Musculoskeletal system

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Nerve:

Nervous tissue consists of two cell types: nerve cells **(neurons)** and **glial cells**.

Neurons:

- Most of neurons consist of 2 parts; the **cell body** &its **processes**; the **dendrites** and the **axon**.
- **Cell body (Perikaryon)**
- It is the part of the neuron containing the nucleus and surrounding cytoplasm.
- **Size:** Varies from 4 - 100 um**.**
- **Shape:** Depends on the number of cell processes:

  Unipolar have globular shape.

  Bipolar have fusiform shape.

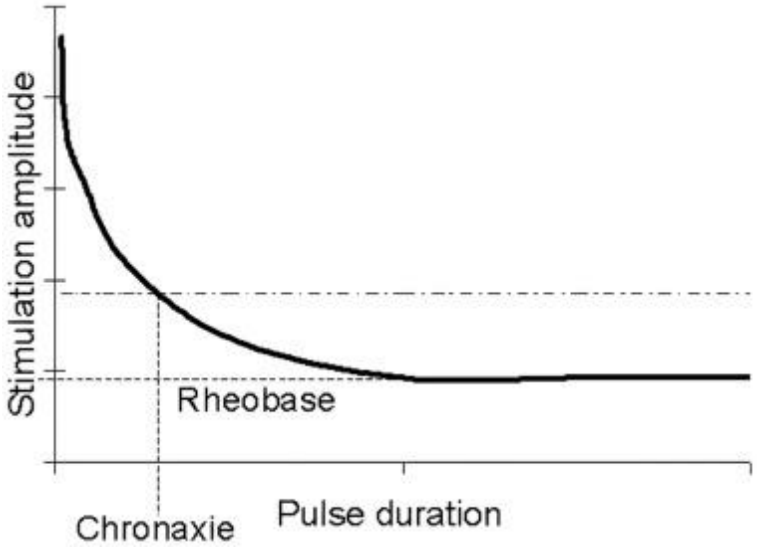
  Multipolar are stellate, pyramidal, or pyriform.

Nerve:

- The nerve is formed of **bundles of axons.**
- The nerve is covered by dense connective tissue called **epineurium.**
- **Each** bundle is surrounded by the **perineurium.**
- Each axon is surroude by **endoneurium.**

Strength duration curve:

Defination: It is a curve show the relation between the strength of the stimulus and duration needed to stimulate the nerve.



Rheobase: It is the minimal intensity needed to stimulate the nerve

Utilization time: It is the time needed by a stimulus of rheobase intensity

Chronaxie: It is the time needed to stimulate the nerve by a stimulus of double rheobase intensity

Resting membrane potential :

Defination:

- All cells have a membrane potential (Em).

- Em is the (potential difference) = voltage difference (in mV) between the extracellular and intracellular faces of the cell membrane.
- Em is usually referenced to the extracellular face.
- At rest, Em is negative, meaning that the inside of the membrane is negative with respect to the outside.
- Its value is -70 mv in medium sized nerves and (-90 mv) in large nerves.

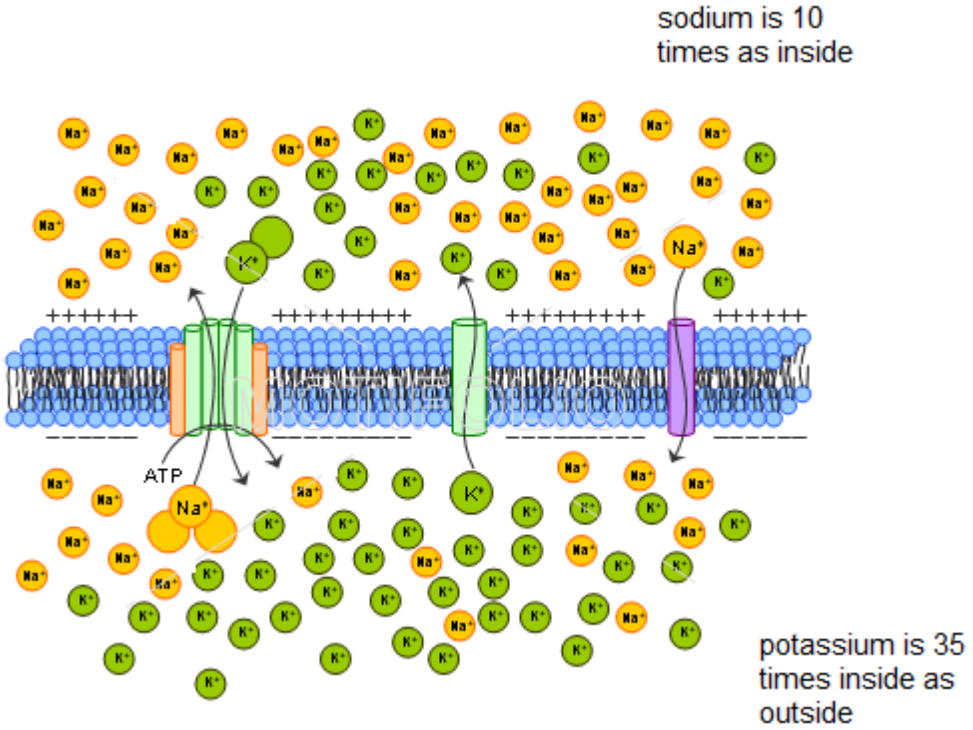
Ionic basis of the resting potential:

The Na^+-K^+ ATPase enzyme establishes high extracellular [Na^+] and high intracellular [K^+]. Sodium outside is ten times its concentration inside, while potassium inside is thirty five times its concentration outside.

Causes of the resting membrane potential:

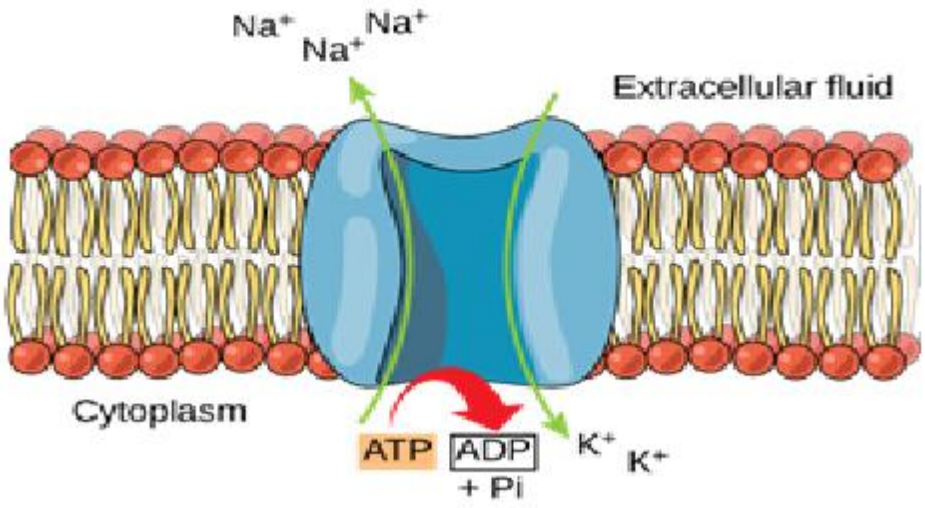
1- Selective permeability:

- Under normal conditions at rest the sodium passes from outside to inside the membrane along its concentration gradient. And potassium passes from inside to outside the membrane along its concentration gradient.
- The sodium is 5 angstrom while the potassium is 4 angstrom.
- The time needed for one sodium to pass from outside to inside is sufficient for the passage of 100 potassium from inside to outside. This adds positive charges outside and make it positive and makes the inside negative.
- This forms about (-86 mv) from the (9 -90 mv) = the main cause for the resting membrane potential.



2- Sodium potassium pump:

- The membrane has a carrier protein contains two potassium sites outside and three sodium sites inside.
- The carrier takes the potassium from outside to inside (against its concentration gradient) and sodium from inside to outside (against concentration gradient) so it needs energy (active transport).
- This takes three positively charged sodium from inside to outside while it takes two positively charged potassium from outside to inside. This leads to increase positive charges outside and makes the inside negative compared to outside.
- It forms about (-4 mv) from the (-90 mv) RMP.

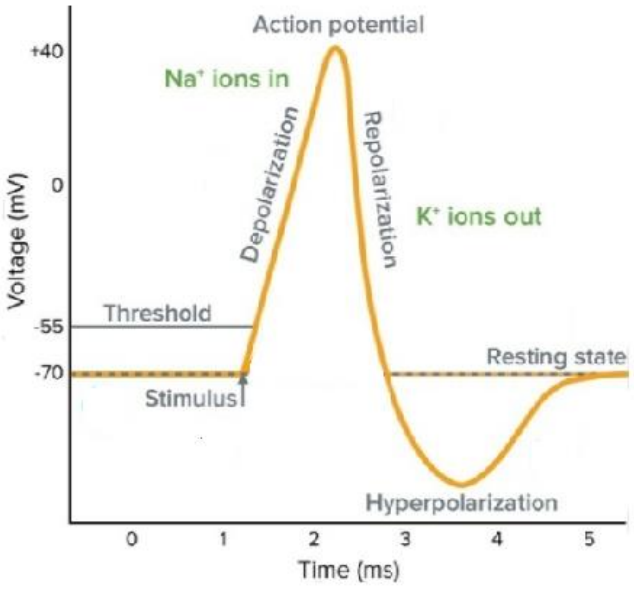


Action potential:

Key events in the nerve action potential :

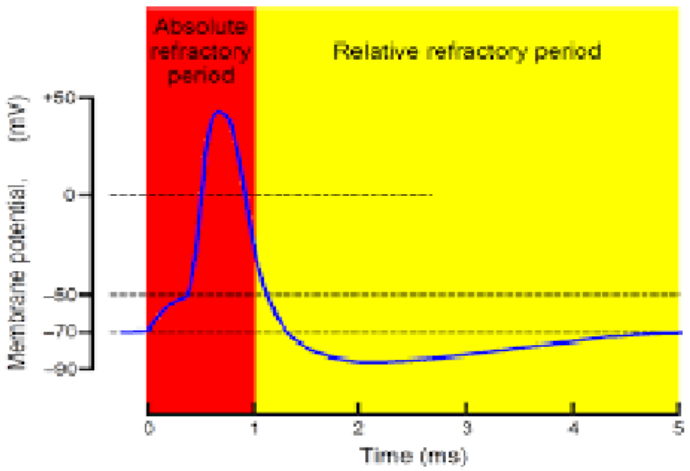
- RMP (outside the membrane is positive while the inside is negative.
- Physical or chemical stimulus.
- Open sodium voltage gated channels and positively charged sodium passes from outside to inside, increasing membrane potential.
- Membrane potential increases –reach firing level (threshold value) (-55 mv).
- On reaching threshold – All sodium voltage gated channels open -sodium rush from outside to inside.
- Membrane potential reaches zero potential (outside and inside positive and negative charges are equal) then reaches +20 mv (reverse polarity.
- This arm is named depolarization and it is due to sodium inflow (influx).
- Then the sodium activated channels become inactive and the potassium activated channels become active – so the positively charged potassium passes from inside to outside returning the membrane potential as it was (repolarization).
- The first ⅔ of repolarization is rapid while the last ⅓ is slow due to accumulation of the positive charges inside.

- The repolarization is due to potassium efflux (outflow).
- The outflow of potassium continues even after reaching the RMP – hyperpolarization. (after hyperpolarization).
- The membrane potential returns back to the RMP by the sodium potassium pump.
- Repolarization returns Na^+ channels from the inactive to closed state, which may open when having another stimulus.



Excitability changes during action potential :

- **Absolute refractory period: the nerve dose not respond to any stimulus in this period, this period coincides with depolarization phase and first one third of Repolarization.**
- **Relative refractory period: the nerve show weak response in this period. It coincides with second and third part of repolarization.**



- **Properties of action potential:**
  1- Action potential caused by threshold stimuli.
  2- Action potential can be propagated.
  3-Action potential obeys all or none law.
  4- Action potential cannot be graded.
  5-Action potential cannot be summated.
  6- Action potential accompanied by ARP.

Difference between action potential and local response:

Local response	**Action potential**
1)Caused by sub threshold stimulus	**-Caused by threshold or suprathreshold**
2)Localized- not conducted	**-It is propagated**
3)Can be graded	**-Cannot be graded**
4)Not obey all or none law	**-Obey all or non-Law**
5)Can be summated	**-Cannot be summated**
6) Not accompanied by absolute refractory period (ARP).	**-Accompanied by ARP**
7)Depolarization is partial	**-Depolarization is complete & reversal of polarity**

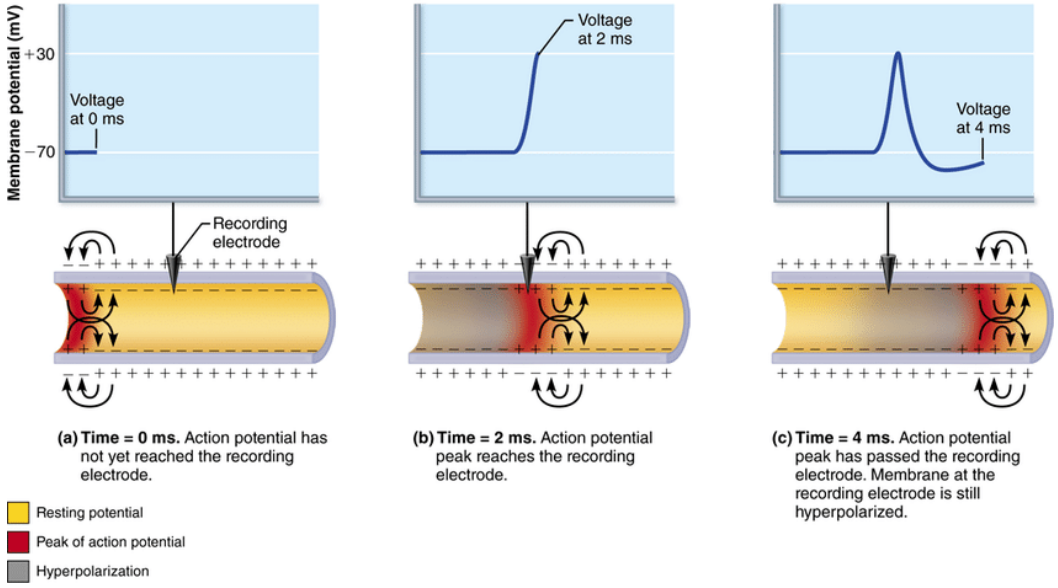
Factors affecting excitability of nerves:

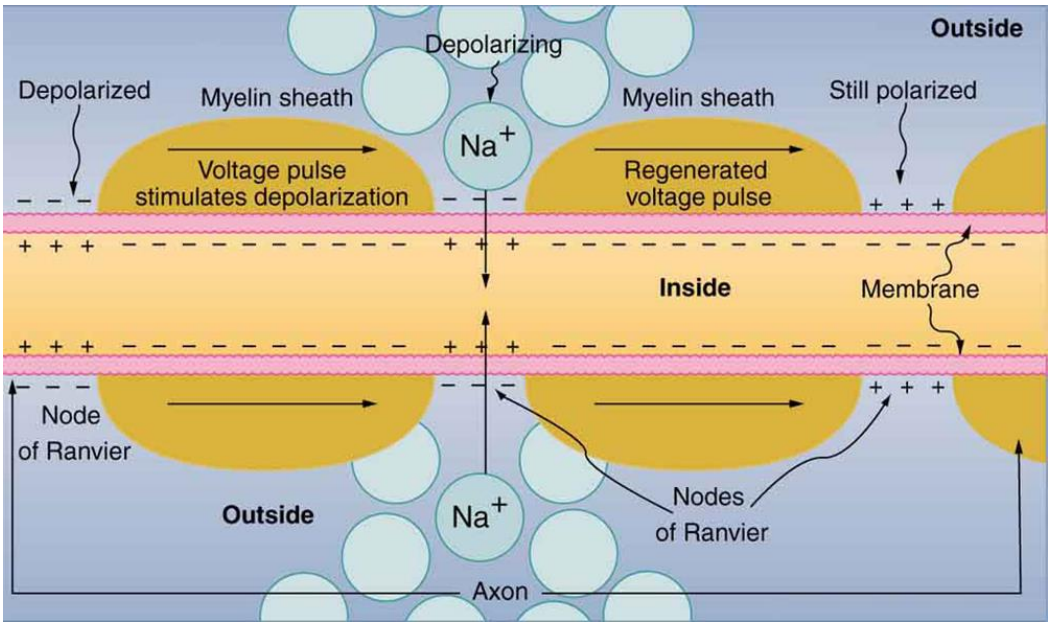
[A]Factors that increase excitability:	**[B]Factors that decrease excitability:**
(1)Conditions increasing Na^+ permeability leading to rapid depolarization:	**(1) Conditions decreasing Na^+ permeability leading to slow depolarization:**
a)Low Ca^{++} in extracellular fluid.	**a) High Ca^{++} in extracellular fluid**
b)Veratrine	**b)Local anesthetics as cocaine**
(2)High K^+ in extracellular fluid	**(2)Low K^+ in extracellular fluid**
Increase K^+ extracellular -→decrease K^+ efflux -→depolarization.	**decrease K^+ extracellular →Increase K^+ efflux →hyperpolarization**
(3)Local response	**-This occurs in hereditary disease known as Familial periodic paralysis: where hypokalemia leads to decrease nerve excitability & paralysis. He is treated by intravenous K^+ administration.**

Action potentials propagate by local current flow:

-At the region of excitation, the nerve potential is reversed

- The negative outside region acts as a current sink, drawing positive charges from areas behind and ahead of the excited region. This 'one-way' propagation is called orthodromic conduction.
- Nerves can be myelinated with concentric wrappings of Schwann cell membranes, to increase membrane resistance, minimize electrotonic current decay across the nerve cell membrane, and speed up conduction. Gaps in the myelination (called nodes of Ranvier) have high densities of voltageactivated channels. The current sink at one node triggers electrotonic depolarization in the next, so the action potential 'jumps' from node to node. This is termed saltatory conduction, and speeds up conduction by up to 50 times.
- In the myelinated nerve fibers the action potential passes from one node of ranvier to the other – this type of conduction is called saltatory conduction – it is less energy consuming and it is rapid.
- In non myelinated nerve fibers the action potential passes from one sodium channel to the other – this type of conduction is called non saltatory conduction. It is more energy consuming and slow.
- As nerve diameter increases, cytoplasmic resistance decreases, local current fl ow is more rapid, and conduction velocity is faster.





Types of nerve fibers

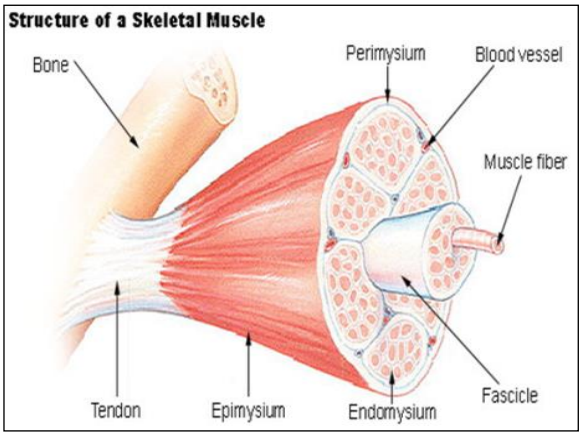
	A	B	C
Diameter	**2-20 micron**	**1-5 micron**	**Less than 1 micron**
Velocity	**20-120 m/sec**	**5- 15 m/sec**	**2 m/sec**
Duration spike	**0.5 m.sec**	**1 m.sec**	**2 m.sec**
Example	**Myelinated somatic**	**Myelinated autonomic**	**Unmyelinated**
Sensitive to	**Hypoxia, pressure**	**In between A and C**	**Local anaesthesia**

Muscular Tissue:

General characteristics:

- **Mesodermal** in origin.
- **Structural and functional unit** is **muscle fibre**.
- **Cell membrane** of muscle fibre is called **sarcolemma.**
- **Cytoplasm** of muscle fibre is called **sarcoplasm.**
- Sarcoplasm is **acidophilic**
- It is **rich** in **sER**, **mitochondria** &**myofibrils** and **inclusions** (fat, glycogen & myoglobin).
- The **smooth endoplasmic reticulum** is called **sarcoplasmic reticulum**.
- The muscle fibre may have **transverse striations** (skeletal & cardiac muscles) or may be **unstriated** (smooth muscle).

Skeletal Muscle:

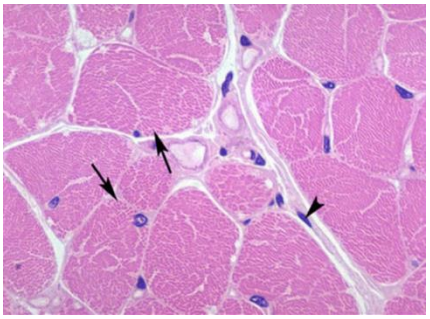


1. **Site:**
   - All muscles **attached to skeleton**
   - face, tongue, eye, pharynx, Upper ⅔ of oesophagus,
   - Diaphragm.
   - Cremasteric muscle.
2. **Size** of fiber: **10-100 um** in diameter, **1-40 mm** in length.
3. **Shape**: of fiber: **Cylindrical**, **non- branching** **EXCEPT** in **face** and **tongue**.
4. **Sarcolemma:** Clear **(very thick).**
5. **Sarcoplasm** **Acidophilic with transverse striations.**

   EM:
   - **Organelles**: It is rich in **mitochondria**, **sarcoplasmic reticulum** & **myofibrils**.
     The **myofibrils** are **parallel longitudinally** arranged.
     Each myofibril shows **alternating dark** and **light bands** giving the muscle fiber **transverse striations**.
     In **TS**, they appear in **bundles** (**Cohenheim's areas**)
   - **Inclusions**: myoglobin, glycogen granules and lipid droplets as a source of energy.
6. **Nucleus:** multiple, peripheral, oval.
7. **C.T. covering of the muscle fibres:**

   Epimysium: The connective tissue surrounding **whole muscle**

   Perimysium: **Thin septa** of connective tissue **around each bundle** of muscle fibers.



Endomysium: A delicate layer of connective tissue around **each muscle fiber**

8. **Origin:** from the fusion of embryonic mononucleated **myoblasts**.
9. **Regeneration:** Can regenerate from **satellite** cells present within the sarcolemma. They are **residual myoblasts**.
10. **Types:** Each muscle contains **3 types** of fibres but at different proportions; **red, white and intermediate**.

	Red(slow twitch)	White(fast twitch)
Colour	red	White
Size	small	Large
Myoglobin	More	Less
mitochondria	More numerous	Less numerous
Glycogen	Less	More
Innervation	Small axons	Large axons

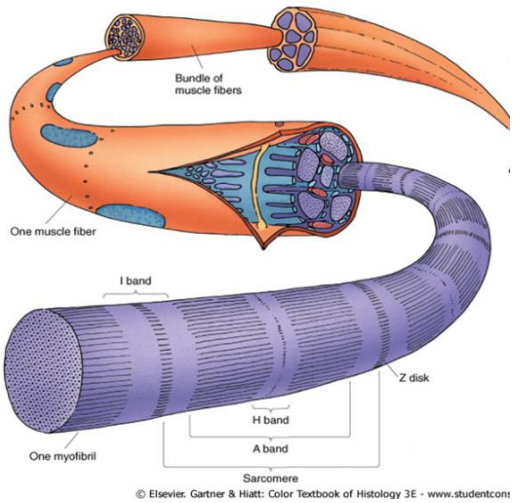
EM Picture of myofibril:

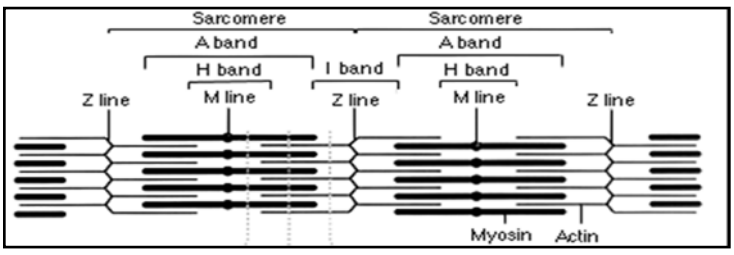
- Have a **diameter** of **1-2 um**.
- Run **parallel** to the **long axis** of muscle fibre.
- Each shows along its length **alternating light and dark bands**.
- **Light band** (**I band**) is **refractile**.
- **Dark band** (**A band**) is **not refractile**
- Each **light band** is subdivided by **dense line** called **Z line**.
- Each **dark band** is subdivided by a **pale area** called Hensen's disc (**H disc**) which is bisected by **M line**.
- The **area enclosed between two Z lines** is called **Sarcomere** it is the **functional unit** of skeletal muscle.It consists of:
  1. Whole A band.
  2. Two halves of I band. One half of I band on each side of A band.
- Each myofibril is formed of **myofilaments** of 2 types:
- **Thin actin filaments** that project from the Z line toward A band but not reaching its middle.
- **Thick myosin filaments** that extend in the A band only. So:

  A band contains both **thick** and **thin** filaments.

  I band contains of **thin filaments** only.

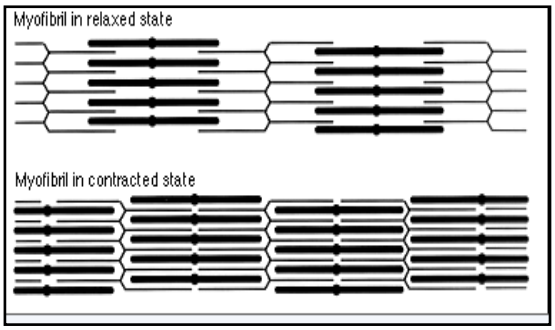
  H band contains **thick filaments** only.





M line is a dark region at the centre of H band formed of **cross connection** at the centre of adjacent **thick filaments.**

- **During contraction**: The two **Z** lines are drawn **closer together** as thin filaments are pulled past the myosin filaments.
- This goes until the **free ends of actin meet in the middle** so **H zone disappears** as it contains **now the 2 types of filaments**.
- The **two halves** of the **I band** are **reduced** so sarcomere and the whole **myofibril is shortened**. **No** changes in **A band**

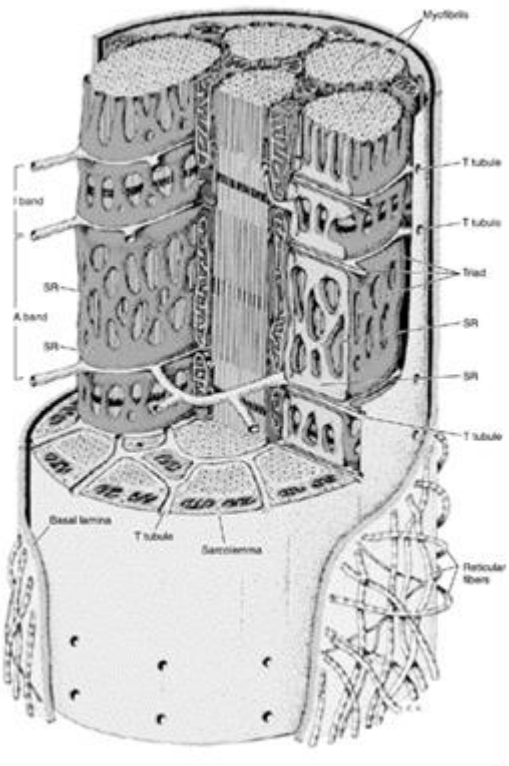


EM picture of sarcolemma:

- It is a typical cell membrane.
- It sends **narrow tubular** invaginations called **transverse tubules**.
- Transverse tubule which encircles the sarcomere like a collar at the A-I junction (**T tubules**).
- It is important for **conducting impulses** from **outside to myofibril**.

EM picture of sarcoplasmic reticulum:

- It is a modified smooth endoplasmic reticulum surrounding the myofilaments.
- It forms **2 dilated tubules** called **terminal cisternae** one on each side of the **transverse tubule** at the **A-I** band.
- The **terminal cisternae** are **joined** together by **longitudinal tubules** forming a **collar** around sarcomere.

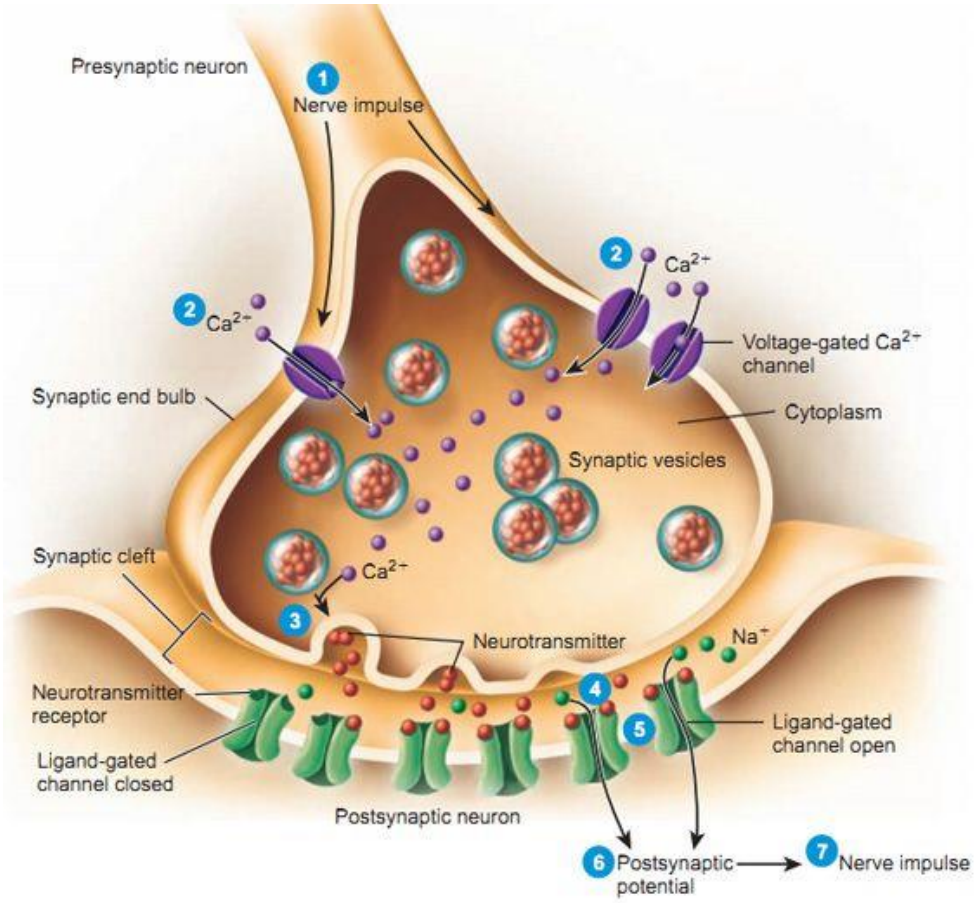


The tubular triad system:

- It consists of:
  a) **T-Tubules** which are invaginations from **sarcolemma**.
  b) **Terminal cisternae** of **sarcoplasmic reticulum** on **each side of T-tubule.**
- It is present at **the A-I band** junction thus **sarcomere has 2 triads**.
- Arrival of nerve impulse → depolarization of sarcolemma, T-tubules and terminal cisternae → release of Ca^{2+} from sarcoplasmic reticulum at the junction of A-I bands → pull the actin past myosin → shortening of sarcomere → muscle contraction. When depolarization ceases, the Ca^{2+} is actively transported back into the sarcoplasmic reticulum cisternae, and the muscle relaxes.

Neuromuscular junction: (motor end plate)

Area of contact between nerve and muscle



a- Neuromuscular transmission: Each myofiber has a single motor endplate or NMJ supplied by a spinal nerve terminal from the axon of an α-motor neuron of the anterior horn of the spinal cord.

Mechanism:

- The nerve AP reaches the nerve terminal
- Open voltage gated calcium channels at the nerve terminal and calcium rush into nerve terminal down its electrochemical gradient.
- Calcium rupture vesicles containing Ach in the knob of the nerve terminal
- Release ACh from the vesicles present in the nerve terminal
- ACh crosses the cleft and sit on ligand receptors on the muscle side
- When ACh binds, a non-specific cation channel is opened, which leads to net influx of positive ions and depolarization.
- This depolarization is approximately 40mV and is termed the end plate potential (epp). If it is sufficiently large, the threshold is reached for opening of voltage-activated Na^{+} channels in the muscle fibre membrane and action potential is initiated in the muscle
- ACh is degraded by acetylcholinesterase (present in the cleft) into choline, which is recycled for reuse in the nerve terminal

b- Properties of neuromuscular transmission:

- Unidirectional (from nerve to muscle and not the reverse).
- Fatigue (due to exhaustion of neurotransmitter)

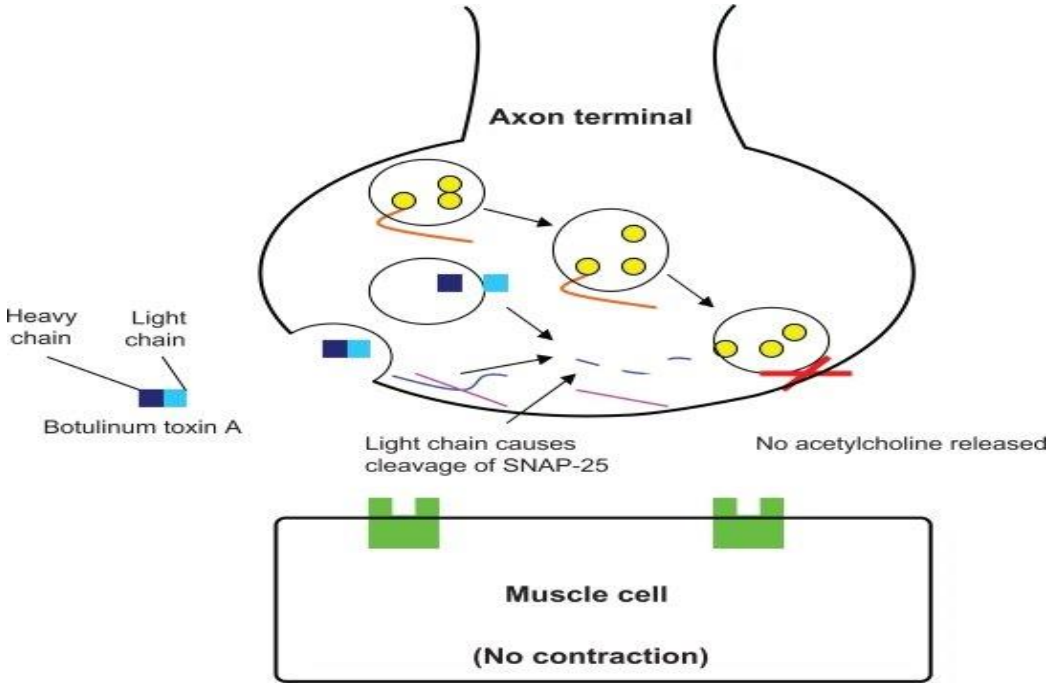
-Delay 0.5 seconds

c- Neuromuscular transmission blockade:

- Drugs and toxins that alter neuromuscular functions include

The neuromuscular blocking drugs can cause muscle paralysis and they can prevent breathing. They can only be used when artificial ventilation is available.

