the heart and is divisible into a proximal *conus* and a distal *truncus arteriosus*
• The *sinus venosus* lies at the *venous end* of the heart tube
• The *truncus arteriosus* is continuous distally with the *aortic sac* which is connected to the *dorsal aortae* by the *pharyngeal arch arteries*
• Each horn of the sinus venosus receives one *vitelline vein*, *one umbilical vein* and *one common cardinal vein*
• As a result of rapid growth of the tube it becomes folded on itself to form a U shaped *bulboventricular loop*
• The *atria and the sinus venosus* now come to lie *above and behind the ventricle*

THE SINUS VENOSUS

• The *communication* between the *sinus and atrium*, initially wide, narrows and *shifts to the right*
• This shift is caused by *left to right shunts* of blood that occur in the *venous system*
    • All that remains of the *left sinus horn* is the *oblique vein of the left atrium* and the *coronary sinus*
    • The *right sinus horn* and veins *enlarge greatly*, forming the only communication between the original sinus venosus and the atrium
    • The *right horn* is incorporated into the *right atrium* to form its smooth walled part
    • The *sinuatrial orifice* is flanked on each side by the *right and left venous valves*, which fuse dorsocranially to form a ridge, the *septum spurium*
    • The *left venous valve* and *septum spurium* fuse with the developing *atrial septum*
    • The *right venous valve* expands greatly and forms the *crista terminalis, valve of the inferior vena cava* and *valve of the coronary sinus*

CARDIAC SEPTA

- *Cardiac septa* may be formed in one of 3 ways:

a) *Two actively growing masses* of tissue approach each other till they fuse
b) A *single tissue mass* grows until it reaches the opposite side of the lumen
c) *Merging of two expanding portions* of the wall of the heart

INTERATRIAL SEPTUM

- The *A.V. canal* undergoes division into *right and left orifices* by the fusion of *dorsal and ventral atrioventricular cushions*
- The fused cushions form the *septum intermedium*
- The *septum primum* grows from the roof of the atrium and fuses with the septum intermedium
- The gap between the septum primum and the septum intermedium is called the *foramen primum*
- As the septum primum fuses with the septum intermedium its upper part breaks down forming the *foramen secundum*
- The *septum secundum* grows down from the roof of the atrial chamber to the right of the septum primum and overlaps the free upper edge of the septum primum
- The *valvular interval* between the septa is called the *foramen ovale*, allowing blood to flow only from the *right to the left*
- *After birth* the *foramen ovale* is *obliterated* by the fusion of the septum primum and septum secundum
- The *annulus ovalis* represents the lower free edge of the *septum secundum* and the *fossa ovalis* represents the *septum primum*

RIGHT ATRIUM

- It is developed from *2 sources*

a) The *posterior smooth part* called the *sinus venarum* is developed from the absorbed *right horn of the sinus venosus*
b) The *anterior rough part* including the *right auricle* is developed from the right half of the *primitive atrium*
c) The *crista terminalis* separates the two parts

NERVOUS SYSTEM DEVELOPMENT
FORMATION OF THE NEURAL TUBE

- Neural plate
- Neural groove
- Neural tube
- Extent
- Anterior and posterior neuropores
- Closure
- Neural crest

PERIPHERAL NERVOUS SYSTEM

- P.N.S. includes spinal and cranial nerves with their sensory ganglia, autonomic nerves and their ganglia
- Derived from neural crest, neural tube and epibranchial placodes

SUBDIVISIONS OF NEURAL TUBE

- Cranial dilated part and caudal tubular part
- Cranial dilated part forms the brain
- Caudal tubular part forms the spinal cord
- Cranial part shows three dilatations craniocaudally- prosencephalon, mesencephalon and rhombencephalon
- Primary brain vesicles
- Prosencephalon – telencephalon with vesicles and diencephalon
- Mesencephalon
- Rhombencephalon – metencephalon and myelencephalon

DERIVATIVES OF THE BRAIN VESICLES

- Telencephalon – cerebral cortex and corpus striatum
- Diencephalon – thalamus, hypothalamus
- Mesencephalon – midbrain
- Metencephalon – pons and cerebellum
- Myelencephalon – medulla oblongata

FLEXURES OF THE NEURAL TUBE

- Cervical flexure – between rhombencephalon and spinal cord
- Mesencephalic flexure – region of midbrain
- Pontine flexure – middle of rhombencephalon
- Telencephalic flexure – between telencephalon and diencephalons

CAVITIES OF THE NEURAL TUBE

- Cavities of the telenephalic vesicles – lateral ventricles
- Cavity of diencephalon – 3rd ventricle
- Cavity of mesencephalon – aqueduct
- Cavity of rhombencephalon – 4th ventricle
- It's continuation – central canal

HISTOGENESIS OF NEURAL TUBE

- Neuroepithelial cells – thick pseudostratified epithelium
- Formation of neuroblasts
- Formation of gliablasts

LAYERS OF THE NEURAL TUBE

- Inner neuroepithelial layer, germinitive or matrix layer – cells in this layer divide rapidly
- Middle mantle layer – later forms the gray matter, consists of neuroblasts
- Outer marginal layer – later forms the white matter, consists of processes of neuroblasts

DEVELOPMENT OF THE NEUROBLASTS

- Neuroblast with transient dendrite
- Apolar neuroblast
- Bipolar neuroblast
- Multipolar neuroblast

DEVELOPMENT OF GLIAL CELLS

- Formed from neuroepithelial cells except for microglia
- Gliablasts – give rise to astrocytes and oligodendrocytes
- Remaining neuroepithelial cells form ependymal cells
- Microglia are formed from mesenchymal cells

NEURAL CREST CELLS

- Groups of cells that appear along each edge of the neural folds
- Ectodermal in origin, extend throughout the length of the neural tube.
- Migrate laterally and give rise to various cell types

DERIVATIVES OF NEURAL CREST CELLS

- Connective tissue and bones of the face and the skull
- Cranial nerve ganglia
- C cells of the thyroid gland
- Conotruncal septum in the heart
- Odontoblasts
- Dermis in the face and neck

- Dorsal root ganglia
- Sympathetic ganglia
- Parasympathetic ganglia of the G.I.T.
- Adrenal medulla
- Schwann cells
- Leptomeninges
- Melanocytes

PLATES OF THE NEURAL TUBE

- Alar plate – form sensory areas
- Basal plate – form motor areas
- Sulcus limitans-boundary between the two
- Roof plate
- Floor plate

DEVELOPMENT OF THE SPINAL CORD

- Mantle layer – gray matter
- Marginal layer – white matter
- Alar plate – dorsal horn, sensory
- Basal plate – ventral horn, motor
- Between the two – intermediate horn
- Tracts

NEURAL TUBE DEFECTS

- Spina bifida occulta
- Spina bifida cystica
- Anterior spina bifida

MYELENCEPHALON

- Develops into medulla oblangata
- Closed part contains central canal, structurally corresponds with spinal cord
- Open part forms the caudal area of the floor of the 4^{th} ventricle
- Open part – roof plate is greatly widened to form roof of 4^{th} ventricle
- Alar laminae come to lie dorsolateral to the basal laminae
- Alar laminae give rise to four sensory functional columns
- Basal laminae give rise to three motor functional columns
- Some cells from the alar laminae migrate
- These form the arcuate and olivary nuclei (caudal part of bulbopontine extension)
- White matter – predominantly extraneous
- Closed part- general somatic afferent column persists as nucleus gracilis and nucleus cuneatus
- Choroid plexus forms in the roof

METENCEPHALON

- Forms pons and cerebellum
- Pons - similar functional columns to medulla
- Marginal layer of basal plate expands
- Pontine nuclei – arise from migration of cells from the alar lamina (cranial part of bulbopontine extension)

CEREBELLUM

- Develop from the dorsolateral parts of the alar laminae of the metencephalon – rhombic lips
- Two primordia extend medially and fuse across the midline in the roof plate
- Intraventricular part and extraventricular part
- Dumbell shaped structure- midline vermis, cerebellar hemispheres

- As size increases fissures appear on the surface
- Cells from mantle layer migrate (external granular layer) to the surface to form cells of cortex
- Remaining cells – form deep nuclei
- Cerebellar peduncles

MESENCEPHALON

- Retains the primitive nature of brain vesicle
- Central cavity progressively narrowed
- Basal plate – two functional columns, with floor plate forms tegmentum
- Alar lamina – two functional columns, with roof plate forms tectum
- Marginal layer of basal plate expanded to form crura
- Substantia nigra and red nucleus – formed by migration of cells from alar lamina

DIENCEPHALON

- Develops from the median portion of the prosencephalon
- Two alar plates and roof plate present, floor plate and basal plates lacking
- Alar plates form the lateral walls
- Hypothalamic sulcus, epithalamic sulci develop
- Between sulci – thalamus and metathalamus
- Above epithalamic sulcus – pineal body and habenular nuclei
- Below hypothalamic sulcus – hypothalamus including mamillary bodies
- Remaining caudolateral walls form subthalamus

- Roof plate with overlying pia forms the choroid plexus of the 3rd ventricle
- Diverticula from the diencephalon form the neurohypophysis and the optic cup and stalk

TELENCEPHALON

- Two lateral outpouchings – cerebral hemispheres
- Median portion – limited rostrally by lamina terminalis
- Interventricular foramen of Monro
- Each telencephalic vesicle- thick basal part and thin superior part
- Mantle cells in the basal part form corpus striatum
- Fibres arising from cerebral cortex divide corpus striatum into deep and superficial parts
- These fibres form internal capsule
- Superficial part forms lentiform nucleus
- Deep part forms caudate nucleus
- Cerebral hemispheres grow in anterior, posterior and inferior directions forming lobes
- Growth over the region of the corpus striatum slows forms insula, later overgrown
- In the final part of fetal life the surface of the cerebral hemispheres grows rapidly forming sulci and gyri
- Cerebral cortex – develops from cells in the mantle layer migrating to a sub-pial position
- The area which gives rise to the cerebral cortex is called the pallium
- Archipallium, paleopallium and neopallium
- Archipallium – part of cortex outside the curve of the choroid fissure
- Paleopallium – immediately lateral to corpus striatum
- Neopallium – remaining part
- Waves of migration occur
- Later waves pass through cells of earlier waves
- Therefore early formed cells deep
- Cortex has a stratified appearance due to the differentiation of the layers
- Archipallium and paleopallium – 3 layers
- Neopallium – 6 layers

WHITE MATTER

- Axons of cortical cells that grow towards other areas of the cortex.
- Axons of cortical cells that pass towards the brain stem and spinal cord
- Axons that connect the thalamus, hypothalamus and basal ganglia to one another and the cortex
- Axons that pass to the cortex from brainstem and spinal cord

MASTER GENES FOR DEVELOPMENT

PAX6-EYE DEVELOPMENT
NODAL GENE-PRIMITIVE STREAK
NKX2.5-HEART DEVELOPMENT
TBX4-LUNG DEVELOPMENT

CLASS DISCUSSION QUESTIONS

1. Meosis occurs in human males in
   A. Epididymis
   B. Seminiferous tubules
   C. Vas deferens
   D. Seminal vesicles
2. Sperm after formation is stored in
   A. Sertoli cell
   B. Epididymis
   C. Rete testes
   D. Seminal vesicle
3. The primary spermatocyte enters a prolonged prophase of around
   A. 2 days
   B. 6 days
   C. 22 days
   D. 12 days
4. Meiosis in spermatogenesis occurs in which of the following step?
   A. Primary spermatocyte to intermediate spermatocyte
   B. Primary spermatocyte to secondary spermatocyte
   C. Secondary spermatocyte to round spermatid
   D. Round spermatid to elongated spermatid
5. Polar bodies are located in
   A. In zona pellucida
   B. Outside the zona pellucida
   C. Between zona pellucida and cell membrane of secondary oocyte
   D. None of above
6. In a female child at birth oocyte is in a stage of
   A. Anaphase 2nd meiotic
   B. Prophase 1st meiotic
   C. Oogony
   D. Maturation
7. Capacitation lasts for
   A. 7 hours
   B. 10 hours
   C. 1 hours
   D. 1 days
8. The arrested state of primary oocyte is produced by a peptide secreted by
   A. Follicular cell
   B. Pituitary gland
   C. Hypothalamus
   D. None of above
9. Which is not true regarding zona pellucida

A. It surrounds morula
B. It is acellular
C. Acetylcholine is the barrier
D. It surrounds the ovum

10. True about morula:
A. 8-cell stage
B. Morula is formed after 3 days
C. Solid mass with fluid inside
D. Ach. Barrier present

11. Implantation occurs at the stage of
A. Zygote
B. Morula
C. Blastocyst
D. Primary villi

12. The gene that initiates and maintains the integrity of primitive node and streak is
A. Nodal
B. FGF 8
C. BMP4
D. LEFTY -2

13. Which of the following is true regarding gastrulation:
A. Establishes all the three germ layers
B. Occurs at the caudal end of the embryo prior to its cephalic end
C. Involves the hypoblastic cell mass
D. Usually occurs at 4 weeks

14. Where the endoderm and ectoderm approach each other in the head & neck region during the 4^{th} week
A. Pharyngeal Grooves
B. Pharyngeal pouch
C. Pharyngeal membrane
D. Pharyngeal arch

15. The bilaminar germ disc is formed by
A. Cuboidal epiblast cells and columnar hypoblast cells
B. Columnar epiblast cells and cuboidal hypoblast cells
C. Cuboidal epiblast and hypoblast cells
D. Columnar epiblast and hypoblast cells

16. The chorion consist of
A. Both layers of trophoblast with the somatopleuric layer of extra-embryonic mesoderm
B. Both layers of trophoblast with the splanchnopleuric layer of extra-embryonic mesoderm
C. Heuser's membrane and both layers of trophoblast
D. Bilaminar germ disc and Heuser's membrane

17. Which of the following is true regarding vessels in the umbilical cord:
A. Two arteries & two vein
B. One art & one vein
C. Two art & the left vein
D. Two vein & the left artery

18. Caudal neuropore is closed on
A. 25 days
B. 27 days
C. 30 days
D. 42 days

19. All the following are derivatives of the neural crest, EXCEPT:
A. Melanocyte
B. Schwann cells
C. Adrenal cortex
D. Odontoblast

20. Paraxial mesoderm develop into:
A. Mesonepric duct

B. Notochord
C. Neural crest
D. Sclerotome

21. Untrue about ectodermal cleft is
A. Cervical sinus is found between 2-6 arches
B. Ventral part of the cleft is obliterated
C. Dorsal part of 1st cleft forms the lining of external ear
D. None of the above

22. Maxillary prominence develops in
A. 1st pharyngeal arch
B. 1st pharyngeal groove
C. 1st pharyngeal pouch
D. 1st pharyngeal membrane

23. All of the following are supplied by mandibular nerve except
A. Masseter
B. Tensor tympani
C. Tensor palati
D. Buccinator

24. Holoprosencephaly is characterised by
A. Single lateral ventricle
B. Hypertelorism
C. Both A and B
D. Large forebrain

25. Geniculate ganglion is formed from
A. First placode
B. Second placode
C. Third placode
D. None of above

26. Tongue muscle develop from
A. Mesoderm of pharyngeal pouch
B. Occipital myotome
C. Somites
D. Endoderm of pharyngeal pouch

27. Neural crest cells are vulnerable to teratogens as they are deficient in
A. Superoxide dismutase
B. Catalase
C. Both a and b
D. The neural crest is resistant to teratogens

28. Collecting tubules of kidney develop from:
A. Uretric bud
B. Mesonephric duct
C. Paramesonephric duct
D. Wolffian duct

29. The testis descends the inguinal canal during … month
A. 5th
B. 6th
C. 7th
D. 8th

30. Gland derived from foramen caecum is
A. Thyroid
B. Parathyroid
C. Pituitary
D. Thymus

31. Superior parathyroid glands are derived from:
A. 1st branchial pouch

B. 3rd branchial pouch
C. 4th branchial pouch
D. 5th branchial pouch
E. None on the above

32.True about Sirenomelia
A. Is a teratogenesis associated with gastrulation
B. Insufficient ectoderm in caudal most portion of embryo
C. Both A and B
D. None of above

33. The glossopharyngeal nerve supplies the posterior part of the tongue because it develops from the
A. Caudal part Hypobranchial eminence
B. Tuberculum impar
C. Mandibular arch
D. Cranial part of Hypobranchial eminence

34.Meckel's diverticulum is a remnant of:
A. Stenson's duct
B. Wolffan duct
C. Mullerian duct
D. Vitellointestinal duct

35.A midline cleft lip is due to the failure of fusion between:
A. Maxillary processes
B. Medial nasal processes
C. Medial and lateral nasal process
D. Medial nasal and maxillary process

36.Primary and secondary palates are divided by
A. Greater palatine foramen
B. Canine teeth
C. Alveolar arch
D. Incisive foramen

37. All the following are true regarding vasculogenesis except
A. It is the formation of new blood vessels from blood islands
B. It refers to sprouting of blood vessels from already existing ones
C. Mediated by VEGF and FGF
D. Involves haemangioblasts

38.The 3 rd aortic arch gives rise to
A. Common carotid artery and part of internal carotid artery
B. Common carotid artery only
C. Internal carotid artery and external carotid artery
D. Internal carotid artery only

39.The axis artery of upperlimb is formed
A. 4th cervical intersegmental artery
B. 5th cervical intersegmental artery
C. 6th cervical intersegmental artery
D. 7th cervical intersegmental artery

40.Human placenta is
A. Hemochorial
B. Hemoendothalial
C. Epitheliochorial
D. None of above

41. The ductus caroticus connects
A. 1st and 2nd arch arteries
B. 2nd and 3rd arch arteries
C. 3rd and 4th arch arteries
D. 4th and 5th arch arteries

42. The branches of the dorsal aorta include the following except
A. Ventral splanchnic branches

B. Lateral splanchnic arteries
C. Somatic intersegmental arteries
D. Dorsal splanchnic arteries

43 .The following ocular structure in not derived from surface ectoderm:
A. Crystalline lens
B. Sclera
C. Corneal epithelium
D. Epithelium of lacrimal glands

44. Surface ectoderm gives rise to all of the following structures except.
A. Lens
B. Corneal epithelium
C. Conjunctival epithelium
D. Anterior layers of iris

45. The retina is an out growth of the:
A. Mesencephalon
B. Diencephalon
C. Telencephalon
D. Pons

46. All are mesodermal origin, except:
A. Sphincter pupillae
B. Cilary muscle
C. Iris
D. Ovarian tissue

47. The diaphragm develops from all the following except
A. Septum transversum
B. Pleuroperitoneal membranes
C. Occipital myotomes
D. Dorsal & ventral mesentry around oesophagus

48. Respiratory bronchioles are formed during which stage of lung development
A. Embryonic
B. Canalicular
C. Pseudoglandular
D. Alveolar

49. The origin of adrenal cortex is
A. Mesoderm
B. Ectoderm
C. Neural crest
D. Endoderm

50. The diverticulum from floor of diencephalon form
A. Posterior pituitary
B. Anterior pituitary
C. Pineal gland
D. Both A & B

51. Kupffer cells are derived from
A. Pars hepatica
B. Septum transversum
C. Vitelline and umbilical veins
D. Ectoderm

52. Sinus venerum is developed from
A. Left horn of sinus venosus
B. Right horn of sinus venosus
C. Primitive atrium
D. Primitive ventricle

53. All the following are contributes to the formation of the interventricular septum except
A. Muscular interventricular septum

B. Truncus septum
C. Conus septum
D. Atrioventricular endocardial cushions

54. Uncinate process developed from the
A. Ventral pancreatic bud
B. dorsal pancreatic bud
C. Both A and B
D. None of above

55. Spleen is formed within the
A. Dorsal mesogastrium
B. Ventral mesogastrium
C. Septum transversum
D. Both A and B

56. The total rotation of midgut is
A. Clockwise 270º
B. Counter clockwise 270º
C. Clockwise 180º
D. Counter Clockwise 180º

57. The position of anterior neuropore is represented in adult as
A. Stria terminalis
B. Nucleus pulposus
C. Lamina terminalis
D. Infundibulum

58. True about Myelination
A. Myelination starts in cranial nerve during sixth month
B. Sensory nerves receives mylein sheath earlier than motor nerves
C. Both A and B
D. None of above

59. Dentate nucleus is developed from
A. A.Spongioblast of mantle zone
B. B.Neuroblast of mantle zone
C. C.Ependymal cells
D. D.both A and C

60. Inferior retention band persist in adult as
A. A.Ligament of treitz
B. B.Phrenico colic ligament
C. C.Mesentry
D. D.None of above

ANSWERS

1.B

- EPIDIDYMIS-storage of sperms
- CAPACITATION OCCURS IN FEMALE GENITAL TRACT

2.B

- Epithelium --pseudostratified stereociliated columnar, having tall principal cells and short basal cells
- The principal cells are tall columnar bear the stereocilia
- Head and body surrounded by a circular layer of smooth muscle
- During their passage through the epididymis sperm become *motile* and acquire the capacity to fertilize eggs

3.C

4.B

Primary spermatocyte to secondary spermatocyte

5.C

- Located between vitelline membrane and zona pellucida

6.B

- First meiotic division is completed just BEFORE OVULATION
- Second meiotic division is completed ONLY IF FERTILIZATION OCCURS

7.A

8.A

Peptide is secreated by follicular cells

9.C

- ZP-6-7 micron
- COMPOSED OF-GLYCOPROTEINS
- ZP1,ZP2,ZP3
- ONLY ACROSOME CAP CAN INTERACT WITH ZP3

10.B

11.C

12.A

- Nodal –activates and maintains integrity of node and streak
- BMP4-ventralizes mesoderm during gastrulation to form intermediate and lateral plate mesoderm
- Nodal ,lefty 2-expression on left side

13.A

14.C

- *Two depressions* appear in the ectoderm, one adjacent to the prechordal plate, the other caudal to the primitive streak
- At these areas *ectoderm fuses* with the *endoderm*, excluding mesoderm, forming membranes
- The cranial membrane is called *buccopharyngeal membrane* and the caudal one, the *cloacal membrane*
- Later, these membranes *break down* to form the openings of the oral cavity, anus, urinary and genital tracts

15.B

- *Hypoblast* - small cuboidal cells adjacent to the blastocyst cavity
- *Epiblast* - tall columnar cells on the trophoblastic side of the embryoblast

16.A

- Division of extraembryonic mesoderm into *somatopleuric* and *splanchnopleuric layer*
- The trophoblast together with the somatopleuric layer is called the *chorion*

17.C

18.B

Caudal neuropore-27 day closes
Cranial neuropore-25 day closes

19.C

- Connective tissue and bones of the face and the skull
- Cranial nerve ganglia
- C cells of the thyroid gland
- Conotruncal septum in the heart
- Odontoblasts
- Dermis in the face and neck
- Dorsal root ganglia
- Sympathetic ganglia
- Parasympathetic ganglia of the G.I.T.
- Adrenal medulla
- Schwann cells
- Leptomeninges
- Melanocytes

20.D

21.D

- The *dorsal part* of the *1st cleft* -- epithelial lining of the *external acoustic meatus*
- Active proliferation of the mesenchymal tissue in the *2nd arch* causes it to overlap the *3rd* and *4th arches*
- It merges with the *epicardial ridge* in the lower part of the neck

22.C
23.D
24.A
25.A

Nerve	Ganglion	Origin
Oculomotor (III)	Ciliary (visceral efferent)	Neural crest at forebrain-midbrain junction
Trigeminal (V)	Trigeminal (general afferent)	Neural crest at forebrain-midbrain junction, trigeminal placode
Facial (VII)	Superior (general and special afferent)	Hindbrain neural crest, first epibranchial placode
	Inferior (geniculate) (general and special afferent)	First epibranchial placode
	Sphenopalatine (visceral efferent)	Hindbrain neural crest
	Submandibular (visceral efferent)	Hindbrain neural crest
Vestibulocochlear (VIII)	Acoustic (cochlear) (special afferent)	Otic placode
	Vestibular (special afferent)	Otic placode, hindbrain neural crest
Glossopharyngeal (IX)	Superior (general and special afferent)	Hindbrain neural crest
	Inferior (petrosal) (general and special afferent)	Second epibranchial placode
	Otic (visceral efferent)	Hindbrain neural crest
Vagus (X)	Superior (general afferent)	Hindbrain neural crest
	Inferior (nodose) (general and special afferent)	Hindbrain neural crest; third, fourth epibranchial placodes
	Vagal parasympathetic (visceral efferent)	Hindbrain neural crest

26.B
Tongue muscles are derived from occipital myotomes

27.C
- Neural crest cells-retonic acid,alcohol
- Deficient in SOD,Catalase

28.A
Ureteric bud-form the ureter

29.C
- During *foetal life* the *testis descend* from the *lumbar region* to the *scrotum*
- They reach the *iliac fossa* during the *3rd month*
- Lie at the *deep inguinal ring till* the *7th month*
- Pass through the *inguinal canal* during the *7th month*
- Normally in *scrotum* by the *end* of the *8th month*

30.A
31.C
32.A

33.D
Post part of tongue-Cranial part of hypobranchial eminence

34.D

35.B
- Median cleft lip—rare anomaly; incomplete merging of the 2 MNP on midline; often associated with mental retardation & loss of midline structs

36.D

37.B
Ii is mediated by VEGF,FGF

38.A
- *Internal carotid artery* – 3rd aortic arch artery and continuation of dorsal aorta bilaterally
- *External carotid artery* – branch from 3rd aortic arch artery bilaterally

39.D
- *Axis artery of upper limb* - 7th cervical intersegmental artery
- *Axis artery of lower limb* - 5th lumbar intersegmental artery

40.A

41.C
It connects 3rd and 4th aortic arch

42.D
- *Primitive dorsal aorta* branches*:*

a) *Ventral* splanchnic
b) *Lateral* splanchnic c. *Somatic* intersegmental

43.B
- The *choroid* differentiates as the *inner, vascular layer* from the *mesenchyme* that surrounds the *optic cup*
- The *sclera* differentiates as the *outer, fibrous layer* from the *mesenchyme* that surrounds the *optic cup*

44.D
- The *iris* develops from the tip of the *optic cup* and the associated forward prolongation of the *mesenchyme* that forms part of the *ciliary body*

- The *sphincter* and *dilator pupillae* develop from cells of the pupillary part of the *optic cup*, thus they are *neurectodermal* in origin

45.B
46.A

47.C
- The diaphragm *migrates in a caudal direction* during development
- This descent is caused by

a) Elongation of the neck
b) Descent of the heart
c) Expansion of the pleural cavities

48.C
49.A
50.A

51.B
Kupffer cells-from septum transversum

52.A

53.B
- the *interventricular septum* is developed from *3 sources*:

a) The muscular interventricular septum
b) The conus septum
c) The atrioventricular endocardial cushions

The last two close the interventricular foramen and form the *membranous part of the interventricular septum*

54.A

55.A
- Developed from *mesoderm* within *dorsal mesogastrium*
- Number of *lobules* appear, *fuse* to form *single mass*, which projects under cover of left leaf of dorsal mesogastrium
- Dorsal mesogastrium divided into *gastrosplenic ligament* in front and *lienorenal ligament* behind
- Primordium of splenic tissue differentiates into *branching trabecular cords* and numerous free cells which differentiate into *blood forming cells*

56.B
Midgut rotation Counterclockwise-270,

57.A
Anterior neuropore persist-stria terminalis

58.C

59.A
- FUNCTIONAL TRACT MYELINATED FIRST-MLF -6 month
- PYRAMIDAL TRACT,CORTICOPONTO CEREBELLAR FIBRES-2-3YRS

60.B
Superior retention band-persist as ligament of treitz
Inferior retention band persist as phrenicocolic ligament

NEUROANATOMY

Neurones

Classification by Morphology

1. Unipolar – perikaryon has one neurite
2. Bipolar – perikaryon has two neurites
3. Multipolar – each neurone has one axon and more than one dendrite

Classification by size

1. Golgi Type I – long axon
2. Golgi Type II – short axon terminating near the parent cell
3. Amacrine NEURON – no axon

CEREBRAL CORTEX

Insula is the buried part of cortex; composed of long and short gyri
Fissure of Rolando is central sulcus
Fissure of Sylvius is lateral sulcus
Central sulcus runs downwards and forwardsto end a little above the lateral sulcus
It is the only long sulcus to pass over on to the medial surface of the hemisphere
Pre-central (primary motor) lie in front of it
Post central (primary sensory) lies behind it.
Para central lobule lies behind the superior border of the central sulcus on its medial surface.
Between the Parieto-occipital sulcus and the paracentral lobule is the **pre cuneus.**
Cuneus is limited inferiorly by Calcrinesulcus (Visual area of the cortex occupies thelips of the sulcus) Parieto occipital sulcus runs in to it.

The cerebral cortex receives fibers from internal and external sources. Internal sources include the cortex of the same hemisphere via association fiber bundles and the contralateral hemisphere via commissural fibers. External sources of input include the thalamus and nonthalamic subcortical sources.

Corticofugal fiber system includes the corticospinal, corticoreticular, corticobulbar, corticopontine, corticothalamic, corticohypothalamic, corticostriate, and others.
Based on thickness of cortex, width of the different cortical layers, cell types within each layer, and nerve fiber lamination patterns, the cerebral cortex has been divided into between 20 and 200 cytoarchitectonic areas. The most widely used classification is that of Brodmann, which contains 52 areas numbered in the order in which they were studied.
There are six primary sensory cortical areas: somesthetic, visual, auditory, gustatory, olfactory, and vestibular.
The primary (unimodal) somatosensory association areas are concerned with the perception of shape, size, and texture and the identification of objects by contact (stereognosis).
Three motor areas have been defined: primary motor, supplementary motor, and premotor.
The cerebral areas most important for saccadic control are the posterior parietal cortex, frontal eye field, supplementary eye field, and the dorsolateral prefrontal cortex.
Cortical areas for smooth pursuit movement include the posterior parietal cortex or the temporooccipitoparietal region.
Two cortical areas traditionally have been associated with language function: Wernicke's and Broca's areas in the left hemisphere.
The prefrontal cortex plays a role in executive function, emotion, and social behavior.
The major association cortex is interconnected with all the sensory cortical areas and thus functions in higher-order, complex, multisensory perception.

- Choroid plexus of lateral ventricle are large and highly vascular.
- Total volume of CSF is about 100-150ml in the adults pressure is about 8-10cmH_2O.
- Body of the lateral ventricle is floored by the thalamus and caudate nucleus.
- The lateral ventricle anterior horn projects forward in front of the inter ventricular foramen. The post horn projects into the occipital lobe. The inferior horn projects into the temporal lobe.
- Choroid plexus of the fourth ventricle is a small T-shaped structure, which indents the medullary part of the roof.

Blood supply of brain

1. The internal carotid arteries provide blood supply to the rostral parts of the brain, whereas the vertebral arteries provide blood supply to the posterior parts of the brain.
2. The anterior cerebral artery and its branches provide blood supply to the medial surface of the hemisphere as far back as the parietooccipital fissure.
3. The middle cerebral artery and its branches provide blood supply to most of the lateral surface of the hemisphere.
4. The posterior cerebral artery, the terminal branch of the basilar artery, supplies the medial surfaces of the occipital, temporal, and the caudal part of the parietal lobes.
5. The circle of Willis comprises the major site of intracranial collateral circulation.

Two prominent superficial anasiomotic venous channels are the anastomotic vein of Trolard and the inferior anastomotic vein of Labbi.

The deep venous system drains via two main veins (the internal cerebral vein and the basal vein of Rosenthal) into the great cerebral vein of Galen.

The dural venous sinuses include the superior and inferior sagittal, straight, confluence, transverse, sigmoid, occipital, petrosal, and cavernous sinuses.

Extrinsic factors that regulate cerebral circulation include systemic blood pressure, blood viscosity, and vessel lumen.
Intrinsic factors that regulate cerebral circulation include autoregulation (the most effective) and biochemical alterations in carbon dioxide, oxygen, and pH.
Cerebrovascular disorders include cerebral infarcts (most common) and cerebral hemorrhages. The clinical picture of cerebral infarcts reflects the affected vessel, the location, and the size of the lesion. Fairly consistent, though not absolute, anatomicoclinical correlations occur for each of the following vascular occlusion syndromes: middle cerebral artery, lenticulostriate artery, and anterior cerebral artery, recurrent artery of Heubner, internal carotid artery, anterior choroidal artery, posterior cerebral artery, and vertebral-basilar arteries. Lacunar syndromes result from occlusion of small penetrating end arteries. Five well-defined lacunar syndromes occur: pure motor, pure sensory, ataxic hemiparesis, dysarthria–clumsy hand, and état lacunaire. Intracranial hemorrhage results from rupture of an arterial wall because of longstanding hypertension, congenital aneurysm, arteriovenous malformation, trauma, or a bleeding disorder

Medulla

- The medulla oblongata is divided into four vascular territories: paramedian, olivary, isteral and dorsal.
- Vascular lesions of the medulla obiongata are designated by the anatomic region affected rather than the arterial supply
- The clinical signs of the medial medullary syndrome include contralateral weakness of the upper motor neuron type, contralateral loss of kinesthesia and discriminative touch, and ipsilateral tongue weakness of the lower motor neuron type.
- The clinical signs of the lateral medullay syndrome include loss of pain and temperature sense in the ipsilateral face and the contralateral half of the body, ipsilateral loss of the gag reflex, hoarseness, dysarthria, ataxia, vertigo, ipsilateral Horner's syndrome, mystagmus, and ocular lateropulsion.
- The clinical signs of combined lateral and medial medullary syndromes constitute the Babinski-Nageotte syndrome
- The clinical signs of the dorsal medullay syndrome include ipsilateral ataxia, nystagmus, vomiting, and vertigo
- The collet-sicard syndrome results from an extra-axial lesion affecting cranial nerves IX to XII
- Bilateral interruption of the corticobulbar or corticoarticulobulbar fibers results in the pseudobulbar syndrome
- The ventral surface of the pona shows the basilar artery in the pontine suicus and four cranial nerves; the abducens at the medullary pontine junction, the facial and cochieovestibular in the cerebellopontine angle, and the trigeminal at the midpontine level.
- The dorsal surface of the pons forms the rostral floor of the fourth ventricle, in which the facial colliculi are seen. Coronal sections of the pons reveal two components; a ventral and phylogenetically newer basis pontis and a dorsal and phyiogenetically older tegmentum.

- The basis pontis contains pontine nuclei and the following nerve fiber bundies; corticospinal, corticobulbar and corticopontocerevellar.
- The tegmentum contains the following nerve fiber bundies; medial lemniscus, trigeminal lemniscus, spinothalamic, trap-ezoid body, central tegmental tract, medial longitudinal fasciculus, tectospinal, and descending sympathetic fibers.
- The prabrachial nucleus plays an important role in autonomic regulation. The pedunculopontine nucleus plays roles in locomotion, motor learning, reward system, rousal and saccadic eye movements.
- Cochlear nerve fibers terminate selectively on neurons in the **dorsal or ventral cochlear nuclei**

PONS

The ventral surface of the pons shows the basilar artery in the pontine sulcus and four cranial nerves: the abducens at the medullary pontine junction, the facial and cochleovestibular in the cerebellopontine angle, and the trigeminal at the midpontine level.

The dorsal surface of the pons forms the rostral floor of the fourth ventricle, in which the facial colliculi are seen. Coronal sections of the pons reveal two components: a ventral and phylogenetically newer basis pontis and a dorsal and phylogenetically older tegmentum.

The basis pontis contains pontine nuclei and the following nerve fiber bundles: corticospinal, corticobulbar, and corticopontocerebellar (the largest).

The tegmentum contains the following nerve fiber bundles: medial lemniscus, trigeminal lemniscus, spinothalamic, trap-ezoid body, central tegmental tract, medial longitudinal fasciculus, tectospinal, and descending sympathetic fibers.
The parabrachial nucleus plays an important role in autonomic regulation. The pedunculopontine nucleus plays roles in locomotion, motor learning, reward system, arousal, and saccadic eye movements. Cochlear nerve fibers terminate selectively on neurons in the dorsal or ventral cochlear nuclei. Reciprocal feedback circuits exist throughout the extent of the auditory pathways. Reflex eye and neck movements to sound are carried out via two pathways: from the inferior colliculus to the superior colliculus and then via the tectobulbar and tectospinal tracts to the nuclei of eye and neck muscles and from the superior olive to the abducens nucleus and then via the medial longitudinal fasciculus to the nuclei of extraocular movements.

Vestibular nerve fibers terminate selectively on four ves-tibular nuclei: medial (Schwalbe's principal), inferior (spinal), lateral (Deiters'), and superior (Bechterew's). Some fibers project directly to the cerebellum. The output of vestibular nuclei is to the following areas: spinal cord, cerebellum, thalamus, nuclei of extraocular movement, vestibular cortex, and vestibular end organ.

Vestibular projections to the nuclei of extraocular movement play important roles in controlling conjugate eye movements.
The sensory facial nuclei are the spinal trigeminal nucleus (exteroceptive sensation) and the nucleus solitarius (taste).
The motor facial nuclei are the facial motor nucleus (somatic motor) and the superior salivatory nucleus (visceral motor).
Cortical input to the facial motor nucleus is bilateral to the upper face motor neurons and only contralateral to the lower face motor neurons.

Characteristic conglomerate clinical signs occur in lesions of the facial nerve at or distal to the stylomastoid foramen, distal to the geniculate ganglion, and proximal to the geniculate ganglion. Lesions of the abducens nerve outside the neuraxis result in ipsilateral lateral rectus paralysis. Lesions of the abducens nucleus result in paralysis of ipsilateral lateral gaze.

The motor nucleus of the trigeminal nerve supplies the muscles of mastication, the tensor tympani, the tensor palati, the mylohyoideus, and the anterior belly of the digastric.

The sensory nuclei of the trigeminal nerve are the spinal (pain, temperature, touch), principal (main) sensory (touch), and mesencephalic (proprioception).

Dorsal and ventral trigeminothalamic tracts link the main sensory and spinal trigeminal nuclei, respectively, with the thalamus.

Blood supply to the pons is provided by the basilar artery via three branches: paramedian, short circumferential, and long circumferential.

MIDBRAIN

In cross section the mesencephalon is divided into three regions: the tectum, the tegmentum, and the basal portion.
The inferior colliculus receives inputs from the lateral lemniscus, medial geniculate body, primary auditory cortex, and cerebellar cortex.

The output of the inferior colliculus is to the medial geniculate body, nucleus of the lateral lemniscus, superior colliculus, and cerebellum.

Axons of trochlear neurons form the trochlear nerve, the smallest cranial nerve and the only one that decussates before exiting the neuraxis from the dorsal surface of the midbrain.

In the cerebral peduncle, corticospinal fibers occupy the middle three-fifths, flanked on each side by corticopontine fibers.
The substantia nigra receives inputs from the neostriatum, cerebral cortex, globus pallidus, subthalamic nucleus, and midbrain reticular formation.

The output of the substantia nigra is to the neostriatum, limbic cortex, globus pallidus, red nucleus, subthalamic nucleus, thalamus, superior colliculus, midbrain reticular formation, and amygdala.
On the basis of its projection sites, the mesencephalic dopaminergic system is subdivided into mesostriatal, mesoallocortical, and mesoneocortical subdivisions.

The superior colliculus receives inputs from the cerebral cortex, retina, spinal cord, and inferior colliculus.
The output of the superior colliculus is to the spinal cord, pontine nuclei, reticular formation of the midbrain, and thalamus.
The pretectal area is involved in the pupillary light reflex and vertical gaze.

Input to the red nucleus comes mainly from the deep cerebellar nuclei and the cerebral cortex.
The output of the red nucleus is mainly to the spinal cord, cerebellum, reticular formation, and inferior olive.
Somatic motor neurons of the oculomotor nucleus are organized into subnuclei that correspond to the eye muscles supplied by the oculomotor nerve. All these subnuclei supply ipsilateral muscles except the superior rectus subnucleus, which supplies the contralateral superior rectus muscle, and the levator palpebrae subnucleus, which supplies both levator palpebrae muscles.

Lesions of the oculomotor nerve within the midbrain result in oculomotor nerve palsy and either contralateral tremor (if the red nucleus is concomitantly involved) or contralateral upper motor neuron paralysis (if the cerebral peduncle is involved).

Accessory oculomotor nuclei include Cajal's interstitial nucleus, rostral interstitial nucleus of the medial longitudinal fasciculus (RiMLF), Darkschewitsch's nucleus, and nucleus of the posterior commissure.
The periaqueductal (central) gray region is concerned with modulation of pain, vocalization, control of reproductive behavior, modulation of medullary respiratory centers, aggressive behavior, and vertical gaze.
Constriction of the pupil ipsilateral to light stimulation constitutes the direct light reflex; constriction of the pupil contralateral to light stimulation constitutes the consensual light reflex.
In an Argyll Robertson pupil, light reflex is lost while accommodation convergence is preserved.
The midbrain reticular formation is involved in wakefulness and sleep.

The midbrain receives the bulk of its blood supply from the basilar artery via the paramedian, superior cerebellar, and posterior cerebral branches.

CEREBELLUM

The cerebellum is divided into three imperfectly delineated lobes or zones based on morphology, connectivity, function, or phylogeny.

The cerebellar cortex has three layers and contains five cell types (one principal and four intrinsic). The major inputs to the cerebellum are from three sources: spinal cord, vestibular system, and cerebral cortex. Within the cerebellum, various inputs are segregated into one of three fiber systems. Cerebellar inputs excite Purkinje cells directly via climbing fibers and indirectly via granule cell axons. Intrinsic cerebellar neurons are excited by cerebellar inputs and in turn inhibit Purkinje cells. Deep cerebellar nuclei provide cerebellar output to extracerebellar targets. Extracerebellar targets include the vestibular and reticular nuclei, red nucleus, and thalamus.

Signs of cerebellar disorders include asynergia (dyssynergia), dysarthria, adiadochokinesis, dysmetria, tremor, muscular hypotonia, ataxia, and nystagmus.

Nonmotor roles for the cerebellum in autonomic regulation, behavior, cognition, and learning are being increasingly documented.

Blood supply of the cerebellum is provided by three arteries from the vertebral–basilar arterial system. They are the posterior inferior cerebellar, anterior inferior cerebellar, and superior cerebellar.