* Botulinum toxin that blocks neuromuscular transmission by blocking ACh vesicle release. botulinum in stored food can block release of ACh, causing muscle paralysis (botulism)



* Tubocurarine was the first 'non-depolarizing' blocking agent to be identified. It is a constituent of curare, *the poison that has long been used by South American Indians on their arrows and darts* It is a competitive antagonist at nicotinic ACh receptors, where it inhibits binding of ACh with the receptors on the muscle (competitive inhibition) & this occurs in a concentration-dependent manner. Tubocurarine has been superseded by modern alternatives with shorter action and fewer side-effects (e.g. pancuronium, vecuronium, atracurium) The side-effects of these compounds are related to their non-selective action on other nicotinic ACh receptors, including those in the autonomic ganglia. Hypotension is sometimes experienced, The effect of these drugs is easily reversed by inhibitors of acetylcholine esterase (AChE), the enzyme that breaks down ACh.

Inhibition of this enzyme ultimately leads to the persistence of ACh in the synaptic cleft, leading to an increase in its concentration and successful competition for ACh receptors.

- The antibiotics streptomycin and neomycin prevent Ca• 2+ entry and can occasionally cause paralysis
- B-bungarotoxin is found in cobra snake venom as it inhibits the nicotinic ACh receptor.

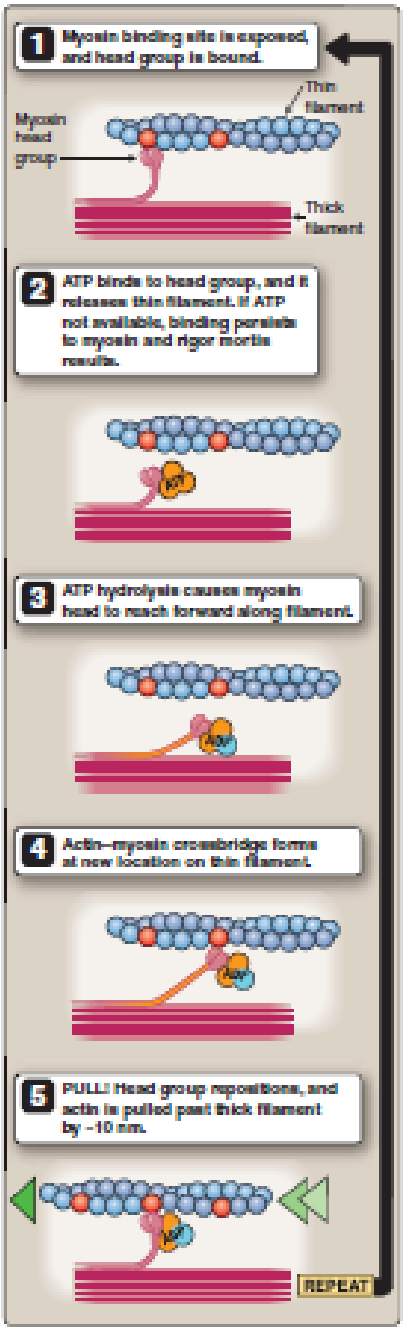
Neuromuscular stimulants :

- Clostridium toxin from Gram-positive, anaerobic bacilli C. tetani in soil and C. prolong ACh action by blocking inhibitory mechanisms (tetanus)
- Cholinesterase inhibitors (neostigmine, edrophonium), nicotinic agonists prolong action of acetylcholine by inhibiting the enzyme which break it (acetylcholine esterase enzyme)

- Vesamicol inhibits uptake of ACh into pre-synaptic vesicles thus increase their effect

Excitation-contraction coupling

- Action potentials are initiated by ACh release from motor nerves.
- Initiation of an action potential in the muscle fibre membrane triggers muscle contraction, by elevating intracellular [Ca^{2+}]
- Excitation spreads along the muscle membrane and into transverse (T) tubules
-The T tubules invaginates at the boundary between the I and A bands which penetrate deep into the myofibre and closely abut pairs of cisternae of SR to form triads
-The muscle membrane contains voltage-activated L-type Ca^{2+} channels (also called dihydropyridine or DHP receptors). They are arranged in clusters of four
-These clusters are adjacent to Ca^{2+} channels in the SR membrane, called ryanodine receptors. Each DHP receptor interfaces with one of the four subunits of the ryanodine receptor.
-The arrival of the action potential in the T tubule membrane opens DHP receptors.
- The conformational change initiates a conformational change in the ryanodine receptor, which opens it and releases Ca^{2+} ions from the cisternae.
- Ca^{2+} ions bind to troponin C, inducing a conformational change in the protein
-The conformational change leads to the Troponin I moves away from actin and troponin T displaces tropomyosin & the Binding sites for myosin on actin monomers are revealed,
- Actin–myosin cross bridges are formed.

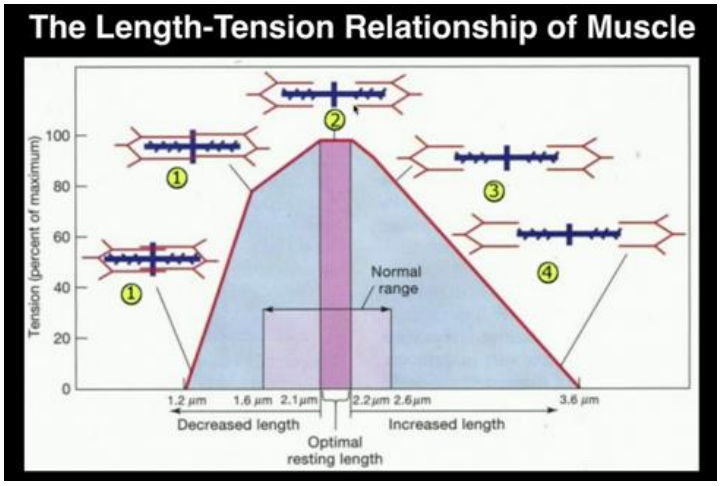


-Cross bridge cycling The sliding of filaments requires cross-bridge cycling
-ATP binds to the head of the heavy chain (Myosin).
- ATP is hydrolysed by the myosin head.
- The head pivots to attain a 90° orientation to the thin filaments
- The head forms a cross-bridge with an actin monomer
- Inorganic phosphate is released from myosin and the head swivels through 45°, drawing the actin past the myosin filament.
- ADP is released and the cycle is complete
- The cycle repeats for as long as [Ca^{2+}] remains elevated and actin sites are accessible to myosin
-When Ca^{2+} ions taken back up into the SR stimulation of the muscle stops.

- ATP is rapidly resynthesized by transfer of phosphate from phosphocreatine to ADP.
-Longer-term recovery of ATP levels can be achieved through production of pyruvate from glycogen stores.
-This anaerobic process yields some ATP, which explains why muscles can cope with short-term deprivation of oxygen. Pyruvate can also be used in oxidative metabolic pathways to generate greater amounts of ATP.

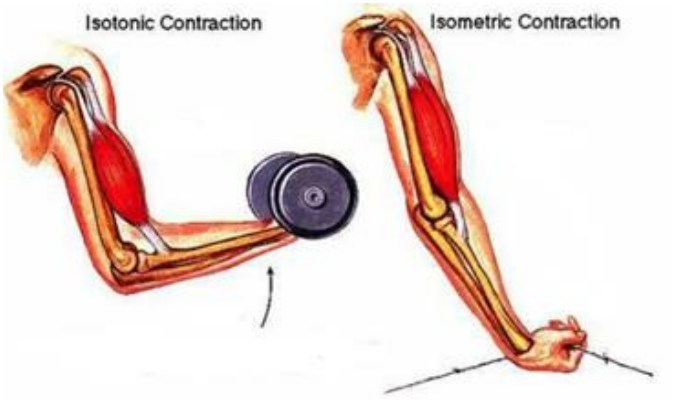
Length tension relation ship:

A- Starling law: Increasing the initial length of the muscle leads to increase the force of contraction within limit as Increasing sarcomere length too much from normal reduces the number of cross-bridges which can be formed & myosin and actin fi laments fail to overlap.



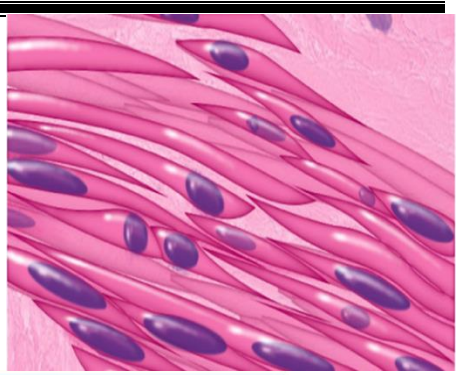
B- In isometric contraction, tension is generated by the fibre without any change in its length. As when you try to push the wall.

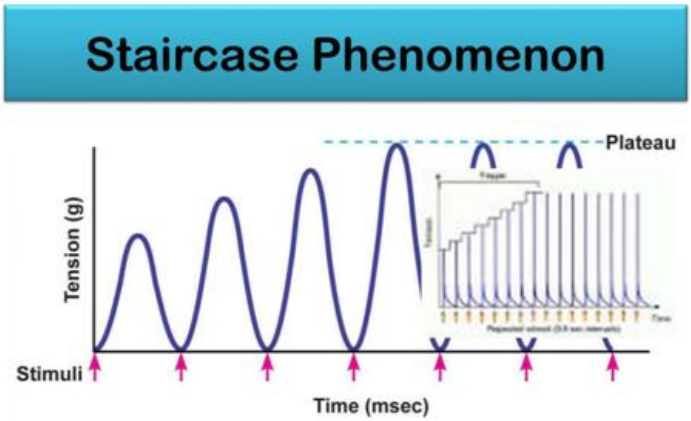
- In isotonic contraction, the muscle contracts against a constant load and shortens. As when you lift object.



- Stair case phenomenon : (Treppe phenomenon)

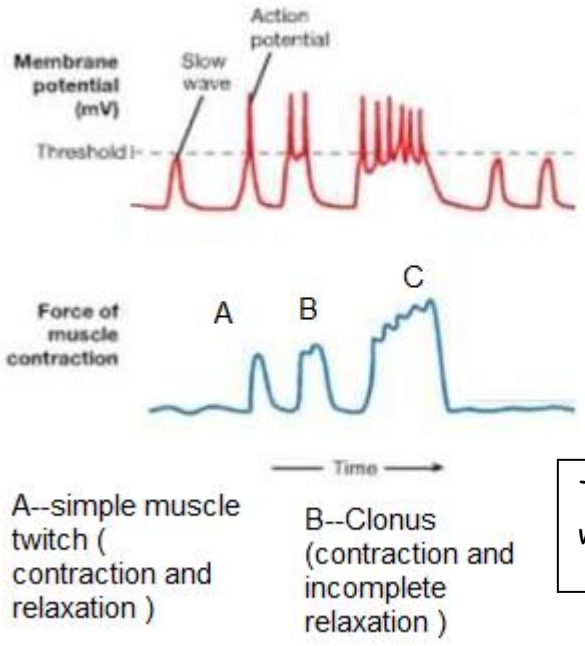
Force generated can be increased by a quick-fire sequence of twitches, where a second action potential fires before Ca4 levels have fallen to resting levels and the muscle fibre has relaxed. This summation is frequency dependent but at very high frequencies a state of tetany will exist. The contraction of whole muscles is enhanced by recruitment of additional motor units.





- The rate of force development can vary according to type of fibers:

* Slow twitch (‘red’) fibres are prevalent in postural muscles. They have a profuse blood supply, and are rich in myoglobin, and can maintain long contractions without fatigue.
* Fast twitch (‘white’= pale) fibres in precision muscles (small pale muscles) are glycolytic, perform oxidative metabolism, and have short twitch durations. They are adapted for fine movements. They can get fatigue easier than red fibers.



A--simple muscle twitch (contraction and relaxation)

B--Clonus (contraction and incomplete relaxation)

Tetanus (contraction with no relaxation)

Smooth Muscle:

1. **Site:** In wall of **blood vessels** and in **viscera** (digestive, respiratory, genitourinary systems).
2. **Size of the fiber:** Smallest **diameter** (**3 um**). Length from **20 um** in wall of blood vessels to **500 um** in wall of pregnant uterus.
3. **Shape of fibre:** Fusiform.
4. **Sarcolemma:** Thin.
5. **Sarcoplasm: Acidophilic** except for dark patches called **dense bodies**.
6. **Nucleus: Single**, **central**, oval.
7. **C.T. covering:** Each muscle **fibre** is surrounded by **endomysium. Muscle fibres** are connected by **gap junction**. Fibres are present **in layers or bundles**
8. **Origin:** From **UMCs.**
9. **Regeneration:** After injury, **viable mononucleated smooth muscle cells** and **pericytes** from **blood vessels** undergo mitosis and provide for the replacement of the damaged tissue.
10. **EM:**

❖ **Sarcolemma:**

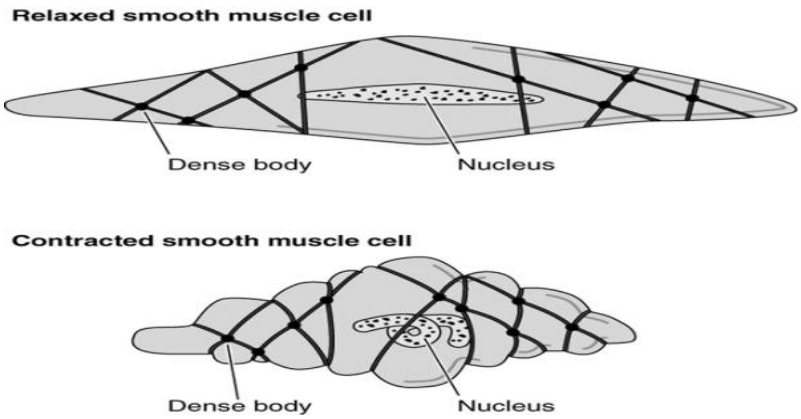
- It is surrounded by **basal lamina** which adhere muscle cells together.
- **Caveolae:** are invaginations in **sarcolemma** similar to **T tubules**.
- **Gap junctions** present between muscle cells to help spread of excitation wave.

❖ **Contractile filaments:**

- **Actin** and **myosin crisscross obliquely** through the cell so **no striation** in smooth muscle.
- **Dense bodies** on inner aspect of sarcolemma and in the cytoplasm which are believed to be **similar to Z** line where **intermediate and thin filaments** are inserted in it.

❖ **Sarcoplasmic reticulum:**

It is **less developed** but closely **related** to **sarcolemmal caveolae**



Characters of smooth muscles:

- Smooth muscles are found within the walls of blood vessels, in the respiratory, gastrointestinal, urinary, and reproductive tracts, in the piloerector muscles associated with hairs in the skin, and in the ciliary muscle and iris of the eye.
- Smooth muscle is a non-striated muscle
- Actin and myosin are present but they are not organized into parallel arrays –
- Tropomyosin is present but troponin is absent.
- SR Ca^{2+} store exists but is less highly developed not enough for muscle contraction.
- Smooth muscle contractions are slow to get established but they are sustained with low energy consumption for long periods.
- Innervation of smooth muscles is derived from the autonomic nervous system.
- Smooth muscles have some degree of tension even at rest —contractions augment the basal tone.

Smooth muscle can be divided into:

1- Visceral or unitary smooth muscle:

- They are Large sheets of cells with common innervation
- They are connected by gap junctions which function as low-resistance electrical connections that allow action potential to pass quickly and permit coordinated contraction

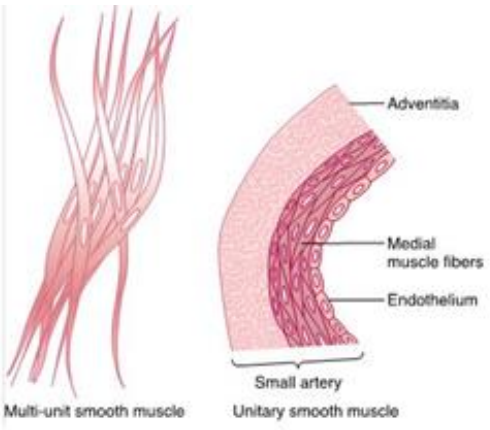
-Spontaneous contractions can occur in them

- Stretch increases the tone.
- Contractions primarily result from circulating hormones but can be modulated by nervous stimuli Found in walls of visceral organs (e.g. gastrointestinal tract, blood vessels, airways)

2- Multi-unit smooth muscle:

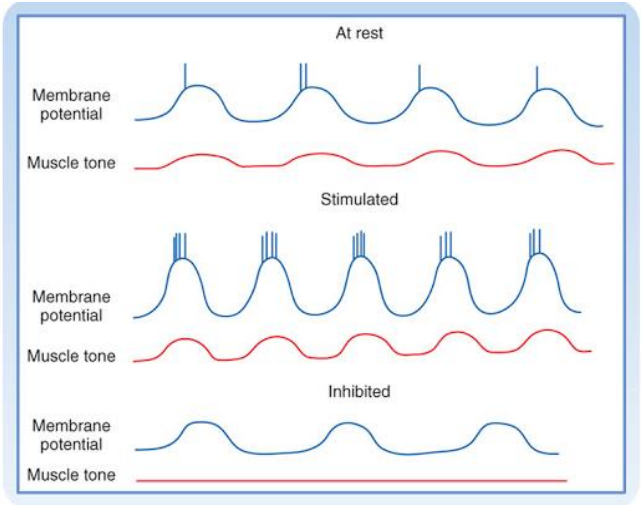
- Their Fibres receive individual innervation and act independently.
- Spontaneous contractions do not occur.
- Contractions initiated primarily by nervous triggers, and they are modulated by hormones
- Functions are more like those of skeletal muscle, with fine graded contractions (e.g. iris, piloerector muscles of skin).

- *Multi unit smooth muscle* (operates independantly, innervated by single nerve fiber).
  - E.g. ciliary and iris muscle of the eye and Arrector pili muscles of the skin.
- *Unitary smooth muscle* (operates together as a single unit). Also called *syncytial* and *visceral* smooth muscles.
  - Found in walls of gut, bile ducts, ureters, uterus and blood vessels.



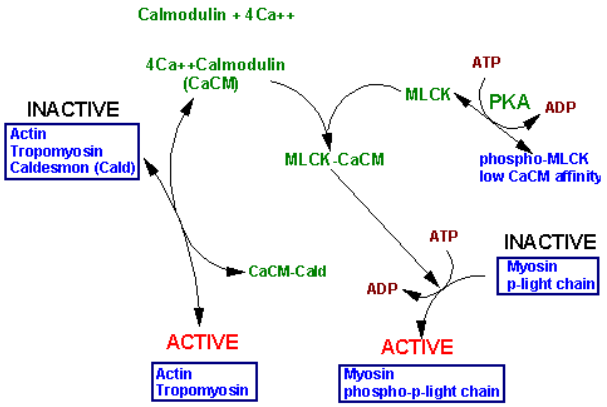
Electrical activity of smooth muscle:

- Minimum values are around –50mV
- Visceral smooth muscle can exhibit pacemaker activity, similar to the
- Spontaneous slow waves of graded depolarization are seen, with spike potentials superimposed at more positive potentials.
- Slow waves Action potentials have slower upstroke and last longer than skeletal muscle. They can be spiked or exhibit a plateau.
- The Upstrokes in smooth muscle represent opening of voltage-activated Ca 2+ channels.



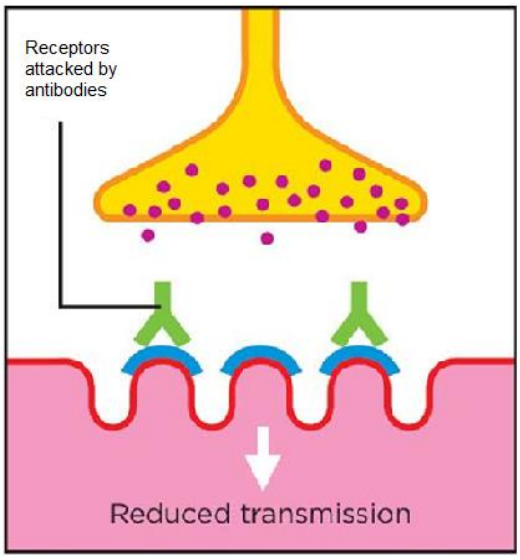
Contraction of the smooth muscle:

- For contraction to occur increase in calcium should happen.
- Increases in [Ca^{2+}] can originate from Influx of Ca^{2+} ions
- During slow waves or action potentials IP 3-mediated Ca^{2+} mobilization from the SR in response to neurotransmitters & hormones.
- Ca^{2+} ions bind to calmodulin (the smooth muscle functional homologue of troponin C)
- In the absence of Ca^{2+}, actin–myosin binding is prevented by the myosin light chain (MLC), not by tropomyosin .
- Ca^{2+}-calmodulin activates MLC kinase and this causes Phosphorylation of MLC & this relieves the inhibition.
- Hydrolysis of ATP by the myosin head occurs; & cross-bridge cycling begins
- A phosphatase dephosphorylates MLC when [Ca^{2+}] falls.
- Tension is generated for long periods, yet [Ca^{2+}] is lower (but still above resting levels), MLC phosphorylation is reduced, and energy consumption is minimal. The interaction of two Ca^{2+} binding proteins, caldesmon and calponin, with thin fi laments is believed to alter the kinetics of actin–myosin binding.



Myasthenia gravis :

- It is an autoimmune disease in which auto-antibodies inhibit neuromuscular transmission.
- The auto-antibody is directed against the ACh receptor of the postsynaptic membrane of the neuromuscular junction.
- Binding of the antibody to this receptor causes an increased rate of degradation of this protein (rather than a simple blocking of the ACh binding site as originally thought) and damage to the post-synaptic membrane by complement binding.
- The patient suffers Clinical effects as Drooping eyelids (ptosis) and double vision due to weakness of the extraocular muscles.
- Anticholinesterase agents—(inhibitors of acetylcholine esterase enzyme) which lead to an increased concentration of ACh at the post-synaptic membrane and thus maximal occupaying of the surviving ACh receptors. Administration of these is also a useful diagnostic test for the disease—reversing weakness, such as ptosis, almost immediately after intravenous injection.



- Creatine phosphate (phosphagen) stores energy in cardiac &skeletal. It captures energy from ATP &release energy during muscle contraction. This energy is needed to help interaction of calcium ions with calmodulin.

1- Cartilage:

Definition:

- Cartilage **is a connective tissue** so it consists of **matrix, fibers &cells.**
- It is a **special type of connective tissue** which has a **rubbery matrix**, so the cartilage is firm with some degree of flexibility.
- The cartilage is **avascular** connective tissue which receives its **nutrition by diffusion** from a surrounding membrane called **perichondrium.**
- According to the dominant fibers the cartilage is classified into **hyaline, yellow elastic & white fibro-cartilage.**

Hyaline Cartilage:

*Sites:

1- Costal cartilage.
2- Articular cartilage.
3- Trachae & bronchi.
4- Foetal skeleton

Histological Structure of Hyaline Cartilage:

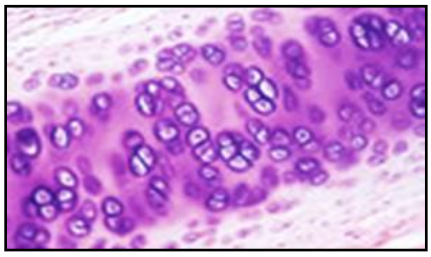
Hyaline cartilage consists of:

1- An outer covering which is called **perichondrium.**
2- Cartilage cells **(Chondroblasts & Chondrocytes).**
3- **Matrix.** 4-**Fibers**

1- Perichondrium:

It is the outer covering which is present on the surface of cartilage **except** at **articular surface**. It is formed of, outer fibrous & inner chondrogenic layer.

A- Outer fibrous layer: It is formed mainly of collagenous fibers (Type I), fibroblast & blood vessels. This layer is responsible for nutrition of the cartilage which is **avascular** tissue.



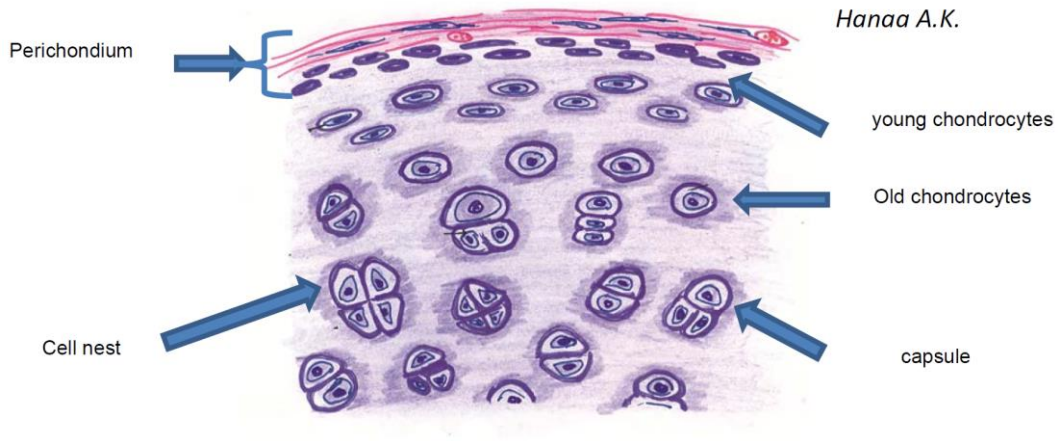
B- Inner chondrogenic layer: This layer is rich in **chondroblasts**

Functions of perichondrium:

1- Nutritive function as its outer layer has blood vessels
2- Formation of new cartilage during growth & regeneration of it after damage.
3- Gives attachment to muscles & tendons

2- Cartilage Cells:

I- Chondroblasts (Immature cartilage cells):



Hyaline cartilages

- **Origin:** UMCs
- **Site:** They are present on the inner layer of perichondrium.
- **LM:**
- Oval cells
- Pale oval nuclei
- Dark basophilic cytoplasm.
- **EM:** [protein forming cells]
- Well-developed rER &Golgi apparatus
- Clear nucleus with well-defined nucleolus.
- **Functions:**

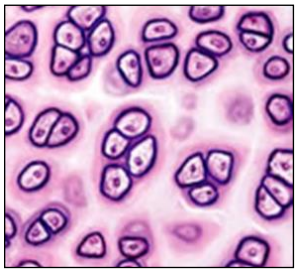
1- Synthesis of collagen fibers type II.
2- Formation of cartilage matrix.
3- They are transformed into chondrocytes after they are surrounded by the matrix (trapped chondroblasts are called chondrocytes) .
4- Growth of cartilage by adding from the outer surface a new layer of cells &matrix (appositional growth).

II-Chondrocytes (Mature cartilage cells):

- **Site:** They are present all over the cartilage, either singly or in groups.

Arrangement & shape:

- Chondrocytes are present in spaces called **Lacunae.**
- Each lacuna is surrounded by a **capsule** which is formed by condensation of the matrix.



- The **young cells** are **small, oval & arranged parallel to the surface**. They are present **singly** in their lacunae in the **outer part** of the cartilage, under the perichondrium.
- The **old chondrocytes** are large, rounded, oval or triangular. They are found in groups within their lacunae (2, 4, & 8 cells) the individual cells of each group are separated by a thin layer of matrix. Each group of cells is surrounded by a capsule & is called

cell nest.

- **L.M.:** Chondrocytes have **lightly stained basophilic** cytoplasm & small **round central nuclei.**
- **EM:**

Chondrocytes have features of **protein forming cells**, they contain large amount of **rER, numerous mitochondria & well developed Golgi apparatus**. Cytoplasm also contains **glycogen & lipid droplets**.

- **Functions:**

1- Continuous replacement of the matrix.
2- Maturation &multiplication of chondrocytes in the center of cartilage accompanied by formation of new matrix result in growth of cartilage from within (interstitial growth).

3-Matrix:

Cartilage matrix is semi-rigid & flexible **(rubbery).**It is mainly formed of **proteoglycans** & **chondroitin sulphate**. It appears homogeneous and basophilic. Matrix is **basophilic** due to the presence of **chondroitin sulphate**. The matrix is formed by both **chondroblast & chondrocytes**.

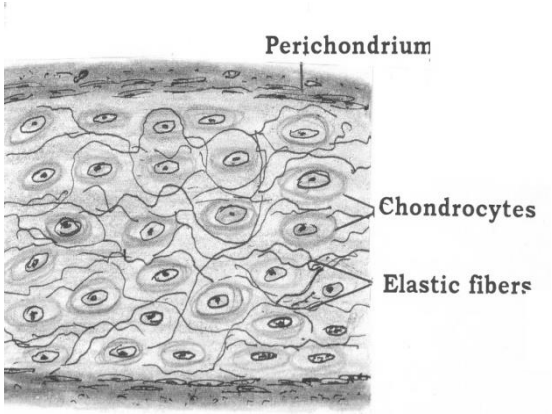
4- Fibers:

The matrix contains **collagen fibers (type II),** but they do not appear by L.M. because:

*They are **very thin** &have the **same refractive index of the matrix**.
*They can be **demonstrated after digestion** of the ground substance

Yellow Elastic Cartilage

Definition: It is a **flexible type** of cartilage which is **yellow in color** in fresh condition



Sites:

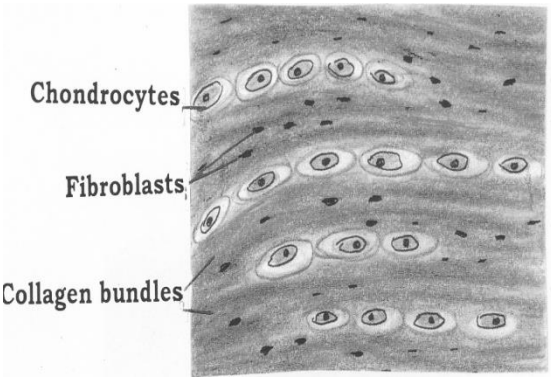
1- **E**ar pinna.
2- **E**xternal auditory meatus.
3- **E**ustachian tube.
4- **E**piglottis.

Structure:

It is **similar to hyaline cartilage** in structure; however, the matrix contains a network of **yellow elastic fibers**.

White Fibro-Cartilage

Definition: It is a **rigid type** of cartilage with features intermediate between **cartilage &white fibrous connective tissue.**



Sites:

1- Symphysis pubis.
2- Intervertebral discs.
3- Lips of the glenoid & acetabular cavities.
4- Mandibular joint.

Structure:

1- It has **no perichondrium**.
2- The matrix contains parallel **bundles of collagenous fibers** (type I) separated by rows of chondrocytes (much like a tendon).

Functions of cartilage:

1- Bone formation & growth as it forms the skeleton of the foetus.
2- Articulation & easy movement at joints
3- Keeps the respiratory tract opened, all the time.
4- It gives support for soft tissue as in nose & ear.

Growth of Cartilage:

1- **Appositional growth**: It means addition of a new layer of cartilage from outside.
2- **Interstitial growth:** It means growth of cartilage from inside.

Bone:

Definition:

It is a highly vascular & hard type of connective tissue.
It is the hardest type of C.T. as it has Calcified matrix.
Since it is a type of connective tissue, it consists of cells, fibers & matrix.

Functions of bone:

1- Body support as it forms the bony skeleton.
2- Protection of vital organs as brain& bone marrow.
3- Minerals store mainly calcium store.

General structure of bone:

The main components of bone are:

a- **Matrix & fibers.**
b- **Bone Cells:** osteogenic cells, osteoblasts, osteocytes and osteoclasts.
c- **Bone covering**: (Periosteum & Endosteum)

These are outer & inner coverings for bone surfaces

a- BONE Matrix & Fibers: Bone matrix is formed of two main parts:

1- Organic Part (35%):

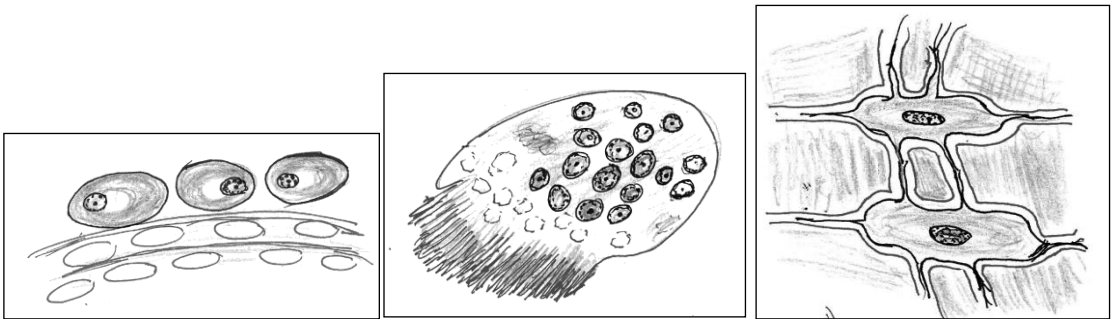
It is mainly formed of type I collagen fibers which are arranged as thick bundles & ground substance

2- Inorganic Part (65%):

It is mainly formed of calcium salts in the form of calcium phosphate & carbonate. They are present on the surface of collagen bundles & also within the ground substance & cause hardness of bone.

N.B. Bone matrix is arranged in the form of **lamellae of calcified collagen bundles** embedded in **calcified ground substances**.

b- Bone Cells: osteogenic cells, osteoblasts, osteocytes and osteoclasts.