BASAL NUCLEI

The terms corpus striatum, striatum, dorsal striatum, neostriatum, ventral striatum, pallidum, paleostriatum, *and* lentiform nucleus *refer to well-defined components of the basal ganglia as summarized in Table 13-1. The striatum receive inputs from the cerebral cortex (major source) and subcortical structures (substantia nigra compacta, thalamus, raphe nuclei, locus ceruleus, and external segment of globus pallidus). The striatum projects to the output nuclei (globus pallidus internus and substantia nigra reticulata) via two pathways; direct and indirect.*

The striatum is the principal receptive structure and the globus pallidus is the principal output structure of the basal ganglia.
Lesions of subthalamic nucleus result in ballism, and stimulation relieves the symptoms of Parkinsonism. Corticostriatothalamocortical connections are organized into five parallel and segregated loops and/or three split circuits.
The role of the basal ganglia in motor control includes the preparation for and execution of cortically initiated movement.
The basal ganglia subserve roles in cognitive function, emotion, and motivation. Blood supply of the basal ganglia is derived from lenticulostriate branches of the middle and anterior cerebral arteries and the anterior choroidal branch of the internal carotid artery.

LIMBIC SYSTEM

The term limbic lobe refers to the structures that form a limbus (ring or border) around the brain stem. These structures include the subcallosal gyrus, cingulate gyrus, isthmus, parahippocampal gyrus, and uncus. The term limbic system refers to the limbic lobe and the structures connected to it.

Limbic system structures play important roles in emotional behavior, memory, homeostatic responses, sexual behavior, and motivation.

The term hippocampal formation refers to the hippocampus, dentate gyrus, and subiculum. The bulk of extrinsic input to the hippocampal formation comes from the entorhinal area and the septal area. The major targets of the hippocampal formation's output are the entorhinal cortex, the hypothalamus, and the septal area.

The entorhinal area is reciprocally connected with the hippocampus and serves as a gateway between the cerebral cortex and the hippocampus.

The hippocampus plays a role in declarative or associative memory, attention and alertness, and behavioral, endocrine, and visceral functions.

Output from the amygdala is carried in two pathways: the stria terminalis (dorsal amygdalofugal pathway) and the ventral amygdalofugal pathway (ventrofugal bundle).

The amygdala plays an important role in a variety of functions, including autonomic and orienting responses, emotional behavior, food intake, arousal, sexual activity, and motor activity.

The term septal area refers to the septum pellucidum and the septum verum. The septum pellucidum is a thin glial partition between the lateral ventricles; the septum verum is a group of basal nuclei that includes the septal nuclei. Reciprocal connections with the hippocampus (via the fornix) constitute the major connection of the septal area. Other connections include those with the amygdala, hypothalamus, thalamus, brain stem, and cingulate gyrus. The septal area plays an important role in emotional behavior, learning, reward, autonomic responses, drinking and feeding, and sexual behavior.

The limbic system plays a major role in integrating exteroceptive and interoceptive information by serving as a link between cortical sensory association areas, the subcortical autonomic and endocrine centers, and the prefrontal association cortex. It thus mediates the effects of emotion on motor function.

Cranial nerve	Functional component (modality)	Nucleus	Location of cranial nerve nuclei	Ganglion	Distribution	Function(s)
I Olfactory	SVA	–	Telencephalon	–	Olfactory mucosa	Smell
II Optic	SSA	–	Diencephalon	–	Ganglion cells of retina	Vision
III Oculomotor	GSE	Oculomotor	Mesencephalon (tegmentum)	–	All extraocular muscles except the lateral rectus and superior oblique	Eye movement
	GVE (parasympathetic)	Edinger–Westphal	Mesencephalon (tegmentum)	Ciliary (parasympathetic)	Sphincter pupillae muscle Ciliary muscle	Pupillary constriction Lens accommodation
	GP	Mesencephalic nucleus of the trigeminal	Mesencephalon	–	All extraocular muscles except the lateral rectus and superior oblique	Kinesthetic sense
IV Trochlear	GSE	Trochlear	Mesencephalon (tegmentum)	–	Superior oblique	Eye movement
	GP	Mesencephalic nucleus of the trigeminal	Mesencephalon	–	Superior oblique	Kinesthetic sense
V Trigeminal	SVE	Motor nucleus of the trigeminal	Metencephalon	–	Muscles of mastication: temporalis masseter medial pterygoid lateral pterygoid Mylohyoid, anterior belly of the digastric Tensor tympani Tens veli palatini	Chewing Tenses tympanic membrane Tenses soft palate
	GSA	Main (chief, principal) nucleus of the trigeminal Spinal nucleus of the trigeminal	Metencephalon (pons) Metencephalon (pons to C3)	Trigeminal	Scalp, anterior two-thirds of the dura, cornea, conjunctiva, face, paranasal sinuses, teeth, gingiva, and anterior two-thirds of the tongue	General sensation
	GP	Mesencephalic nucleus of the trigeminal	Mesencephalon	–	Muscles of mastication Periodontal ligament	Muscle stretch sensation Pressure sensation
VI Abducent	GSE	Abducens	Metencephalon (pons)	–	Lateral rectus	Eye movement
	GP	Mesencephalic nucleus of the trigeminal	Mesencephalon	–	Superior oblique	Kinesthetic sense
VII Facial	SVE	Facial	Metencephalon (pons)	–	Muscles of facial expression, platysma, posterior belly of the digastric, and stylohyoid Stapedius	Facial expression Tension on stapes
	GVE (parasympathetic)	Superior salivatory	Myelencephalon	Pterygopalatine (parasympathetic)	Lacrimal gland Glands of the nasal cavity and palate	Lacrimation Mucous secretion
				Submandibular (parasympathetic)	Submandibular and sublingual glands	Salivation
	SVA	Solitarius	Myelencephalon	Geniculate	Anterior two-thirds of the tongue	Taste
	GVA	Solitarius	Myelencephalon	Geniculate	Middle ear, nasal cavity, and soft palate	Visceral sensation

Cranial nerve	Functional component (modality)	Nucleus	Location of cranial nerve nuclei	Ganglion	Distribution	Function(s)
	GSA	Spinal nucleus of the trigeminal	Metencephalon (pons)	Geniculate	External auditory meatus and area posterior to ear	General sensation
VIII Vestibulocochlear						
Cochlear	SSA	Dorsal and ventral cochlear	Myelencephalon	Spiral	Organ of Corti (inner ear)	Hearing
Vestibular	SSA	Vestibular complex	Myelencephalon	Vestibular	Utricle Saccule Semicircular canal ampullae (inner ear)	Equilibrium
X Glossopharyngeal	SVE	Ambiguus	Myelencephalon	–	Stylopharyngeus and pharyngeal constrictors	Swallowing
	GVE (parasympathetic)	Inferior salivatory	Myelencephalon	Otic (parasympathetic)	Parotid gland	Salivation
	SVA	Solitarius	Myelencephalon	Inferior ganglion of the glossopharyngeal	Posterior one-third of the tongue and adjacent pharyngeal wall	Taste
	GVA	Ambiguus Solitarius	Myelencephalon	Inferior ganglion of the glossopharyngeal	Middle ear, pharynx, tongue, carotid sinus	Visceral sensation
	GSA	Spinal nucleus of the trigeminal	Myelencephalon	Superior ganglion of the glossopharyngeal	Posterior one-third of the tongue, soft palate, upper pharynx, and auditory tube	General sensation
X Vagus	GVE (parasympathetic)	Dorsal motor nucleus of the vagus	Myelencephalon	Thoracic and abdominal submucosal and myenteric autonomic plexuses	Thoracic and abdominal viscera	Gland secretion, peristalsis
	SVE	Ambiguus	Myelencephalon	–	Muscles of the larynx and pharynx	Phonation
	SVA	Solitarius	Myelencephalon	Inferior (nodose)	Epiglottis	Taste
	GVA	Solitarius	Myelencephalon	Inferior (nodose)	Thoracic and abdominal viscera Carotid body	Visceral sensation
	GSA	Spinal nucleus of the trigeminal	Myelencephalon	Superior (jugular)	Area posterior to the ear, external acoustic meatus, and posterior part of meninges	General sensation
XI Spinal accessory	SVE	Ambiguus	Myelencephalon	–	Laryngeal muscles To sternocleidomastoid and trapezius	Phonation Head and shoulder movements
XII Hypoglossal	GSE	Hypoglossal	Myelencephalon	–	Muscles of the tongue	Tongue movement

Cranial Nerves
CN I = olfactory

- *Special sensory nerve* of smell
- Olfactory nerve = bundle of nerves, located in upper nasal mucosa
  - 25 million olfactory cells on each side of mucosa
  - bipolar neuron cells: their deep processes merge to make plexiform network
  - plexiform network then recombine to give bundles of nerve that give olfactory nerve, proper
- Nerves come through cribriform (=sieve like) plate: piece of ethmoid bone
  - Ethmoid bone: thin, complex bone between orbits
  - In middle of cribriform plate: cristae galae: where falx cerebri attaches in front
  - Holes in cribriform plate: where nerves are transmitted into end of anterior portion of endocranial fossa
- Nerves are attached to olfactory bulbs, which are then joined to olfactory tracts
  - Bundles of nerve travel through cribriform to olfactory bulbs where they synapse @ mitral cells→olfactory tracts
  - Olfactory tracts connected to telencephalon
  - Olfactory cells: degenerate at 1% a year; regenerate

CN II: optic

- *Special sensory nerve* of vision
- Nerve begins in retina in back of eyeball
  - Retina: developmentally is an outgrowth of brain
  - Retina converges at optic disk to become continuous with optic nerve
  - Optic nerve is surrounded by meninges because of connexn with retina
  - Each optic nerve: million of ganglion cells
    - Ganglion cells synapse at bipolar cells
    - Bipolar cells lengthen to form rods and cones
- Nerve travels through optic canals: oblique openings
  - Optic canals open at junction between anterior middle cranial fossae
- Two optic nerves meet to form optic chiasma: in front of pituitary
  - Nerve fibers from medial half of retina cross in optic chiasma
  - Lateral fibers stay on the same side
  - Effect: carry neurons in related visual field end up in same optic tract
  - The fibers go back to the thalamus or midbrain (lateral geniculate ganglion or superior colliculi ganglion)

- A complete lesion of the left optic nerve gives rise to complete blindness in the left eye
- Compression of the optic chiasma, as by a pituitary tumour, causes bitemporal hemianopia (blindness in the temporal half of both visual fields) because the nasal fibtres from both retina are interrupted. This effectively narrows the outer part of each visual field, so that the patient complains of bumping into the sides of a doorway or into people on each side
- A lesion of the left optic tract gives a right homonymous hemianopia, due to interruption of fibres from the same (left) sides of both retinas (hence homonymous meaning same sided). The field defects are therefore right sided
- A lesion of the lower fibres in the left optic radiation(as from an abscess in the temporal lobe spreading upwards from the middle ear) causes a right upper quadrantic homonymous hemianopia, because the lower fibres in the optic radiation (from the lower part of the retina) are represented in the upper part of the visual field
- Similar to (4), a lesion of the upper fibres in the left optic radiation (as from a parietal lobe lesion, and in practice very rare) gives a right lower quadrantic homonymous hemianopia.
- A lesion of the anterior part of the left visual cortex (as from occlusion of the posterior cerebral artery) gives a right homonymous hemianopia similar to the optic tract lesion in (3), but there may be sparing of the macular (central) vision when the most posterior part of the visual cortex at the very tip of the occipital lobe, where macular vision is represented, is (sometimes) supplied by the middle cerebral artery
- Traumatic damage to the tip of the left occipital lobe, i.e. to the macular area, gives a right homonymous macular defect.

CN III: oculomotor

- Comes off of midbrain and goes under the lesser wing of sphenoid
- Goes through superior orbital fissure: opens into back of orbit
- Nerve is lateral to optic nerve
- Associated with all muscles of the eye: both smooth and striated
- *General somatic motor* and *parasympathetic* component
- General somatic motor
    - Supply most (5 out of 7) of the muscles around eyeball that move it
    - Nerve splits immediately after exit
    - Superior division:
        - Superior rectus: moves eyeball
        - Levator palpebrae superioris: elevator of upper eyelid
    - Inferior division
        - Medial and inferior rectus
        - Inferior oblique
        - Three extraocular muscles move eyeball
- Parasympathetic: third division of CN III
    - Synapse in ciliary ganglion on way to eye
        - Postganglion parasympathetics carried in short ciliary nerves
    - Ciliary nerves fibers pierce eyeball and travel to front to supply two smooth muscles
        - Pierce sclera and travel between outer and middle coat
        - Sphincter pupillae: in the iris, controls size of pupil (amount of light)
        - Ciliary muscle: surrounds the lens, allows up-close focus
- Nasociliary nerve from trigeminal suspends ciliary ganglion but does not synapse
    - All 4 parasymp ganglion suspended by a fiber from trigeminal nerve

CN IV: trochlear

- Smallest CN
- Emerge - DORSAL aspect of midbrain
- Passes on side of middle cranial fossa
- Exits through superior orbital fissure to travel in medial roof of orbit
- *Somatic motor nerve* to superior oblique muscle that moves the eye
- Superior oblique muscle:
    - Changes direction of pull within the orbit by passing through a fibrocartilage loop in superomedial angle of orbit= trochlea
    - Origin: apex of orbit
    - Insertion: above eyeball
    - Muscles courses along upper medial angle of orbit

CN V: trigeminal

- Largest cranial nerve
- Emerges from pons and goes thru middle cranial fossa
- Forms huge semilunar/trigeminal sensory ganglion (medial side of middle cranial fossa) and divides into 3 pieces
- Primary *somatic sensory* nerve of head; also a *motor* nerve of first pharyngeal arch
- CN V^1 = ophthalmic, entirely sensory
    - Goes to superior orbital fissure to join CN III and IV to go to back of orbit
    - Supplies cornea, conjunctiva, eyeball, lacrimal gland, forehead, nose, upper eyelid, frontal and ethmoid sinuses
    - Emerges in forehead from frontalis
    - Branches
        - Lacrimal: small, lateral
            - provides somatic sensory to lacrimal gland, adjacent eyelid and conjuncitva (doesn't control secretions)
        - Frontal (supraorbital, supratrochlear): both travel to upper medial corner of eye through foramen

- Terminal branches on forehead: sensory
- Nasociliary
  - Under levator palpebrae superioris and superior rectus
  - Four branches
    - *Suspends ciliary ganglion* with sensory root: see above
      - Fibers are considered part of short ciliary nerves
      - Short ciliary
        - Parasympathetic
        - To back of eyeball, pierce sclera and travel on eyeball
        - May contain some sympathetic fibers
    - Long ciliary nerves:
      - Follows same course as short ciliary
      - Sensory to eye
      - Primary carrier of sympathetics to ciliary body, iris
        - dilate muscles

- Superior cerv. Ganglion
  - base of skull, above of carotids
  - where sympathetics of head will synapse
  - fibers form plexuses around internal and external carotid
  - fibers can come up with internal carotid and contribute to CNs
    - Ethmoidal and nasal: from ethmoidal and sphenoidal sinuses, nasal cavity and front and tip of nose
      - pierces medial wall of orbit
      - Supplies mucosa
      - Pierces forward to supply nasal cavity: nasal nerves
    - Infratrochlear: from superomedial corner of orbit below trochlea
      - Just sensory

- CN V^2 =maxillary, entirely sensory
  - Goes thru foramen rotundum (a round hole behind the medial angle of the superior orbital fissure, that goes forward in skull)
  - Takes a bent course to go to floor of orbit; travels the infraorbital fissure and thru infraorbital canal and out the infraorbital foramen
  - Sensory innervation of cheek; sensory for everything from floor of orbit to roof of mouth
    - Upper jaw, maxillary sinus, nasal cavity, middle of face, middle ear cavity, auditory tube and dura
  - Branches
    - *Supends pteryogopalantine ganglion* (CN VII)
      - To reach ganglion, travels vertically along pteryogomaxillary canal
      - Fibers pass thru then go medially along nasal cavity to palate
    - Zygomatic: from cheek
      - Sends sensory thru lateral wall of orbit onto cheek
    - Nasal branches: from mucous membranes of nasal sinuses
    - Palatine branches (lesser, greater, nasopalatine)
      - Fibers pass through pteryogpalatine ganglion
      - Descend through palatine canal and exit respective foramen
      - Sensory nerves to palate
    - nasopalatine nerve
      - supplies nasal septum
      - goes to front of palate and exits out opening behind upper incisors (incisor foramen)
      - sensory to front of palate
    - Superior alveolar branches from upper teeth, gums, maxillary sinus

- Maxillary sinus: hollow cavity from floor of orbit to roof of mouth; lined with mucosa
- infraorbital: terminal branch
- sensory between orbit and mouth
- meningeal: from middle and anterior cranial fossae
  - given off before exiting foramen rotundum
  - supplies dura around area
- pharyngeal: passes thru ganglion
  - from middle ear cavity and auditory tube
  - upper part of pharynx (back of throat)
  - connection to middle ear

- CN V^3= mandibular, sensory and motor
  - Largest division
  - Exits skull thru foramen ovale (postero lateral from foramen rotundum; oval opening); exits at lower jaw
  - Supplies sensory to lower jaw (tongue, lower teeth, chin, cheek, floor of mouth, anterior 2/3 of tongue, tympanic membrane, salivary glands)
  - Also supplies motor innervation for mastication
    - Branchiomotor: associated with first branchial/pharyngeal arch
    - Striated muscles are supplied
    - Branches to muscles of mastication
      - Temporalis, masseter, medial and lateral pterygoids
    - Branches to floor of mouth: mylohyoid, digastric (anterior belly), tensor veli palatine (tenses roof of palate) and tensor tympani (tenses ear drum)
  - Branches after motor branches
    - Buccal
      - Sensory from cheek, internal and external
      - Pierces buccinator to mucus membranes and skin
    - Auriculotemporal
      - Sensory from external acoustic meatus and tympanic membrane, temporal region and temperomandibular junction
      - *Suspends otic ganglion (CN IX)*
    - Lingual
      - Sensory for anterior 2/3 of tongue, floor mouth, mandibular gums
      - Joined by piece of chorda tympani of facial nerve
      - *Suspends submandibular ganglion (CN VII)*
    - Inferior alveolar
      - Sensory from lower jaw, gums, lips and teeth
      - Dental, mental nerves
    - Meningeal
      - Accompanies middle meningeal artery (enters back into skull thru foramen spinosum: immediately adjacent to foramen ovale)
      - Sensory for dura mater of middle cranial fossa

CN VI: abducent

- Pierces dura where pons and medulla meet
- Travels to superior orbital fissure; enters orbit
- *General somatic motor* nerve
- Supplies lateral rectus muscle: abducts (turn out) eye from midline

CN VII: facial

- *general sensory, special sensory, branchiomotor, parasympathetic*
- Comes off junction of pons and medulla
- Goes laterally into opening of petrous temporal: division of middle and posterior fossa
  - Opening: interior acoustic meatus: large hole that goes laterally
  - Lies on top of CN VIII

- In the petrous temporal:
  - gives off many branches
  - sensory cell bodies in the geniculate ganglion
- Part of nerve turns out of petrous temporal and exits out stylomastoid foramen, behind parotid gland (anteromedial from mastoid process; in between the mastoid process and skinny styloid process (may be broken in skull))
  - Passes through parotid gland and then branches (major branchiomotor component; small, inconsequential general sensory component)
    - Associated with 2nd pharyngeal arch
    - Goes to all muscles of facial expression: branchiomotor (see more below)
    - General sensory component: goes to part of external ear (auricle) and external auditory meatus
- Branches of facial nerve
  - Nervus intermedius: sensory root of VII, includes parasymp
  - Geniculate ganglion: site of sensory cell bodies
    - Within petrous bone
    - After exiting ganglion, nerve bends at genu and makes tortuous path, gives off more branches, motor branches goes out of stylomastoid foramen
  - Chorda tympani
    - Small filament passes thru tympanic cavity b/w malleus and incus, across tympanic membrane
    - Special sensory and parasympathetic components
    - goes to tongue and joins up with the trigeminal nerve (lingual nerve) to anterior 2/3 of tongue
      - Provides taste
    - One branch of parasymmpathetics synapse in submandiublar ganglion
      - Controls secretomotor function of submandibular (large) and sublingual (small) salivary glands
  - Great petrosal
    - Joins with sympathetic deep petrosal nerve, becomes nerve of pterygoid canal towards foramen lacerum (merges with internal carotid)
    - Nerve of pteryogoid canal carries parasympathetics, sympathetics and taste fibers
      - parasympathetics synapse in pteryopalatine ganglion
      - Relayed to lacrimal gland to create tearing, mucus glands of nasal cavity and perinasal sinuses (hitches ride with trigeminal)
      - Also provides taste for palate: “fine palate”
  - Branchiomotor branches: stylomastoid foramen
    - 2nd pharyngeal arch
    - To facial muscles of expression
    - Occipitofrontalis
    - Posterior belly digastric, stylohyoid, stapedius muscles

CN VIII: vestibulocochlear

- Originates from pons and medulla
- Goes out posterior cranial fossa through internal acoustic meatus but never exits skull (unique); stays in petrous temporal
- Goes to 2 sensory ganglion in ear/cochlea (spiral ganglion) and semicircular canals (vestibular ganglion)
- *Special sensory nerve* of hearing and balance (equilibrium)