	Osteogenic cells	Osteoblast [Bone forming]	Osteocyte Bone maintaining	Osteoclast Bone Destroying
Origin	UMC & pericytes	Osteogenic cell	Osteoblasts	Blood monocytes
Site	Present in the inner layer of periosteum & endosteum	• Present immediately under the periosteum • Form single layer on the bone surface. • Also present under the endosteum. • Cannot Divide	• Singly in bony lacunae • Lacunae connect by canaliculi Cannot Divide	• On the surfaces of bone near the bone marrow • Howship's lacuna.
L.M.	• Flat cell • Flat nucleus • Pale basophilic cytoplasm	• Oval cells with minute few processes • Eccentric nuclei. • Cytoplasm is darkly basophilic with a negative Golgi image • Rich in alkaline phosphatase enzyme.	• Oval cells with fine processes. • Oval central nuclei. • Cytoplasm is lightly basophilic • Alkaline phosphatase-enzyme.	Large irregular cells having brush border multinucleated cells (6-12), with foamy Acidophilic cytoplasm.
E.M.	Many free ribosomes (immature cell)	They have characters of protein forming cells. [Rich in r ER, well-developed Golgi apparatus &mitochondria].	• Less r ER, Golgi apparatus than odteoblasts.	Has ruffled surface =microvilli - Lysosomes, Golgi rER & cytoplasmic vesicles
Functions	• They divide &differentiate to osteoblasts • They are numerous in young age &fracture. • Change to chondroblasts in area of poor	1-They are bone forming cells. 2-Secrete the organic part of the matrix 3-Alkaline phosphatase enzyme deposits calcium 4-They change into imprisoned cells called osteocytes.	1-Bone maintaining cells 2-Form organic &inorganic part of the matrix. N.B. Lacuna contains Only one osteocyte unlike chondrocytes as	I-Bone Resorption in two steps Osteocl 1-Secret CO_2 change into carbonic acid >remove calcium [decalcification] 2-Secrete lysosomal proteolytic

	vasculature		osteocytes cannot divide. NO interstitial growth	enzymes remove organic part Osteoclasts secrete lysosomal proteolytic enzymes (osteolytic enzymes) which cause lysis of the organic part of the matrix. II-Bone remodeling during ossification process. N.B. Osteoclasts are not phagocytic cell

c-Bone Covering (Periosteum & Endosteum)

I- Periosteum:

Definition: A connective tissue which covers the outer surface of bone.

Structure: It consists of

1- **Outer fibrous layer:** It is formed of a layer of **dense collagen fibers, fibroblasts & blood capillaries.**

2- **Inner osteogenic layer:** It is formed of **osteogenic cells**. This layer is **very thick** in case of **growth & fracture** as osteogenic cells multiply & differentiate to osteoblasts.

Functions:

- Protection of bone.
- It gives attachment for muscles.
- Nutrition for bone.
- Bone growth as osteogenic cells differentiate to osteoblast which form bone matrix & change to osteocytes **(appositional growth)**.

II- Endosteum:

Definition: It is a delicate layer of connective tissue that contains a single layer of osteogenic cells.

Functions: 1- Protection of bone surface.
2- Bone growth by adding from inside

Methods of preparation of bone sections:

Hardness of bone is the main problem in preparing a bone section as it makes it difficult to be cut. This hardness is due to its calcium contents.

1- Decalcification method:

a- Calcium is removed by treating the bone with mineral acid as nitric acid 10%.
b- Bone becomes soft & sections can be cut and stained.
c- **Decalcified bone sections** demonstrate the **bone cells** and **soft tissues.**

2- Grinding method:

a- Bone is left to dry in air.

b- Small pieces of the bone are cut by a saw.

c- Bone is thinned by grinding by using a carborandum wheel.

d- **Ground bone sections** are unstained sections which only show the **bone lamellae**, the **lacunae**, **canaliculi** (no cells) & **Volkmann's canals.**

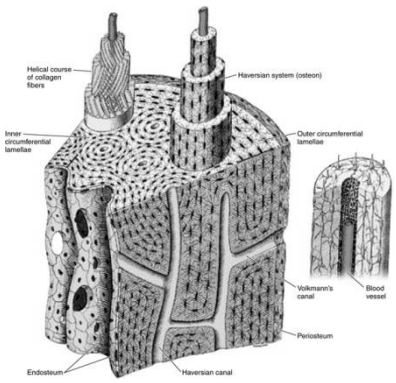
N.B. Grinding method cannot be used for spongy bone sections.

Classification of bone: (According to **histological** structure)

1- Compact bone: It has regular bone lamellae [**Haversian system]**.

2- Spongy bone: It is formed of irregularly arranged bone trabeculae & multiple bone marrow cavities.

General Components of Compact Bone:



Sites: It forms the **shaft of long bones** & also presents as a **covering plate over** the surface of **spongy bone.**

It is formed of:

1- Periosteum: It covers the outer surface of bone.

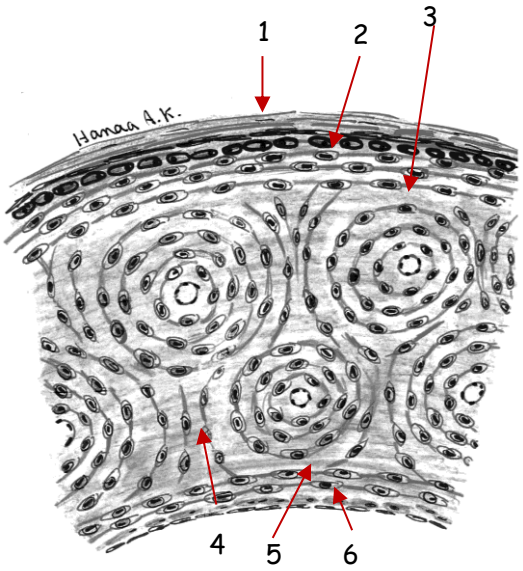
2- External Circumferential Lamellae:

They are found under the periosteum. They are formed of **osteocytes within lacunae** embedded in between **lamellae** of calcified collagen bundles **parallel** to the surface of bone.

3-Haversian System (OSTEON):

-It is the **structural units** of compact bone.

- It is a **cylindrical structure** which is **longitudinally** arranged **parallel** to **longitudinal axis** of bone shaft.
- It is formed of a central canal **(Haversian canal)** that contains b.vs. & nerves embedded in loose C.T. **surrounded by 5-20** of concentrically arranged **circular bony lamellae** & **osteocytes** within lacunae embedded in between them.
- Compact bone has **transverse** or **oblique canals** that **connect** the **Haversian canals** together & **with periosteum** or **bone marrow** cavity, they are called **Volkmann's canals**



4-Interstitial Lamellae:

They are irregularly arranged bony lamellae & osteocytes in between Haversian systems.

5- Internal Circumferential Lamellae:

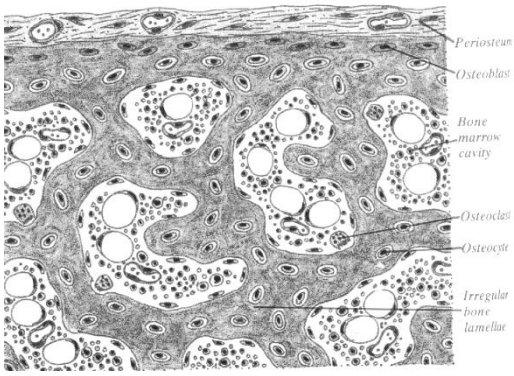
These are bone lamellae parallel to the inner circumference of bone & they surround the bone marrow cavity.

6- Endosteum:

It lines the bone marrow cavity.

General Components of Cancellous (SPONGY) Bone:

Sites: Spongy bone is present in the center of flat bones, short bones, irregular bones as well as epiphysis of long bones.



Structure: It is formed of **irregular branching** & anastomosing bony trabeculae enclosing between them **irregular bone marrow cavities**. Each **trabeculum** is formed of **irregularly arranged bony lamellae** & osteocytes, **No Haversian system.** Bone **surface** is covered by **periosteum** & bone **marrow cavities** are lined by **endosteum**.

OSSIFICATION (BONE FORMATION)

Bones of the body are formed by one of two methods:-

I- **Intramembranous** ossification.

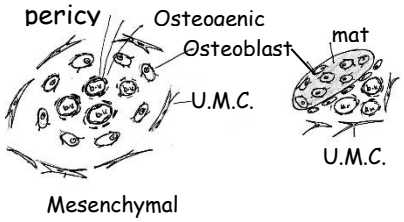
II- **Intracartilaginous** ossification

I- Intramembranous ossification:

It occurs in **flat bones, short bones & irregular bones**. It starts in **a membrane of C.T.** & ends by formation of **spongy bone**. **Intramembranous ossification occurs in the following steps:**

1- **UMCs** are condensed in a **central vascular area** rich in **blood capillaries**. This area is called **ossification center**

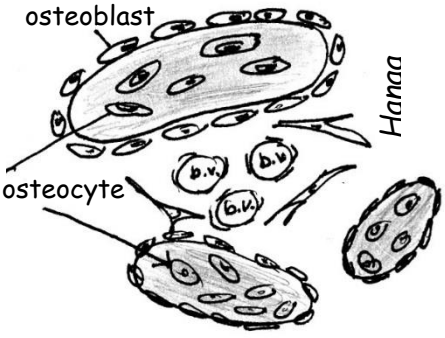
2- **UMCs & pericytes** change into **osteogenic** cells that differentiate into **osteoblasts** which form **bone matrix** & become imprisoned now they change to **osteocytes.**



3- **Numerous ossification centers** are formed in the C.T. membrane.

4- **Irregular bone trabeculae** are formed &joined together to form **spongy bone.**

5- **Multiple spaces** between trabeculae are occupied by **blood vessels & UMCs** which form **bone marrow cells.**



II- Intracartilagenous ossification:

It means **replacement** of a **cartilage model** by **compact bone**, it occurs in **long bones**, as follows:

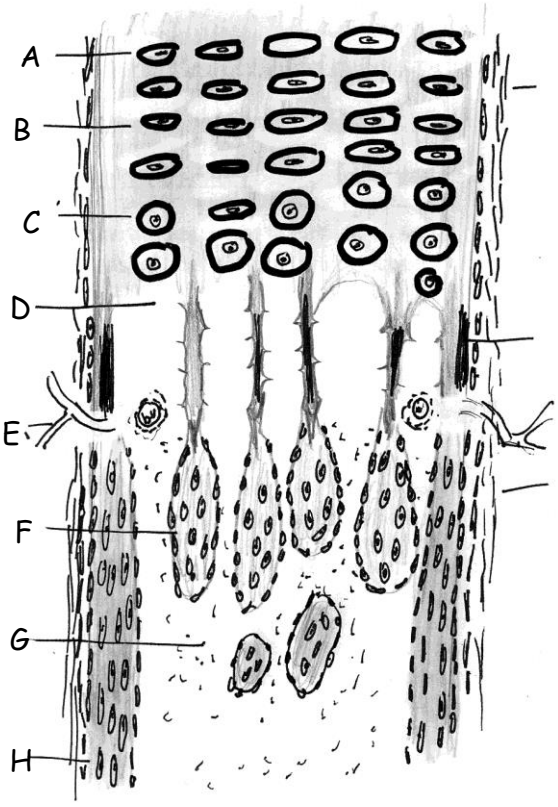
N.B.: Long bone is formed of a shaft called diaphysis & two ends called epiphyses.

1- Primary ossification centre:

* It occurs in the **middle of the diaphysis** of the cartilage model.
* **Chondrocytes** in the **centre** of the cartilage model **increase in size** & **deposit calcium**. **Calcification** of cartilage **matrix** will lead to **death** of **chondrocytes** leaving **irregular cavities**.
* As a result of **increased vasculature** of **perichondrium** **UMCs** cells change into **osteogenic cells** which differentiate into **osteoblasts**. Now **perichondrium** is changed **to periosteum.**
* **Osteoblasts** form a **layer of bone around the cartilage** model & **under the periosteum** called **periosteal collar**.
* **Osteoclasts** form **holes** in the **bone collar** so a **vascular core** formed of **U.M.C. & blood vessels** **invade** the irregular **cavities** within the model.
* **U.M.C. & pericytes** around blood vessels change into **osteogenic cells** which differentiate to **osteoblasts**.
* **Osteoblasts** deposit bone **matrix** forming **irregular bony trabeculae** i.e. **spongy bone**.
* The **spaces** between the **bony trabeculae** are occupied by **bone marrow tissue.**
* **Osteoclasts** coming by fusion of blood monocytes change the **irregular bone marrow cavities** into one **regular bone marrow cavity**.
* **Bony lamellae** become regularly & concentrically **arranged** forming **Haversian system & compact bone**.

2- Secondary ossification centre:

* It is present in the **epiphysis**.
* The **steps are similar** to that occurring in the **primary centre** until the **cartilage** is replaced by **spongy bone**.
* **Now** the **entire cartilage** model is replaced by **bone EXCEPT** a **plate** of **cartilage** present between **epiphysis &diaphysis** & is called **epiphyseal plate.**



3- Changes at the epiphyseal cartilage:

Formed of cartilage cells.

A-Zone of resting hyaline cartilage: Formed of cartilage cells

B-Proliferative zone: Cartilage cells **increase in number** & become arranged in parallel rows.

C-Zone of hypertrophy: Cells **increase in size** as a result of accumulation

of **glycogen & alkaline phosphatase enzyme**.

D-Zone of calcification: Chondrocytes **deposit calcium** in the surrounding **matrix** as well as **under the periosteum** & so cartilage **cells die** leaving empty spaces.

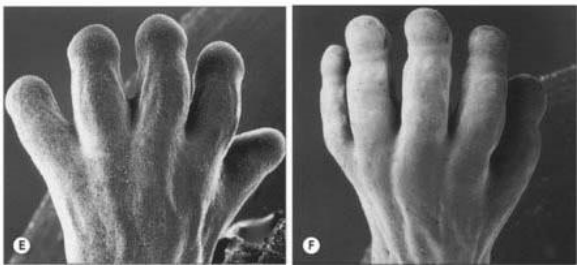
E- Zone of invasion: a **vascular bud** formed of blood capillaries & U.M.C. enters through **holes** formed by **osteoclasts** in the periosteal collar.

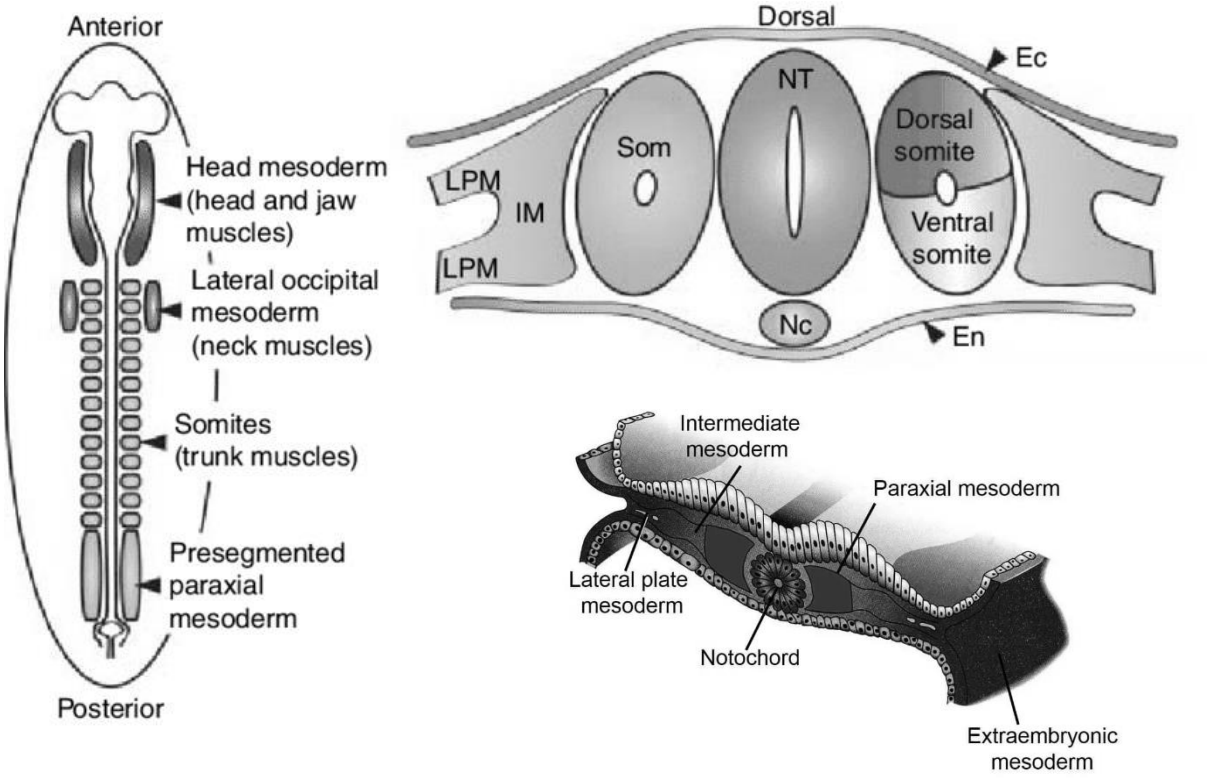
F- Zone of ossification: **U.M.C. & pericytes** change into **osteogenic** cells which differentiate to **osteoblasts** that **deposit matrix** & form **irregular trabeculae** of spongy bone.

G-Remodeling stage: It results from **resorption** of bone from certain areas by **osteoclasts** & **deposition of new bone** in other areas by **osteoblasts**. This stage results in a **single bone marrow cavity**.

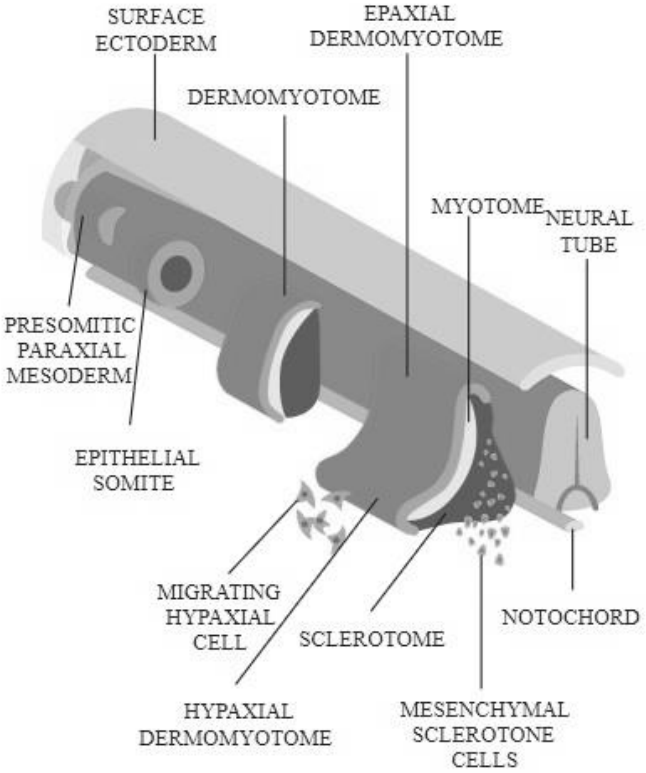
H-Stage of compact bone formation: In this stage **Haversian system** develop & there is only **one central bone marrow cavity**.

EMBRYOLOGICAL PREVIEW





Intraembryonic mesoderm



Somites

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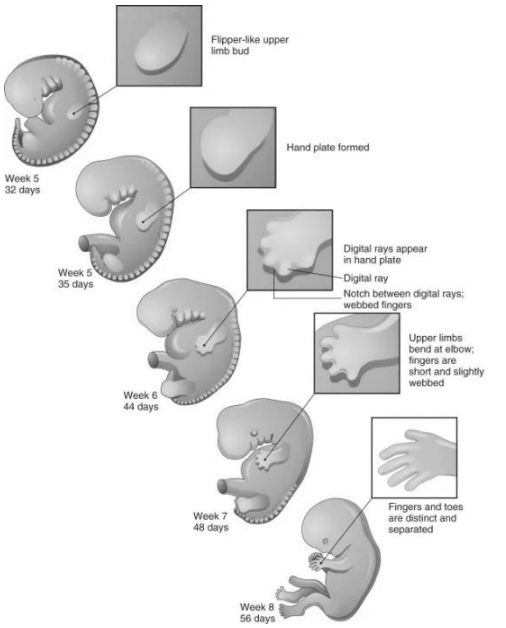
EMBRYOLOGICAL PREVIEW

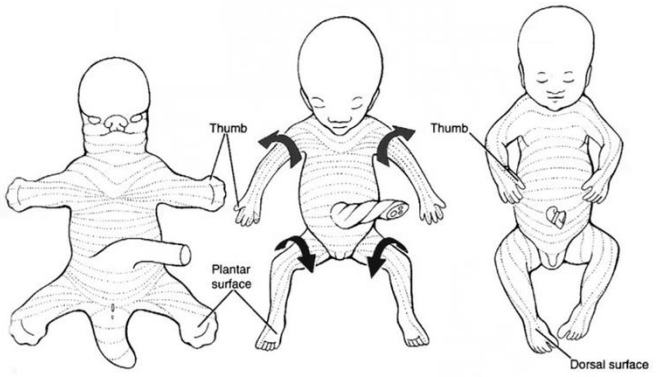
INTRAEMBRYONIC MESODERM (IEM)

Derivatives of IEM: on each side of the notochord, the intraembryonic mesoderm is divided into three parallel craniocaudal masses (from medial to lateral):

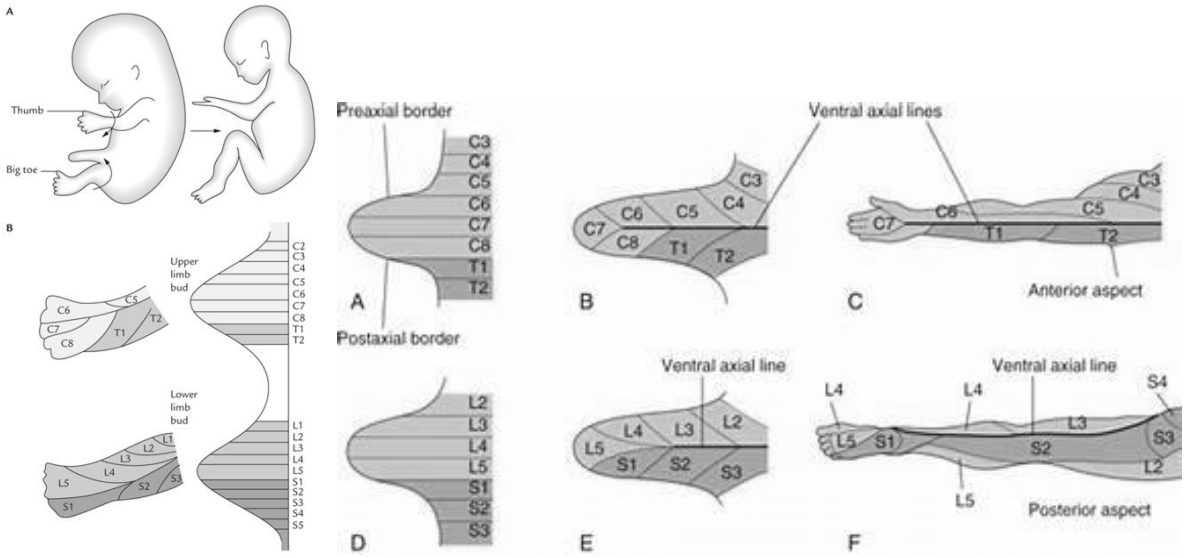
1) **Paraxial mesoderm:**
   - It is divided into cubical masses called somites, which appear in a craniocaudal sequence. The first pair of somites appear on the 20^{th} day of development and the last one in the 5^{th} week.
   - There are 42–44 pairs of somites; 4 occipital, 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and 8–10 coccygeal.
   - Each ***somite*** is divided into three parts:
     a) Sclerotome: ventromedial, it surrounds the notochord and differentiates into vertebral column and ribs. Each vertebra is formed of 4 parts (2 successive sclerotomes on each side). The union of the 2 sides will interrupt the notochord which will form the nucleus pulposus of the intervertebral discs. Each vertebra shows extensions forming laminae and spine, transverse processes and articular processes. an extension called costal process appears anterior to the transverse process, both fuse together in all segments except in thorax where the costal process grows to form the rib
     b) Myotome: intermediate, it differentiates into the muscles of the back.
     c) Dermatome: dorsolateral, it differentiates into the dermis of the skin, which cover the muscles of the back. (both the skin and the muscles of the back are supplied by dorsal rami of the spinal nerves).
2) **Intermediate cell mass:** it differentiates into most of the urogenital system.
3) **Lateral plate mesoderm:**
   - Many small cavities appear in that plate. These cavities fuse together to form a u shaped cavity called intraembryonic coelom (IEC) whose base is cranial to the oropharyngeal membrane. The IEC divides the lateral plate mesoderm into:
     a) Somatic (parietal) layer: dorsal layer in contact with ectoderm, differentiates into the dermis, bones, joints, muscles and vessels of the limbs and ventral part of the trunk.
     b) Splanchnic (visceral) layer: ventral layer in contact with endoderm, differentiates into the connective tissue, smooth muscles and vessels of the viscera (gastrointestinal, respiratory and urogenital systems).



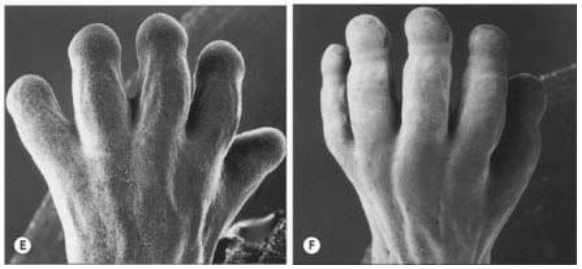
Development of limbs



Rotation of limbs



Innervation of limbs



Hand (scanning EM)

Foot (scanning EM)

Obgynkey / Springer / Duenas / Quizlet / Clinicalgate / Obgynkey

DEVELOPMENT OF LIMBS

- The four limbs appear as limb buds by the 5th week of development.
- Each bud is formed mainly of lateral plate mesoderm covered with ectoderm.
- the upper limb buds develop opposite the lower cervical and upper thoracic segments of spinal cord while the lower limb buds develop opposite the lumbosacral segments (hence their innervation).
- at first each bud has a cranial and caudal borders and ventral and dorsal surfaces
- the upper limbs rotate 90° laterally so that its ventral surface becomes anterior, and the dorsal surface becomes posterior.
- the lower limbs rotate 90° medially so that its dorsal surface becomes anterior, and the ventral surface becomes posterior.
- The bones development starts as mesodermal thickening inside the buds, followed by transformation into cartilage (chondrification) then bones (ossification), the mesoderm surrounding them will form the muscles, the outer layer of mesoderm will form the dermis while the covering ectoderm will form the epidermis.
- The joints appear as non-chondrified mesoderm between the developing bones, cavities appear and unite forming the joint space and become filled which synovial fluid.
- As the limb buds elongate by newly joined proximal cells. The distal cells start to differentiate.
- The most distal part of the limb will differentiate into hand plate or foot plate with projection of digital rays forming the digits (fingers or toes). At first the digits are connected with webs which disappears leaving separate digits.

Congenital anomalies

Amelia: absence of a limb

Micromelia: abnormal small limb

Meromelia: the limb is only hand or foot attached to the trunk

Polydactyly: formation of an extra digit

Syndactyly: fusion between digits due to persistence of finger webs

Lobster claw: the middle digit is absent, the first two digits are fused and the last two digits are fused.

mermaid syndrome: very rare. Both lower limbs are fused together. Usually it is associated with other maldevelopments.

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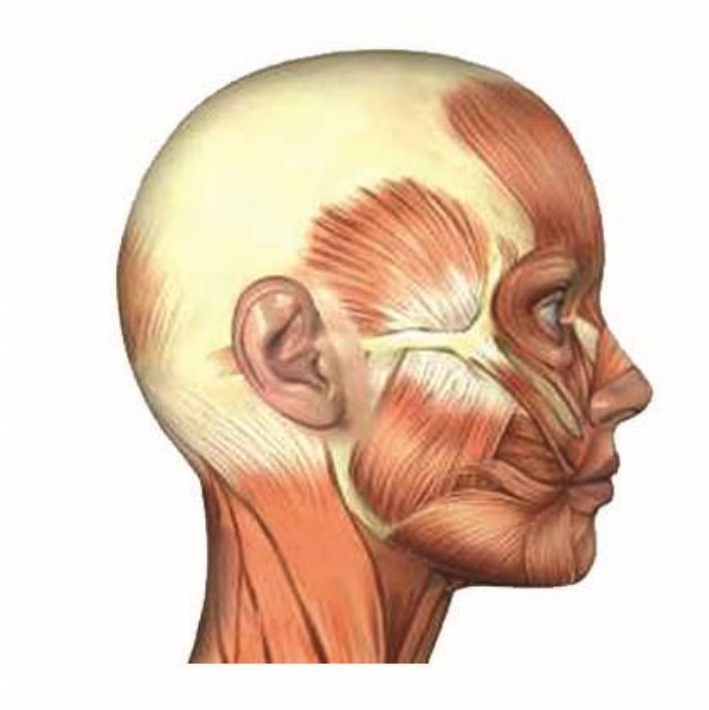
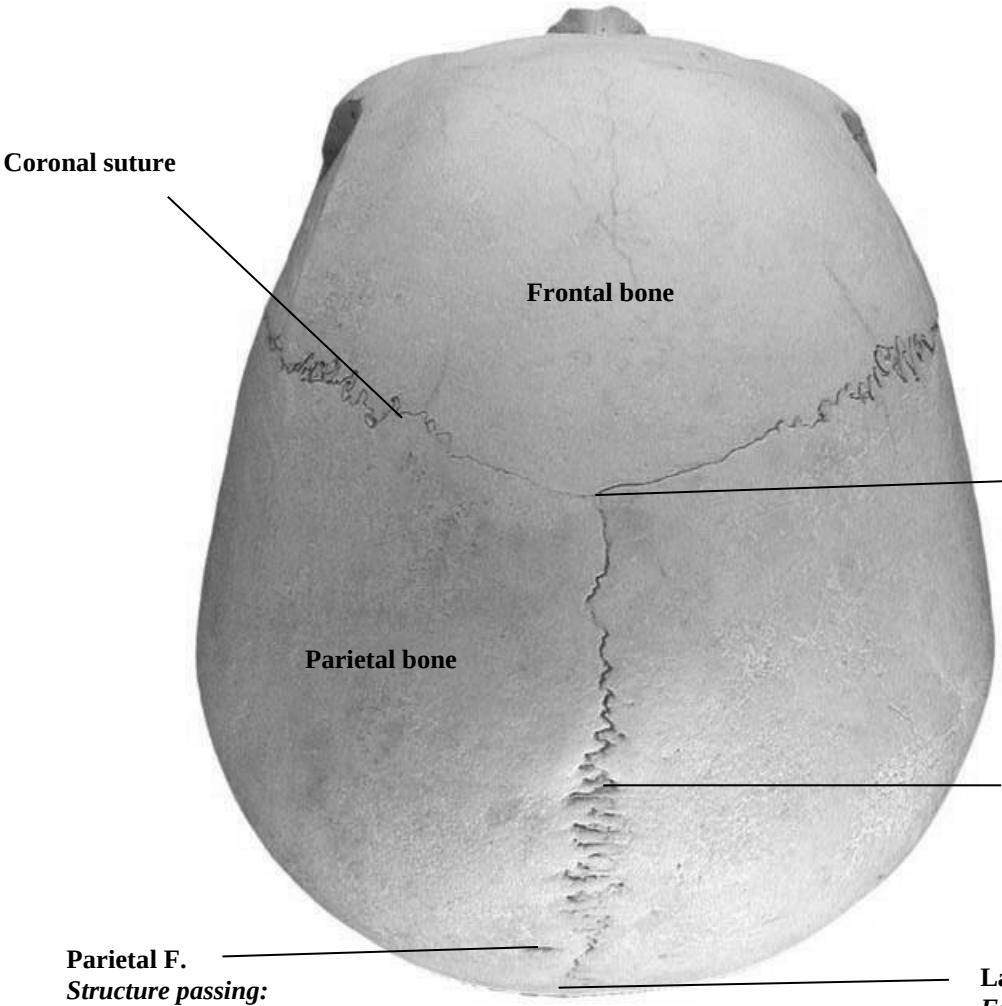
HEAD AND NECK