CN IX: glossopharyngeal

- Originates from medulla oblongata
- Exits large jugular foramen (inferior to internal acoustic meatus; huge irregular opening at end of the sigmoid sinus; out this opening also find drainage of sigmoid sinus (posterior) and inferior petrosal sinus (anterior))
- After exit, forms superior and inferior sensory ganglia
  - Base of skull inferior to jugular foramen

- Complicated: : *general sensory, special sensory, branchiomotor, parasympathetic*
  - Most important component: sensory
- Associated with tongue and pharynx
- Branches
  - Provides sensory (gen'l and special) to posterior 1/3 of tongue, soft plate, middle ear, upper pharynx
    - Makes contribution to pharyngeal plexus; joins with branches from CN X and sympathetics
    - Provides taste
  - Carotid sinus nerve: visceral sensory
    - supplies carotid body (blood pressure receptor) and carotid sinus (chemoreceptor)
  - tympanic nerve: off of inferior ganglion
    - turns and goes back up floor of tympanic cavity; goes into middle ear and spreads out over promontorium (bony swelling on medial wall of middle ear cavity overlying cochlea; covered with mucus)
    - visceral sensory from mucus membranes of tympanic cavity, auditory tube and mastoid air cells
    - carries parasympathetics
      - Reenters skull
      - Travels with lesser petrosal nerve
      - goes to otic ganglion and synapses (deep to ear, behind jaw joint; medial side of auriculotemporal nerve, branch of mandibular nerve)
      - Controls secretomotor function of parotid gland
        - Possible connection with facial nerve
  - Small branchiomotor component: third pharyngeal arch
    - Goes to stylopharyngeus muscle of pharynx

CN X: vagus

- Originates from medulla oblongata
- Exits large jugular foramen
- Complicated: : *general and visceral sensory, special sensory, branchiomotor, parasympathetic*
- Most extensively distributed
- Forms two sensory ganglia under jugular foramen
  - Superior and inferior ganglia
    - Sites of sensory cells
    - Superior (Jugular)
      - General somatic
    - Inferior (Nodos)
      - Special sense: taste for epiglottis (inconseq. in adults)
      - Visceral sense (abdomen and thoracic viscera)
- Branches
  - Sends a general visceral branch to carotid nerve
  - Pharyngeal plexus with CN IX
    - Sends out branchiomotor branches to most muscles pharynx and soft palate (except tensor veli palatini [CN V])
  - Very large parasympathetic component
    - Everything in thorax, much of abdomen (as far as left colic flexure)
    - Motor component and sensory component: smooth muscles, glands in lining
    - Afferent from mucosa in lower pharynx, larynx, trachea, bronchi, lungs and GI tract to left colic flexure
  - Auricular
    - From superior ganglion
    - Small general sensory component
    - To external ear and external auditory meatus, auricle
      - Complicated structures with multiple innervation from different nerves

- Inconsequential special sensory component
  - To the region of epiglottis
- Superior laryngeal: nerve of 4th pharyngeal arch
  - External laryngeal
    - Branchiomotor to inferior constrictor and cricothyroid muscle
  - Internal laryngeal
    - Pierces thyrohyoid membrane
    - Visceral sensory from mucus membrane of larynx (except cricothyroid)
    - Visceral sensory from upper larynx
    - Parasymp innerv
- Recurrent layrngeal: sixth pharyngeal arch
  - Left (under ligamentum arteriosum), right (under subclavian art)
  - Ascends along trachea and enters larynx from below
  - Branchiomotor to all laryngeal muscles except cricothyroid
  - Visceral sensory and parasymp to lower larynx (inferior to vocal folds)

- General overview
  - Sensory
    - Mucus linings
  - Secretory to all glands of pharynx, larynx, trachea, bronchii, lungs, esophagus and abdominal viscera up to middle of transverse colon

CN XI: accessory

- Originates from medulla oblongata
- Exits large jugular foramen
- Cranial part and spinal part
  - Cranial part: closely associated with vagus and often considered as vagus
    - Cannot just call as accessory, must qualify as "cranial accessory"
  - Spinal part is what we will consider in gross anatomy as accessory nerve
    - Originates from upper cervical roots
    - Renters skull foramen magnum
    - Exits out jugular foramen
    - Supplies sternomastoid and trapezius muscle
    - Controversial if *branchiomotor or somatic motor*

CN XII: hypoglossal

- Originates from medulla oblongata
- Exits through canals that are developed in front of foramen magnum (2 and 10 o'clock of foramen magnum)
- *Somatic motor*
- Goes under tongue
- Controls nearly all tongue muscles except palatoglossus (CN X)
- Related Branches, but not really part of hypoglossal nerve; not separable from CN
  - Ansa cervicalis
    - Loop formed by roots of C1-C3
    - Supplies infrahyoid muscles (omohyoid, sternohyoid, sternothyroid—muscles of swallowing (other muscles by CN)) except thyrohyoid
    - Contains only cervical nerves
  - Nerves to thyrohyoid, geniohyoid
    - Originate from C1

Syndrome*	Symptoms and Signs	Involved Structures
Claude	Ipsilateral III Contralateral ataxia	III—brainstem fascicle Red nucleus/superior cerebellar peduncle
Nothnagel	Ipsilateral III Ipsilateral ataxia	III—brainstem fascicle Superior cerebellar peduncle
Weber	Ipsilateral III Contralateral hemiparesis	III—brainstem fascicle Cerebral peduncle
Benedikt	Ipsilateral III Contralateral chorea or tremor	III—brainstem fascicle Red nucleus
Tolosa-Hunt	Ipsilateral III, IV, VI Ipsilateral 1st and 2nd branches of V Ipsilateral Horner syndrome	Cavernous sinus III, IV, VI, 1st and 2nd branches of V Sympathetic nerves
Wallenberg lateral medullary syndrome	Ipsilateral facial numbness and ↓ pinprick Contralateral hemibody ↓ pain and temperature Dysphagia and ↓ gag reflex Limb ataxia Horner syndrome Vertigo	Spinal trigeminal tract and nucleus Spinothalamic tract Nucleus ambiguus Inferior cerebellar peduncle Sympathetic nerves Vestibular nuclei
Opalski syndrome	Wallenberg in addition to ipsilateral hemiparesis	Corticospinal fibers caudal to pyramidal decussation
Gradenigo	Facial and mastoid area pain Ipsilateral 1st branch of V Ipsilateral VI and VII	Petrous apex—temporal bone V, VI, VII
Foville	Ipsilateral VI and VII Contralateral ataxia Ipsilateral Horner syndrome Ipsilateral deafness Ipsilateral ↓ taste and facial sensation	VI and VII—brainstem Mid-cerebellar peduncle Sympathetic nerves Vestibulocochlear nerve/fascicle Spinal trigeminal tract/nucleus solitarius
Millard-Gubler	Ipsilateral VI and VII Contralateral hemiparesis	VI and VII—brainstem Pyramidal tract
Raymond	Ipsilateral VI Contralateral hemiparesis	VI—brainstem Pyramidal tract
Bell palsy	VII	VII—intratemporal nerve and geniculate ganglion
Ramsay Hunt	VII Vesicular otic or oral rash ± ↓ hearing	VII ± VIII
Melkersson-Rosenthal	VII Facial edema Fissured tongue	VII—distal branches
Eagle	IX	XI—elongated styloid process or ossified stylohyoid ligament
Vernet	IX, X, XI	Jugular foramen
Villaret	IX, X, XI XII Horner syndrome	Jugular foramen Hypoglossal canal Sympathetic nerves
Collet-Sicard	IX, X, XI XII	Jugular foramen Hypoglossal canal
Avellis	X Contralateral hemiparesis	X—brainstem or peripheral Pyramidal tract
Tapia	X and XII	X and XII—brainstem or peripheral
Dejerine medial medullary syndrome	Ipsilateral XII Contralateral hemiparesis Contralateral hemisensory deficit	XII—nuclei or fascicle Pyramidal tract Medial lemniscus
Babinski-Nageotte	Combined symptoms and signs of Wallenbergand Dejerine syndromes	Hemi-medullary: lateral and medial medulla

↓, Decreased.
*Descriptions of named syndromes vary slightly depending on reference used.

CLASS DISCUSSION QUESTIONS

NEURON

1. Myelin sheath is absent in a myelinated peripheral nerve in following areas except
   A. Nodes of ranvier
   B. Near termination of axon
   C. Proximal segment of axon
   D. None of above
2. The blood brain barrier is absent in all following except
   A. Pineal body
   B. Posterior lobe of pituitary
   C. OVULT
   D. Anterior lobe of pituitary

CEREBRAL CORTEX

3. Cisterna ambiens is located
   A. Between spelinum of corpus callosum and tectum of midbrain
   B. Overlies the interpeduncular fossa
   C. Intervenes between ventral surface of pons and base of skull
   D. Intervenes between cerebellum and dorsal surface of medulla
4. Stria of Gennari is seen in
   A. Frontal lobe
   B. Occipital lobe
   C. Parietal lobe
   D. Temporal lobe
5. Association fibres includes all the following except
   A. Fimbria
   B. Cingulum
   C. Uncinate fasciculus
   D. Inferior longitudinal fasciculus

BASAL NUCLEI

6. Ventral striatum include
   A. Caudate and putamen
   B. Globus pallidus
   C. Anterior perforated substance
   D. Nucleus accumbens and olfactory tubercle
7. The main output of Amygdala is conveyed by
   A. Lamina terminalis
   B. Stria terminalis
   C. Fornix
   D. Both A & C

THALAMUS

8. The nuclei of thalamus involved in papez circuit
   A. Anterior nuclei
   B. Ventral posterior lateral
   C. Ventral anterior
   D. Ventral lateral

MEDULLA

9. Wallenberg syndrome is lesion affecting the
   A. Posterior inferior cerebellar artery
   B. Anterior inferior cerebellar artery
   C. Anterior spinal artery
   D. All the above

SPINAL CORD

10. True about Ligamentum denticulatum is all except
    A. Is an extension of duramater
    B. Twenty two pairs of triangular structure
    C. The first tooth is attached to foramen magnum
    D. The last tooth is between T12 & L1
11. The peripheral part of retina is represented in the
    A. Anterio r part of visual field
    B. Posterior part of visual field
    C. Both anterior & posterior part of visual cortex
    D. None of above
12. The dominent hemisphere is concerned with all except
    A. Arithmetical problems
    B. Analysis
    C. Geometrical & Spatial representation
    D. Speech
13. The complete sulci of the following is
    A. Lunate sulcus
    B. Parietoccipital sulcus
    C. Collateral sulcus
    D. Central sulcus
14. The splenial fibres that connect the occipital lobes of two hemispheres is
    A. Forceps minor
    B. Tapetum
    C. Forceps major
    D. Both A & B

CRANIAL NERVE

15. The pontomedullary junction gives attachment to
    A. Abducent nerve
    B. Glossopharyngeal nerve
    C. Accessory nerve
    D. Hypoglossal
16. Red nucleus is located in
    A. Midbrain at superior colliculus
    B. Midbrain at inferior colliculus
    C. Medulla at pyramidal decussation
    D. Pons at facial colliculus
17. The Cranial nerve nuclei that belong to somatic efferent column are
    A. III,IV,VI,X
    B. III,IV,V,X
    C. IV,VI,X,XII
    D. III,IV,VI,XII

CEREBELLUM

18. Cerebellar rossette is formed by all except
    A. Mossy fibres
    B. Granule cell
    C. Golgi cell
    D. Purkinje cell
19. A tumor in the floor of the fourth ventricle has compressed the abducens nucleus in the dorsal part of the pons on the right. Your patient exhibits an internal strabismus. What else might you expect you to see in the patient?
    A. An ability to voluntarily look to the left with either eye
    B. An inability to wrinkle the forehead on the right
    C. A sensorineural hearing loss
    D. Alteration of taste on the anterior two-thirds of the tongue

20.A patient suddenly can no longer read or write. He seems to speak normally, although he misuses words, and he understands and executes simple motor commands. Later testing reveals that he cannot add and subtract, and he cannot identify which fingers are which. You suspect that his lesion has affected the

A. Splenium of the corpus callosum
B. Angular gyrus
C. Cuneus gyrus
D. Arcuate fasciculus

21. Your patient has suffered a stroke involving the posterior cerebral artery. Your might expect the patient to exhibit

A. A homonymous hemianopsia with macular sparing
B. Bladder incontinence
C. Alexia with agraphia
D. Acalculia

22. If it were possible to surgically isolate the pathway mediating pain impulses to the thalamus, which pathway would be most appropriate to isolate and disconnect?

A. Fasciculus gracilis
B. Fasciculus cuneatus
C. Spinocerebellar tract
D. Spinothalamic tract

23.The middle cerebellar pedumcle is made of

A. Posterior spinocerebellar
B. Rubrocerebellar
C. Pontocerebellar
D. Cerebello-olivary

24. A patient has trouble sleeping due to a decreased production of melatonin. What neural structure influences melatonin synthesis at night?

A. Preoptic nuclei
B. Lateral geniculate body
C. Suprachiasmatic nucleus
D. Supraoptic nucleus

25.HGWhich of the following thalamic nuclei is correctly matched with its function?

A. Ventral posterior lateral/motor planning
B. Ventrallateral/somatosensory
C. Medial geniculate/auditory processing
D. Anterior/language processing

26. A lawyer suffers a bad fall that results in head trauma. His motor, sensory, and language skills are intact after the incident, and he has no visual problems. In the following weeks, he begins to lose interest in his work and doesn't seem to care much about his family. The Trauma most likely affected the

A. Temporal lobe
B. Parietal lobe
C. Occipital lobe
D. Frontal lobe

27.Your female patient has suffered a stroke. She has difficulty copying simple diagrams, even though she hears and understands your requests to do so. You notice that she only has make-up on the right side of her face and does not seem to know where her left hand is in space. Which blood vessel might have been occluded to cause these symptoms?

A. Left vertebral artery
B. Right middle cerebral artery
C. Left anterior cerebral artery
D. Right posterior cerebral artery

28.The CA1 area referred to as Sommer sector is exceptionally sensitive to oxygen lack are in

A. Amygdala
B. Hippocampus
C. Thalamus
D. Hypothalamus

29.The Grey matter of the lateral geniculate body is in the form of six lamina, three of which receive fibres from the ipsilateral retina, and three the contralateral retina.The lamina receiving ipsilateral fibres are

A. 1,2,3
B. 4,5,6
C. 1,3,5
D. 2,3,5

30.Which of the following tracts is predominantly uncrossed.

A. Rubrospinal
B. Tectospinal
C. lateral corticospinal
D. Medial reticulospinal

ANSWERS & EXPLANATION

1.D

Myelin sheath is ABSENT in a myelinated nerve at ---Nodes of ranvier, near termination of axon, proximal segment of axon

2.D

Blood brain barrier is absent in pineal body, Posterior lobe of pituitary, OVULT

The walls of the ventricular system are lined with ependymal cells covering a subependymal layer of glia. At certain midline sites in the ventricular walls, collectively referred to as circumventricular organs, the blood–brain barrier is absent and specialized ependymal cells called tanycytes are present . The functions of ependyma and tanycytes may include secretion into the CSF; transport of neurochemicals from subjacent neurones, glia or vessels to the CSF; transport of neurochemicals from the CSF to the same subjacent structures; chemoreception. In the adult, the ependymal and subependymal glial cell layers are the source of undifferentiated stem cells that are currently under intensive study for their potential neurorestorative properties

3.A

The largest cistern, the cisterna magna or cerebellomedullary cistern, is formed where the arachnoid bridges the interval between the medulla oblongata and the inferior surface of the cerebellum. The cistern is continuous above with the lumen of the fourth ventricle through its median aperture, the foramen of Magendie, and below with the subarachnoid space of the spinal cord. The pontine cistern is an extensive space ventral to the pons, that is continuous below with the spinal subarachnoid space, behind with the cisterna magna and, rostral to the pons, with the interpeduncular cistern. The basilar artery runs through the pontine cistern into the interpeduncular cistern. As the arachnoid mater spans between the two temporal lobes it is separated from the cerebral peduncles and structures within the interpeduncular fossa by the interpeduncular cistern, which contains the circulus arteriosus (circle of Willis). Anteriorly, the interpeduncular cistern extends to the optic chiasma. The cistern of the lateral fossa is formed by the arachnoid as it bridges the lateral sulcus between the frontal, parietal and temporal opercula; it contains the middle cerebral artery. The cistern of the great cerebral vein (cisterna ambiens or superior cistern) lies posterior to the brain stem and third ventricle, and occupies the interval between the splenium of the corpus callosum and the superior cerebellar surface. The great cerebral vein traverses this cistern and the pineal gland protrudes into it.

Several smaller cisterns have been described, including the prechiasmatic and postchiasmatic cisterns, which are related to the optic chiasma, and the cistern of the lamina terminalis and the supracallosal cistern, all of which are extensions of the interpeduncular cistern and contain the anterior cerebral arteries. The subarachnoid space also extends through the optic foramen into the orbit where it is bounded by the optic nerve sheath. The latter is formed by fusion of the arachnoid and dura mater, and surrounds the orbital portion of each optic nerve as far as the back of the globe, where the dura fuses with the sclera of the eye

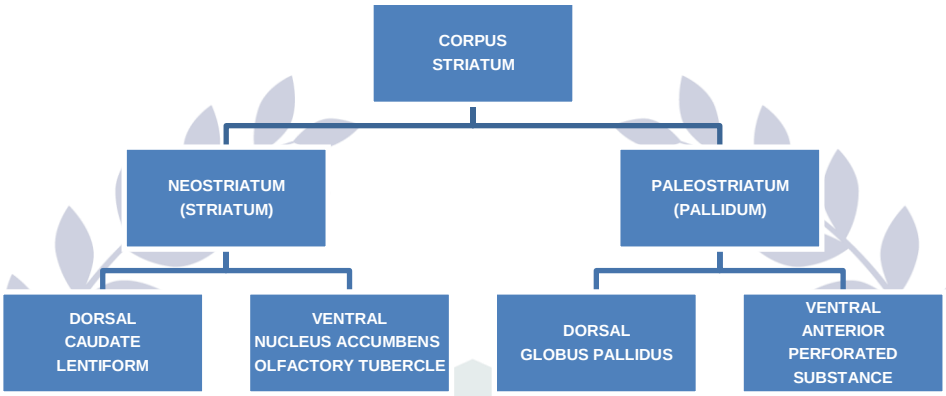
4.B

- The primary visual cortex is mostly located on the medial aspect of the occipital lobe, and is coextensive with the subcortical nerve fibre stria of Gennari in layer IV; hence its Alternative name, the striate cortex. It occupies the upper and lower lips and depths of the posterior part of the calcarine sulcus and extends into the cuneus and lingual gyrus

5.A

- Short association fibres may be entirely intracortical. Many pass subcortically between adjacent gyri, some merely pass from one wall of a sulcus to the other.
- Long association fibres are grouped into bundles, e.g. uncinate fasciculus, cingulum, superior longitudinal fasciculus, inferior longitudinal fasciculus and fronto-occipital fasciculus.

6.D



7.B

The main output of amygdala is through ventral amygdalofugal fibres and striae terminalis

8.A

- The anterior thalamic group is incorporated in the *Papez circuit* of limbic system, and a lesion affecting this group may produce *Korsakoff's syndrome* with loss of recent memory
- Hippocampus fimbria and fornix Mamillary body anterior nucleus of thalamus cingulate gyrus hippocampus

9.A

In Wallenberg's syndrome, occlusion of the posterior inferior cerebellar branch of the vertebral artery leads to loss of pain and temperature sensation in the ipsilateral half of the face with retention of common sensation. Neurosurgery in this region, as early as the 1890s, attempted to alleviate paroxysmal trigeminal neuralgia. The introduction of medullary tractotomy confirmed that dissociated thermoanalgesia of the face was associated with destruction of the tract.

10.A

It is an extension of piamater triangular structure that pierces the arachnoid and is attached to duramater
There are 21 pairs

11.A

The peripheral part of retina is represented in anterior part of visual field.
The primary visual cortex is mostly located on the medial aspect of the occipital lobe, and is coextensive with the subcortical nerve fibre stria of Gennari in layer IV; hence its alternative name, the striate cortex. It occupies the upper and lower lips and depths of the posterior part of the calcarine sulcus and extends into the cuneus and lingual gyrus.
The primary visual cortex receives afferent fibres from the lateral geniculate nucleus via the optic radiation. The latter curves posteriorly and spreads through the white matter of the occipital lobe. Its fibres terminate in strict point-to-point fashion in the striate area. The cortex of each hemisphere receives impulses from two hemi-retinae, which represent the contralateral half of the binocular visual field. Superior and inferior retinal quadrants are connected with corresponding areas of the striate cortex. Thus, the superior retinal quadrants (representing the inferior half of the visual field) are connected with the visual cortex above the calcarine sulcus, and the inferior retinal quadrants (representing the upper half of the visual field) are connected with the visual cortex below the calcarine sulcus. The peripheral parts of the retinae activate the most anterior parts in the visual cortex. The macula impinges upon a disproportionately large posterior part around the occipital pole.