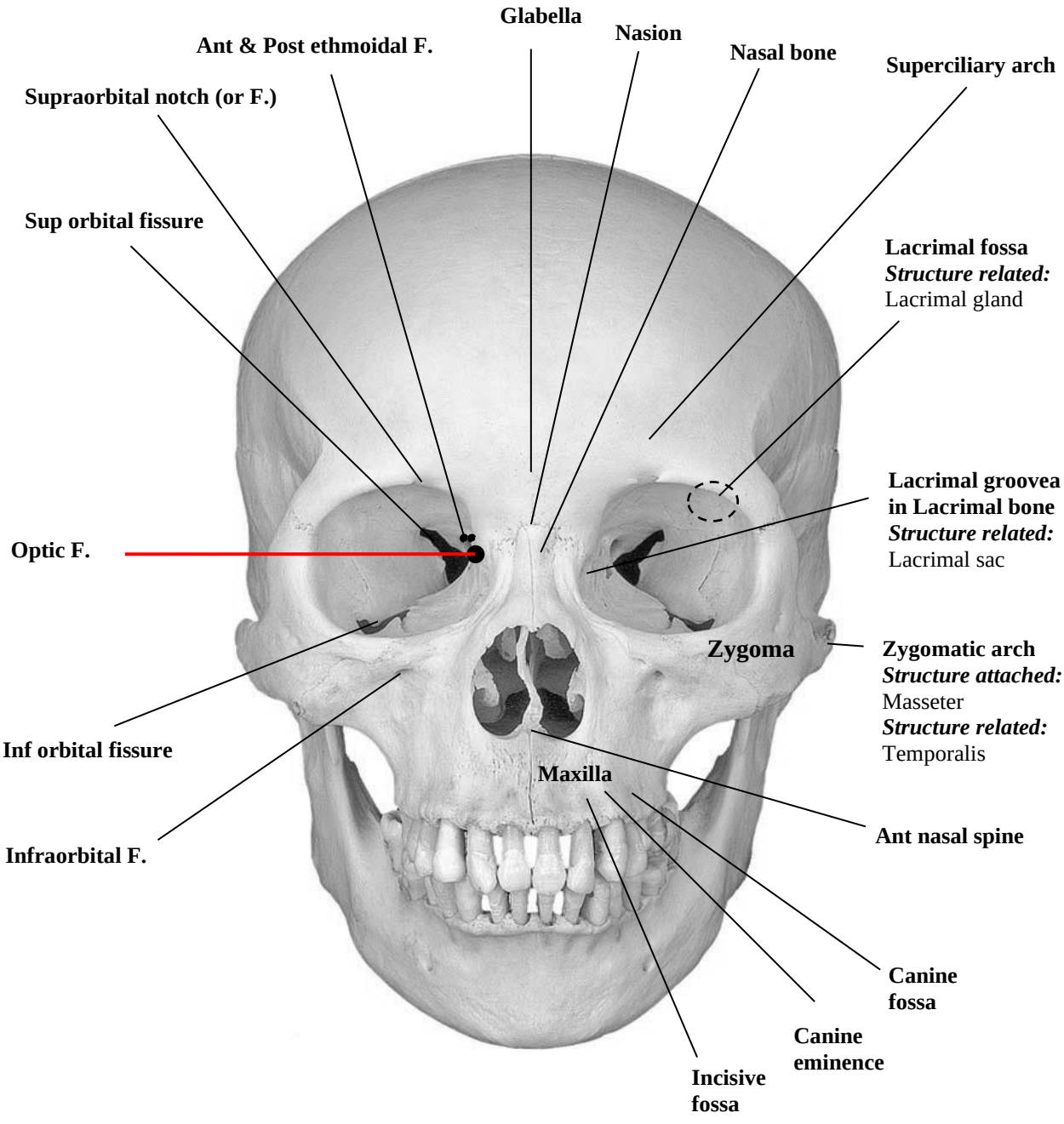


NORMA VERTICALIS



Tortora & Nielsen

NORMA FRONTALIS



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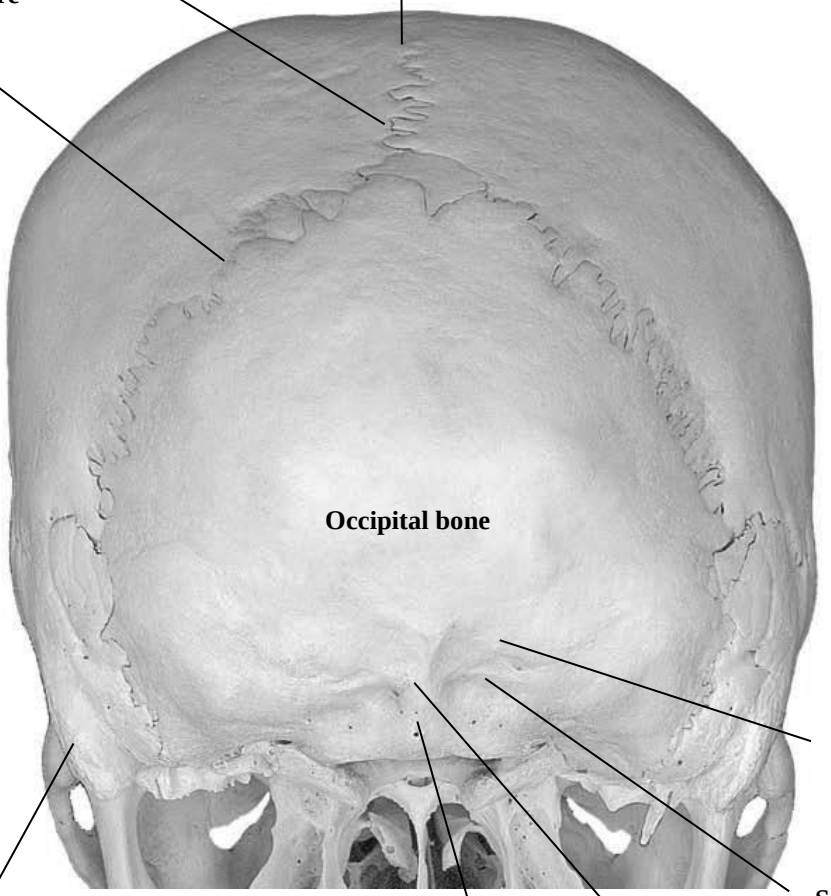
NORMA OCCIPITALIS



Sagittal suture

Lambda

Lambdoid suture

Occipital bone

Highest nuchal line
Structure attached:
Occipitalis

Sup nuchal line
Structure attached:
Trapezius

Mastoid process

Ext occipital protuberance
Structure attached:
Trapezius + Ligamentum nuchae

Ext occipital crest
Structure attached:
Ligamentum nuchae

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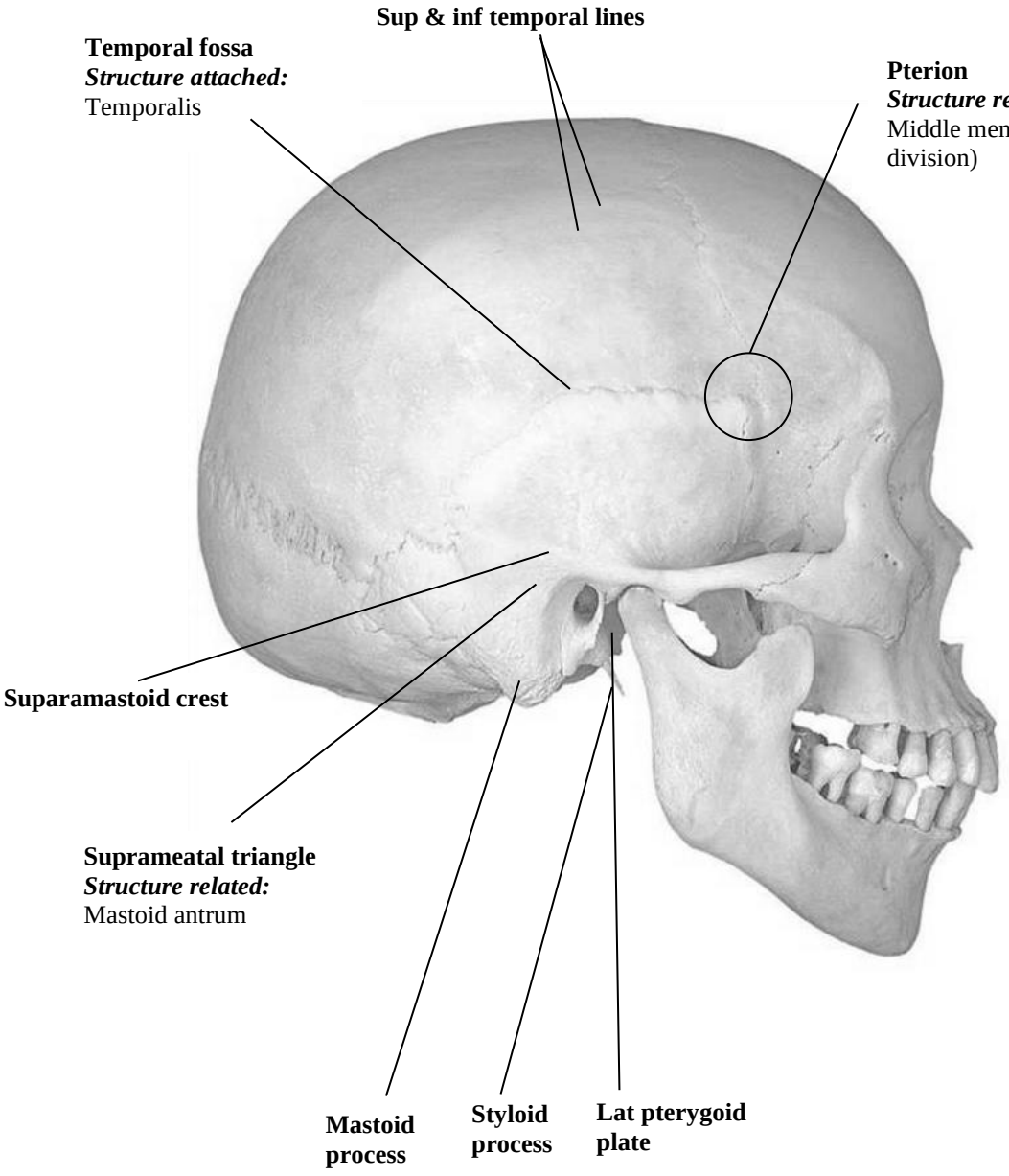
n

NORMA LATERALIS



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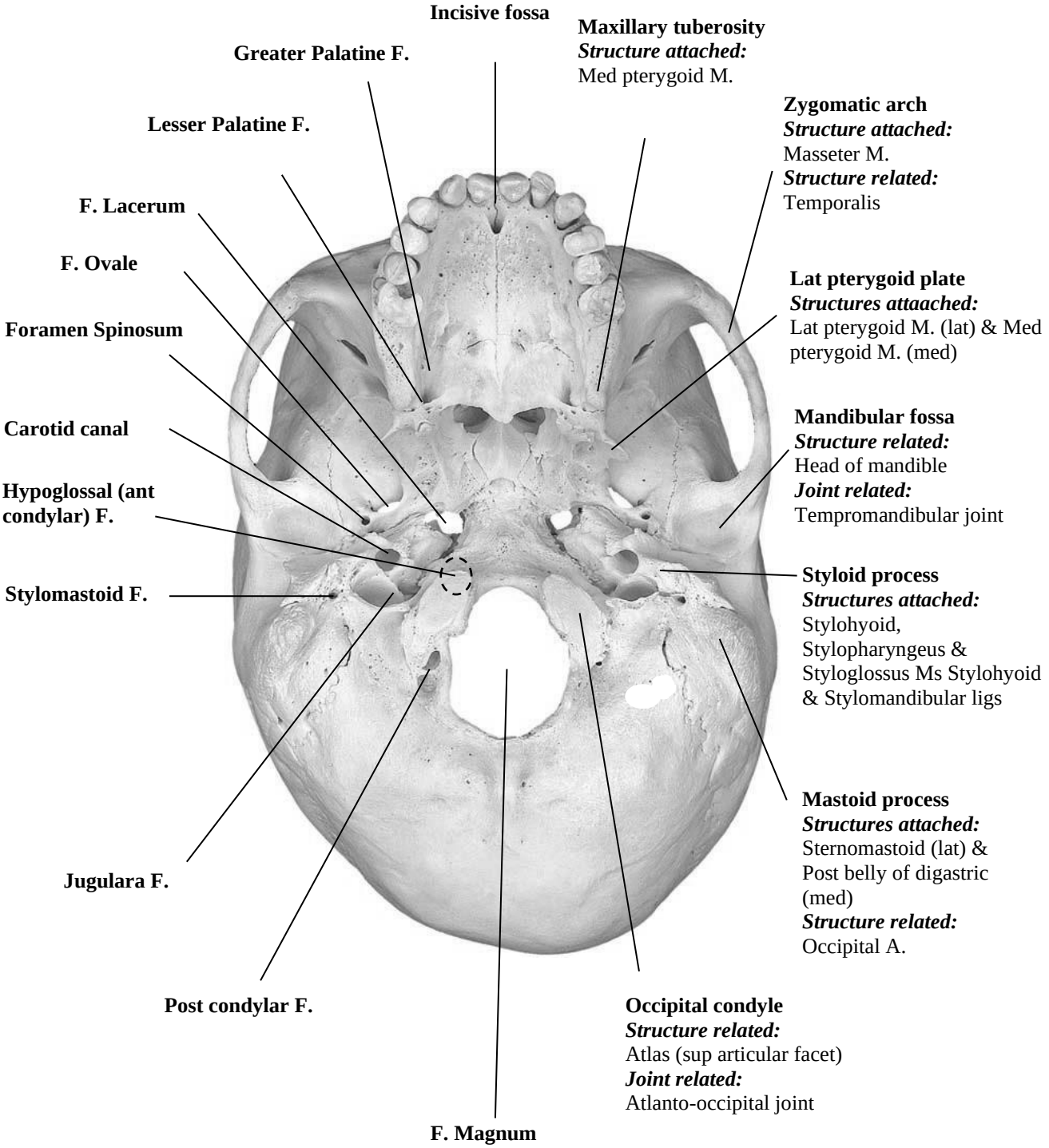
NORMA BASALIS EXTERNA



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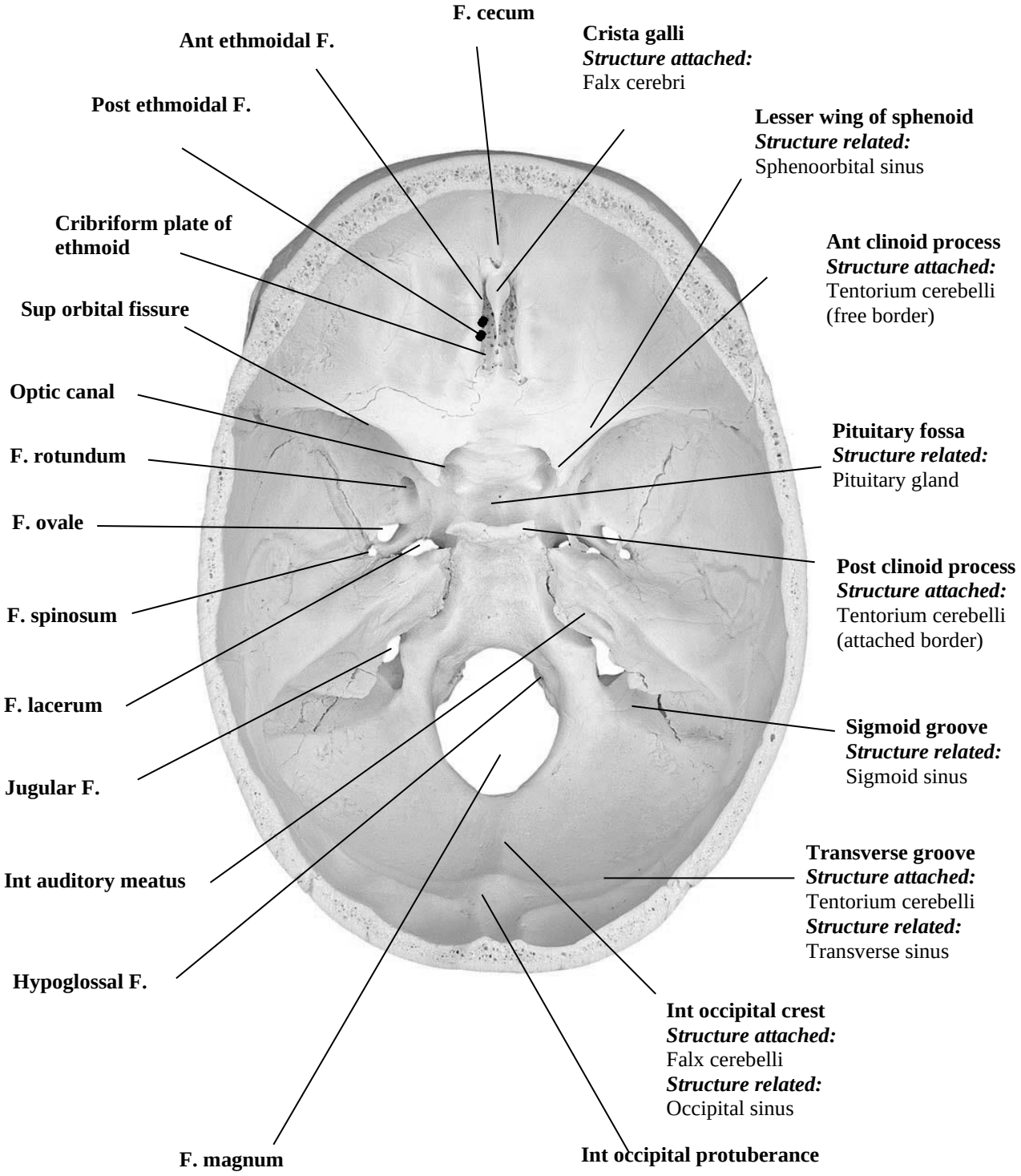
NORMA BASALIS INTERNA



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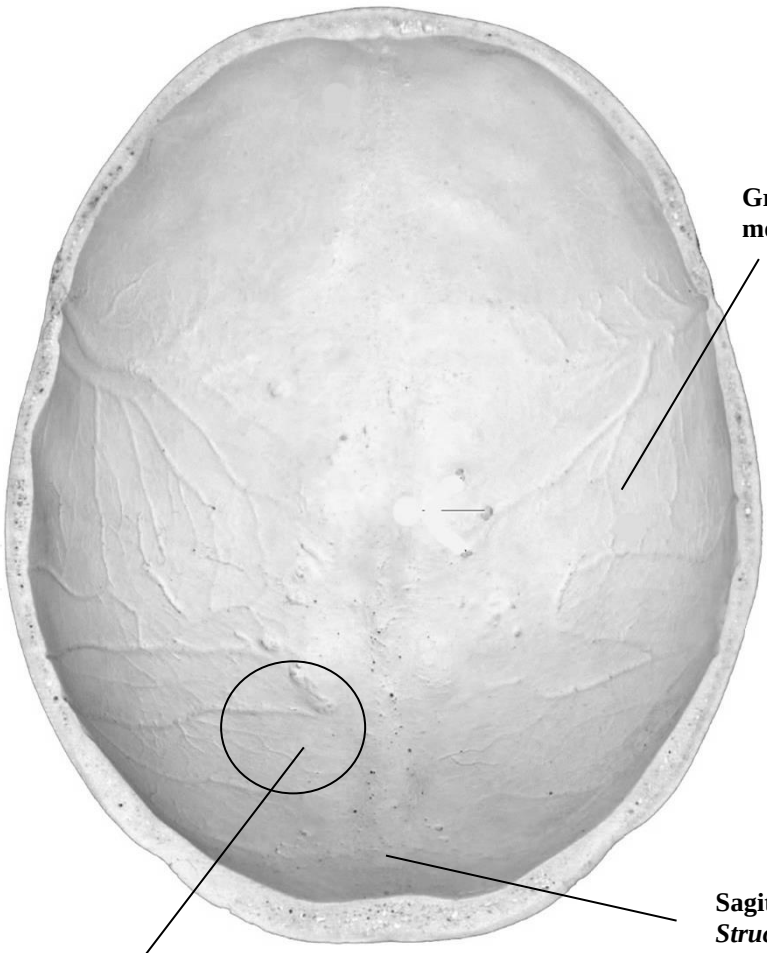
SKULL CAP



Groove for middle meningeal A.

Sagittal groove
Structure attached:
Falx cerebri
Structure related:
Sup sagittal sinus

Arachnoid fovea
Structure related:
Arachnoid granulations

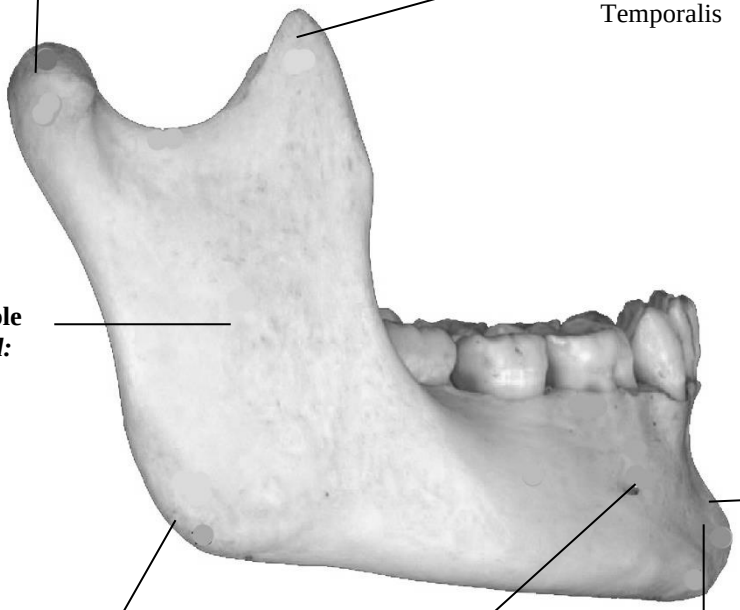
Tortora & Nielsen

SKULL FORAMINA

Foramen	*Structures passing through it*
Parietal F.	E.V.
Ant ethmoidal F.	Ant ethmoidal N. & Vs.
Post ethmoidal F.	Post ethmoidal N. & Vs.
Supraorbital notch or F.	Supraorbital N. & Vs.
Optic canal	Optic N. + Ophthalmic A.
Sup orbital fissure	3,4,6 Cr. Ns. + Lacrimal, frontal, nasociliary Ns. + Ophthalmic veins
Inf orbital fissure	Maxillary + Zygomatic Ns.
Infraorbital notch or F.	Infraorbital N. & Vs.
Incisive fossa	Greater palatine Vs. + Nasopalatine Ns.
Greater palatine F.	Greater palatine N. & Vs.
Lesser palatine F.	Lesser palatine N. & Vs.
F. Lacerum	E.V. + Int carotid A.
F. ovale	Mandibular & Lesser petrosal Ns. + Accessory meningeal A. + E.V.
F. spinosum	Middle meningeal A. + Nervus spinosus
Carotid canal	Int. carotid A. + sympathetic plexus
Jugular F.	Sigmoid & inf petrosal sinuses + Cranial Ns 9,10,11
Stylomastoid F.	Facial N.
Hypoglossal canal	Hypoglossal N.
Post condylar F.	E.V.
F. Magnum	Medulla, cerebellar tonsils, meninges, spinal accessory N., vertebral, ant & post spinal As. Apical & cruciate Ligs., membrana tectoria,
F. cecum	E.V.
Cribriform plate of ethmoid	Olfactory N.
F. rotundum	Maxillary N.
Internal auditory meatus	7,8 Cranial Ns.

EV = emissary veins

MANDIBLE (OUTER)



Head of mandible (condyle)
Structure related:
Mandibular fossa
Joint related:
Tempromandibular joint

Coronoid process
Structure attached:
Temporalis

Ramus of mandible
Structure attached:
Masseter

Symphysis menti

Angle of mandible
Structure attached:
Stylomandibular lig.

Mental F.
Structures passing:
Mental N. & Vs.

Mental protuberance

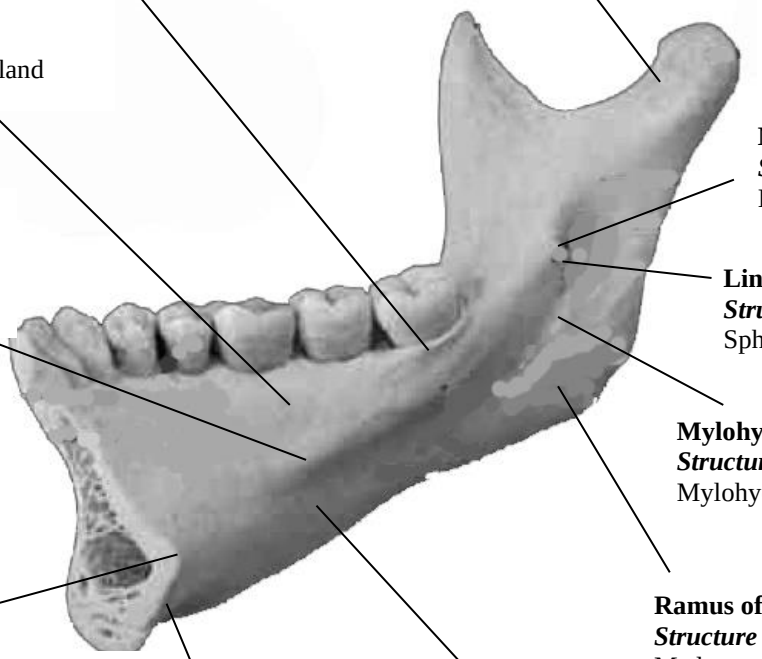
Tortora & Nielsen

MANDIBLE (INNER)

Neck of mandible (condyle)
Structures attached:
Lat pterygoid (inner), Tempromandibular lig (outer)
Structures related:
Auriculotemporal N., Maxillary Vs.

Groove for lingual N.

Sublingual fossa
Structure related:
Sublingual salivary gland



Mandibular F.
Structures passing:
Inf alveolar N. & Vs.

Mylohyoid line
Structure attached:
Mylohyoid M.

Lingula
Structure attached:
Sphenomandibular Lig.

Mylohyoid groove
Structure related:
Mylohyoid N. & Vs.

Ramus of mandible
Structure attached:
Med pterygoid

Mental (genial) tubercles
Structure attached:
Genioglossus & Geniohyoid Ms.

Submandibular fossa
Structure related:
Submandibular salivary gland

Digastric fossa
Structure attached:
Ant belly of digastric

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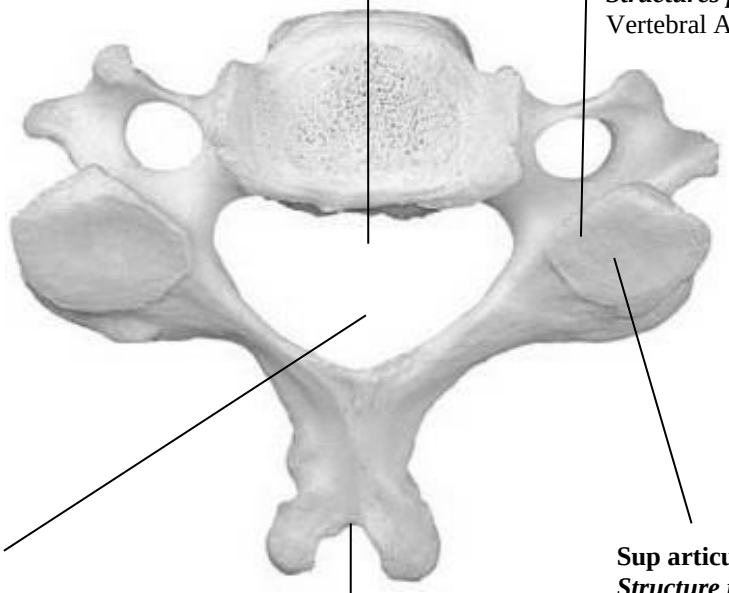
TYPICAL CERVICAL VERTEBRA



Body
Structure attached (or related):
Intervertebral disc

F. transversarium
Structures passing:
Vertebral A. & V.

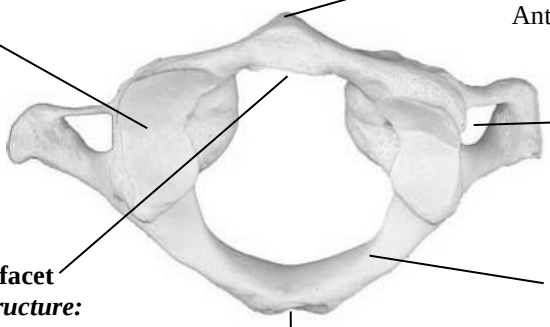
Vertebral canal
Structure related:
Spinal cord & meninges

Sup articular facet
Structure related:
Inf articular facet of the vertebra above

Spine
Structure attached:
Ligamentum nuchae

Tortora & Nielsen

ATLAS



Sup articular facet
Structure related:
Occipital condyle
Joint related:
Atlanto-occipital joint

Ant tubercle
Structure attached:
Ant longitudinal lig.

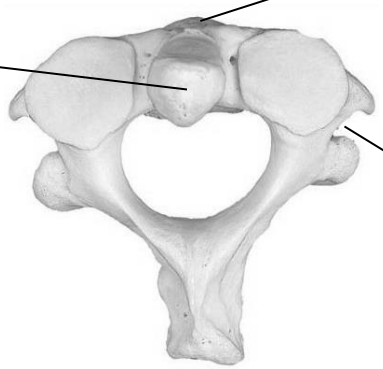
F. transversarium
Structures passing:
Vertebral A. & V.

Articular facet
Related structure:
Dens
Related joint:
Atlantoaxial joint

Groove for vertebral A. & C1 N.

Post tubercle
Structure attached:
Ligamentum nuchae

AXIS



Dens (odontoid process)
Related joint:
Atlantoaxial joint
Attached structures:
Apical & alar ligs.

Body
Structures attached:
Ant longitudinal lig (ant)
Post longitudinal lig, membrane tectoria, cruciate lig (vertical band) (post)

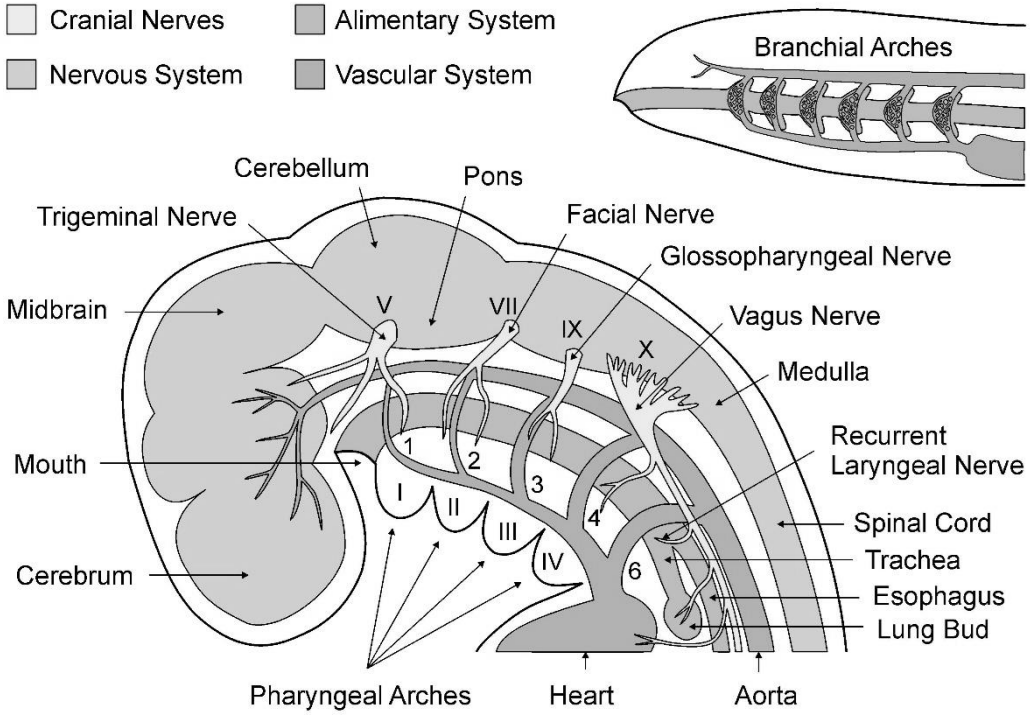
F. transversarium
Structures passing:
Vertebral A. & V.

C7 VERTEBRA

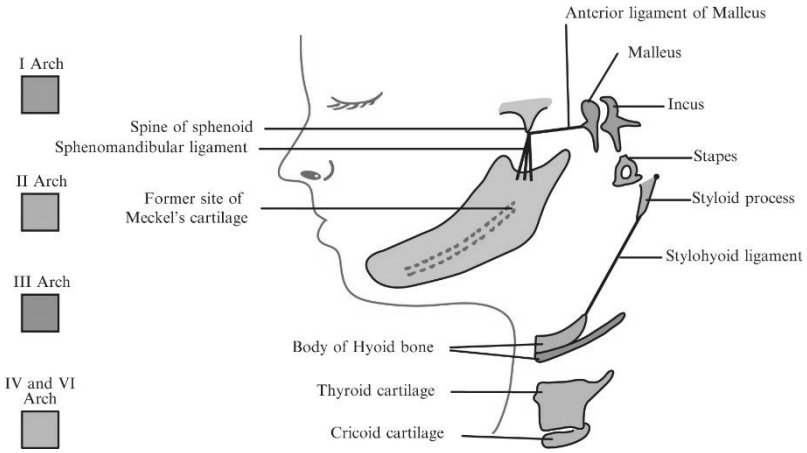
F. transversarium
Structures passing:
Vertebral veins.

Spine (long & not bifid)
Structure attached:
Ligamentum nuchae

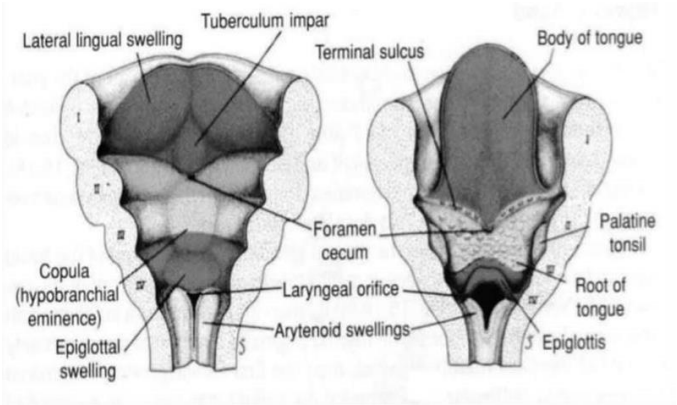
Tortora & Nielsen



Components of pharyngeal arches



Derivatives of pharyngeal arches



Endoderm of pharyngeal arches

Pinterest / Springer / Quizlet

EMBRYOLOGICAL PREVIEW

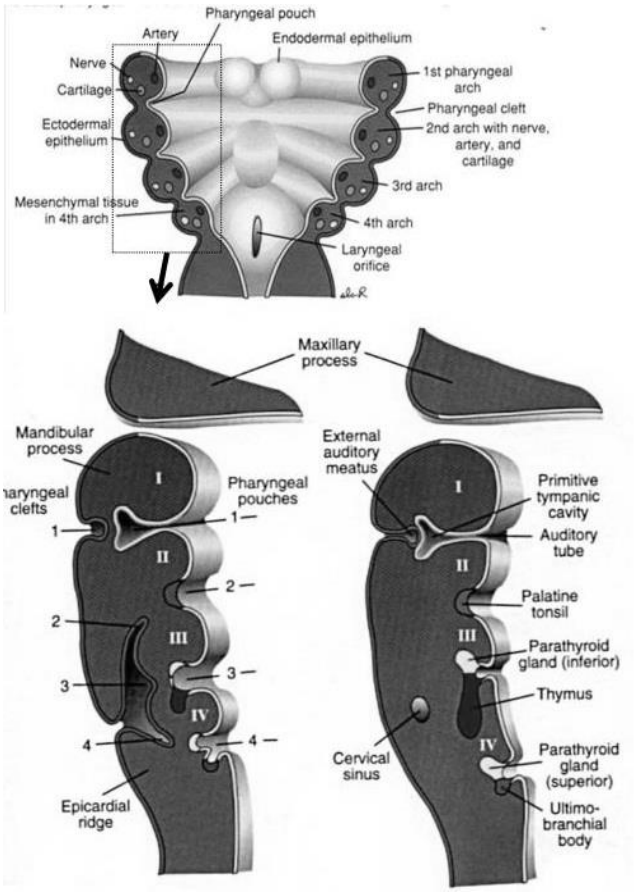
PHARYNGEAL ARCHES, POUCHES & CLEFTS

- The mesoderm at the side of the pharynx develops forming 6 curved cylindrical thickenings. Each is covered externally with ectoderm and lined internally with endoderm. The grooves of the ectoderm are called pharyngeal clefts while the grooves of the endoderm are called pharyngeal pouches.
- The mesoderm of each arch develops into:
  - Cartilaginous bar differentiates into skeletal structures.
  - Muscular element differentiates into skeletal striated muscles (special visceral).
  - Nerve containing special visceral efferent fibers (SVE) to supply the muscles of the arch.
  - Artery called aortic arch.