12.C

The left hemisphere usually prevails for verbal and linguistic functions, for mathematical skills and for analytical thinking. The right hemisphere is mostly non-verbal. It is more involved in spatial and holistic or 'Gestalt' thinking, in many aspects of musical appreciation, and in some emotions. Memory also shows lateralization. Thus, verbal memory is primarily a left hemisphere function, while non-verbal memory is represented in the right hemisphere. These asymmetries are relative, not absolute, and vary in degree according to the function and individual concerned. Moreover, they apply primarily to right-handed men. Those men with left-hand preference, or mixed handedness, make up a heterogeneous group, which (as an approximation) shows reduced or anomalous lateralization, rather than a simple reversal of the situation in right-handers. For example, speech representation can occur in either or both hemispheres. Women show less functional asymmetry, on average, than men.

13.C

Collateral sulcus and calcarine sulcus are complete sulcus

The larger, posterior region of the inferior cerebral surface is partly superior to the tentorium but also to the middle cranial fossa. The collateral sulcus starts near the occipital pole, and extends anteriorly and parallel to the calcarine sulcus, separated from it by the lingual gyrus. The lingual gyrus, between the calcarine and collateral sulci, passes into the parahippocampal gyrus, which begins at the isthmus where it is continuous with the cingulate gyrus. Anteriorly, the parahippocampal gyrus continues into the hook-shaped uncus, which lies lateral to the midbrain and posterolateral to the anterior perforated substance. The uncus is part of the piriform cortex of the olfactory system, phylogenetically one of the oldest parts of the cortex, and is separated from the temporal pole by the rhinal sulcus (fissure) which marks the lateral limit of the entorhinal cortex (area

14.C

Nerve fibres of the corpus callosum radiate into the white matter core of each hemisphere, thereafter dispersing to the cerebral cortex. Commissural fibres forming the rostrum extend laterally, below the anterior horn of the lateral ventricle, connecting the orbital surfaces of the frontal lobes. Fibres in the genu curve forwards, as the forceps minor, to connect the lateral and medial surfaces of the frontal lobes. Fibres of the trunk pass laterally, intersecting with the projection fibres of the corona radiata to connect wide neocortical areas of the hemispheres. Fibres of the trunk and splenium, which form the roof and lateral wall of the posterior horn and the lateral wall of the inferior horn of the lateral ventricle, constitute the tapetum. The remaining fibres of the splenium curve back into the occipital lobes as the forceps major

15.A

Pontomedullary junction -6,7,8 cranial nerves emerge

16.A

Red nucleus is located in mmidbrain at superior colliculus

The red nucleus is a pink, ovoid mass, approximately 5 mm in diameter and lying dorsomedial to the substantia nigra. The tint appears only in fresh material and is caused by a ferric iron pigment in its multipolar neurones. The latter are of varying size and their relative proportions and arrangement vary between species. In primates the magnocellular element is decreased, and there is a reciprocal increase in the size of the parvocellular component. Small multipolar neurones occur in all parts of the nucleus. In man, the larger neurones are restricted to the caudal part of the nucleus and have been estimated to be as few as 200 in number. The magnocellular element is considered phylogenetically old, which accords with the parvocellular predominance in primates. Rostrally, the red nucleus is poorly demarcated, and it blends into the reticular formation and caudal pole of the interstitial nucleus. It is traversed and surrounded by fascicles of nerve fibres, including many from the oculomotor nucleus.

17.D

- SE-III,IV,VI,XII
- SVE-V,VII,NA[IX,X,XI]
- GVE-EWN,SSL,ISL,DNV
- GVA/SVA-NTS
- GSA-V
- SSA-VIII

18.D
The granular layer consists of the somata of granule cells and the initial segment of their axons; dendrites of granule cells; branching terminal axons of afferent mossy fibres; climbing fibres passing through the granular layer *en route* to the molecular layer; and the somata, basal dendrites and complex axonal ramifications of Golgi neurones. Cerebellar glomeruli are synaptic rosettes consisting of a mossy fibre terminal that forms excitatory synapses upon the dendrites of both granule cells and Golgi cells
Of the five cell types to be described, the first four are inhibitory, liberating γ-aminobutyric acid (GABA), and the fifth is excitatory, liberating L-glutamate.

19.B
The skeletal motor fibers of the lower motor neurons in the facial nerve form an internal genu around the abducens and, if compressed, might affect the patient's ability to wrinkle the forehead on the side of the tumor.

20.B
- The patient has the signs of Gerstmann syndrome, which affects the angular gyrus of the dominant parietal lobe

21.A
The posterior cerebral artery supplies primary visual cortex and, if occluded, results in a homonymous hemianopsia with macular sparing. All other choices are seen in occlusion of either the anterior (bladder incontinence, transcortical apraxia) or middle cerebral artery (alexia with agraphia, acalculia)

22.D
The spinothalamic tract is the only sensory pathway listed that mediates pain. The fasciculus gracilis and cuneatus mediate conscious proprioception, not pain; the spinocerebellar tract mediates unconscious (muscle spindle and Golgi tendon organ inputs to cerebellum); and the tectospinal tract is a descending tract, mediating no sensory information to the brain

23.C
Middle cerebral peduncle –corticopontocerebellar fibres

24.C
Suprachiasmatic nucleus-circardian rhythm

25.A
VPL/VPM-Sensory nuclei
VA,VL-Motor nuclei

26.D

27.B
- The patient suffers from unilateral neglect, where she ignores the entire left side of her visual and somatosensory world, and presents with constructional apraxia. Neglect is seen in lesions of the nondominant or right parietal lobe supplied by branches of the right middle cerebral artery.

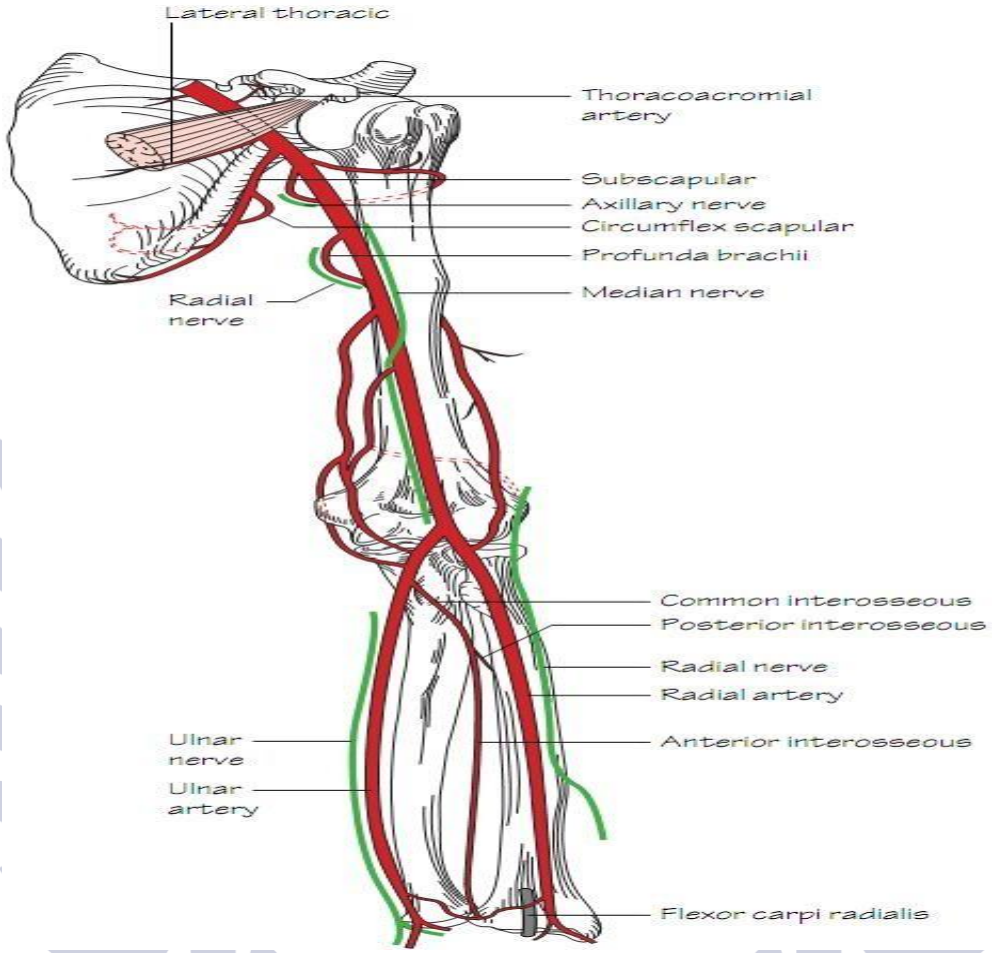
28.B

29.D
Ipsilateral fibres to 2,3,5 of LGB
Contralteral fibres to 1,4,6 of LGB

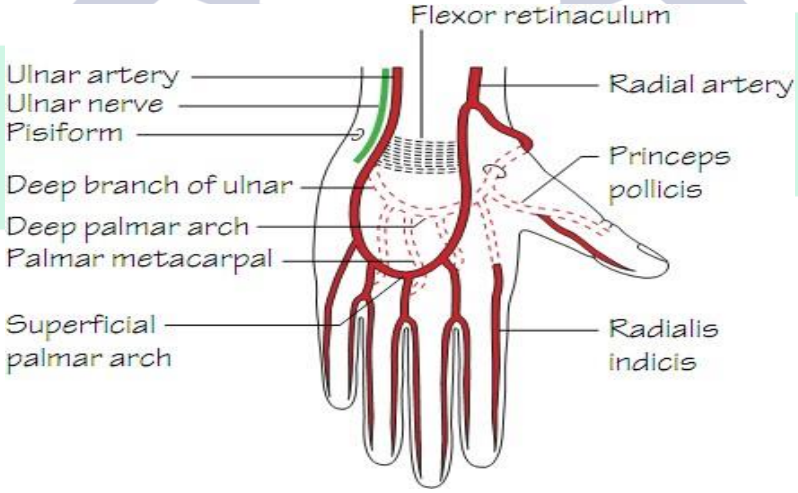
30.D
- Uncrossed tracts
- Anterior corticospinal
- Medial reticulospinal
- Posterior spinocerebellar