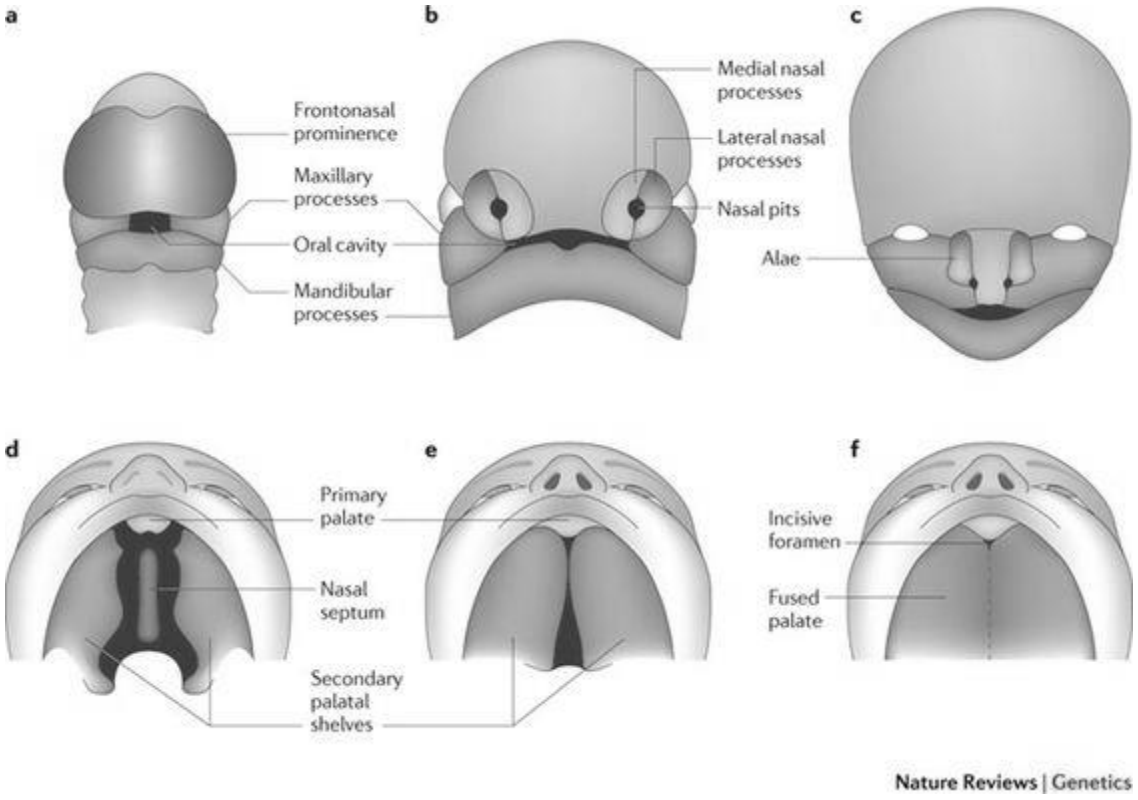
Derivatives of pharyngeal arches:

Arch	*Skeletal*	*Muscular*	*Nerve*	*Artery*
1st	• Malleus and incus • Maxilla • Mandible	• Muscles of mastication • Tensor tympani and tensor palati • Mylohyoid & ant belly of digastric	Mandibular N	Maxillary
2nd	• Stapes • Styloid process • Stylohyoid ligament • Upper ½ of hyoid	• Facial muscles • Stapedius • Stylohyoid & post belly of digastric	Facial N	Stapedial
3rd	Lower part of hyoid	Stylopharyngeus	Glossopharyngeal N	Carotid arteries
4th	Thyroid cartilage	Cricothyroid	Superior laryngeal (vagus) N	Rt: subclavian Lt: arch of aorta
5th	Disappears			
6th	Other laryngeal cartilages	• All muscles of palate except palatoglossus • All muscles of pharynx except stylopharyngeus • All muscles of larynx except cricothyroid	cranial accessory (through vagus)	Pulmonary

N.B.: the endoderm of pharyngeal arches develops into the mucous membrane of the tongue, epiglottis, and thyroid gland acini (for further details revise these organs).



Pharyneal pouches and clefts



Development of face and palate

Slide serve / Pinterest

Derivatives of pharyngeal pouches:

Pouch	***Derivatives***
1	Middle ear and Eustachian tube
2	Tonsils (the lymphocytes migrate from mesoderm)
3	• Thymus • Inf parathyroid
4	Sup parathyroid
5	Parafollicular cells of thyroid

Derivatives of pharyngeal clefts:

1st cleft: differentiates into external auditory meatus and outer layer of tympanic membrane.

2nd – 5th clefts: the mesoderm of the 2nd arch grows caudally and unites with the other arches forming a cavity lining with ectoderm (cervical sinus) which normally disappears.

Congenital anomalies:

Branchial cyst: due to persistence of cervical sinus. It appears as a swelling at the side of the neck

Branchial fistula: a branchial cyst opening at the skin of the neck (ectoderm) forming ***external fistula***. Or at the pharynx (endoderm) forming ***internal fistula*** or ***both.***

DEVELOPMENT OF THE FACE AND PALATE

- ❖ It occurs by union of 5 mesodermal processes surrounding the stomodium (1 frontonasal (mesoderm covering the brain) and 2 maxillary and 2 mandibular (from 1st pharyngeal arch).

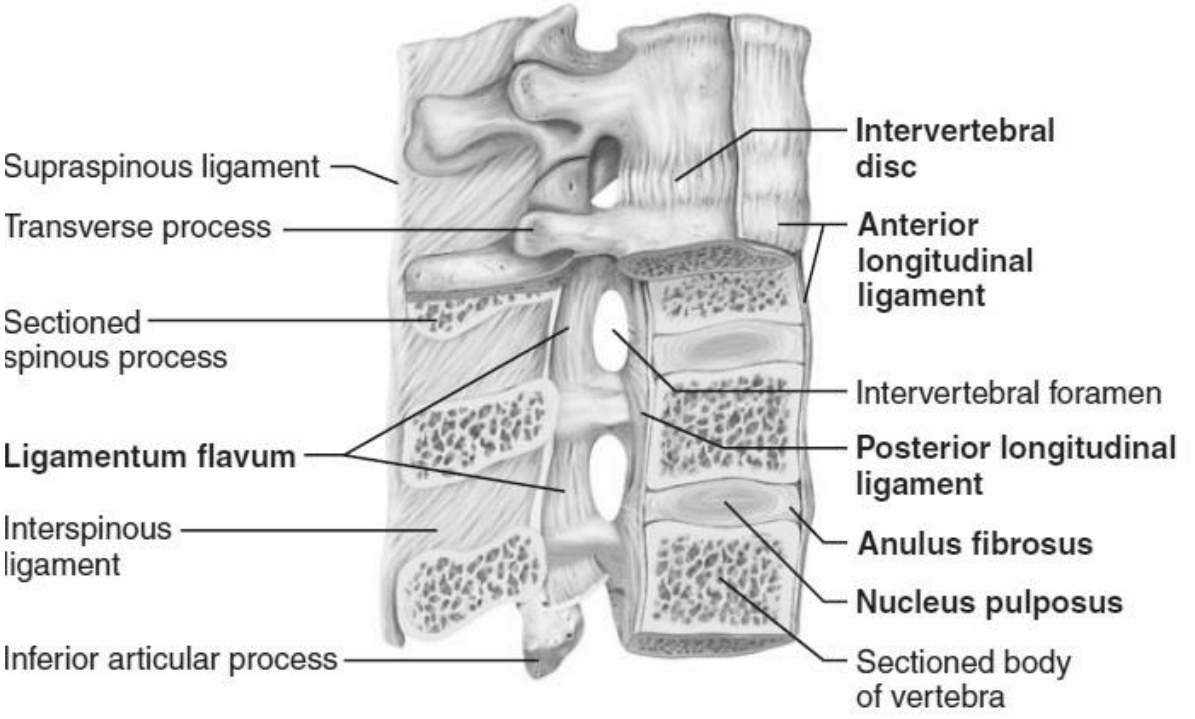
  Frontonasal process: develops into the forehead, the nose, the central part of upper lip (filtrum), central part of upper jaw (containing the incisors) and the palate behind them.

  Maxillary process: develops into upper lip (except the fitrum), upper jaw (except the incisors area) and palate (except the part behind the incisors) and upper part of cheek.

  Mandibular processes: develops into lower lip, lower jaw and lower part of cheek.
- ❖ The muscles of the face migrate from the 2nd pharyngeal arch accompanying their innervation (branches of facial nerve).
- ❖ The palate is formed by central anterior part (from frontonasal process) and completed by the maxillary processes. The fusion between them is Y shaped.

Congenital anomalies:

- Failure of fusion between frontonasal process and maxillary process at one side may cause oblique facial cleft, Lateral hare lip, unilateral cleft palate.
- Failure of fusion between frontonasal process and maxillary processes on both sides may cause bilateral hare lip, bilateral cleft palate or combined anomaly.
- Failure of fusion between the 2 maxillary processes may cause midline cleft pala



Intervertebral joints
Marieb

GENERAL JOINTS OF THE VERTEBRAE

INTERVERTEBRAL JOINTS

1) **The bodies:**
   a) **Intervertebral discs:** (2ry cartilaginous).
      - 23 discs forming 20% of vertebral column length

- The 1st one is between C2 & C3, the last one (the lumbosacral disc) is between L5 & sacrum
- Formed of annulus fibrosus (outer annular fibrous tissue and attached to vertebral bodies and nucleus pulposus (inner gelatinous tissue which is the remnant of notochord).

Clinical Anatomy: ***(disc prolapse):*** it is the bulge of nucleus pulposus through annulus fibrosus. It is common in cervical and lower lumbar discs. Commonly it is directed posterolateral pressing on the roots of spinal Ns → pain according to site. Post prolapse is less commonly (due to the presence of post longitudinal ligament) but more dangerous as it may press on the spinal cord.

b) Ant Longitudinal Ligament: (fibrous, syndesmosis).

- It is attached to the front of the vertebral bodies and intervertebral discs.
- It extends from occipital bone to S1.

c) Post Longitudinal Ligament: (fibrous, syndesmosis).

- It is attached to the back of vertebral bodies and discs (inside the vertebral canal)
- It extends from C2 to S1

2) Between sup & inf articular processes: (synovial, plane)

3) The transverse processes: intertransverse ligaments (fibrous, syndesmosis).

4) The laminae: ligamentum flavum (fibrous, syndesmosis).

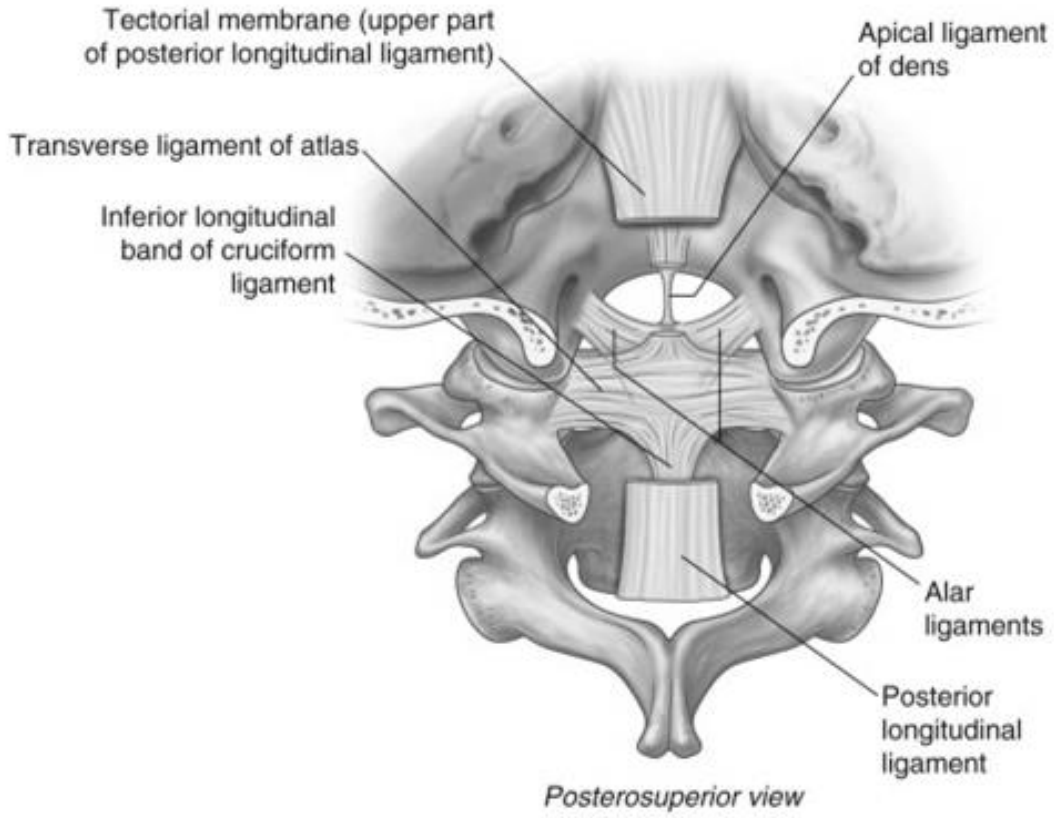
5) The spines:

a) Interspinous ligaments: between the spines (fibrous, syndesmosis).

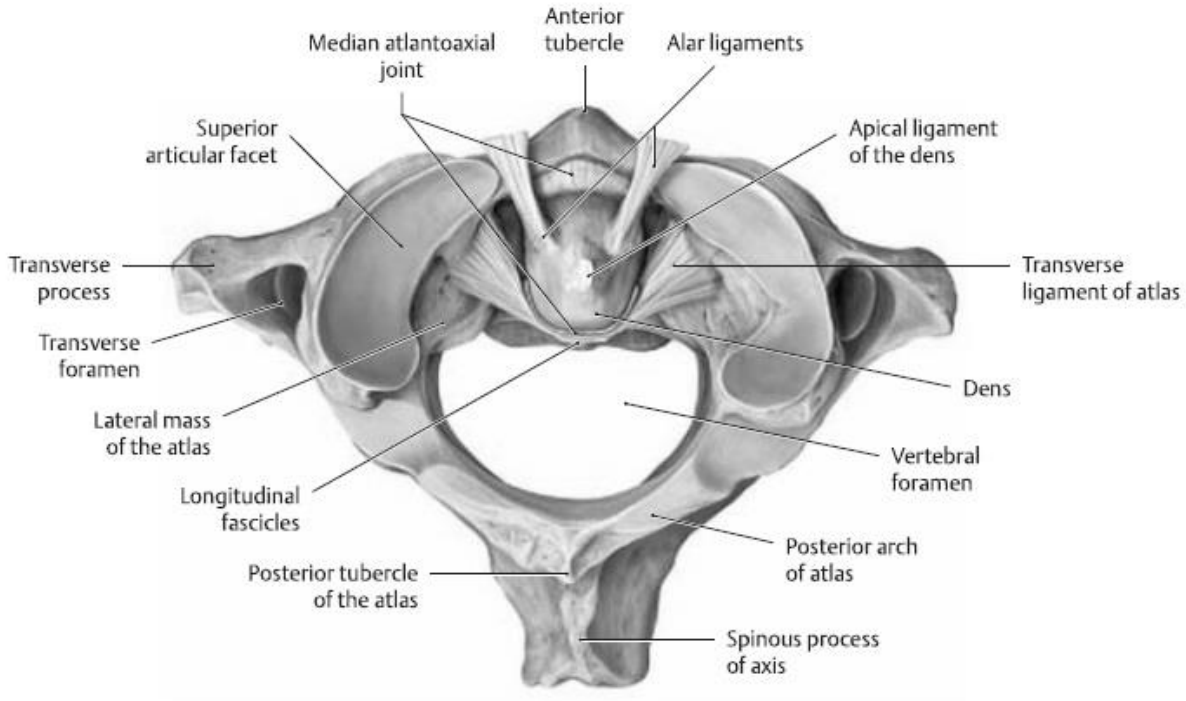
b) Supraspinous ligaments: attached to the tips of spines (fibrous, syndesmosis).

N.B.: nuchal ligament (ligamentum nuchae) is the union of interspinous & supraspinous ligaments in the neck. It is thick and hides the spines (the 1st palpated spine is C7).

N.B.: the pedicles has no articulation to allow the escape of the spinal Ns



Atlantooccipital joint



Atlantoaxial joints

ddxof.com / Schuenke

JOINTS OF THE HEAD AND NECK VERTEBRAE

ATLANTOOCCIPITAL JOINT

Type & variety: synovial, ellipsoid.
Articular surfaces: condyles of occipital bone, sup articular facet of atlas.
Capsule: attached to the margins of articular surfaces.
Synovial membrane: lines the capsule.
Ligaments:

Ant atlantooccipital membrane: from foramen magnum (ant margin) to the ant arch of atlas.

Post atlantooccipital membrane: from foramen magnum (post margin) to the post arch of atlas.

Ant longitudinal ligament: it extends from the occipital bone (basilar part) to attach to the bodies of vertebrae.

Movements & muscles :

Flexion: gravity, longus capitis, rectus capitis ant & sternomastoid (both sides).

Extension: rectus capitis post major & minor, semispinalis capitis & splenius capitis.

Lat flexion: longissimus capitis, rectus capitis lateralis & sternomastoid (unilateral).

MEDIAN ATLANTOAXIAL JOINT

Type & variety: synovial, pivot.
Articular surfaces: ant arch of atlas (facet on inner side) and dens of axis (ant facet).
Capsule: attached to the margins of articular surfaces.
Synovial membrane: lines the capsule.
Ligaments:

Apical: from foramen magnum (ant margin) to the apex of dens.

Alar (2): from medial margin of occipital condyles to the sides of the dens.

Cruciate ligament:

Transverse: between the lateral masses of atlas.

Vertical: between the occipital bone (inner surface) to the body of axis (post aspect).

Membrana tectoria:

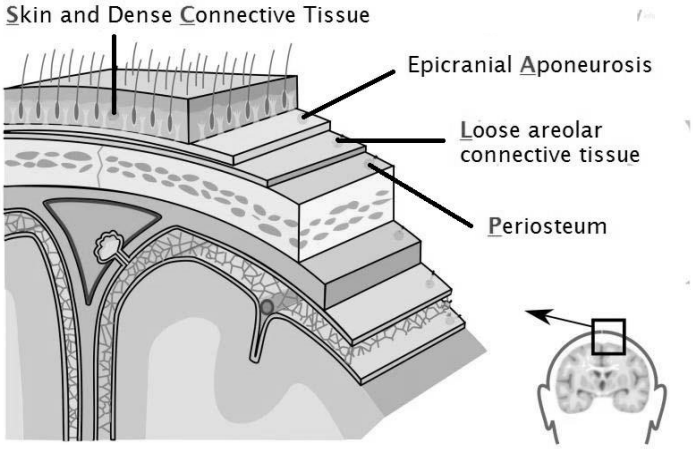
- It is the upper continuation of post longitudinal ligament.
- Extends between the occipital bone (inner surface) to the body of axis (post aspect), post to the vertical part of cruciate ligament.

Movements & muscles:

Rotation: splenius capitis, oblique capitis & opposite sternomastoid.

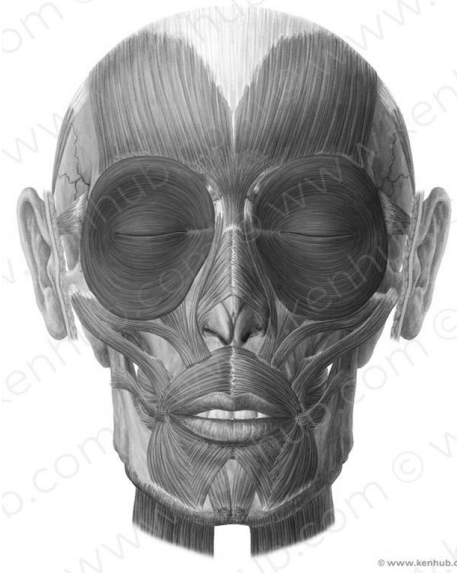
LATERAL ATLANTOAXIAL JOINT

❖ Synovial, plane: between sup & inf articular processes:

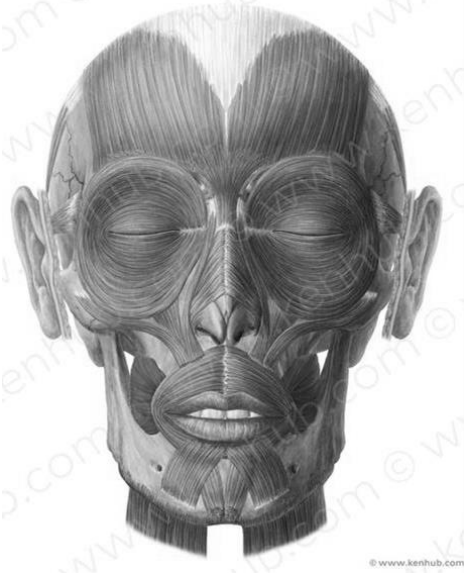


Layers of scalp (after Teachmeanatomy.com)

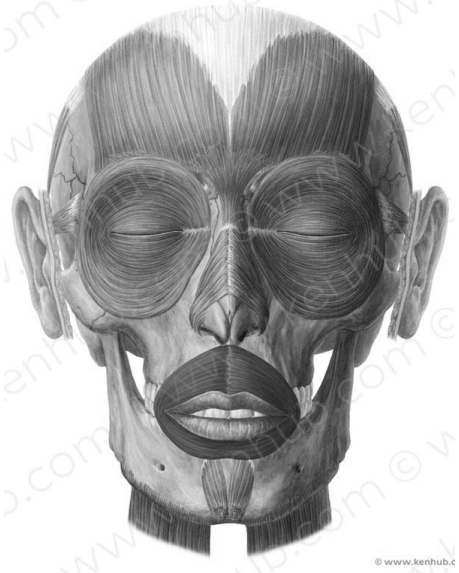
Occipitofrontalis



Orbicularis oculi



Buccinator



Orbicularis oris

Ken Hub

SCALP AND FACE

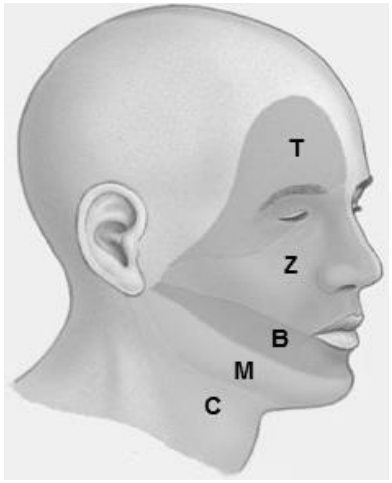
LAYERS OF SCALP

1) **Skin:** thick, hairy & rich in sebaceous glands.
2) **CT (dense):** highly vascular (severe bleeding but good healing) & contains sensory nerves.
3) **Aponeurosis:** epicranial aponeurosis of occipitofrontalis muscle.
4) **Loose areolar tissue:** contains emissary Vs (dangerous layer of the scalp). Haemorrhage may extend to the upper eye lid (black eye).
5) **Periosteum** (pericranium).

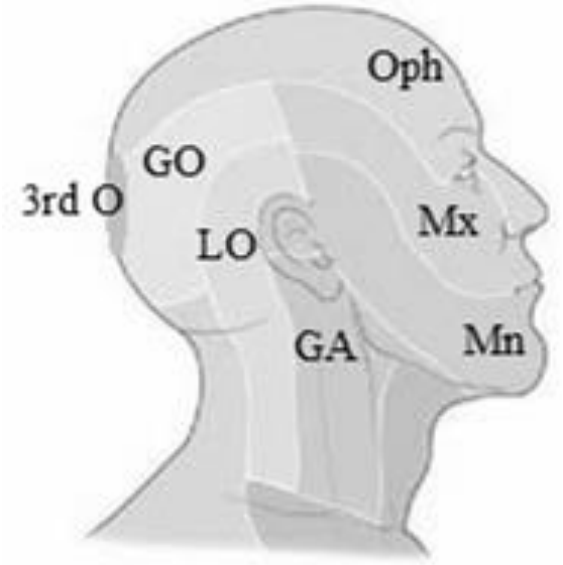
N.B.: Sutural ligament: extension from periosteum of the skull through the sutures to the dura.

MUSCLES OF SCALP & FACE

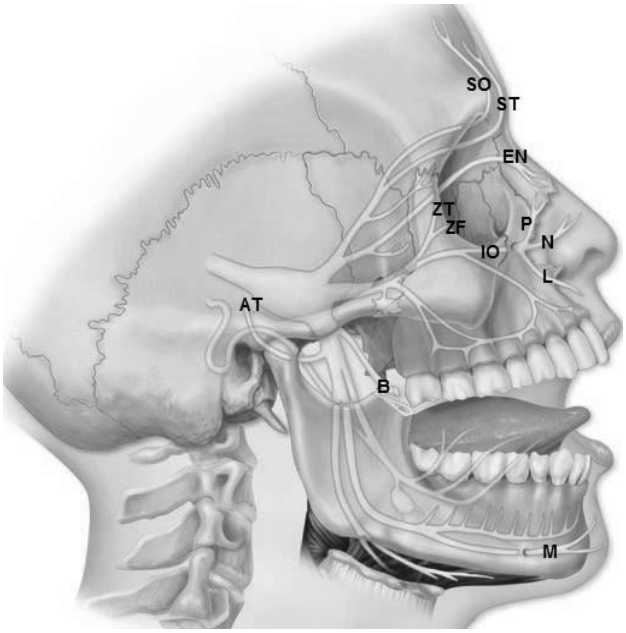
Muscle		*Origin*	*Insertion*	*Action*	*NS*
occipitofrontalis	**Occipital belly**	Sup nuchal line	Epicranial aponeurosis	Elevation of brows	Facial N
	Frontal belly	Epicranial aponeurosis	Skin of brows		
Orbicularis Oculi	**Orbital**	Med palpebral ligament	Encircles orbit & returns to origin	Forcible closure of eye	
	Palpebral	Med palpebral ligament	Lat palpebral raphe	Gentle closure of eye	
	Lacrimal	Lacrimal sac	palpebral part	drainage of tears	
Buccinator		Maxilla & mandible opposite molars	Upper fibers: upper lip Lower fibers: lower lip Middle fibers: cross to opposite lip	• Obliteration of vestibule • Blowing of air	
Orbicularis Oris	**Deep**	Maxilla & mandible near midline	Encircles the mouth and inserts in the skin of lips	closure of lips	
	Superficial	Neighboring muscles e.g. buccinator			



Motor nerves of scalp and face



Sensory innervation of scalp and face



Sensory nerves of scalp and face

NERVES OF THE SCALP & FACE

A] Motor: Facial N:

- Leaves the skull through stylomastoid foramen.
- Gives the post auricular branch, which supplies occipital belly of occipitofrontalis.
- Enters the parotid gland.
- Divides into 5 terminal branches:
  1) ***Temporal:*** supplies frontal belly of occipitofrontalis & orbicularis oculi.
  2) ***Zygomatic:*** muscles near zygomatic arch & orbicularis oculi.
  3) ***Buccal:*** buccinator.
  4) ***Mandibular:*** muscles of lower lip.
  5) ***Cervical:*** platysma.

B] Sensory:

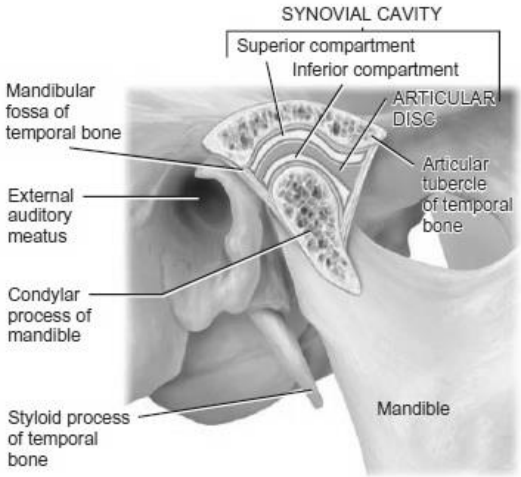
Nerve & its origin				***Supplied area***
Trigeminal	***Ophthalmic***	***Frontal***	**Supratrochlear**	Forehead
			Supraorbital	Passes through supraorbital notch & supplies forehead and scalp till vertex
		Nasociliary	**infratrochlear**	Skin over bony nose
			external nasal	Skin over cartilaginous nose
		Lacrimal	**palpebral**	Upper lid
	Maxillary	***Zygomatic***	**Zygomaticotemporal**	Non hairy temporal region
			Zygomaticofacial	Skin of cheek (upper part)
		Infraorbital	**Palpebral**	Lower lid
			Nasal	Ala of nose
			Labial	Upper lip
	Mandibular	***Auriculotemporal***		Auricle (outer surface) Hairy temporal region
		Buccal		Skin over buccinators & lower cheek
		Mental		Passes through mental foramen & supplies chin & lower lip
Cervical plexus	***Great auricular (C2,3)***			Over angle of mandible & mastoid process
	Lesser occipital (C2)			Occipital region (lat part)
Dorsal rami	***Greater occipital (C2)***			Occipital region (med part)
	Third occipital (C3)			Over external occipital protuberance.

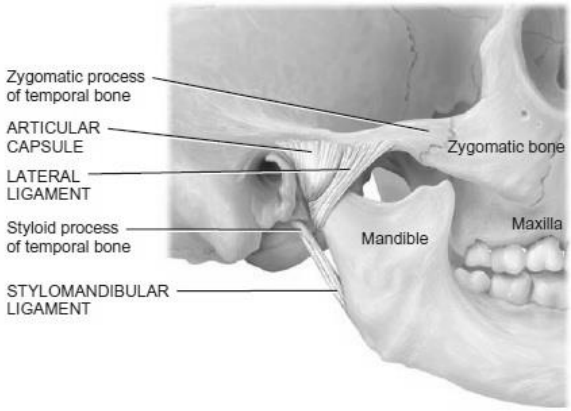
Temporalis

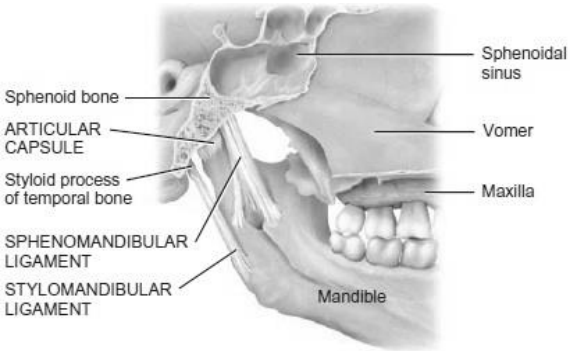
Masseter

Temporalis

Masseter







Temporomandibular joints

Ken Hub / Tortora & Nielsen

MUSCLES OF MASTICATION

Muscle	*Origin*	*Insertion*	*Action*	*NS*
Temporalis	temporal fossa	Coronoid process of mandible	• Elevation of mandible. • Retraction of mandible (the only retractor)	mandibular N (ant division)
Masseter	zygomatic arch	Ramus of mandible (outer surface)	• Elevation of mandible • Protraction of mandible	
Lat Pterygoid	Upper head: greater wing of sphenoid Lower head: lat pterygoid plate (lat surface)	Neck of mandible	• Depression of mandible • Protraction of mandible • Side to side movement	
Med pterygoid	Superficial head: maxillary tuberosity Deep head: lat pterygoid plate (med surface)	Ramus of mandible (lower part of inner surface)	• Elevation of mandible • Protraction of mandible • Side to side movement	mandibular N (trunk)

TEMPROMANDIBULAR JOINT

Type: Synovial, bicondylar.

Articular surfaces: head of mandible, mandibular fossa of temporal bone.

Capsule:

Attachments: margins of articular surfaces.

Intracapsular structure: ***Intraarticular disc*:** a fibrous disc dividing the cavity into upper & lower parts.

Synovial membrane: lines the capsule.

Ligaments:

1) **Temporomandibular lig:** from mandibular fossa to neck of mandible.
2) **Stylomandibular lig:** from styloid process to angle of mandible.
3) **Sphenomandibular lig:** from spine of sphenoid to lingula of mandible.
4) **Pterygomandibular lig:** from pterygoid hamulus to mandible behind mylohyoid line.

Movements & muscles:

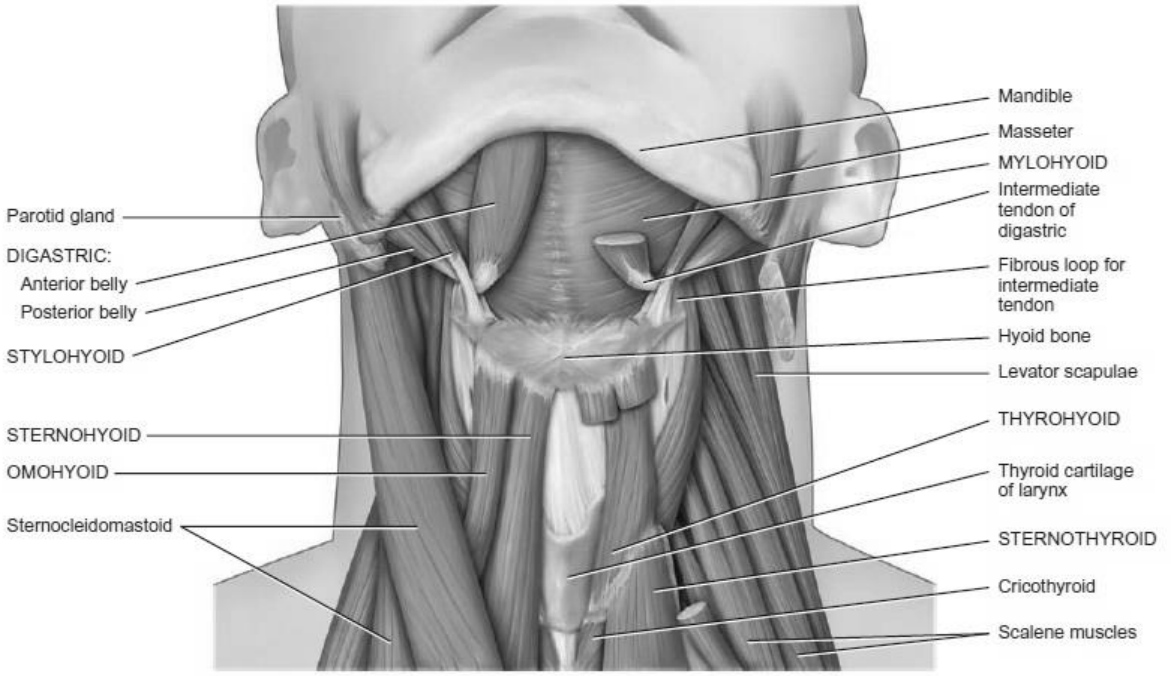
Elevation: temporalis, masseter & med pterygoid.

Depression: gravity, lat pterygoid, mylohyoid, digastric & geniohyoid.

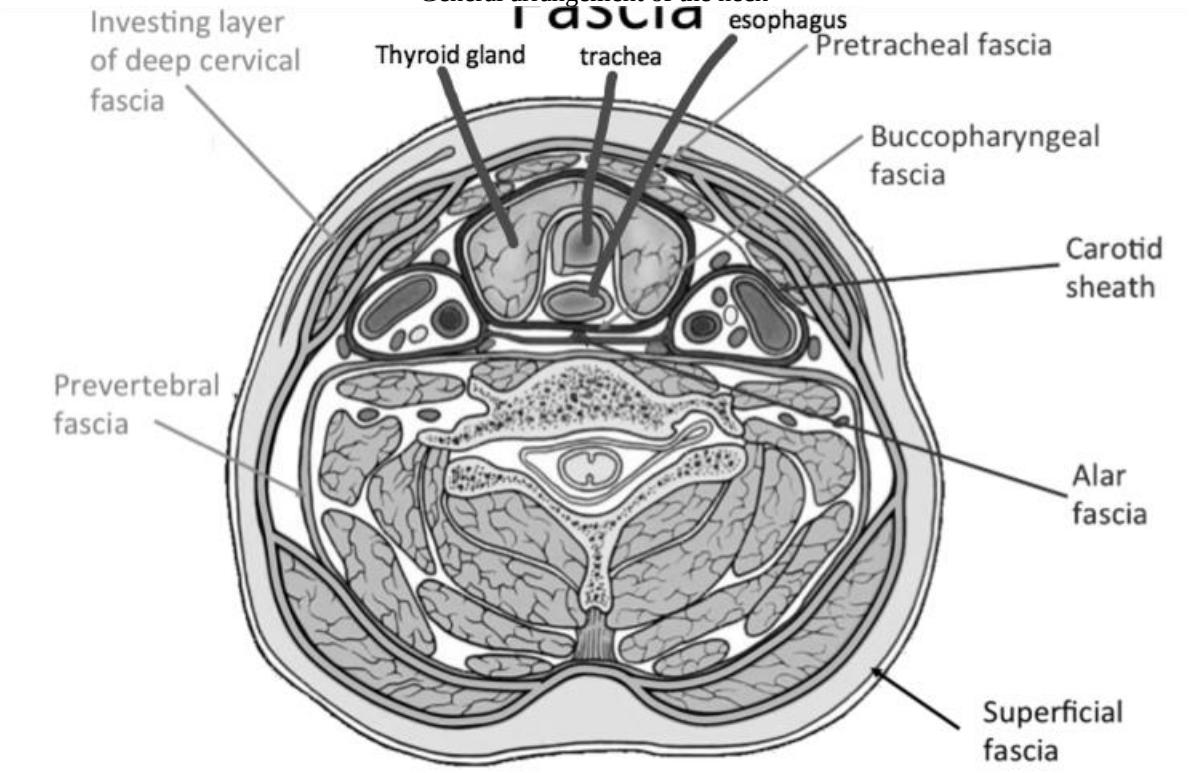
Protraction: masseter, lat & med pterygoid.

Retraction: temporalis.

Side to side: Lat & med pterygoid.



General arrangement of the neck



Deep fascia of the neck

Tortora & Nielsen / Quizlet

GENERAL ARRANGEMENT OF THE NECK

layers: (from superficial to deep)

- **Skin.**
- **Superficial fascia** containing superficial Ns, vessels, lymphatics and lymph nodes. Anteriorly it also contains platysma muscle.
- **Investing deep fascia.**
- **Deep to the investing deep fascia:**
  - — Post triangle (post to sternomastoid muscle).
  - — Ant triangle (between 2 sternomastoid muscles), it includes:
    - Hyoid bone.
    - Suprahyoid (submandibular) region: between hyoid and mandible. It includes (from superficial to deep).
      - Suprahyoid Ms and digastric and submental triangles.
      - Floor of mouth.
  - — Infrahyoid region: between hyoid and sternum. It includes (from superficial to deep):
    - Infrahyoid Ms and carotid and muscular triangles.
    - Viscera of the neck (thyroid gland, larynx, pharynx, trachea and oesophagus).
    - Styloid apparatus and prevertebral Ms.

DEEP FASCIA OF THE NECK

1] Investing layer:

Attachment: manubrium sterni → clavicle → scapula (acromion and spine) → C7 spine → nuchal ligament → external occipital protuberance → sup nuchal line → mastoid → mandible (inf border & symphysis menti) → hyoid.

- It splits to enclose sternomastoid and trapezius muscles, parotid and submandibular glands.
- It forms the roof of post and ant triangles of the neck.

2] Pretracheal fascia:

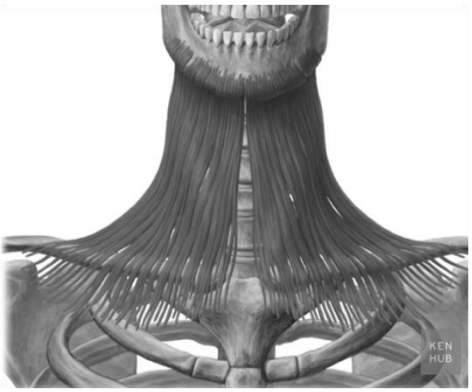
Attachment: hyoid → larynx → arch of aorta.

- It encloses thyroid gland.

Applied anatomy: thyroid gland swellings move with swallowing as it is connected to larynx.

3] Prevertebral fascia: covers the prevertebral Ms. Attached superiorly to the base of skull and inferiorly to T3 vertebra.

4] Carotid sheath: it forms a tube surrounding CCA, ICA, IJV and vagus N.



Platysma

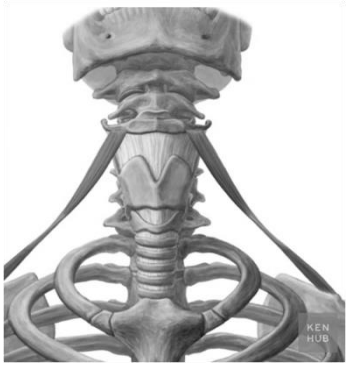
Sternomastoid

Mylohyoid

Digastric

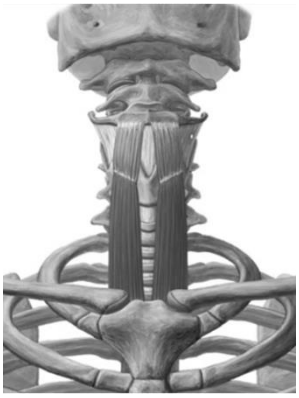
Stylohyoid

Geniohyoid



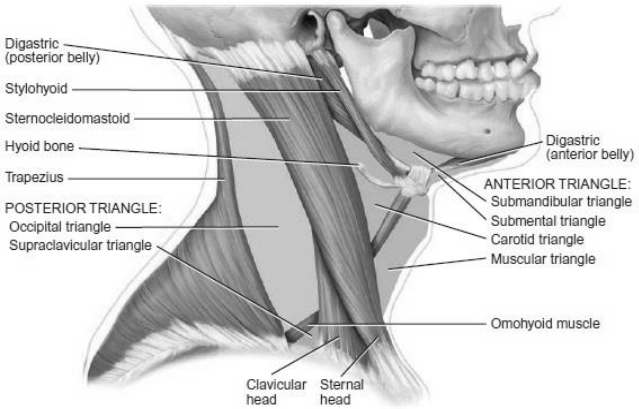
Omohyoid

Sternohyoid



Sternothyroid

Thyrohyoid



Triangles of the neck

Ken Hub / Tortora & Nielsen

SUPERFICIAL MUSCLES OF THE NECK

Muscle	*Origin*	*Insertion*	*Action*	*NS*
Platysma	Superficial fascia of chest	• Skin of lower face • Base of mandible	Depression of lower lip (shaving)	Facial N
Sternomastoid	Sternal head: manubrium (ant surface) Clavicular head: med 1/3 of clavicle (sup surface)	Mastoid process (outer surface)	One muscle: lat flexion to the same side & lat rotation to opposite side of head (directing face to opposite side) Both muscles: flexion of head	Spinal accessory N

SUPRAHYOID MUSCLES

Muscle	*Origin*	*Insertion*	*Action*	*NS*
Mylohyoid	Mylohyoid line of mandible	• Hyoid • Median raphe	• Elevation of hyoid • Depression of mandible • Mylohyoid → elevate floor of mouth (Diaphragm of mouth)	N to mylohyoid (mandibular)
Digastric	Ant belly: digastric fossa of mandible Post belly: digastric notch of mastoid	Central tendon Attached to hyoid		Ant belly: N to mylohyoid (mandibular) Post belly: facial N
Stylohyoid	Styloid process	Hyoid		Facial N
Geniohyoid	Inf genial tubercle	Hyoid		C1 through hypoglossal

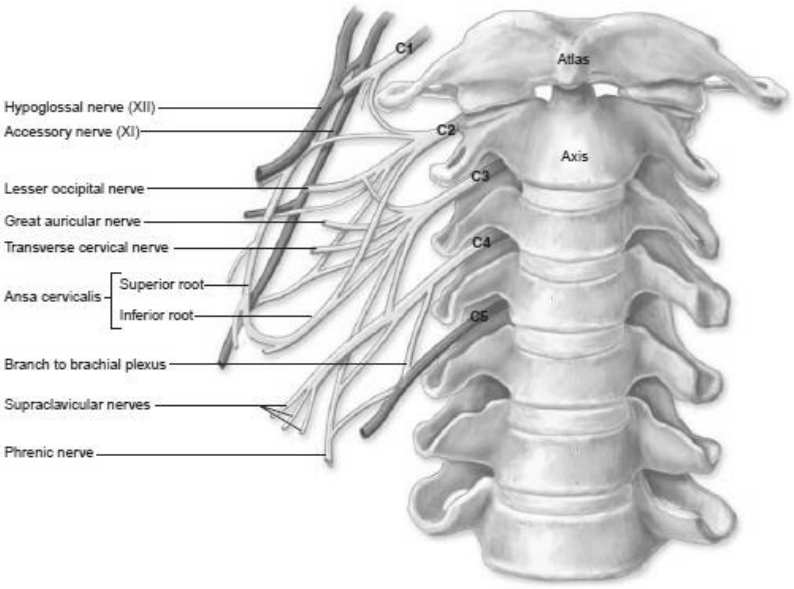
INFRAHYOID MUSCLES

Muscle	*Origin*	*Insertion*	*Action*	*NS*
Omohyoid	Sup belly: hyoid Inf belly: sup border of scapula	Central tendon attached to clavicle	Depression of larynx	Ansa cervicalis
Sternohyoid	Manubrium (post surface)	Hyoid		
Sternothyroid	Manubrium (post surface)	Thyroid cartilage		
Thyrohyoid	Thyroid cartilage	Hyoid	Elevation of larynx	C1 through hypoglossal N

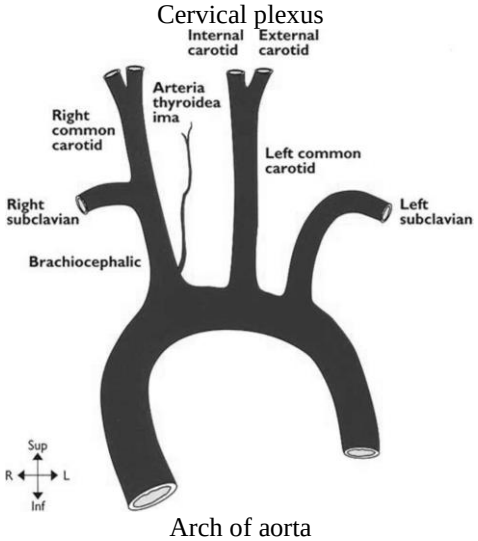
ANTERIOR TRIANGLE OF THE NECK

❖ Is subdivided into:

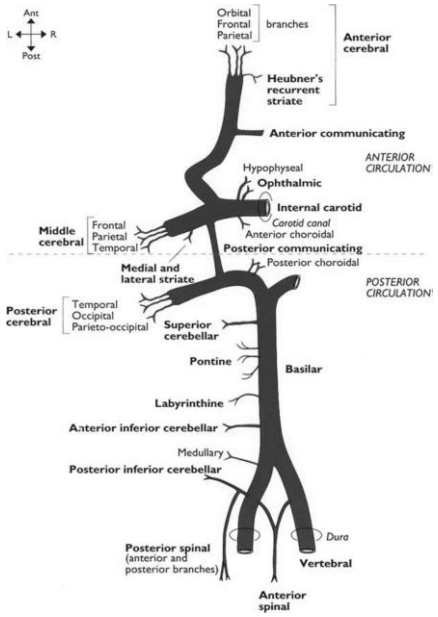
	Submandibular triangle	**Submental triangle**	**Muscular triangle**	**Carotid triangle**
Boundaries	• Ant belly of digastric • Post belly of digastric • Mandible	• 2 ant bellies of digastric • Hyoid	• Sternomastoid • Sup belly of omohyoid • Midline	• Sternomastoid • Sup belly of omohyoid and • Post belly of digastric



Cervical plexus



Arch of aorta



Internal carotid artery

Mckinley & o'loughlin / Whitaker & Borley

CERVICAL PLEXUS

Formation: by C1-4 ant rami.

Branches:

1) **Muscular branches:**
   - ***a)*** Phrenic N (C3-5).
   - ***b)*** Lat vertebral (scalene) muscles.
   - ***c)*** Prevertebral muscles.
   - ***d)*** Proprioceptive (sensory) fibers to sternomastoid & trapezius.
2) **Cutaneous branches:**
   - ***a)*** Lesser occipital (C2).
   - ***b)*** Great auricular (C2-3).
   - ***c)*** Transverse cervical (C2-3).
   - ***d)*** Supraclavicular (C3-4).
3) **C1 through hypoglossal N:** C1 fibers join hypoglossal N, gives meningeal branch, N to thyrohyoid, N to geniohyoid & descendens hypoglossi.
4) **Ansa cervicalis:** formed by union of descendens hypoglossi (C1) & descendens cervicalis (C2-3). It supplies all infrahyoid muscles except thyrohyoid.

SUMMARY OF THE ARTERIES OF THE HEAD AND NECK

❖ The arch of aorta gives 3 branches; brachiocephalic (innominate A) (which divides into Rt common carotid and Rt subclavian), Lt common carotid and Lt subclavian. All enter the neck behind the sternoclavicular joint.

COMMON CAROTID ARTERY (CCA)

Beginning: at the Rt side from brachiocephalic and at the Lt side from the arch of aorta.

Course and relations: ascends inside the carotid sheath.

End: ends between C3-4 vertebrae by dividing into ICA and ECA

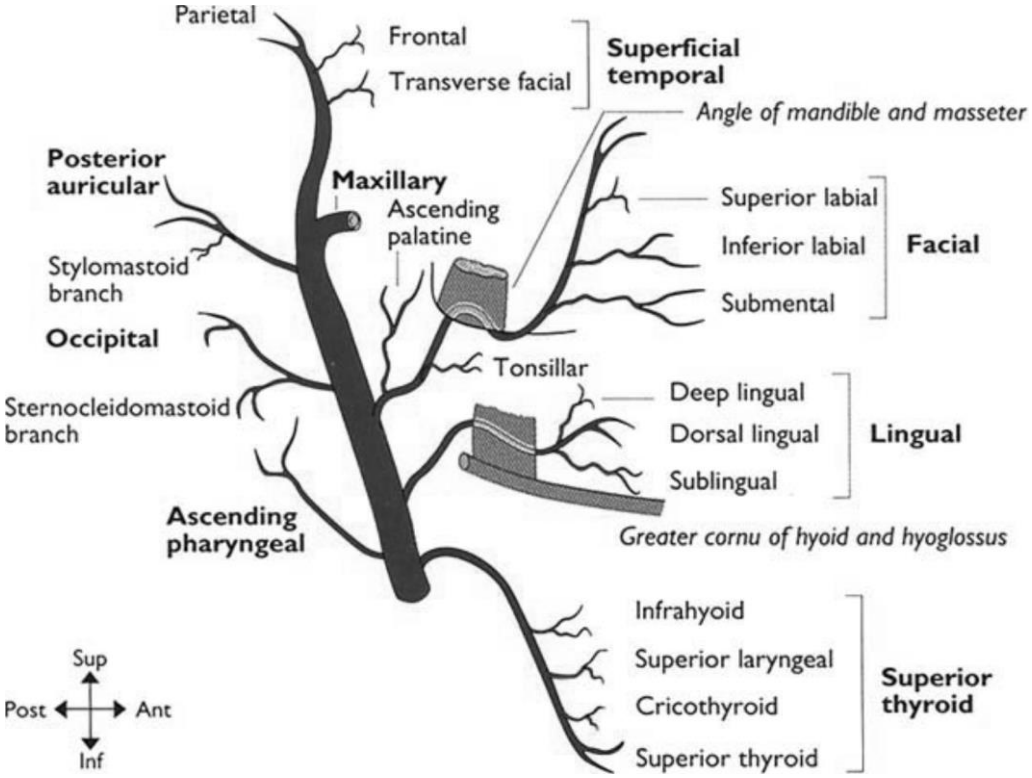
INTERNAL CAROTID ARTERY (ICA)

Beginning: between C3-4 vertebrae as one of two terminal branches of CCA.

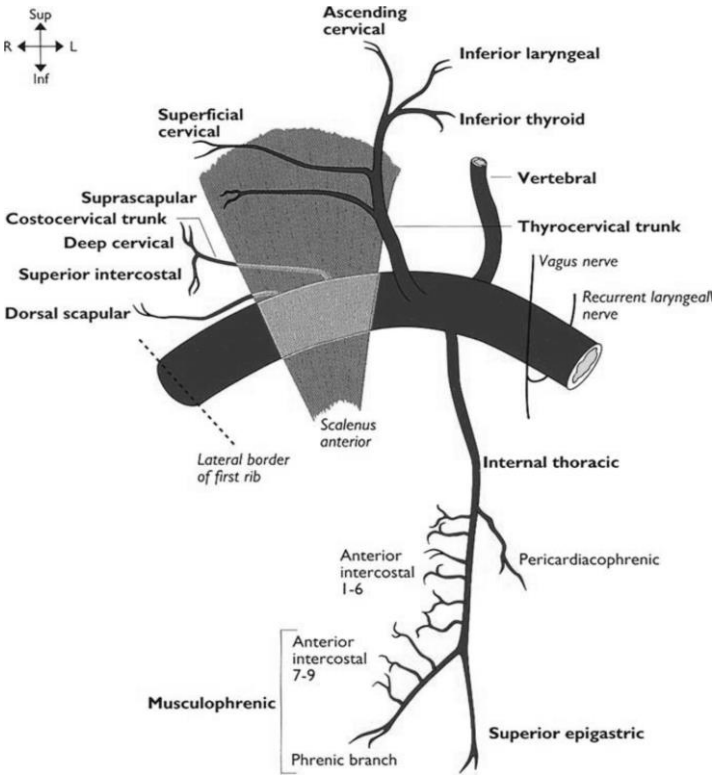
Course and relations: ascends inside the carotid sheath→ carotid canal → foramen lacerum → traverses cavernous sinus.

Branches: it supplies the brain, pituitary, meninges, eye and scalp and face (by supratrochlear and supraorbital As). It does not give any branches before it enters the cranial cavity.

End: by dividing into ant and middle cerebral As.



External carotid artery



Subclavian artery

Whitaker & Borley

EXTERNAL CAROTID ARTERY (ECA)

Beginning: between C3-4 vertebrae as one of two terminal branches of CCA.

Course and relations: ascends superficial to ICA outside the carotid sheath → enters the parotid gland.

Branches:

1) **Sup thyroid A:** it passes to thyroid gland (accompanied by external laryngeal N). It supplies the thyroid gland and larynx.
2) **Ascending pharyngeal A:** supplies the pharynx.
3) **Lingual A** (tortuous): passes deep to hyoglossus M. It supplies the tongue and sublingual salivary gland.
4) **Facial A** (tortuous): passes between the submandibular gland and mandible → angle of mouth and nose → med angle of the eye. It supplies tonsils, submandibular gland and face.
5) **Occipital A:** supplies the occipital part of scalp.
6) **Post auricular A:** supplies the scalp behind the ear.
7) **Superficial temporal A:** supplies the parotid gland and the side of the scalp and face.
8) **Maxillary A:** it passes superficial to lat pterygoid M → pterygomaxillary fissure → pterygopalatine fossa. It supplies both jaws, meninges, nose, palate pharynx, ear and cheek. Its most important branch is:

   Middle meningeal A: enters the skull through foramen spinosum, passes between the dura and the skull (grooving the bone) and ends by dividing into ant & post branches. Bleeding of the ant branch leads to extradural hematoma → pressure on motor area → paralysis. Removal of the hematoma is done by trephine operation.

End: by dividing into superficial temporal and maxillary As.

SUBCLAVIAN ARTERY

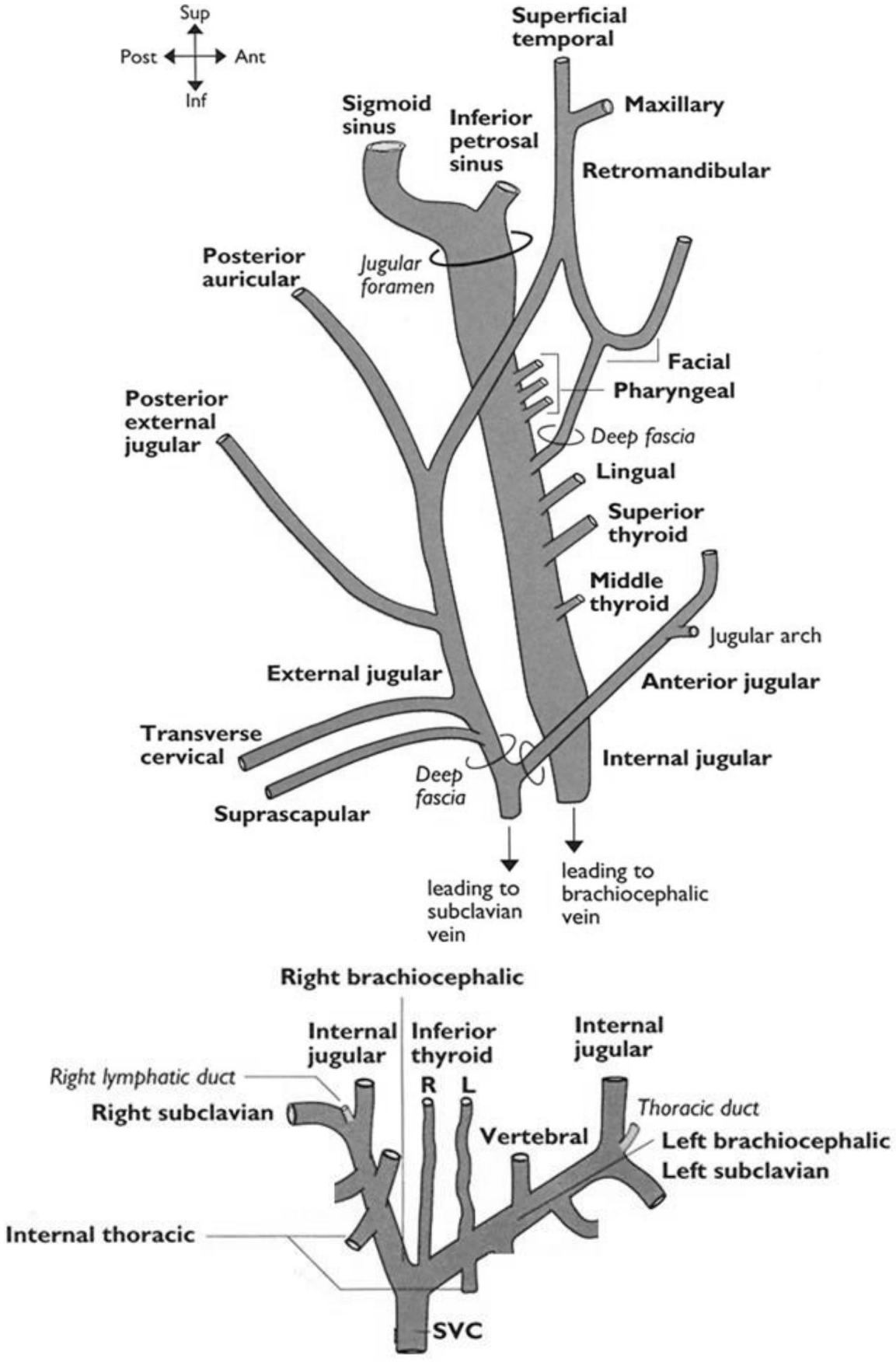
Beginning: at the Rt side from brachiocephalic and at the Lt side from the arch of aorta.

Course and relations: it crosses the neck above the apex of the lung, grooves the sup surface of 1st rib.

Branches:

1) **Vertebral A:** passes in the neck → foramina transversaria of C6-C1 → foramen magnum → intracranial → the 2 vertebral As end by uniting together forming basilar A. It supplies the spinal cord, medulla and cerebellum.
2) **Thyrocervical trunk:** divides into:
   a) ***Inf thyroid A:*** passes to thyroid gland (accompanied by RLN). It supplies the thyroid gland, larynx, pharynx, trachea and oesophagus.
   b) ***Superficial cervical A.***
   c) ***Suprascapular A.***
3) **Internal thoracic A.**
4) **Costocervical trunk:** divides into
   a) ***Deep cervical A.***
   b) ***Sup intercostal A.***
5) **Dorsal scapular A.**

End: at outer surface of 1st rib by becoming the axillary artery (of upper limb).



Veins of head and neck

Whitaker & Borley

SUMMARY OF THE VEINS OF THE HEAD AND NECK

SUMMARY OF VENOUS DRAINAGE OF SCALP AND FACE:

- Supratrochlear and supraorbital Vs unite together forming ant facial (facial) V.
- Superficial temporal V unites with the maxillary V forming post facial (retromandibular) V → divides into ant and post divisions.
  - The ant division unites with the ant facial forming common facial V → ends in IJV.
  - The post division unites with the post auricular V forming EJV.

EXTERNAL JUGULAR VEIN (EJV):

- it begins below parotid gland by union of post division of post facial V and post auricular V → descends in superficial fascia superficial to sternomastoid → pierces investing fascia → ends in subclavian V.

Tributaries:

- Ant jugular V: it begins in submental triangle from submental venous plexus → descends in superficial fascia → pierces investing fascia → passes post and ends in EJV.
- Superficial cervical V.
- Suprascapular V.

Applied anatomy: the investing deep fascia is attached to EJV while piercing it. If injured, it will remain open leading to air embolism.

INTERNAL JUGULAR VEIN (IJV):

- it begins at jugular foramen as a continuation of sigmoid sinus → passes inside the carotid sheath lat to ICA and CCA → it ends behind the med end of clavicle by joining subclavian V to form brachiocephalic (innominate) V.

Tributaries: pharyngeal, common facial, lingual, sup and middle thyroid Vs.

SUBCLAVIAN VEIN:

- it begins as a continuation of axillary V from upper limb → passes ant to subclavian A (both groove the 1st rib) → it ends behind the med end of clavicle by joining IJV to form brachiocephalic (innominate) V.

Tributaries: EJV and dorsal scapular V.

BRACHIOCEPHALIC (INNOMINATE) VEIN:

- it begins behind the med end of clavicle by union of subclavian V and IJV → the 2 brachiocephalic Vs ends by uniting together forming SVC.

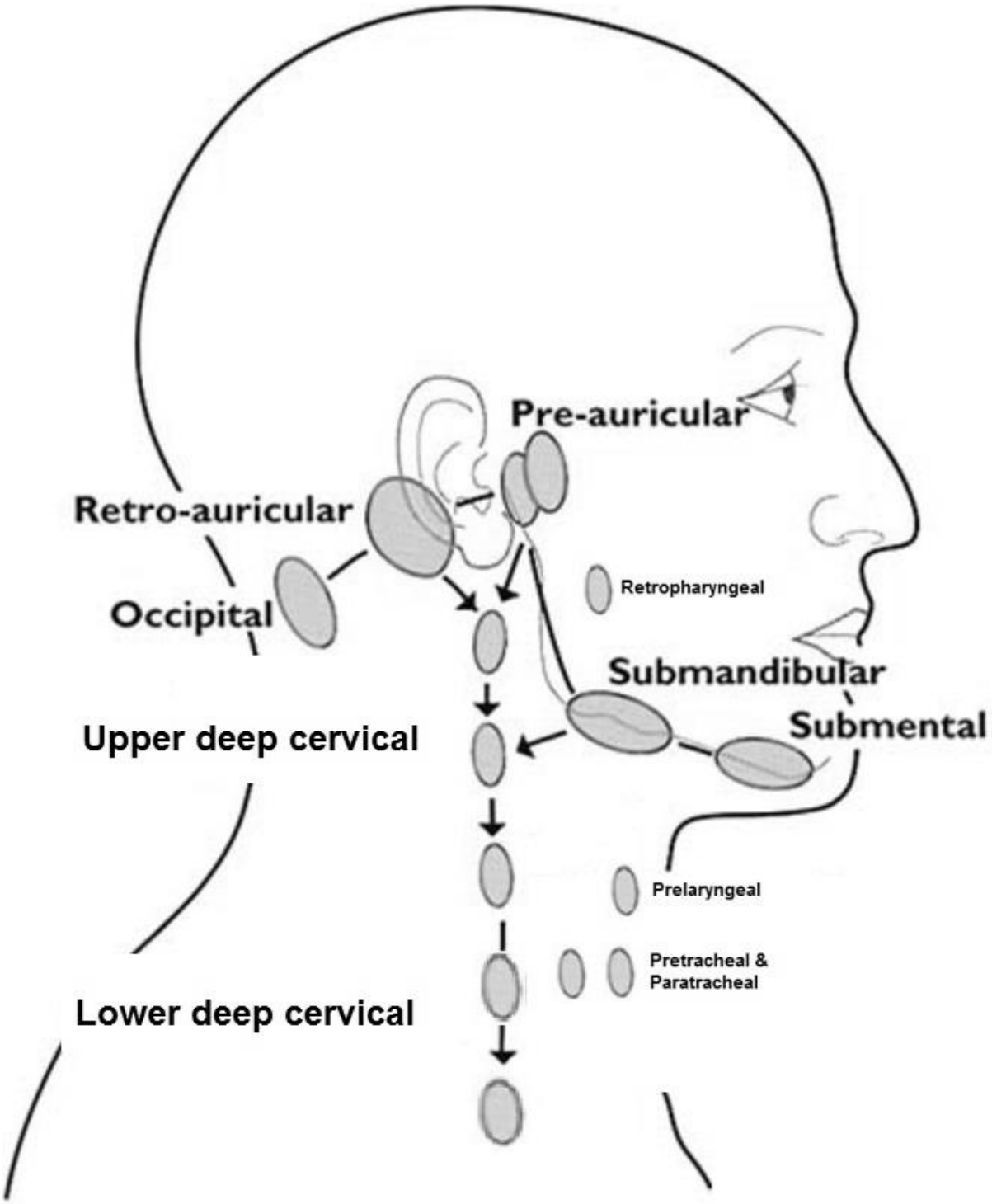
Tributaries: inf thyroid, vertebral and internal thoracic Vs.

EMISSARY VEINS

- Valveless veins connecting veins outside the skull with intracranial venous sinuses.

Function: maintain intracranial pressure.

Applied anatomy: they may transmit infections to venous sinuses leading to sinus thrombosis, meningitis (inflammation of meninges) or encephalitis (inflammation of brain), both may be fatal.