Posterior column

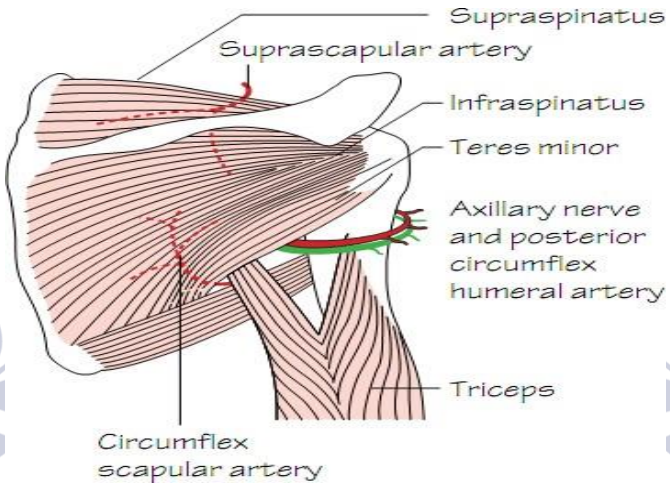
UPPER LIMB



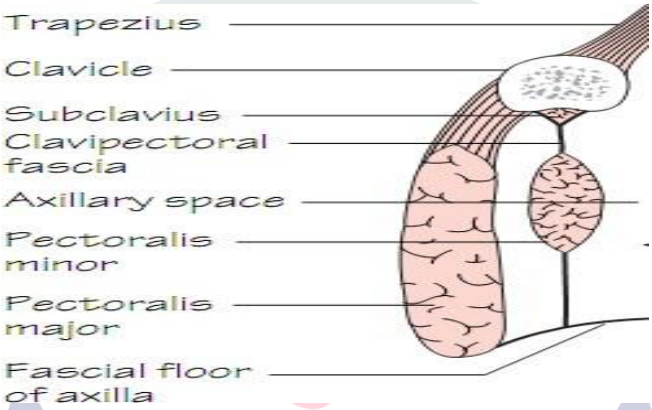
UPPER LIMB ARTERIES



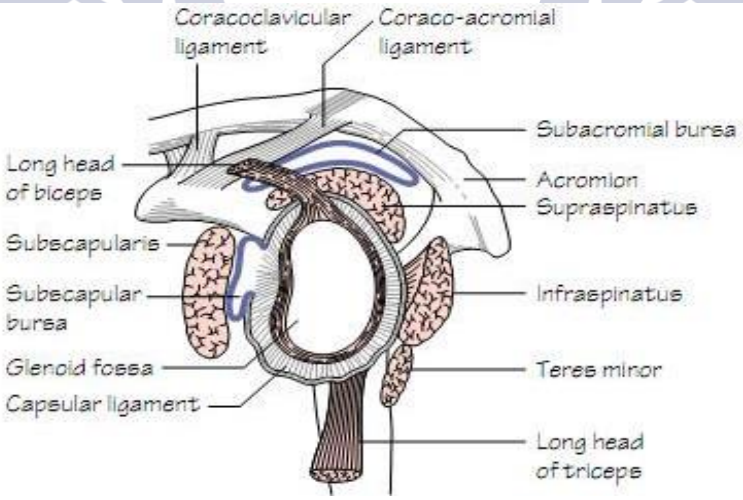
PALMAR ARCH



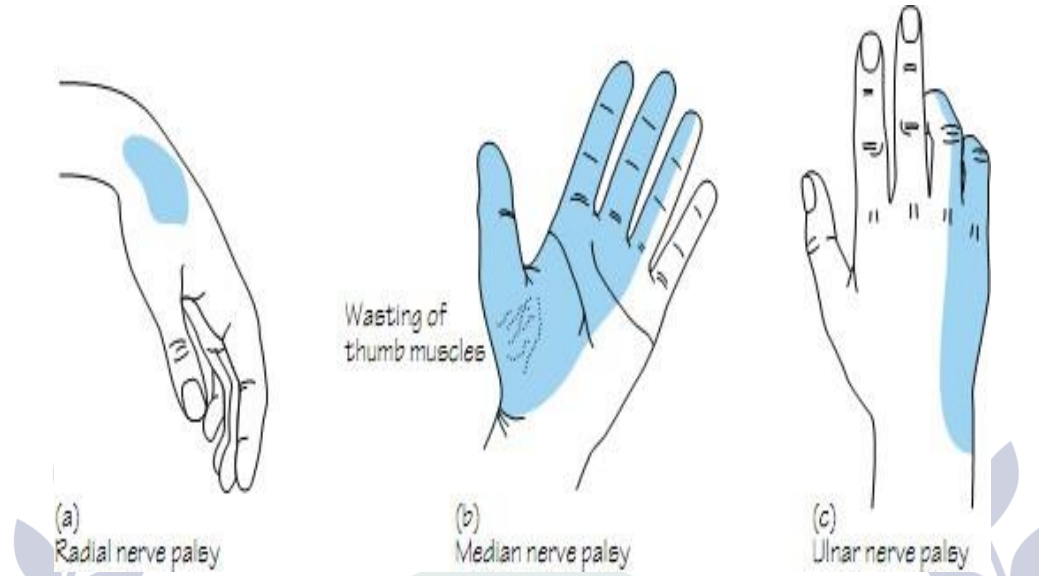
QUADRANGULAR AND TRIANGULAR SPACES

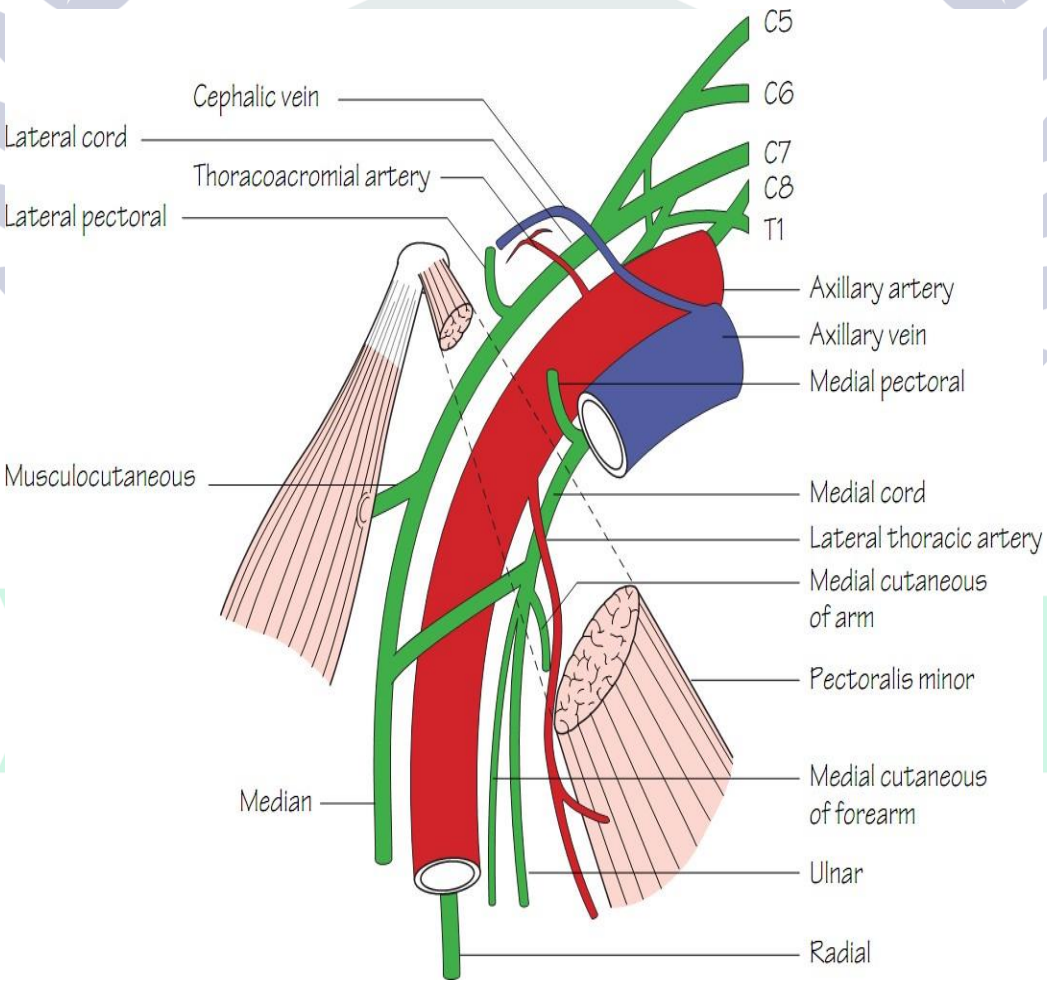


CLAVIPECTORAL FASCIA



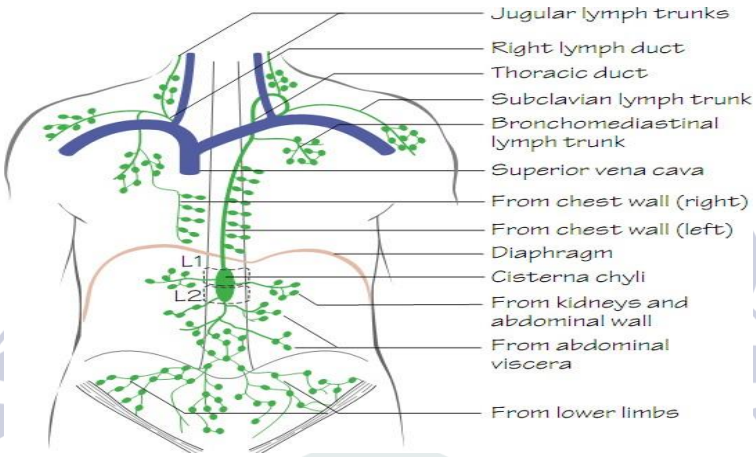
SHOULDER JOINT



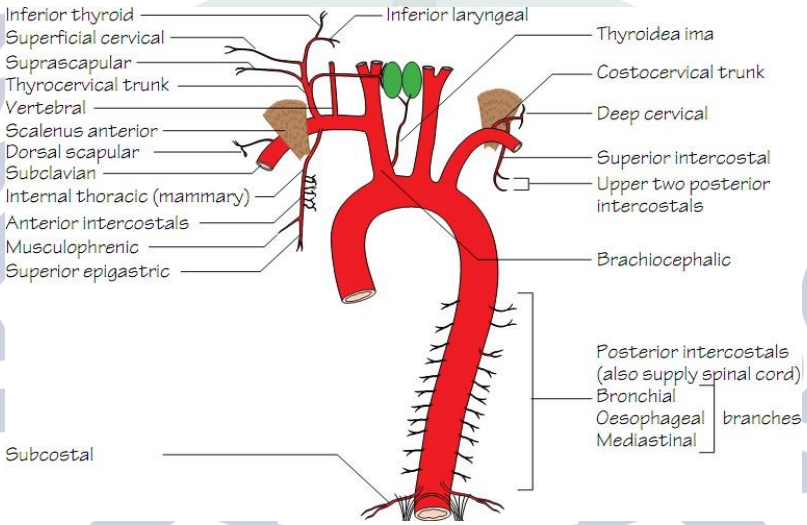


BRACHIAL PLEXUS WITH AXILLARY ARTERY

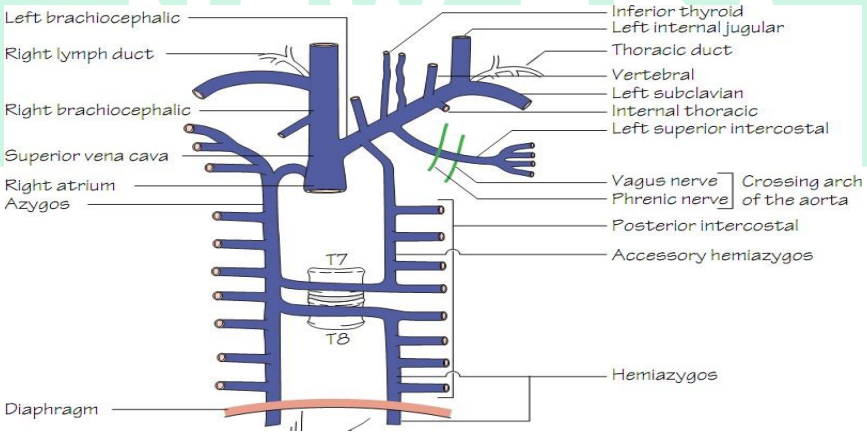
THORAX



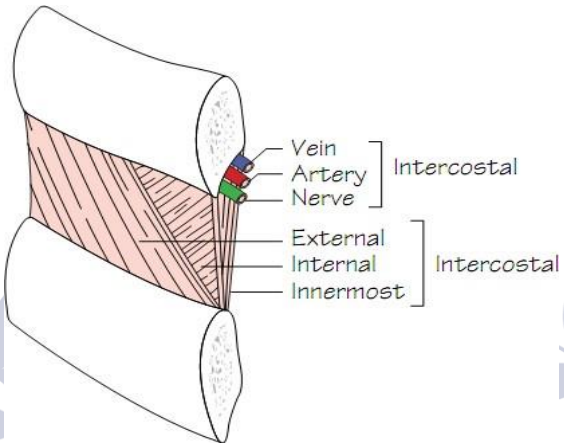
THORACIC DUCT



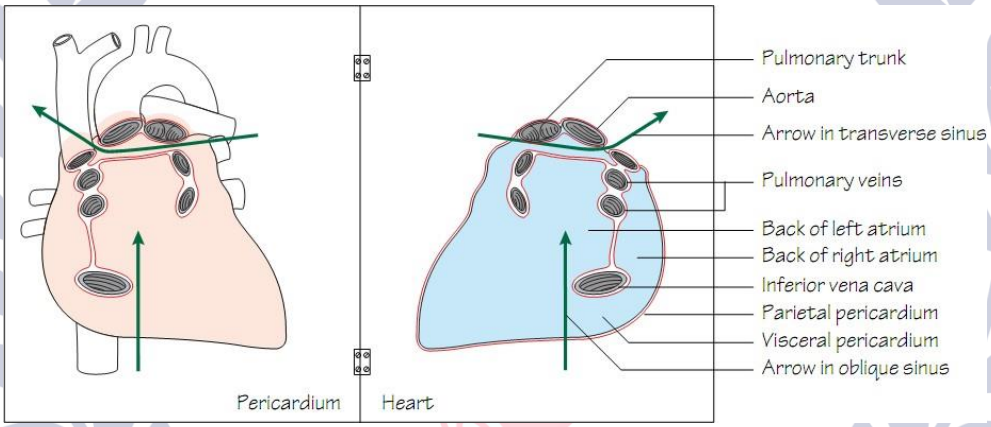
ARCH OF AORTA WITH BRANCHES



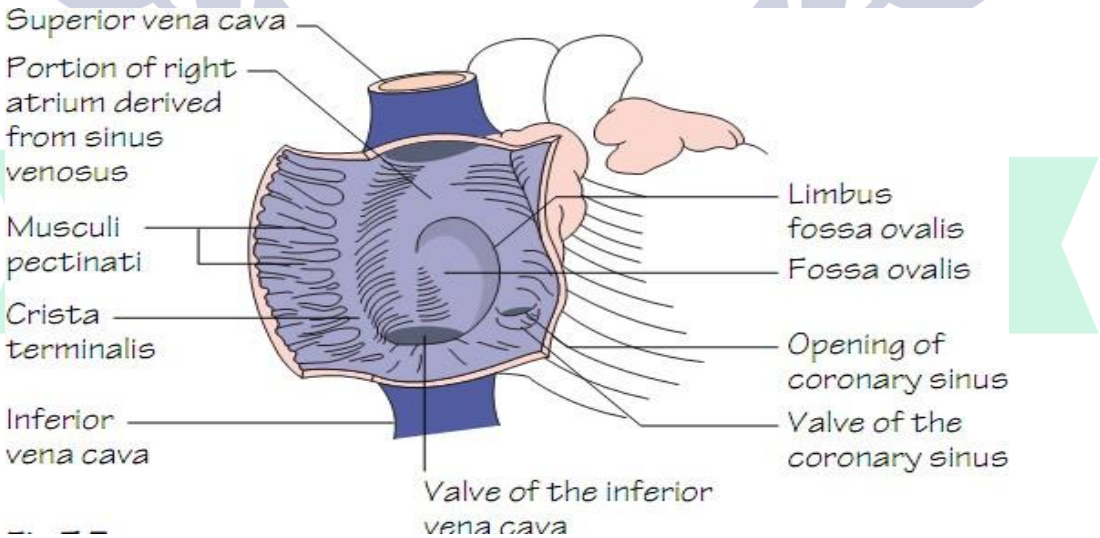
AZYGOS VEIN



INTERCOSTAL SPACE

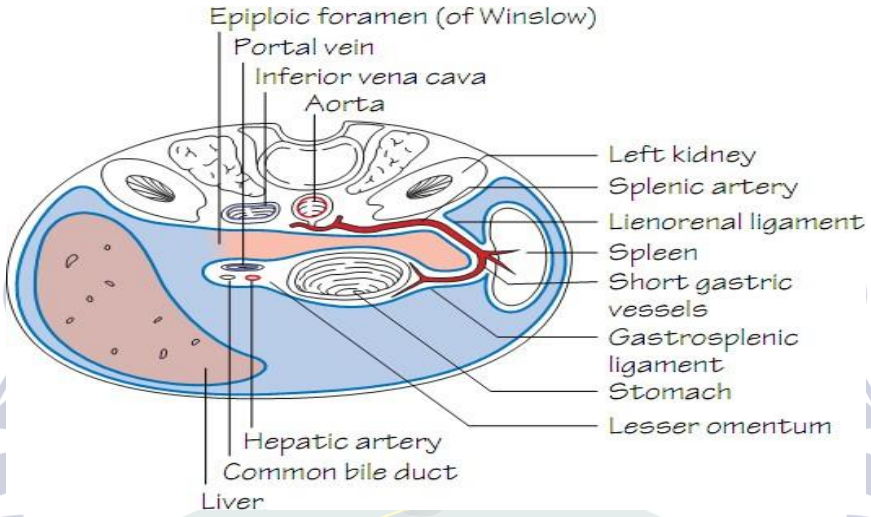


TRANSVERSE AND OBLIQUE SINUS

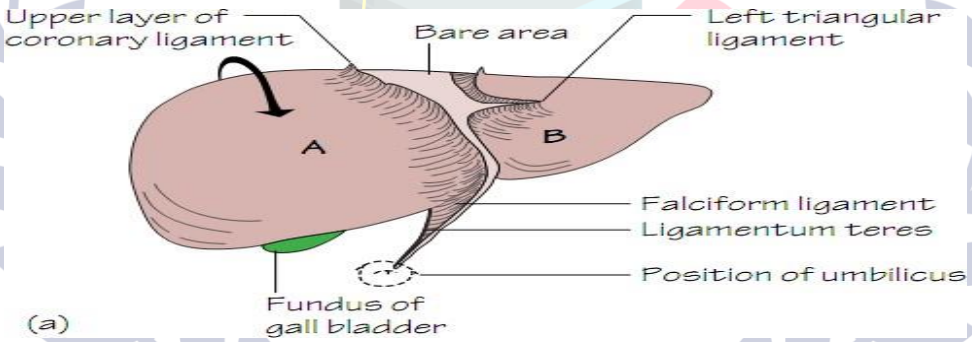


RIGHT ATRIUM INTERIOR

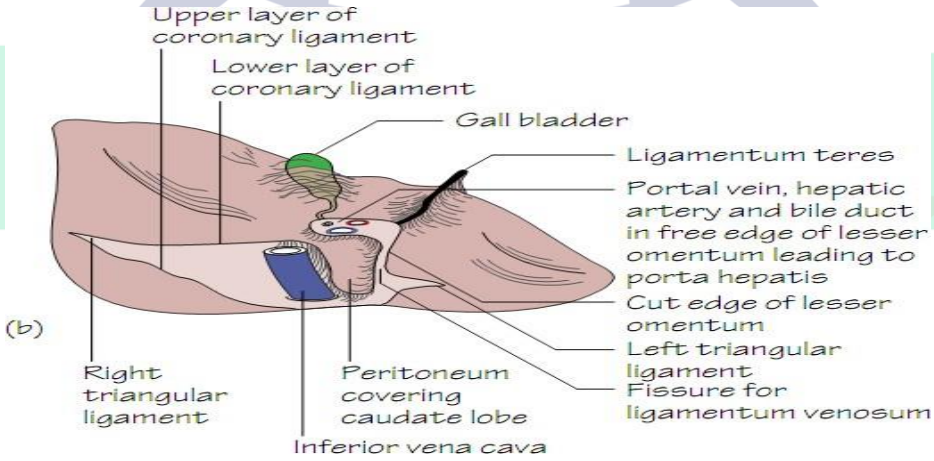
ABDOMEN PELVIS



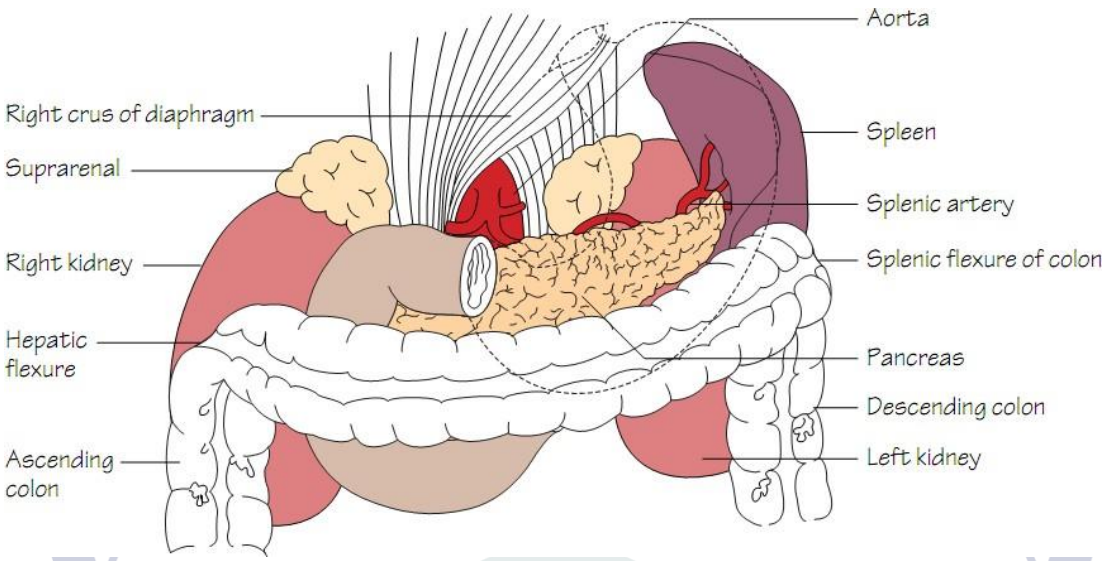
EPIPLOIC FORAMEN



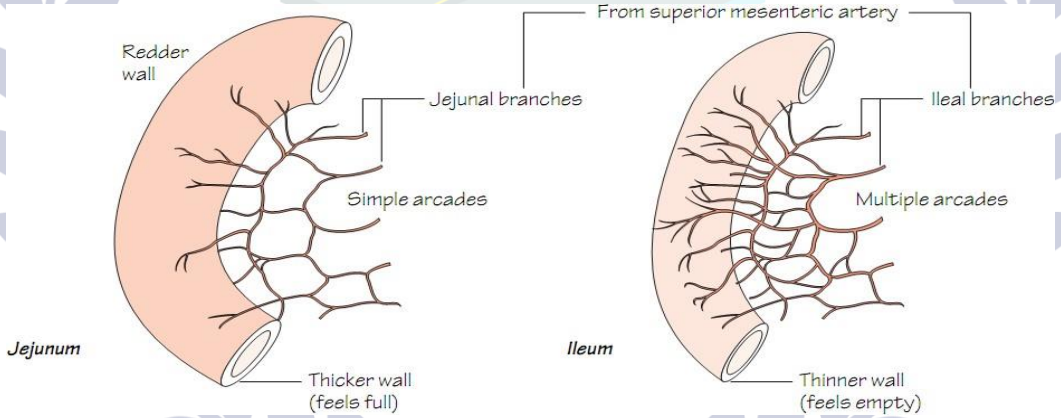
LIVER LIGAMENTS



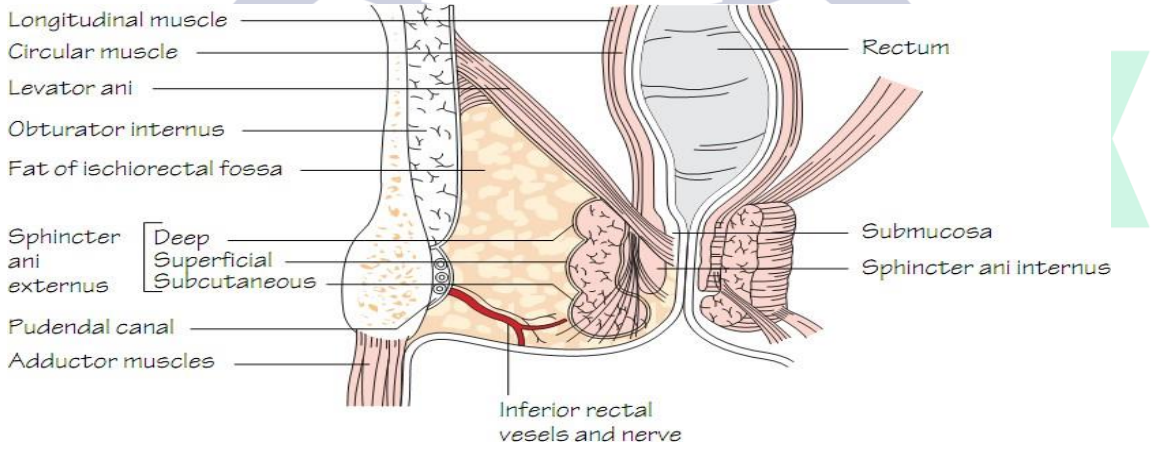
LIVER LIGAMENTS 1



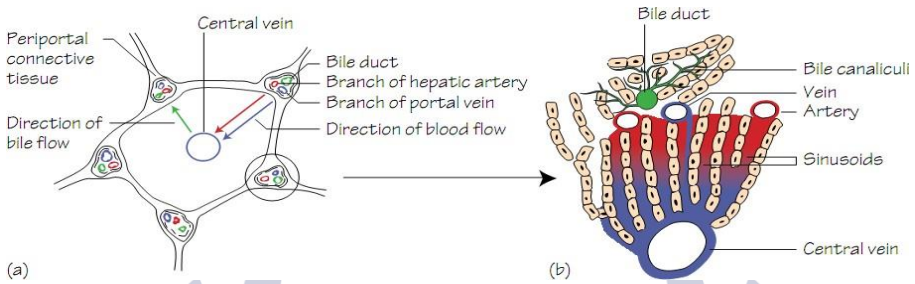
STOMACH BED RELATION

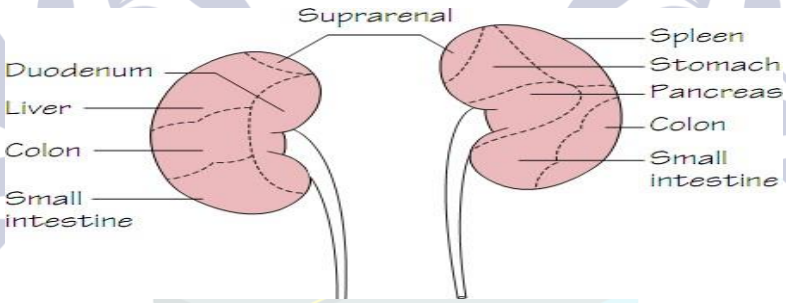


JEJUNUM & ILEUM DIFFERENCES



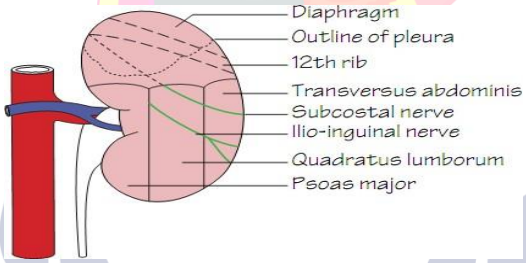
ISCHIORECTAL FOSSA AND ANAL SPHINCTERS



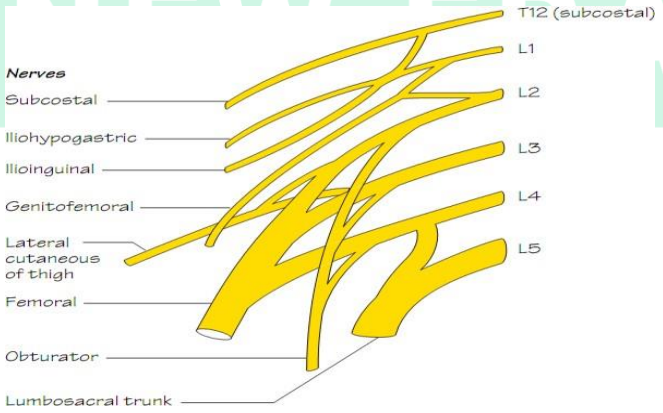


LIVER BILE AND BLOOD FLOW

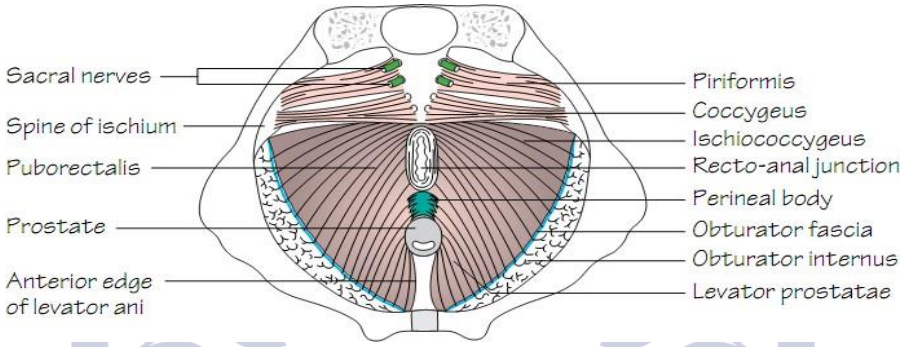
KIDNEY ANTERIOR RELATION

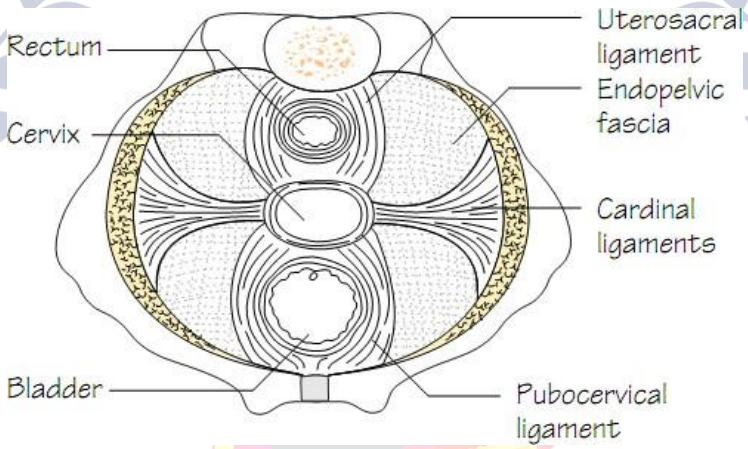


KIDNEY POSTERIOR RELATION

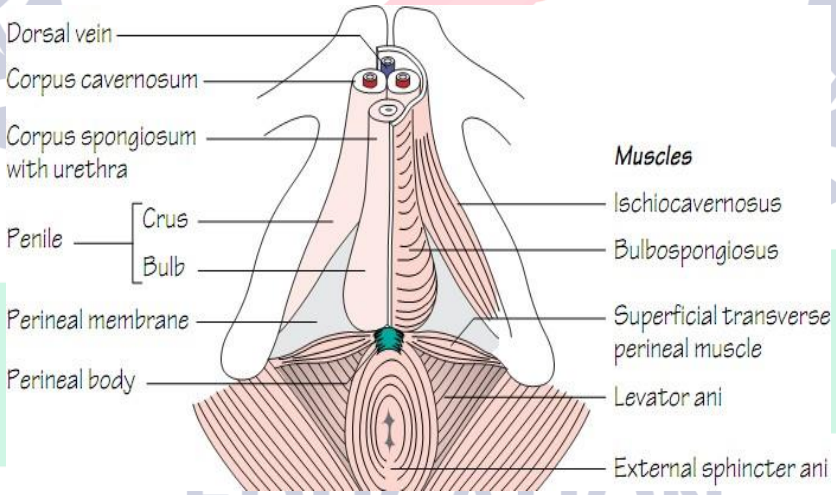


LUMBAR PLEXUS

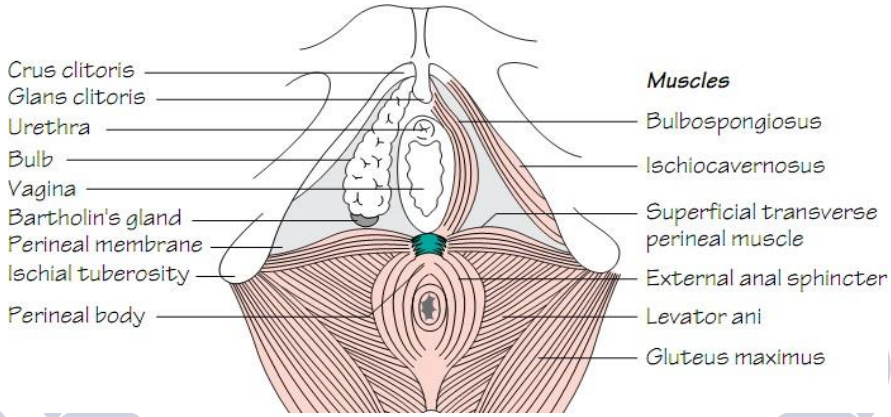


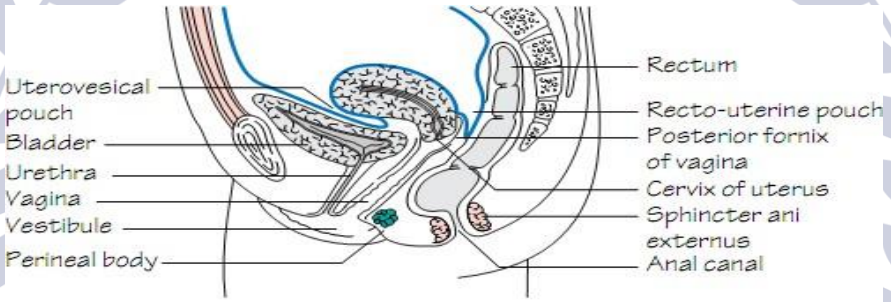


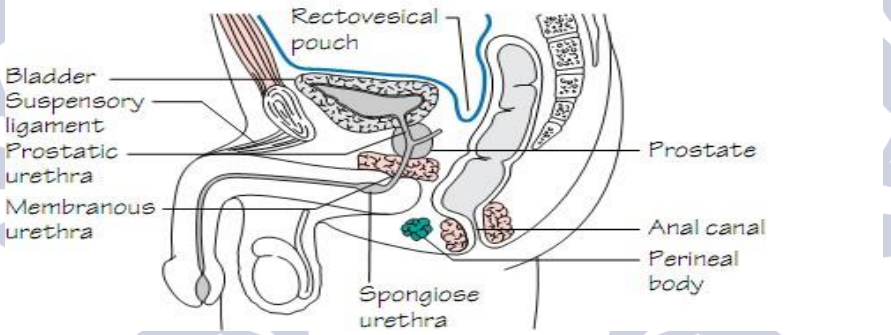
UTERUS SUPPORTS



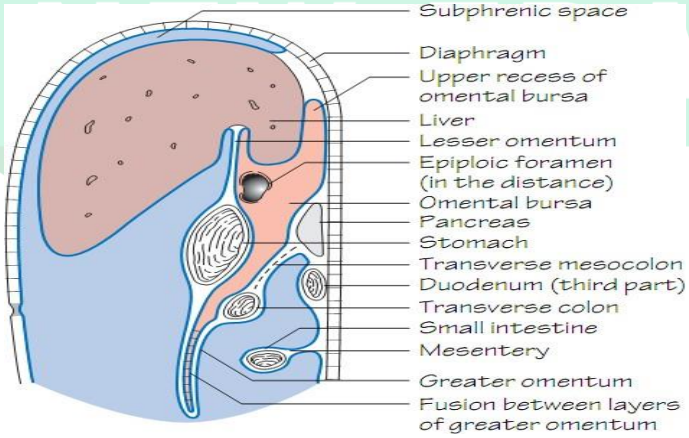
PERINEAL BODY ATTACHMENTS







SAGITAL SECTION MALE AND FEMALE PELVIS



STRUCTURE	LEVEL
Oropharynx and Soft Palate with Mouth Open	C2 vertebra
Hyoid Bone	C3 vertebra
Thyroid Cartilage	C4 & C5 vertebrae
Bifurcation Common Carotid Artery	C3 & C4 vertebral junction (disc)
Cricoid Cartilage	C6 vertebra
Thyroid Lobe (Superior Extent)	Oblique line of thyroid cartilage
Isthmus Thyroid Gland	Overlies the second through fourth tracheal rings
Thyroid Lobe (Inferior Extent)	Sixth tracheal ring
Superior Angle of Scapula	Overlies part of second rib - First intercostal space superior to angle
Spine at Root of Scapula (Medially)	Opposite third thoracic spine
Inferior Angle of Scapula'	Overlies part of seventh rib - Seventh intercostal space inferior to angle
Jugular (Suprasternal) Notch	T2 & T3 vertebral junction
Sternal Angle (Angle of Louis|Manubriosternal Joint)	T4 & T5 vertebral junction
Tracheal Bifurcation	T4 & T5 vertebral junction
Concavity and Ends of Aortic Arch	T4 & T5 vertebral junction
Azygos Vein Enters Superior Vena Cava	T4 & T5 vertebral junction