Lymph nodes of head and neck

Whitaker & Borley

LYMPHATIC DRAINAGE OF THE HEAD AND NECK

Lymph node	*Site*	*Afferent*	*Efferent*
Submental	Submental triangle	• Median part of lower lip and chin • Median part of floor of mouth, tongue (tip), Lower teeth (incisors) and its gum	Submandibular
Submandibular	Digastric triangle	• **Submental lymph nodes** • Lat part of tongue, floor of mouth, teeth and gums • Face med to facial vessels	Upper deep cervical
Preauricular (parotid)	Superficial & inside parotid	• Face Lat to facial vessels • Scalp ant to auricle (including its lat surface)	
Post auricular	On mastoid	Scalp post to auricle (including its med surface)	
Occipital	Sup nuchal line	Occipital part of scalp and upper part of neck	
Retropharyngeal	Post to pharynx	• Nose (post) + paranasal sinuses • Nasopharynx + auditory tube + middle ear • Palate • oropharynx	
Prelaryngeal	Ant to larynx	• Larynx • Thyroid	
Prettracheal	Ant to trachea	• Trachea • Thyroid	
Paratracheal	On the side of trachea	• Trachea • Oesophagus	
Upper deep cervical	Around IJV above omohyoid	**All the previous lymph nodes**	Lower deep cervical
	N.B.: one of them is jugulodigastric (at the meeting of IJV & digastric). It is the main lymph node of tonsils		
Lower deep cervical	Around IJV below omohyoid	**Upper deep cervical**	Jugular trunk • Rt → Rt lymphatic duct • Lt → thoracic duct
	N.B.: one of them is juguloomohyoid (at the meeting of IJV & omohyoid). It is the terminal lymph node of tongue		

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THORAX

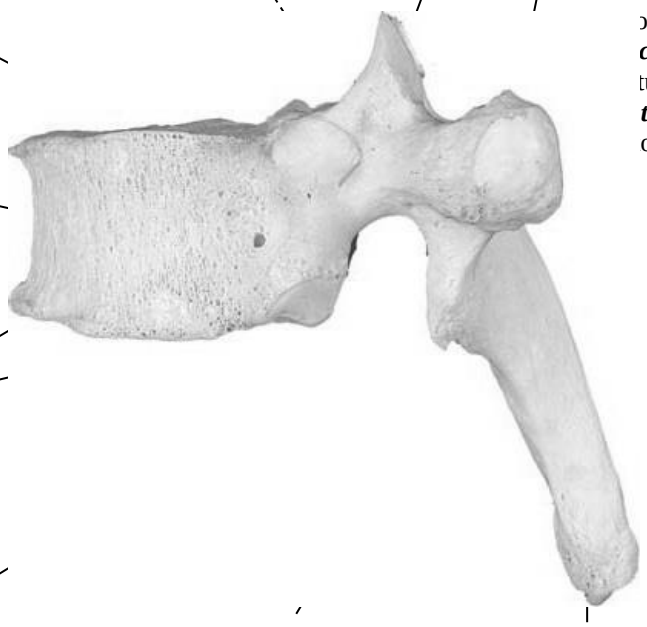
TYPICAL THORACIC VERTEBRA

Vertebral foramen
Structures passing:
Spinal cord

Sup articular process
Related structure:
Inf articular process of the vertebra above

Body (sup surface)
Structure related (or attached):
Intervertebral disc (sup & inf)

Transverse process
Structures attached:
Intertransverse & otransverse lig
cture related:
tubercle
t related:
otransverse joint



Body
Structure attached:
Ant longitudinal lig (ant)
Post longitudinal lig (post)

Body (demifacets)
Structure related:
Head of typical rib
Joint related:
Costovertebral joint

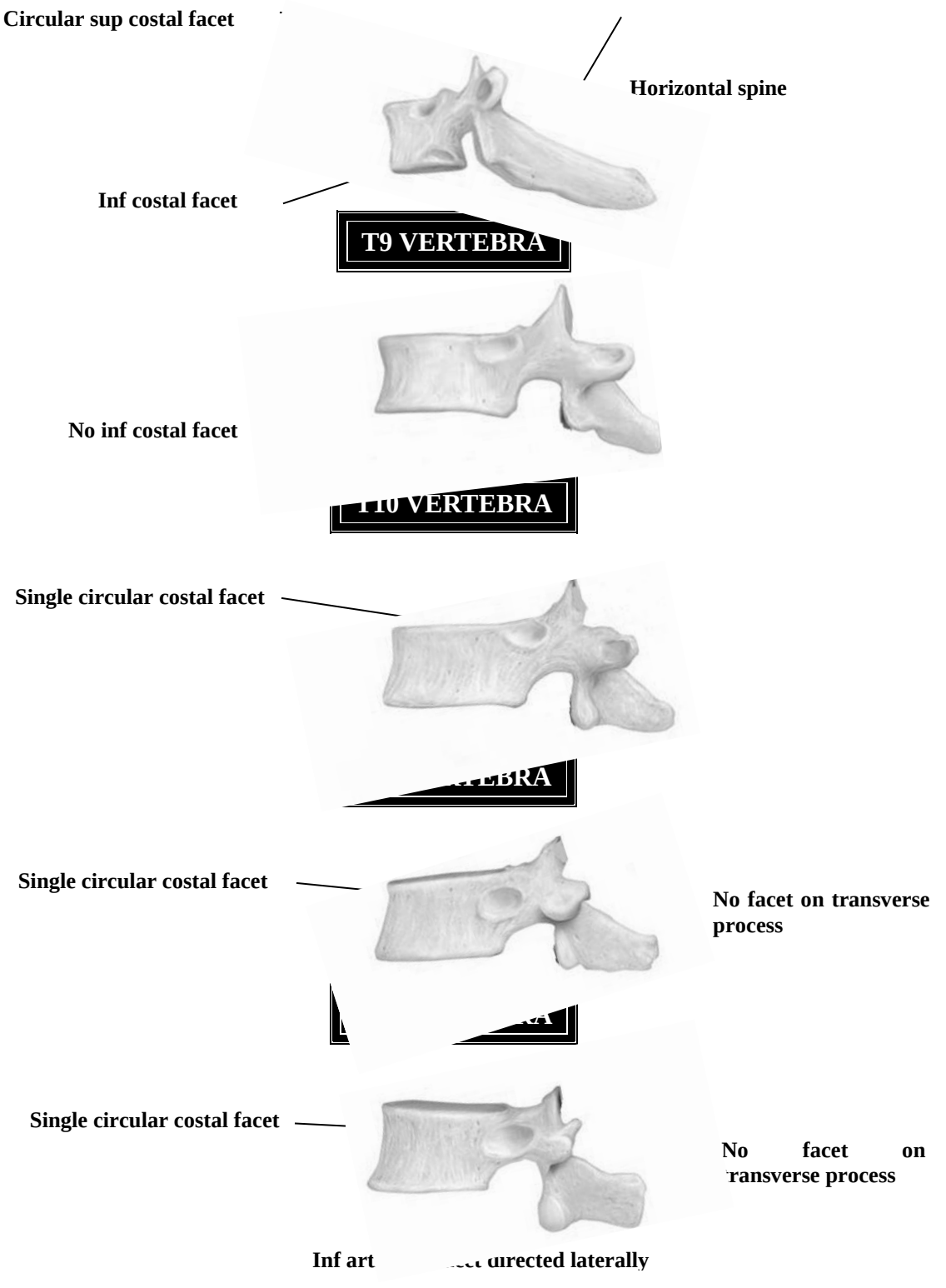
Inf articular process
Related structure:
Sup articular process of the vertebra below.

Lamina
Ligament attached:
Ligamentum flavum.

Spine
Ligaments attached:
Interspinous lig. (sup & inf)
supraspinous lig. (post)

Tortora & Nielsen

T1 VERTEBRA



Tortora & Nielsen

TYPICAL RIB

Tortora & Nielsen

1ST RIB

Ant end
Joint related:
Costochondral joint

Sup surface
Structures attached:
Subclavius (ant), scalenus ant (middle) & scalenus medius (post)

Neck

Tubercle (articular facet)
Structure related:
Transverse process of T1 vertebra
Joint related:
Costotransverse joint

Head (1 articular facet)
Structure related:
Body of T1 vertebra
Joint related:
Costovertebral joint

Tortora & Nielsen

2ND RIB

Superolateral surface

le facet in the head

Tapering ant end

No neck, angle or tubercle

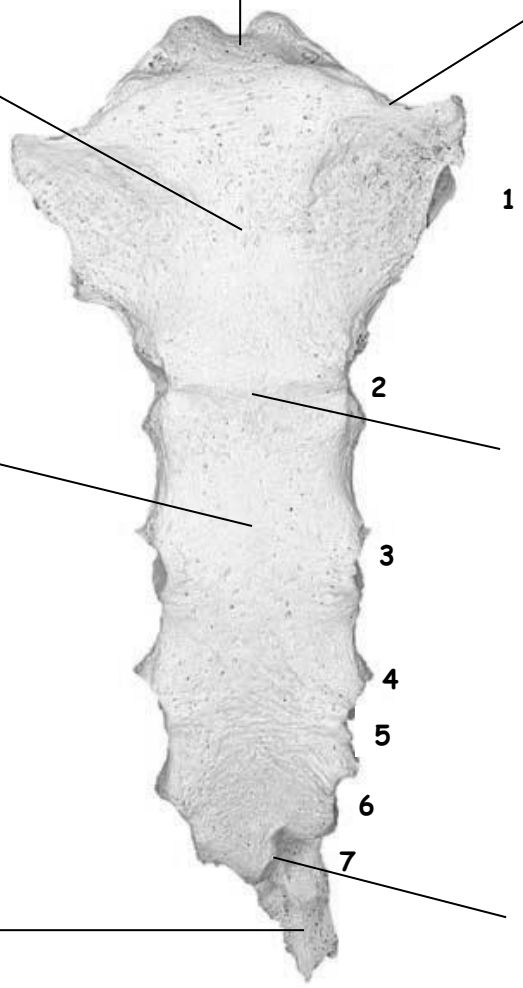
Shallow costal groove

12TH RIB

Single facet in the head

Tortora & Nielsen

STERNUM



Suprasternal notch
Attached structure:
Interclavicular lig

Clavicular notch
Related structure:
Clavicle (med end)
Related joint:
Sternoclavicular joint

Manubrium sterni
Related structures:
Arch of aorta & its branches, lungs & pleurae (post)
Attached structures:
Pectoralis major (ant)

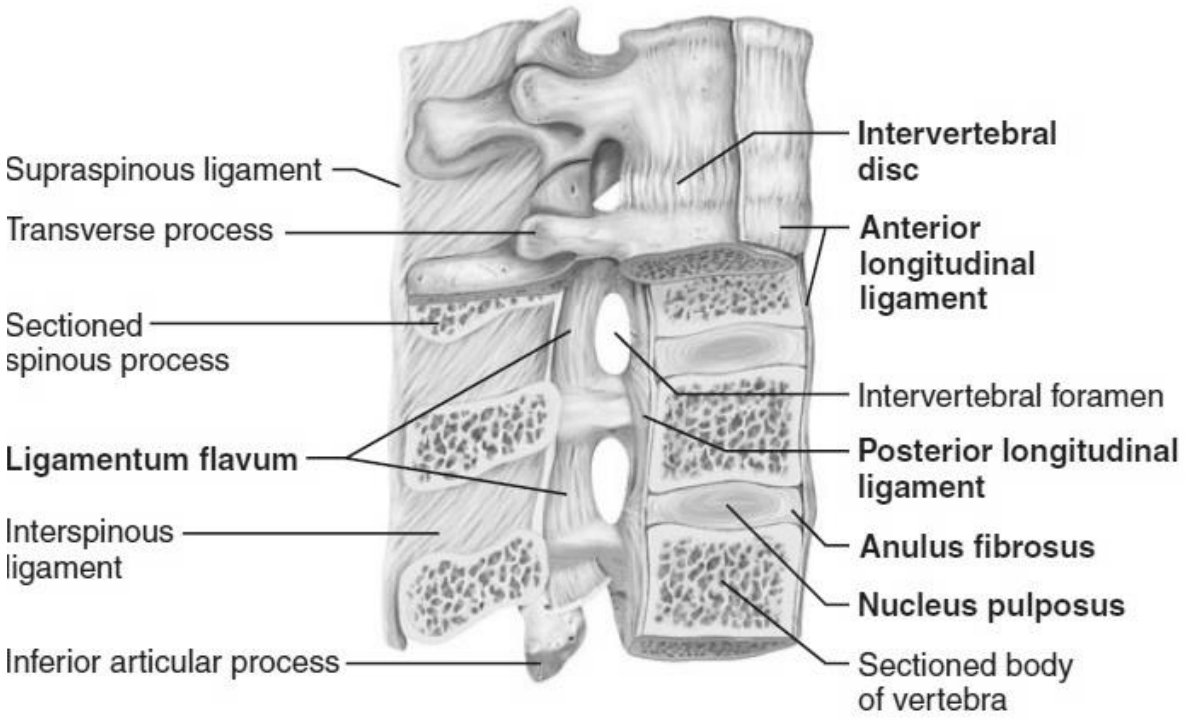
Manubriosternal angle
Related structures:
2nd costal cartilage, beginning & end of arch of aorta, end of pulmonary trunk

Body of sternum
Attached structures:
Pectoralis major (ant),
Related structures:
Lungs & pleurae, Ht & pericardium (lt side from 2-4 ribs) (post)

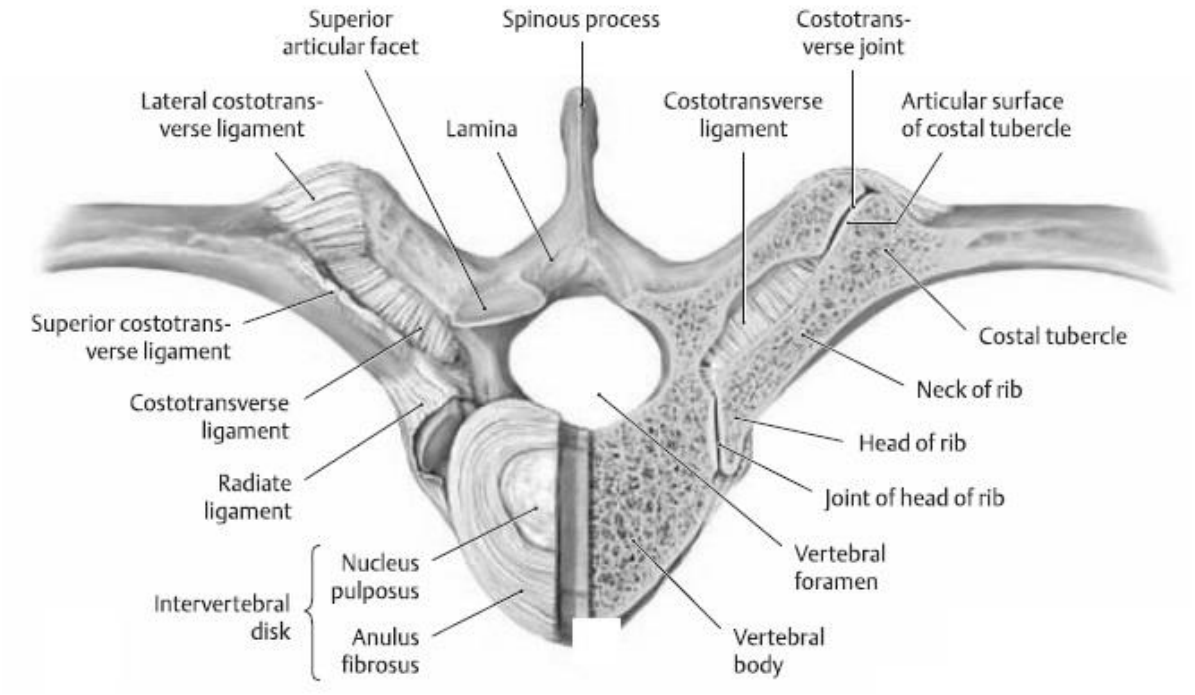
Xiphoid process

Xiphsternal junction

Tortora & Nielsen



Intervertebral joints



Costovertebral joints

Marieb / Schuenke

JOINTS OF THE THORAX

INTERVERTEBRAL JOINTS

See before

COSTOVERTEBRAL JOINTS

❖ between the ribs and the vertebrae.

1) Costovertebral joints: (synovial, plane).

- Between the head of the rib and the bodies of 2 successive vertebrae and the intervertebral discs (or single body in ribs 1,10,11 and 12)
- Ligaments: radiate and intraarticular ligaments.

2) Costotransverse joints: (Synovial, plane).

- Between the costal tubercle of the rib and the transverse process of the corresponding vertebra (absent in ribs 11 and 12 due to the absence of tubercles)

- Ligaments: costotransverse , lat costotransverse and sup costotransverse.

COSTOCHONDRAL JOINTS

❖ (primary cartilaginous). Between each rib and its costal cartilage.

INTERCHONDRAL JOINTS

❖ (synovial, plane). Between costal cartilages 6-9

CHONDROSTERNAL (STERNOCOSTAL) JOINTS

❖ (1^{st} is primary cartilaginous the rest are synovial, plane). Between the sternum and costal cartilages 1-7

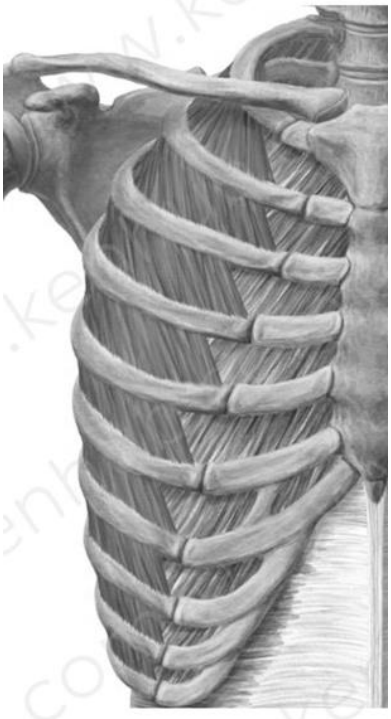
INTERSTERNAL JOINTS

❖ (2ry cartilaginous).

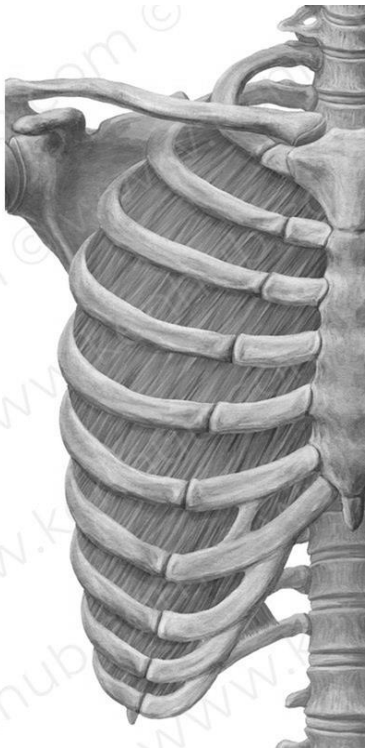
❖ **Manubriosternal** (between manubrium and body) and **xiphsternal** (between body and xiphoid process).

❖ Unlike other 2ry cartilaginous joints, they ossify at the age of 50 and 40 years respectively

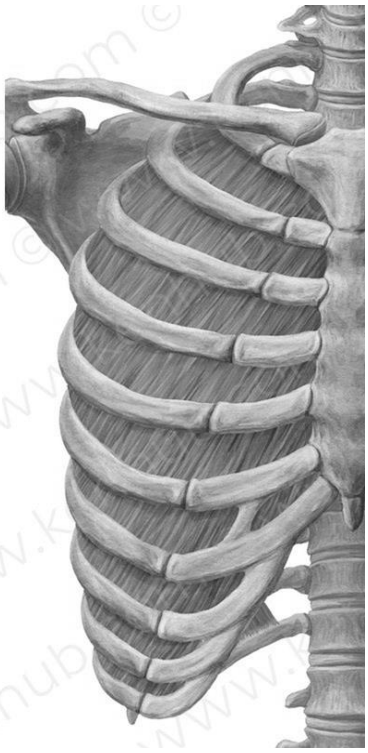
N.B.: Manubriosternal joint (sternal angle - angle of Louis) marks the attachment of 2nd costal cartilage (for rib counting)



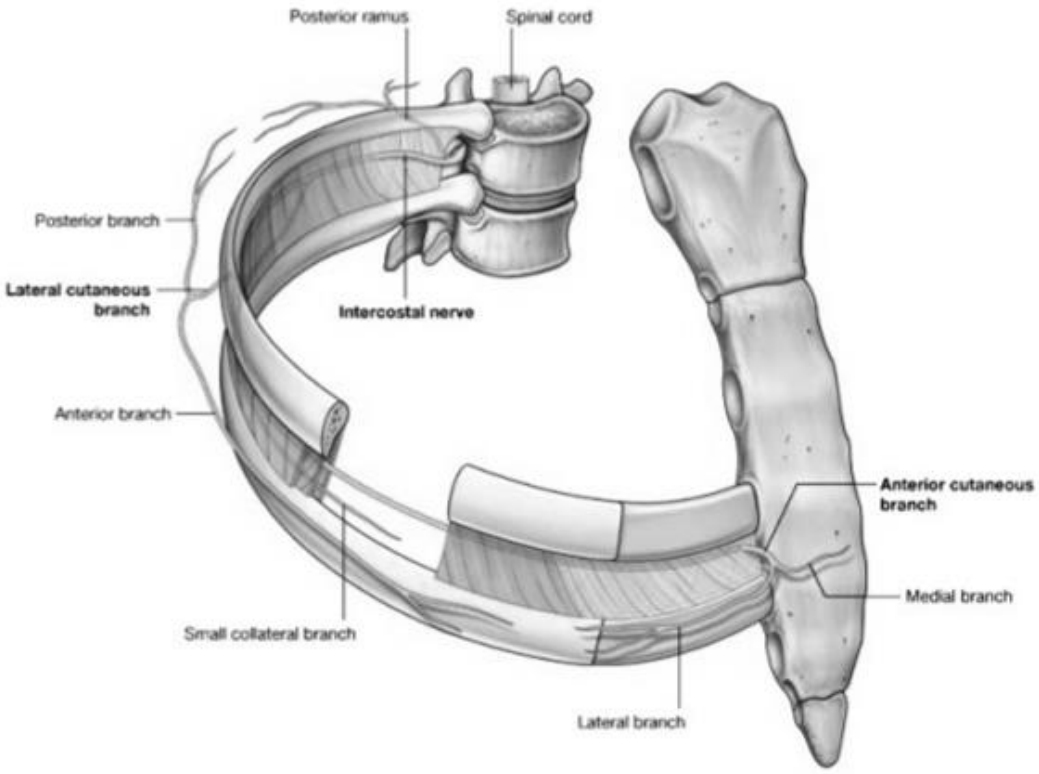
External intercostal



Internal intercostal



Innermost intercostal



Intercostal nerve

Ken Hub / criticalcaremcqs

MUSCLES OF THORACIC WALL

Muscle	*Origin*	*Insertion*	*Action*	*NS*	*Notes*
External intercostal	Lower border of a rib	Upper border of the rib below	Inspiration	Intercostal N	• Fibers: downward & forward • Continues ant as external intercostal membrane
Internal Intercostal	Costal groove	Upper border of the rib below	Expiration		• Fibers: downward & backward • Continues post as internal intercostal membrane
Innermost intercostal	Costal groove	Upper border of the rib below	Expiration		Part of internal intercostals separated from it by intercostals VAN (same direction)

NERVES OF THORACIC WALL

TYPICAL INTERCOSTAL NERVES

Beginning: ant ramus of spinal thoracic Ns.

Course & Relations:

- It comes out from corresponding intervertebral foramen.

➢ Passes in costal groove inf to vessels, between internal intercostal & innermost intercostal muscles (neurovascular plane).

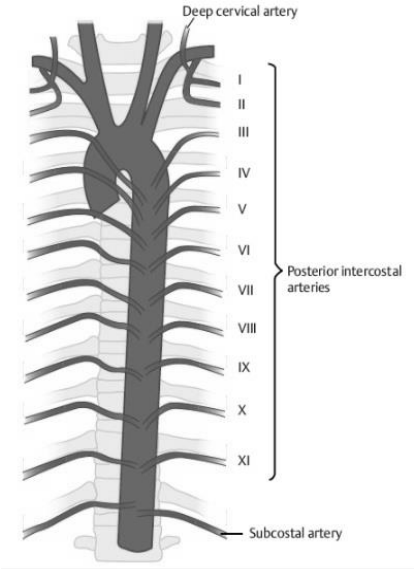
➢ 1 cm lat to sternum, it pierces internal intercostal muscle, external intercostal membrane & pectoralis major to become ant cutaneous N.

Branches:

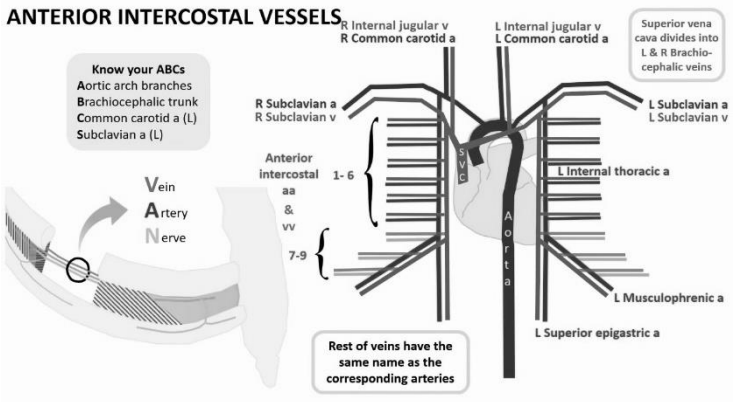
1) **White ramus communicans** (preganglionic sympathetic, myelinated, from the nerve to the sympathetic ganglion).
2) **Grey ramus communicans** (postganglionic sympathetic, non myelinated, from the ganglion to the nerve).
3) **Muscular:** to intercostals muscles.
4) **Collateral:** muscular branch running above the sup border of the rib below.
5) **Lat cutaneous branch:** pierces muscles, divides into ant & post branches.
6) **Ant cutaneous branch:** terminal branch, divides into med & lat branches.

ATYPICAL INTERCOSTAL NERVES

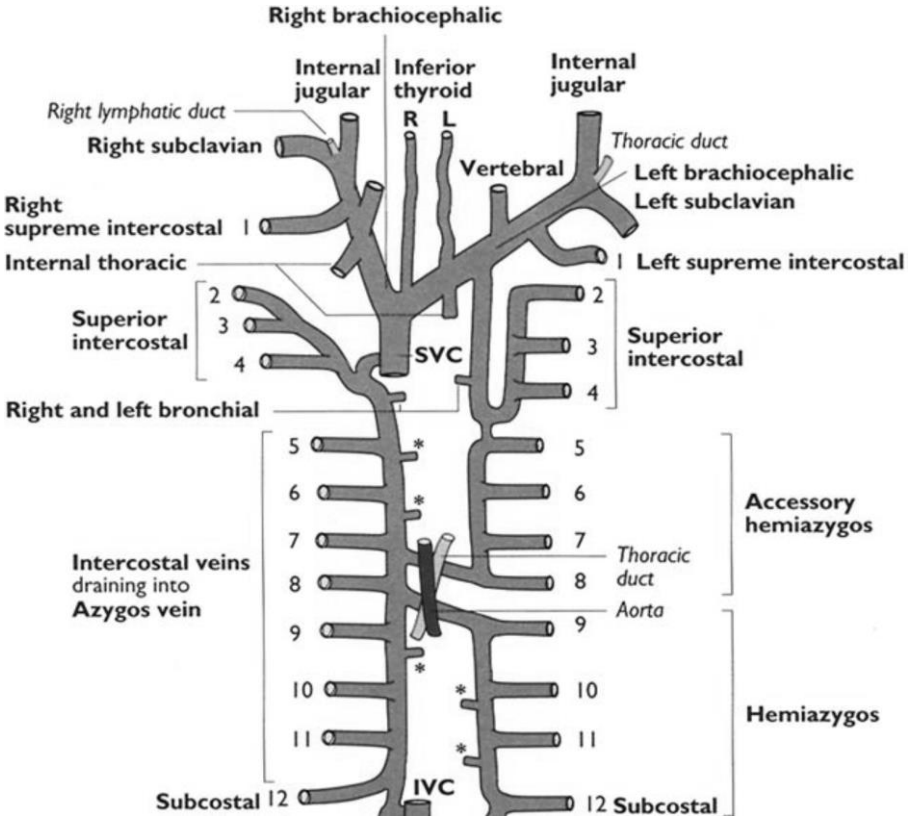
1st	2nd	Lower 5 intercostal Ns (T7-11)	Subcostal N (T12)
• Greater part joins brachial plexus • The remaining part has no cutaneous branches	Its lat cutaneous branch (intercostobrachial N) does not divide, it communicates with med cutaneous N of arm & supply skin of axilla	• Same as typical but anteriorly it pierce diaphragm to enter the abdomen • Pierce transversus abdominis, passes between it & internal oblique • Pierces rectus abdominis (& its sheath) to become ant cutaneous branch • Supplies Ms of ant abdominal wall & give lat & ant cutaneous branches —Skin just below xiphoid process is supplied by T7. —Skin around the umbilicus is supplied by T10.	• Passes behind lat arcuate lig. • Passes between kidney & quadrates lumborum • Pierces transverses abdominis, passes between it & internal oblique • Then as lower 5 intercostal Ns



Posterior intercostal arteries



Anterior intercostal arteries



Posterior intercostal veins

Quizlet / Whitaker & Borley

SUMMARY OF THE ARTERIES OF THORACIC WALL

INTERNAL THORACIC ARTERY

Beginning: as a branch of subclavian A.
Course: descends 1 cm lat to sternum between thoracic wall and lungs and pleurae.
Important branches: ant intercostal As: 2 at each space for the upper 6 spaces.
End: at 6th intercostal space by dividing into musculophrenic and sup epigastric As (both pierce the diaphragm to reach abdominal muscles).

POSTERIOR INTERCOSTAL ARTERIES:

Beginning: begin as a single branch which will give collateral branch
- **1-2:** from sup intercostal A (of costocervical trunk of subclavian)
- **3-11 & subcostal:** from descending aorta

Course: passes in the costal groove between the intercostal V (sup) and N (inf).
Branches: muscular & collateral.
End: at costochondral junction by anastomosing with the 2 ant intercostal As.

ANTERIOR INTERCOSTAL ARTERIES

Beginning: begin as 2 arteries in each space
- **1-6:** from internal thoracic A (of subclavian)
- **7-9:** from musculophrenic (of internal thoracic)

Course: 2 arteries passing in the the costal groove and above the rib below
Branches: muscular
End: at costochondral junction by anastomosing with the post intercostal A and its collateral

SUMMARY OF THE VEINS OF THORACIC WALL

INTERNAL THORACIC AND ANTERIOR INTERCOSTAL VEINS

- Correspond to the arteries.

POSTERIOR INTERCOSTAL VEINS:

- Each runs in the costal groove.

End:

Vein	*Rt*	*Lt*
1	Rt brachiocephalic	Lt braciocephalic
2 & 3 unite forming sup intercostal V	Azygos V	Lt brachiocephalic
4-8		Sup hemiazygos
9-11 & subcostal		Inf hemiazygos

AZYGOS VEIN

Beginning: IVC in the abdomen
Course: passes through aortic opening of diaphragm → ascends post then arches above the hilum of Rt lung.
End: SVC

INFERIOR HEMIAZYGOS VEIN

Beginning: Lt renal vein
Course: pierces Lt copula of the diaphragm → crosses to Rt opposite T8 vertebra
End: azygos vein

SUPERIOR HEMIAZYGOS VEIN

Beginning: by union of 4-8 left post intercostal Vs
Course: crosses to Rt opposite T7 vertebra
End: Azygos vein

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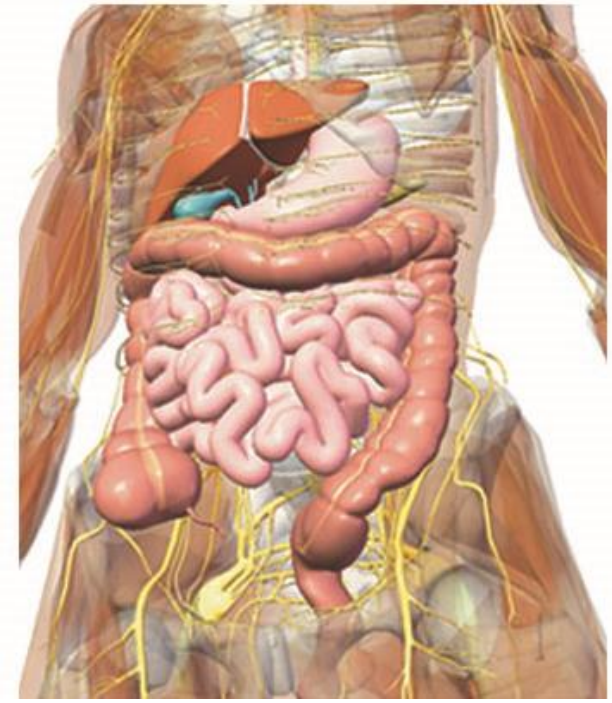
ABDOMEN AND PELVIS



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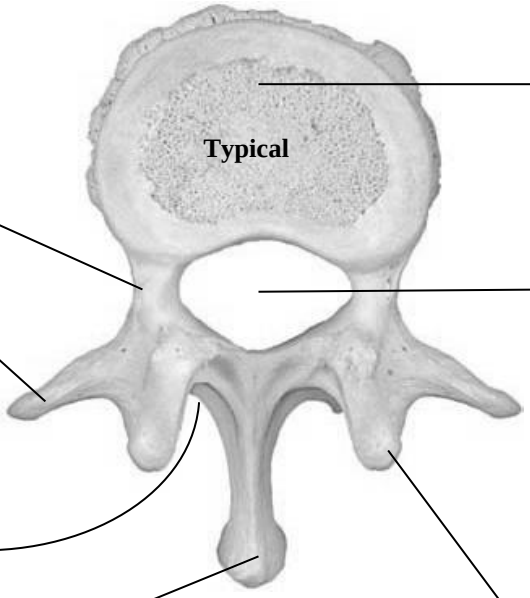
LUMBAR VERTEBRAE



Pedicle
Related structures:
Spinal Ns.

Body
Structure related (or attached):
Intervertebral disc

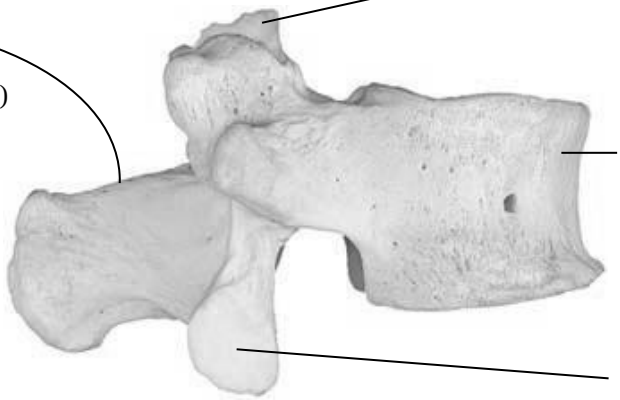
Transverse process
Structures attached:
Intertransverse lig.
Psoas major
Quadratus lumborum

Vertebral foramen
Structures passing:
Dura & arachnoid
Filum terminale
quda equina

Lamina
Ligament attached:
Ligamentum flavum.

Sup articular process
Related structure:
Inf articular process of the vertebra above.

Spine
Ligaments attached:
Interspinous lig. (sup & inf)
supraspinous lig. (post)

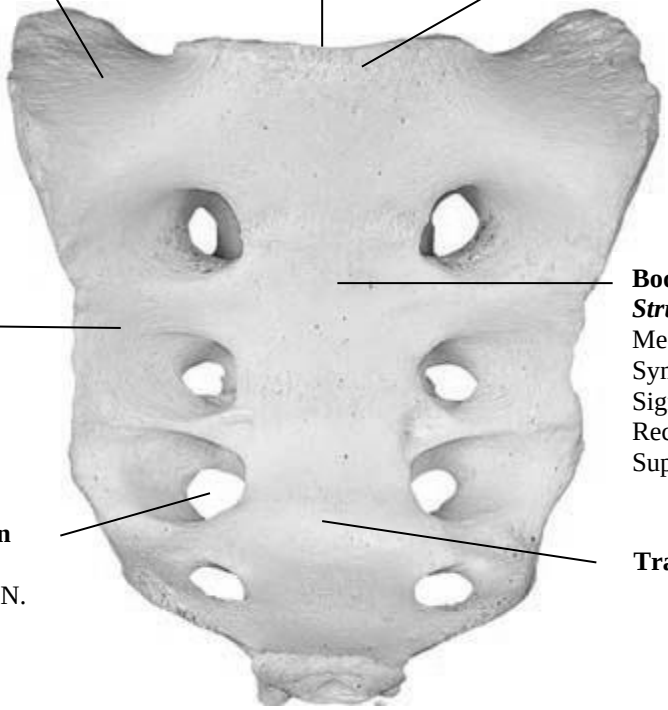


Body
Ligaments attached:
Ant longitudinal lig. (ant)
Post longitudinal lig. (post)

Inf articular process
Related structure:
Sup articular process of the vertebra below.