Origin Great Vessels (eg. Brachiocephalic Trunk, etc.)	Approximately center of manubrium or first intercostal space which would put it at the level of the T3 & T4 vertebral junction
Manubrium	T5 to T8 vertebrae
Xiphisternal Joint (Refer to Plane)	T9 vertebra (typically)

Superior Mediastinum	From superior thoracic inlet to the horizontal plane passing from the sternal angle to the inferior border of T4 vertebra
Pulmonary valve	L second intercostal space, medial
Aortic valve	R second intercostal space
Tricuspid valve	R lower sternum
Nipple in Male	Fourth intercostal space in midclavicular line
Apex of Heart (mitral valve)	Fifth intercostal space
Base of Heart (Supine Position)	T5 to T8 vertebrae
(Erect Position)	T6 to T9 vertebrae
greater splanchnic n.	T5-T9 sym ganglia
Oblique fissure of lung	T6
Vena Caval Foramen	T8 vertebra
Esophageal Hiatus	T I 0 vertebra
Lesser splanchnic n.	T10-T11 sym ganglia
Least splanchnic n.	T12 sym ganglia
Aortic Hiatus	T 12 vertebra
Median Arcuate Ligament of Respiratory Diaphragm	T 12 & L I vertebral j unction
Celiac Trunk	LI vertebra (superior border)
Superior Mesenteric Artery	LI vertebra (inferior third)
Inferior Mesenteric Artery	L3 vertebra (subcostal plane)
Horizontal (Third) Part of Duodenum	L3 vertebra (subcostal plane)
Right Kidney - Superior Pole	T12 vertebra (superior border)
Inferior Pole	L3 vertebra
Hilum	LI vertebra (transpyloric plane)
Left Kidney - Superior Pole	T12 vertebra (superior border)
Inferior Pole	L3 vertebra
Hilum	LI vertebra (transpyloric plane)

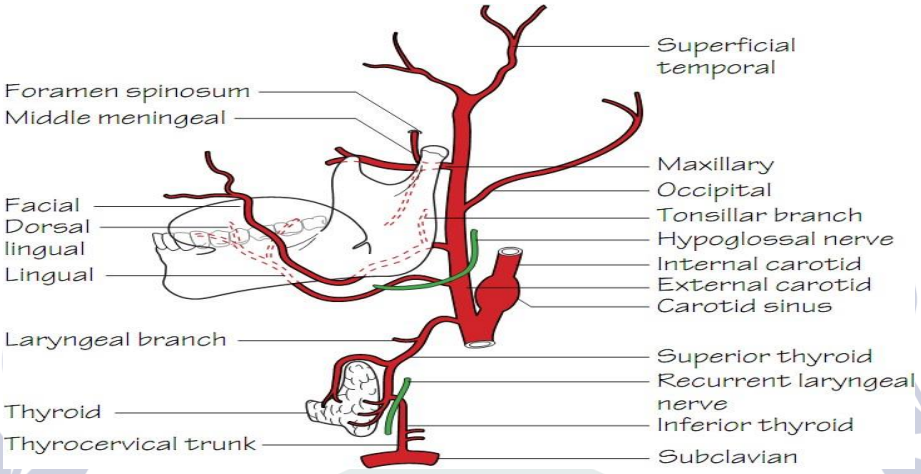
Pancreas - Head	L2 & L3 vertebrae
Duodenum	
- First Part	L I vertebra
- Second Part	LI, L2 & L3 vertebrae (right side)
- Third Part	L3 vertebra
Umbilicus (Supine/Recumbent Position)	Disc between L3 & L4 vertebrae
Bifurcation Abdominal Aorta	L4 vertebra
Origin of Inferior Vena Cava	L5 (transtubercular plane)
Anterior Superior Iliac Spine	S I vertebra
Posterior Superior Iliac Spine	S2 vertebra

II. BODY PLANES

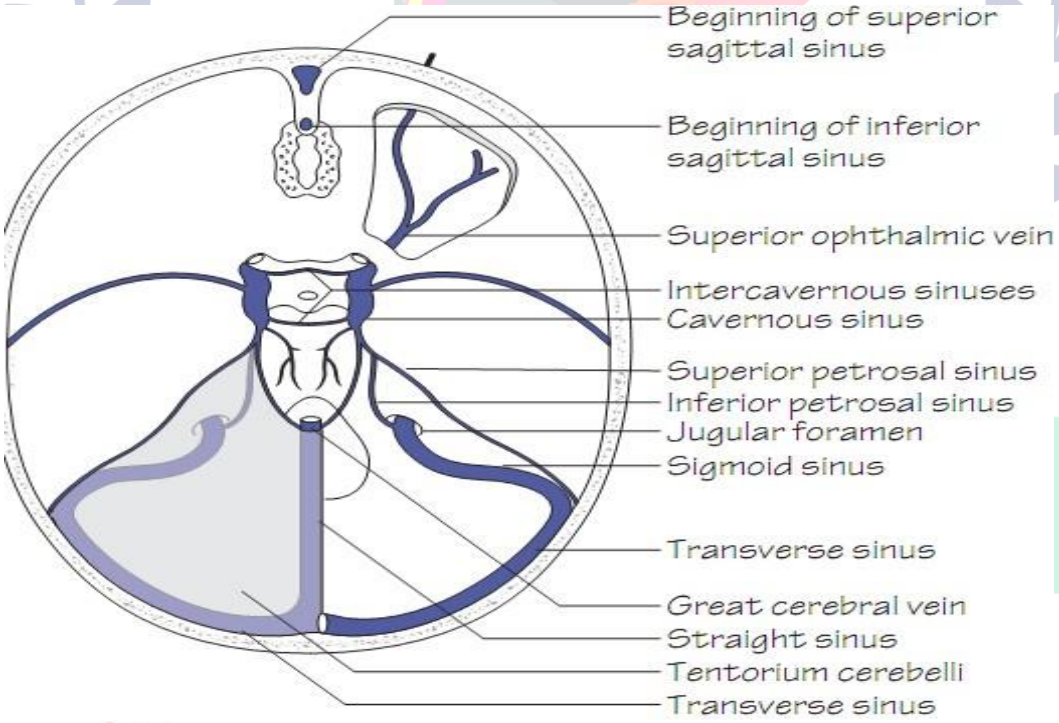
- **Transverse Thoracic Plane -** a horizontal line that anteriorly passes through the sternal angle and posteriorly through the T4 & T5 vertebral junction.
- **Xiphisternal Plane -** marks the anterior, inferior limit of thoracic cavity, the superior surface of the liver, the respiratory diaphragm and the inferior border of the heart. It is typically at the level of the T9 vertebra.

• **Transpyloric Plane - Supine Position**	LI vertebra (inferior border)
• **Hila Both Kidneys**	L I vertebra (transpyloric plane)
• **Superior Mesenteric Artery**	L 1 vertebra (transpyloric plane)
• **Neck, Body and Head of Pancreas**	L I vertebra (transpyloric plane)
• **Transpyloric Plane (Erect Position)**	L2 to L4 vertebral levels depending on person
• **Subcostal Plane**	L3 vertebra (superior border or transacts it)
• **Transumbilical Plane**	Disc between L3 & L4 vertebrae
• **Supracristal Plane (Highest Point on Iliac Crest)**	L4 vertebra
• **Transtubercular Plane**	L5 vertebra

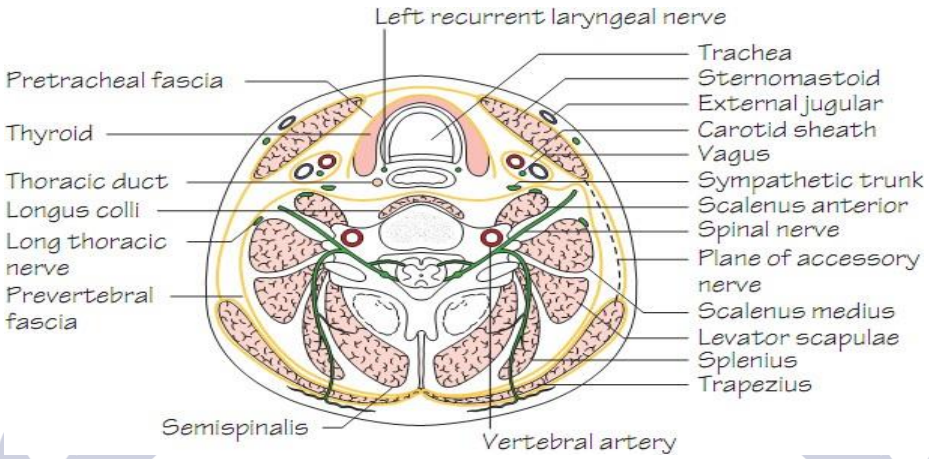
HEAD AND NECK



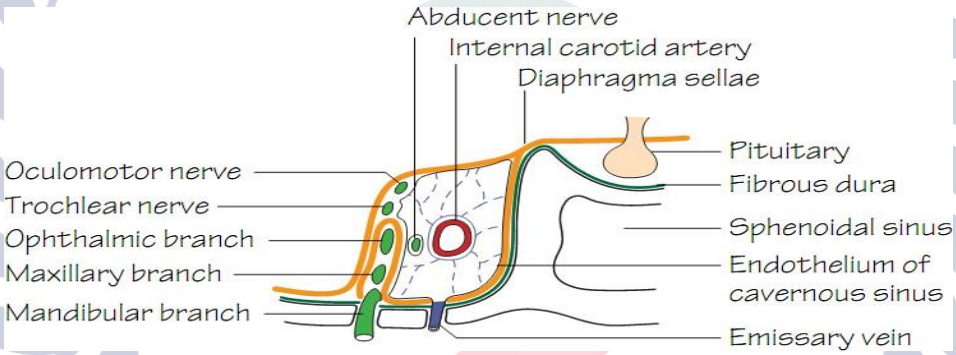
EXTERNAL CAROTID ARTERY



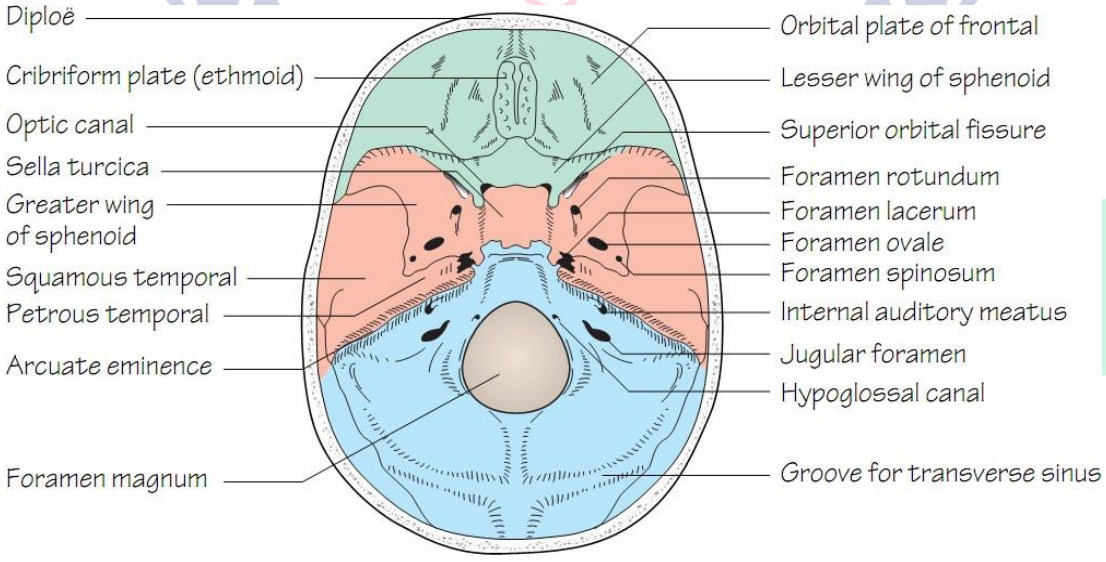
DURAL VENOUS SINUSES



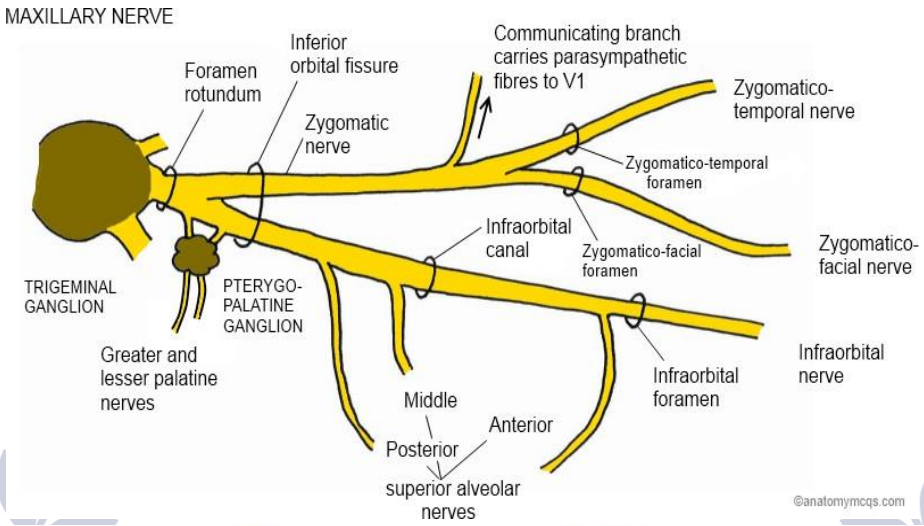
FASCIA COLLI

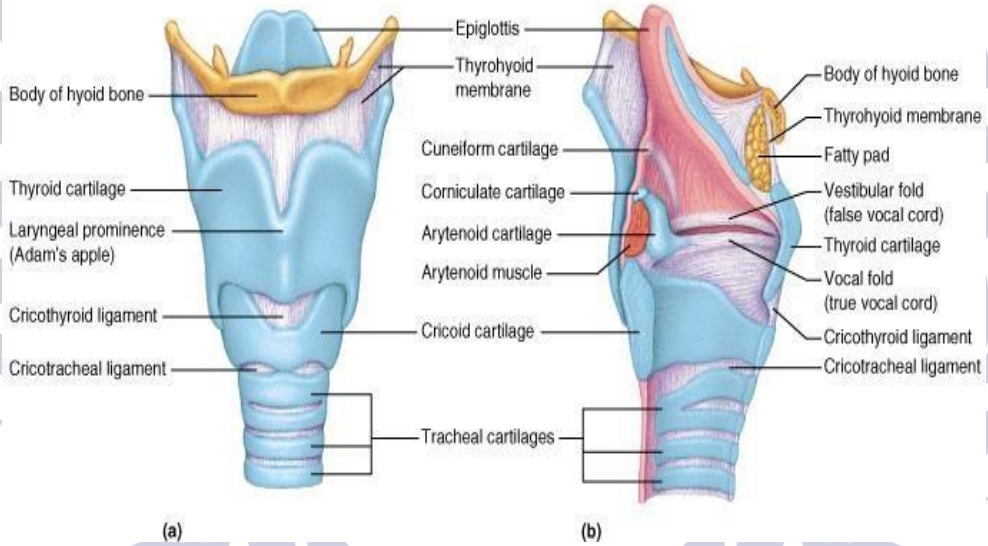


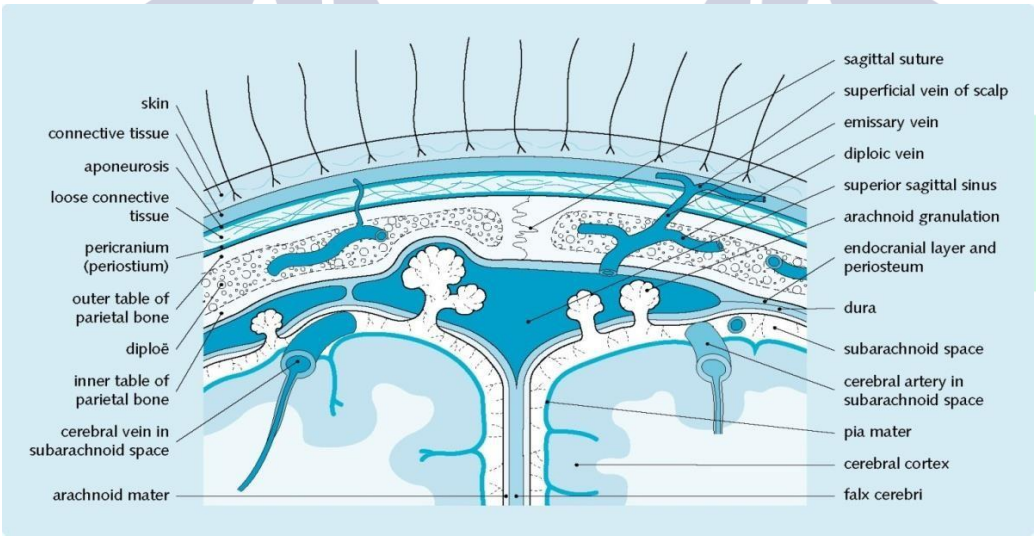
CAVERNOUS SINUS

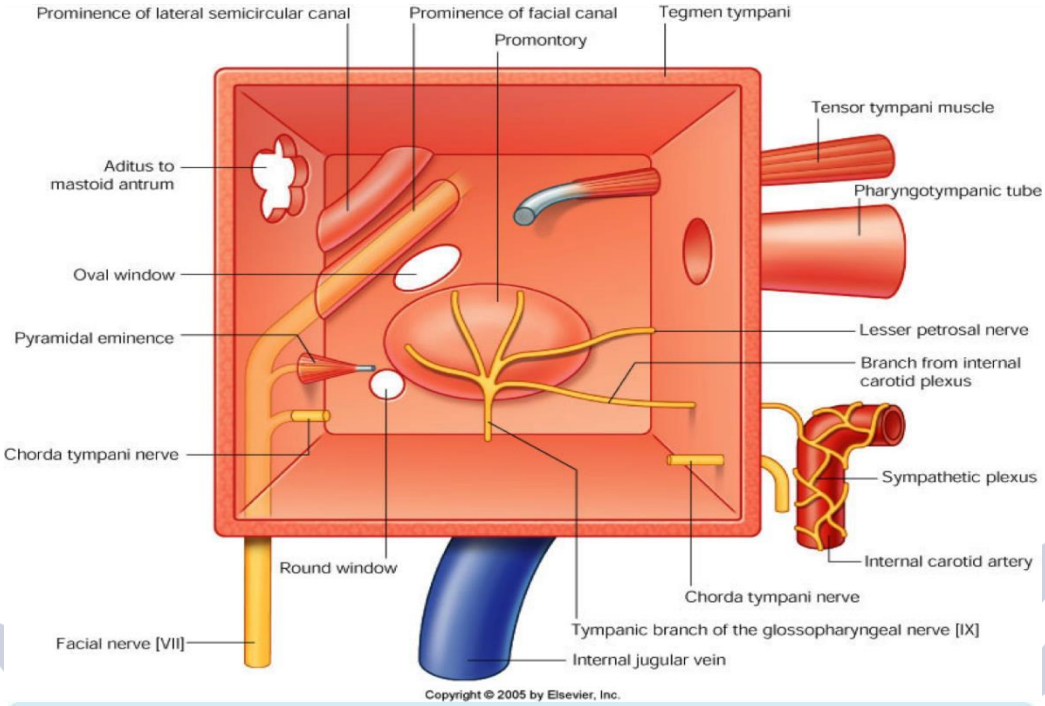


INTERIOR OF SKULL


MAXILLARY NERVE
Foramen rotundum
Inferior orbital fissure
Zygomatic nerve
Communicating branch carries parasympathetic fibres to V1
Zygomatico-temporal nerve
Zygomatico-temporal foramen
Infraorbital canal
Zygomatico-facial foramen
Zygomatico-facial nerve
TRIGEMINAL GANGLION
PTERYGO-PALATINE GANGLION
Greater and lesser palatine nerves
Infraorbital foramen
Infraorbital nerve
Middle
Anterior
Posterior
superior alveolar nerves
©anatomymcqs.com


Epiglottis
Thyrohyoid membrane
Body of hyoid bone
Thyroid cartilage
Laryngeal prominence (Adam's apple)
Cricothyroid ligament
Cricotracheal ligament
Cricoid cartilage
Tracheal cartilages
Cuneiform cartilage
Corniculate cartilage
Arytenoid cartilage
Arytenoid muscle
Body of hyoid bone
Thyrohyoid membrane
Fatty pad
Vestibular fold (false vocal cord)
Thyroid cartilage
Vocal fold (true vocal cord)
Cricothyroid ligament
Cricotracheal ligament
(a)
(b)


skin
connective tissue
aponeurosis
loose connective tissue
pericranium (periostium)
outer table of parietal bone
diploë
inner table of parietal bone
cerebral vein in subarachnoid space
arachnoid mater
sagittal suture
superficial vein of scalp
emissary vein
diploic vein
superior sagittal sinus
arachnoid granulation
endocranial layer and periosteum
dura
subarachnoid space
cerebral artery in subarachnoid space
pia mater
cerebral cortex
falx cerebri


Prominence of lateral semicircular canal
Prominence of facial canal
Promontory
Tegmen tympani
Tensor tympani muscle
Aditus to mastoid antrum
Pharyngotympanic tube
Oval window
Pyramidal eminence
Lesser petrosal nerve
Branch from internal carotid plexus
Chorda tympani nerve
Sympathetic plexus
Internal carotid artery
Round window
Chorda tympani nerve
Tympanic branch of the glossopharyngeal nerve [IX]
Facial nerve [VII]
Internal jugular vein
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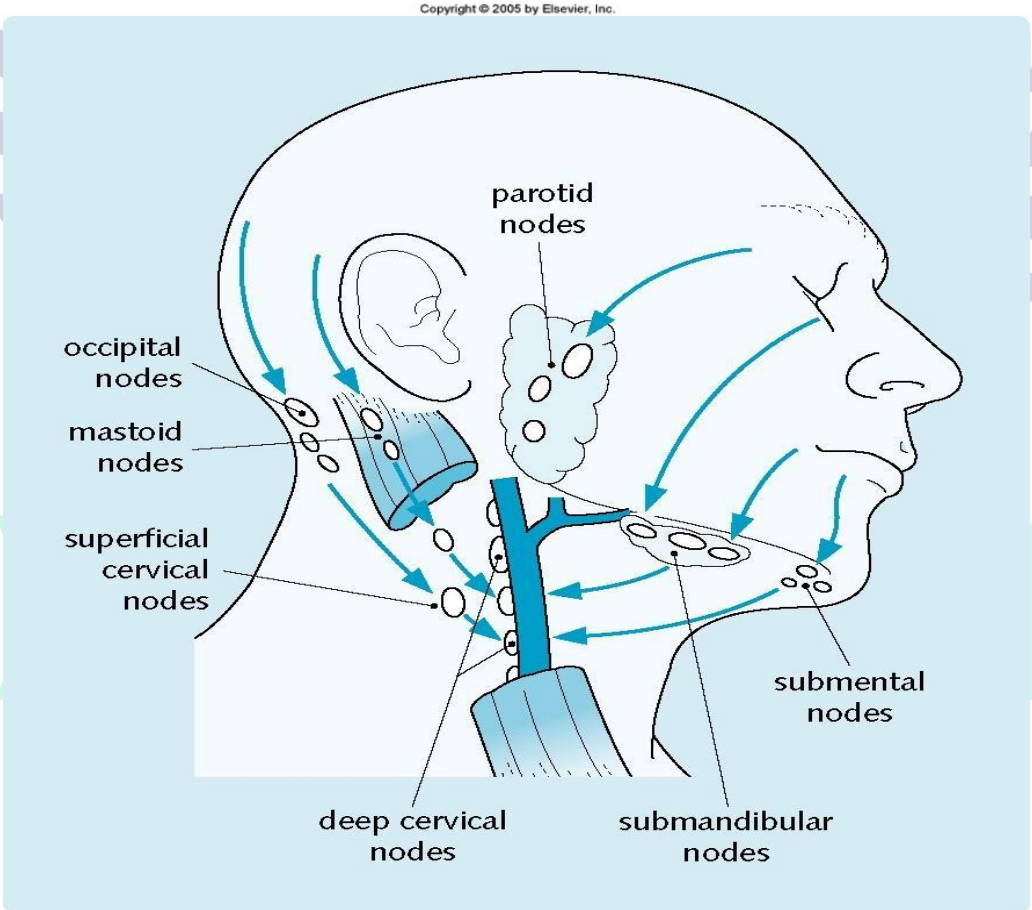
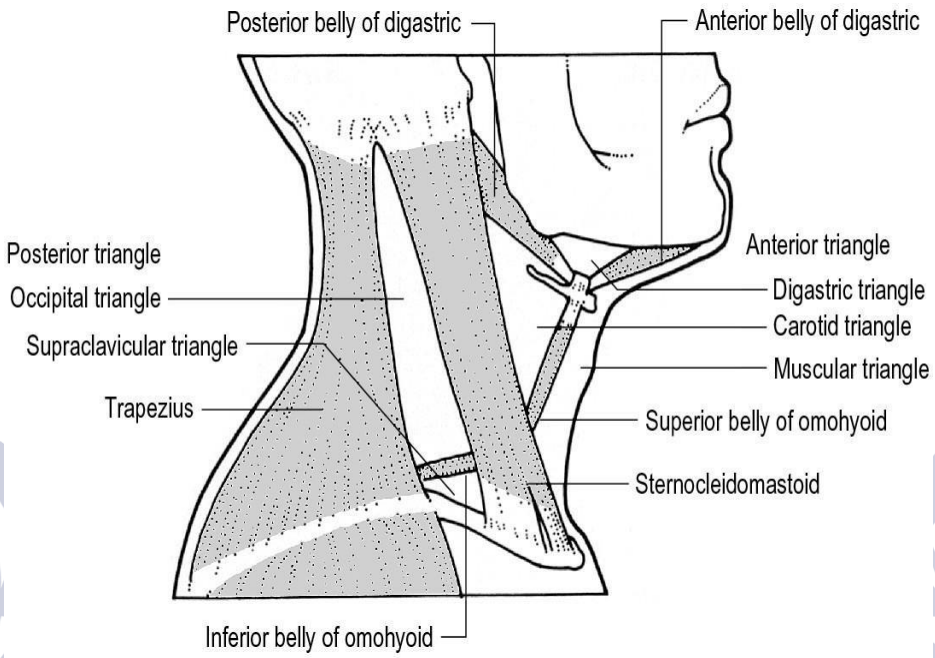
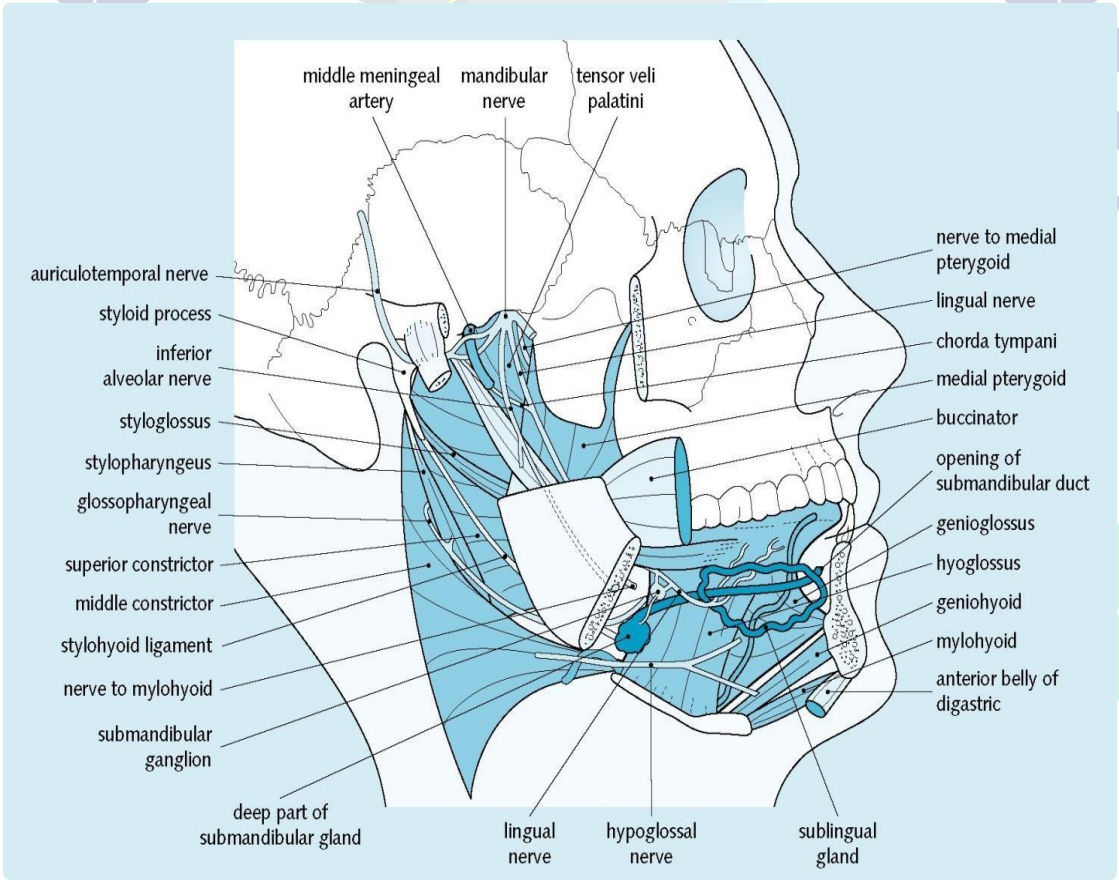
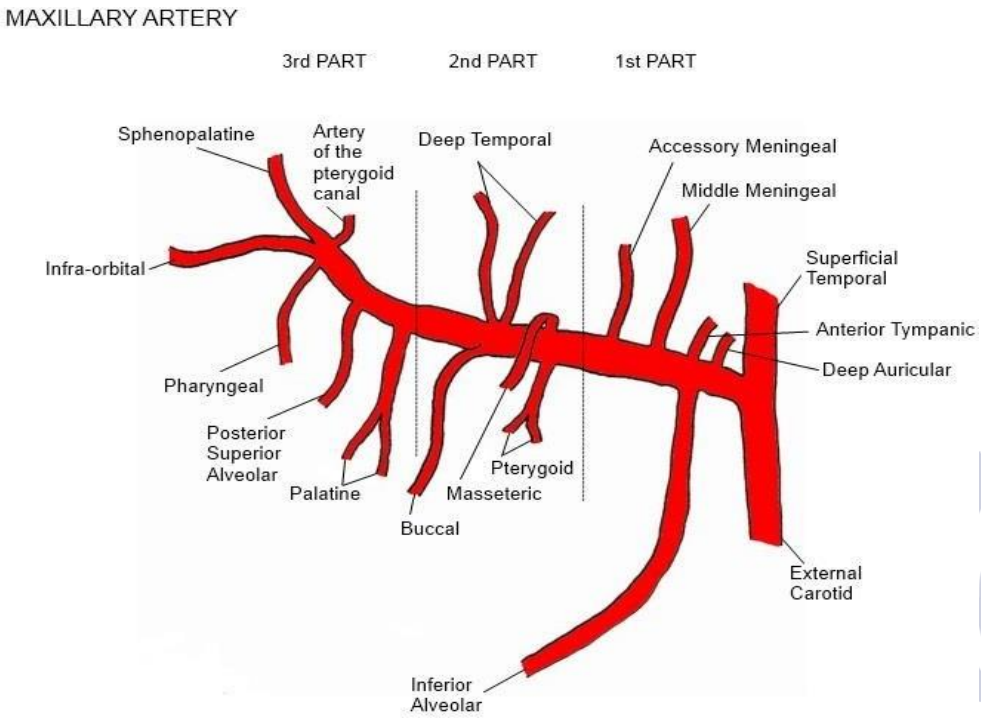
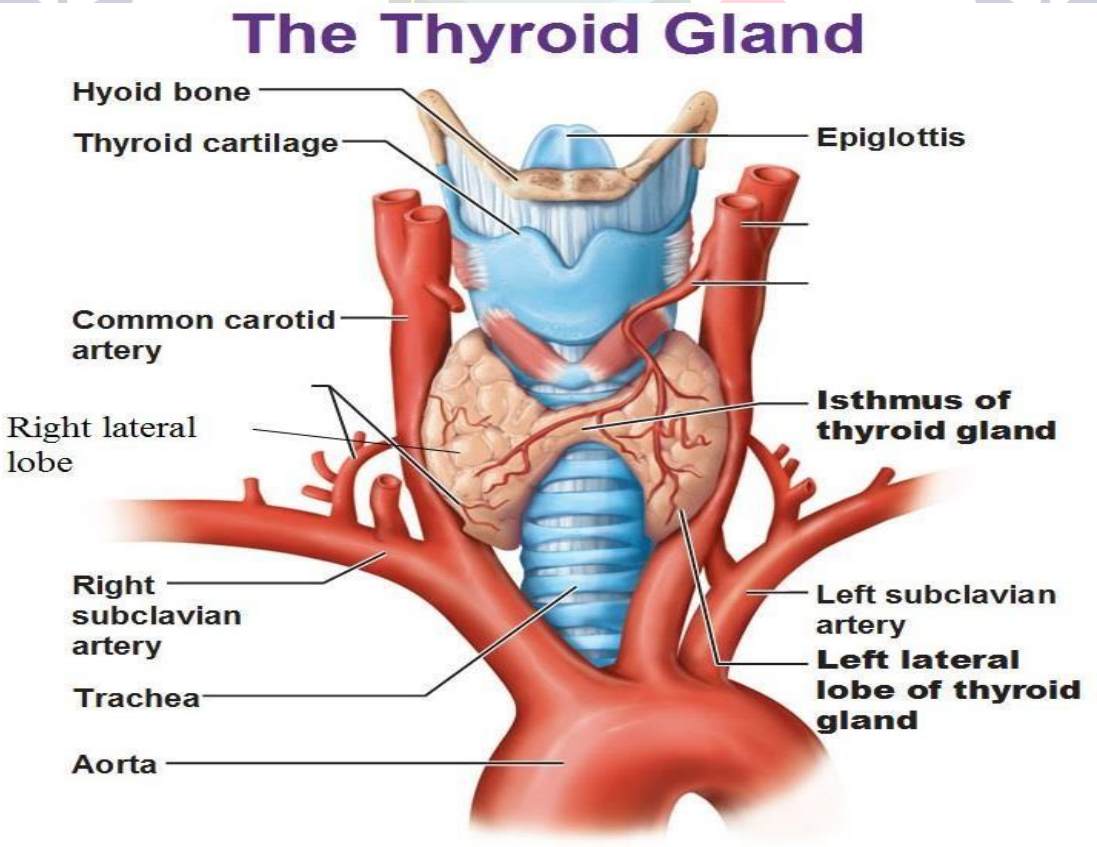

parotid nodes
occipital nodes
mastoid nodes
superficial cervical nodes
submental nodes
deep cervical nodes
submandibular nodes


Posterior belly of digastric
Anterior belly of digastric
Posterior triangle
Occipital triangle
Supraclavicular triangle
Trapezius
Anterior triangle
Digastric triangle
Carotid triangle
Muscular triangle
Superior belly of omohyoid
Sternocleidomastoid
Inferior belly of omohyoid


middle meningeal artery
mandibular nerve
tensor veli palatini
auriculotemporal nerve
styloid process
inferior alveolar nerve
styloglossus
stylopharyngeus
glossopharyngeal nerve
superior constrictor
middle constrictor
stylohyoid ligament
nerve to mylohyoid
submandibular ganglion
deep part of submandibular gland
lingual nerve
hypoglossal nerve
sublingual gland
nerve to medial pterygoid
lingual nerve
chorda tympani
medial pterygoid
buccinator
opening of submandibular duct
genioglossus
hyoglossus
geniohyoid
mylohyoid
anterior belly of digastric


MAXILLARY ARTERY
3rd PART
2nd PART
1st PART
Sphenopalatine
Artery of the pterygoid canal
Deep Temporal
Accessory Meningeal
Middle Meningeal
Infra-orbital
Superficial Temporal
Anterior Tympanic
Deep Auricular
Pharyngeal
Posterior Superior Alveolar
Palatine
Pterygoid
Masseteric
Buccal
External Carotid
Inferior Alveolar


The Thyroid Gland
Hyoid bone
Thyroid cartilage
Epiglottis
Common carotid artery
Right lateral lobe
Isthmus of thyroid gland
Right subclavian artery
Left subclavian artery
Left lateral lobe of thyroid gland
Trachea
Aorta