Tortora & Nielsen

SACRUM (ANT)



Tortora & Nielsen

SACRUM (POST)

Vertebral foramen → Sacral canal
Structures passing:
Dura & arachnoid (to S2)
Filum terminale
quda equina

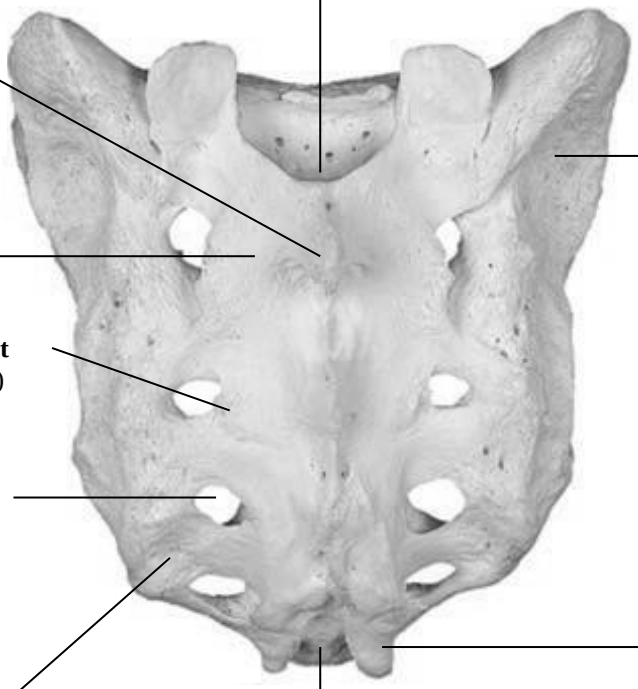
Median sacral crest
(Fused spines)

Fused laminae

Intermediate sacral crest
(fused articular processes)

Post. Sacral foramina
Structures passing:
Post ramus of sacral Ns.
Lat sacral As.

Lateral sacral crest
(fused transverse processes)

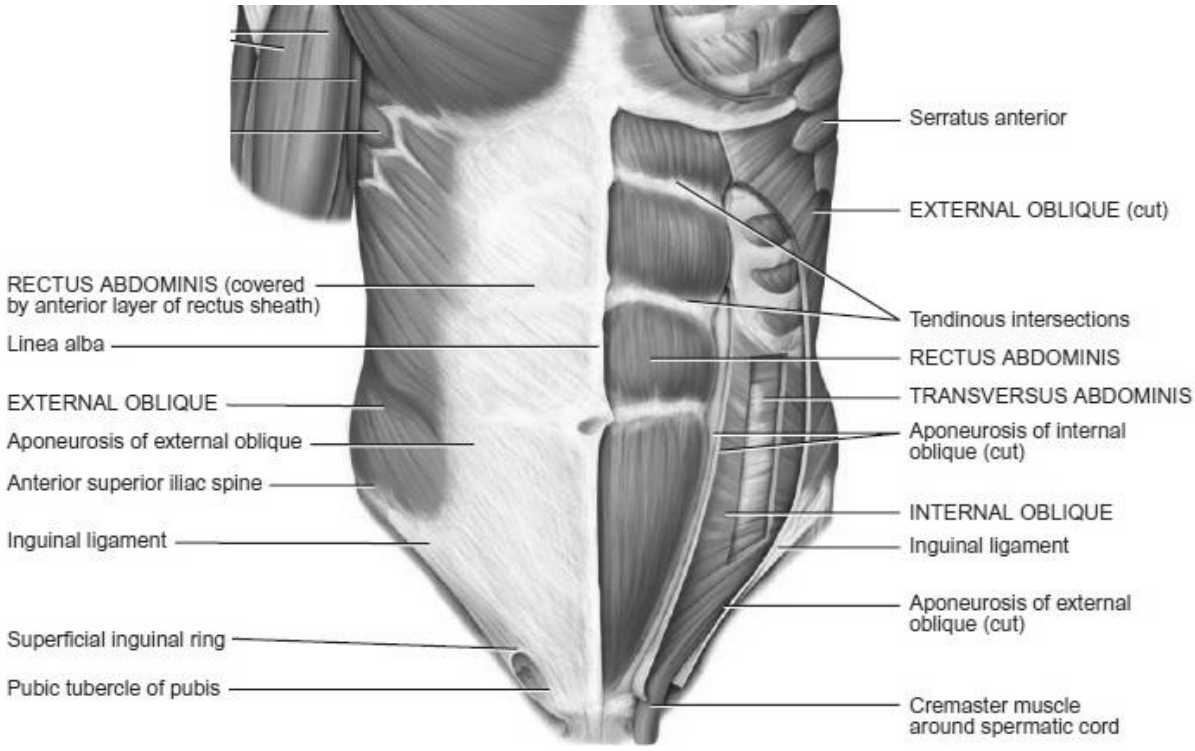


Auricular surface
Related joints:
Sacroiliac Joint

Sacral cornu

Sacral hiatus
Structures passing:
Filum terminale
S5 N.
Coccygeal N.

Tortora & Nielsen



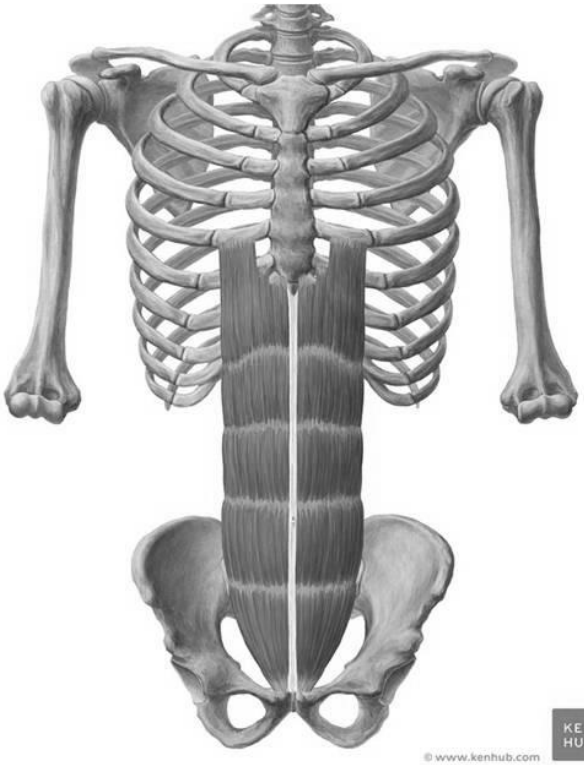
Layers of anterolateral abdominal wall

Tortora & Nielsen

ANTEROLATERAL ABDOMINAL WALL

layers: (from superficial to deep)

- **Skin.**
- **Superficial fascia** (no deep fascia).
  - — Superficial fatty.
  - — Deep membranous.
- **Muscular layer:** (from med to lat)
  - — Linea alba.
  - — From superficial to deep:
    - Rectus sheath (ant layer).
    - Rectus abdominis muscle.
    - Rectus sheath (post layer).
  - — From superficial to deep:
    - External oblique.
    - Internal oblique.
    - Neurovascular plane.
    - Transversus abdominis.
- **Fascia transversalis.**
- **Extraperitoneal fat.**
- **Peritoneum:**
  - — Parietal layer.
  - — Visceral layer.



Rectus abdominis

Pyramidalis

External oblique

Internal oblique

Transversus abdominis

Ken Hub

MUSCLES OF ANTEROLATERAL ABDOMINAL WALL

Muscle	*Origin*	*Insertion*	*Action*	*NS*	*Fibers*
Rectus abdominis	• Pubic crest • Symphysis pubis	• Xiphoid process • 5-7 costal cartilages	• Tone: keep viscera in position • protect viscera from trauma • Increase abdominal Pressure (cough, vomiting… etc) • flexion of trunk	Lower 5 intercostal & subcostal Ns	Vertical
Pyramidalis	As rectus abdominis	Lower part of linea alba	Strength the linea alba	Subcostal N	May be absent
External oblique	Lower 8 ribs	• Linea alba • Inguinal ligament • Iliac crest	• As rectus • Lat flexion & rotation of trunk	As rectus	Downwards forwards & med
Internal oblique	• Inguinal ligament • Iliac crest • Lumbar fascia	• Lower 6 costal cartilages • Xiphoid process • Linea alba • Conjoint tendon		• As rectus • L1 (for conjoint tendon)	Upwards forwards & med
Transversus abdominis	• Inguinal ligament • Iliac crest • Lumbar fascia • Lower 6 costal cartilages	• Xiphoid process • Linea alba • Conjoint tendon	• As rectus (– flexion) • Lat flexion of trunk		Transverse

N. B.:

Linea semilunaris: lat border of rectus abdominis.

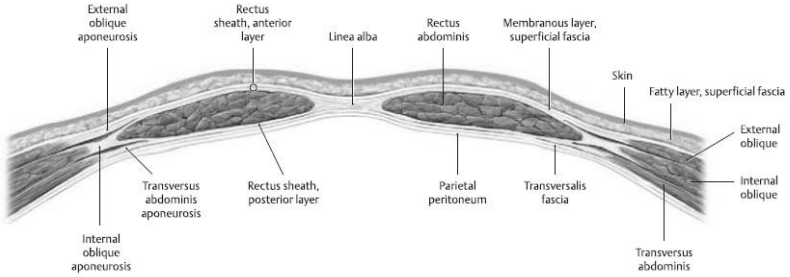
Tendinous intersections: 3 intersections between muscle fibers.

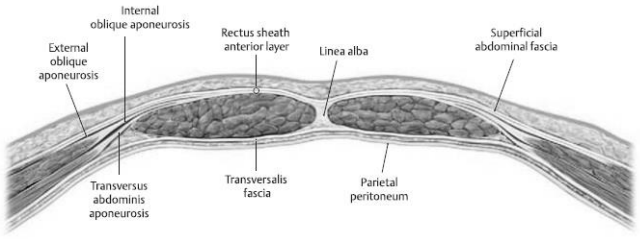
1) At xiphoid process.

2) At umbilicus.

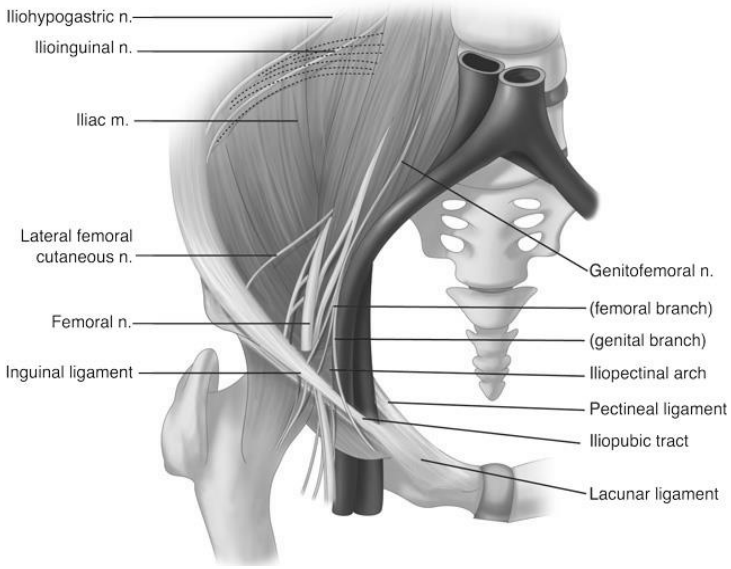
3) Midway between xiphoid process & umbilicus.

Conjoint tendon: lower fibers of internal oblique and transversus abdominis muscle uniting together, passing behind inguinal canal and inserted in pubic crest

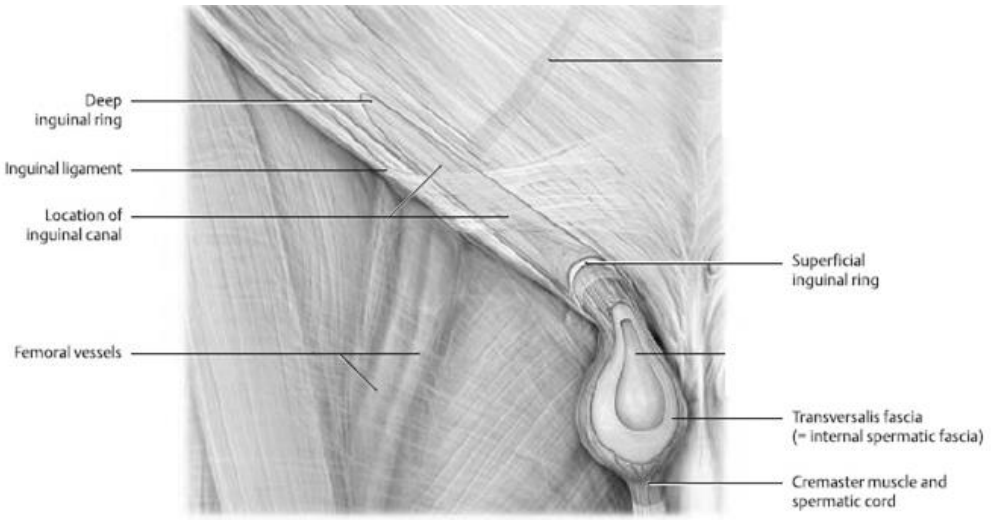




Rectus sheath



Inguinal ligament (after accessmedicine.mhmedical.com)



Inguinal canal

RECTUS SHEATH

Schuenke / accessmedicine / Quizlet

Walls:

Level	ant wall	post wall
Above costal margin	External oblique	Deficient
From costal margin to arcuate line (midway between umbilicus & symphysis Pubis)	• External oblique • Internal oblique (ant layer)	• Internal oblique (post layer) • Transversus abdominis
Below the arcuate line	• External oblique • Internal oblique • Transversus abdominis	Deficient

Contents:

1) Rectus abdominis.
2) Pyramidalis.
3) Sup epigastric vessels
4) Inf epigastric vessels
5) Lower 5 intercostal & subcostal Ns:

INGUINAL LIGAMENT

Definition: lower part of external oblique aponeurosis folded backwards upon itself.

Attachments:

Lat: ASIS.

Med: pubic tubercle.

Parts:

1) **Inguinal ligament proper:** extends from ASIS to pubic tubercle.
2) **Pectineal ligament:** extends on pectineal line.
3) **Lacunar:** triangular; attached to pubic tubercle (med), inguinal ligament (ant), pectineal line (post) with a free concave border (lat).
4) **Reflected:** directed medially to linea alba.

INGUINAL CANAL

Definition: intramuscular canal from deep inguinal ring (in fascia transversalis) to superficial

inguinal ring (in external oblique).

- 4 cm (1.5 inches) long.
- 1 cm (0.5 inch) above med 1/2 of inguinal ligament.

Boundaries:

Ant:

Whole length: external oblique.

Lat ½: internal oblique.

Post:

Whole length: fascia transversalis.

Med ½: conjoint tendon.

Floor: inguinal ligament & its lacunar part.

Roof: arching fibers of internal oblique.

Contents:

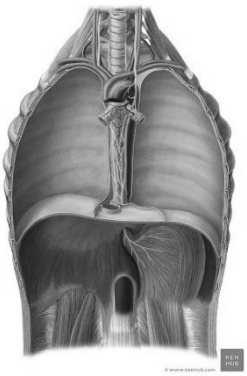
- **From deep to superficial rings:**
  In males: spermatic cord.
  In females: Round ligament of uterus.
- **From the side of canal to superficial ring:** ilioinguinal N.

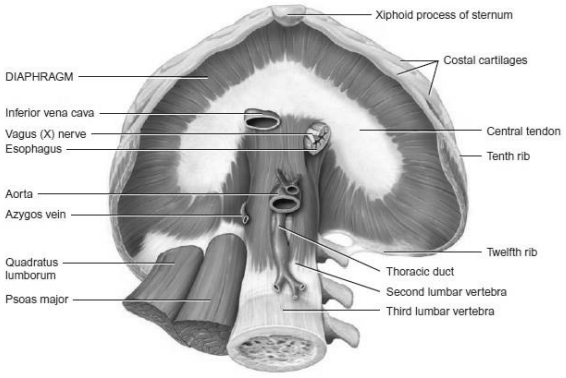
Psoas major

Iliacus

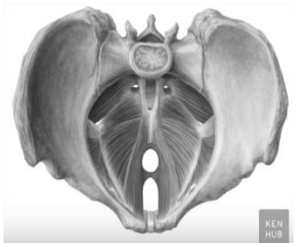
Psoas minor

Quadratus lumborum

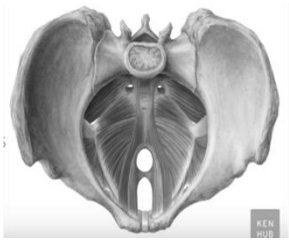




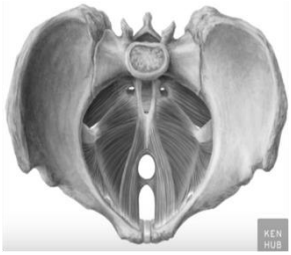
Diaphragm



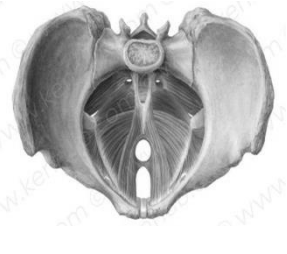
Levator prostatae or sphincter vaginae + puborectalis



Pubococcygeus

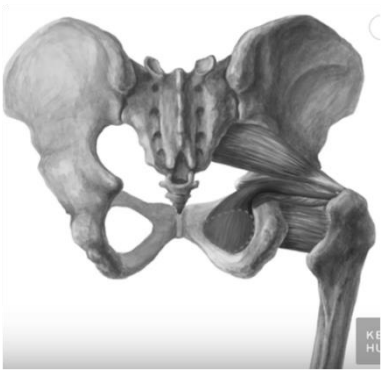


Iliococcygeus



coccygeus

Piriformis



Obturator internus

Ken Hub / Tortora & Nielsen

MUSCLES OF POSTERIOR ABDOMINAL WALL

Muscle		*Origin*	*Insertion*	*Action*	*NS*
Iliopsoas	**Psoas major**	• T12-L5 vertebrae (bodies) & intervertebral discs • L1-L5 vertebrae (transverse processes)	Lesser trochanter	Flexion hip	L1-4 (ant rami)
	Iliacus	Iliac fossa			Femoral N (in abdomen)
Psoas minor (may be absent)		T12-L1 vertebrae (bodies) & intervertebral disc	Iliopectineal eminence	Flexion hip	L1 (ant ramus)
Quadratus lumborum		Iliac crest	• Last rib • L1-4 vertebrae (transverse processes)	• Fixation of last rib during respiration • Lat flexion of trunk	T12-L4 (ant rami)

DIAPHRAGM

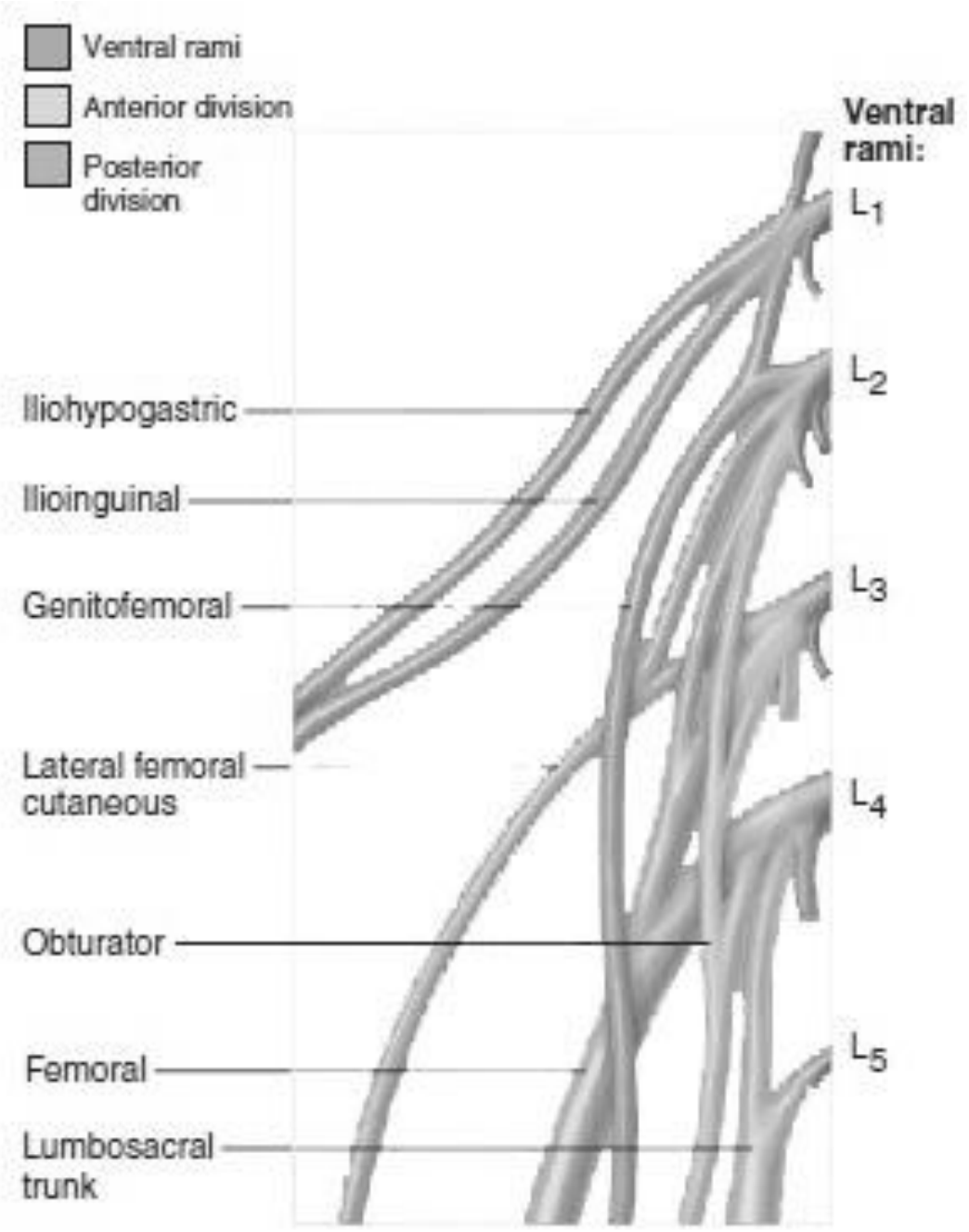
Origin	*Insertion*	*Action*	*NS*
Sternal: back of xiphoid process Costal: lower 6 ribs & costal cartilages Rt crus (stronger): L1-3 vertebrae (bodies) & intervertebral discs Lt crus: L1-2 vertebrae (bodies) & intervertebral discs 5 arcuate ligaments: between the crurae, L1 transverse processes & last ribs	Central tendon	• Inspiration • Increase abdominal pressure (cough, vomiting... etc)	Phrenic N (C3-5)

Major openings of diaphragm:

Opening	*Site*
Inf vena cava	T8, 1 inch to Rt (in central tendon)
Oesophagus	T10, 1 inch to Lt
Aorta	T12 in midline

MUSCLES OF PELVIC WALLS

Muscle				*Origin*	*Insertion*	*Action*	*NS*
Pelvic floor	**Levator ani**	**Pubococcygeus**	• **Levator prostatae** • **Sphincter vaginae**	• Body of pubis • White line (ant ½ of fascia covering obturator internus muscle)	Perineal body: with opposite side behind prostate or vagina	• <u>Pelvic diaphragm:</u> modify abdominal pressure & support pelvic organs • <u>Sphincter vaginae:</u> support uterus • <u>Puborectalis:</u> help anal sphincters	• S4 • Inf rectal N
			Puborectalis		With opposite side behind anorectal junction		
			Pubococcygeus proper		• Anococcygeal raphe (between coccyx & anal canal) • Coccyx		
		Iliococcygeus		• White line (post ½) • Ischial spine	• Anococcygeal raphe • Coccyx		
	Coccygeus			Ischial spine	S5 & 1st coccygeal vertebrae	Pelvic diaphragm	S4
Lat wall	**Piriformis**			S2-4 vert	Greater trochanter	Lat rotation hip	S1-2
	Obturator internus			Obturator membrane			N to obturator internus



Lumbar plexus

Marieb

SOMATIC NERVES OF ABDOMEN AND PELVIS

LUMBAR NERVES & PLEXUS

- The ant rami of L1-3 & part of L4 give muscular branches, then share in lumbar plexus within psoas major. Part of L4 & L5 form lumbosacral trunk which shares in sacral plexus.

Formation: by L1-4 ant rami inside psoas major.

Branches:

1) **Muscular (from the roots of the plexus):**
   - ***a)*** Psoas major (L1-4).
   - ***b)*** Psoas minor (L1).
   - ***c)*** Quadratus lumborum (L1-4).
2) **Iliohypogastric & ilioinguinal Ns** (L1):

   Course & relations:

   - Appear from lat border of psoas major & pass ant to quadratus lumborum.
   - Pass ant to transversus abdominis then pierce it & run in neurovascular plane.
   - Pierce internal oblique.
   - Iliohypogastric N pierces external oblique above the inguinal canal to become cutaneous. Ilioinguinal N enters the side of inguinal canal & emerges from superficial inguinal ring.

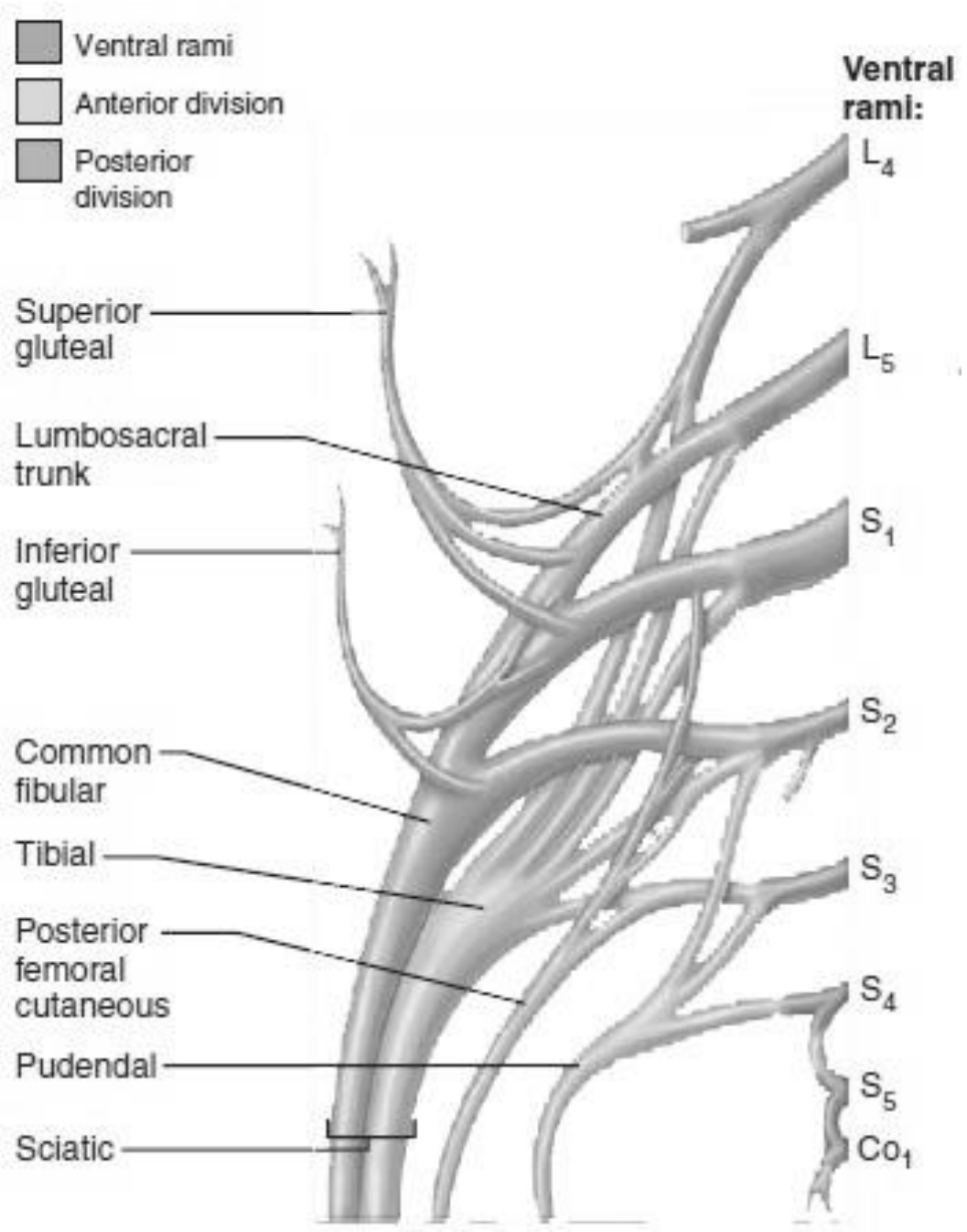
   Branches:

   Iliohypogastric: supplies suprapubic skin.

   Ilioinguinal: supplies conjoint tendon and skin of external genitalia.
3) **Lat cutaneous N of thigh** (L2-3): appears lat to psoas major & enters the thigh behind inguinal ligament.
4) **Femoral N** (L2-4): appears lat to psoas major, passes between it & iliacus & enters the thigh behind inguinal ligament.
5) **Genitofemoral N** (L1-2): appears ant to psoas major, divides into:

   Genital branch: supply cremaster muscle & skin of scrotum.

   Femoral branch: supply skin over femoral triangle.
6) **Obturator N** (L2-4): appears med to psoas major, passes on lat pelvic wall to obturator foramen to enter med side of thigh.
7) **Accessory obturator N** (L3-4).



Sacral plexus

Marieb

SACRAL NERVES & PLEXUS

- The ant rami of S1-3 & part of S4 give muscular branches, then share with lumbosacral trunk (L4-5) in sacral plexus. Part of S4 & S5 share in coccygeal plexus.

Formation: by L4-5, S1-4 ant rami.

Branches:

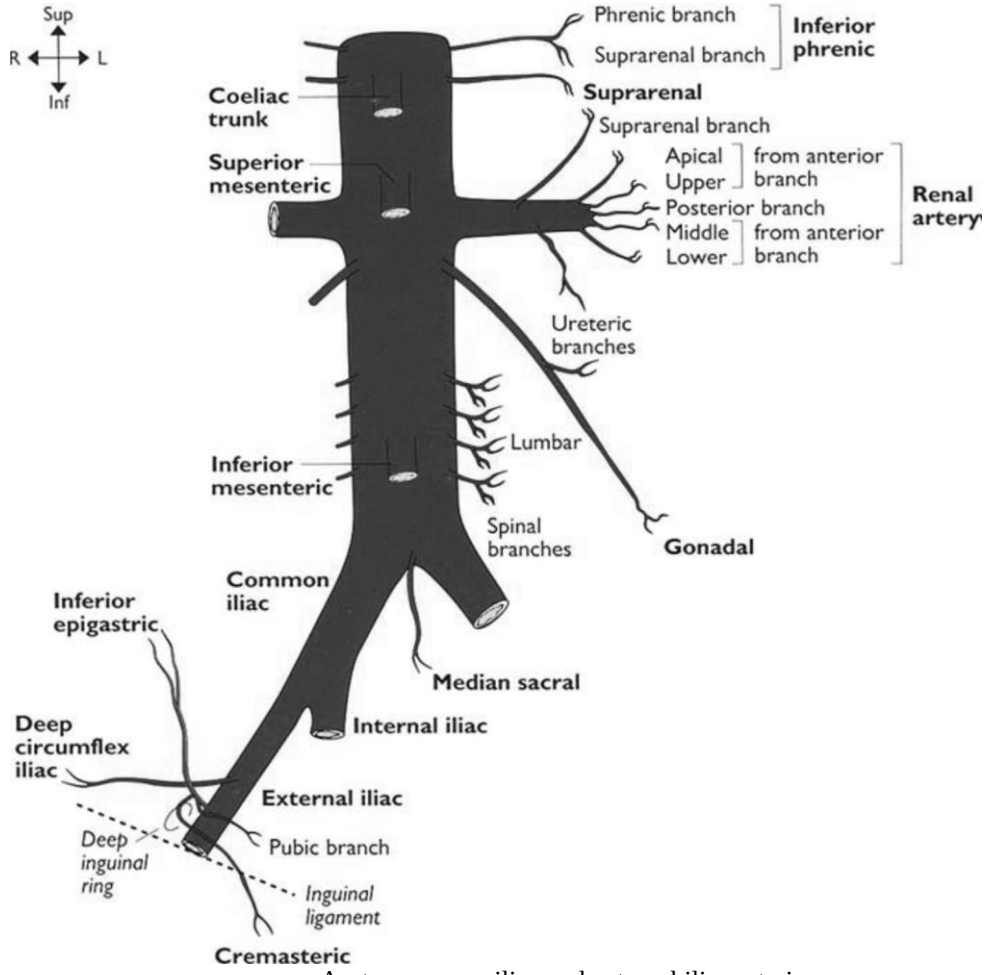
1) **Pelvic splanchnic nerve** (S2-4) (from the roots of the plexus): parasympathetic branch which supplies pelvic viscera.
2) **Muscular** (from the roots of the plexus):
   a) Piriformis (S1-2).
   b) Levator ani & coccygeus (S4).
3) **Muscular** (after formation of the plexus):
   a) Sup gluteal N (L4-5,S1).
   b) Inf gluteal N (L5,S1-2).
   c) N to quadratus femoris (L4-5,S1).
   d) N to obturator internus (L5,S1-2).
4) **Posterior cutaneous N of the thigh** (S1-3).
5) **Perforating cutaneous N** (S2-3): to gluteal skin.
6) **Pudendal N** (S2-4): supplies external genitalia & anal canal.
7) **Sciatic N** (L4-5,S1-3): to lower limb.

Applied anatomy: sciatica: disc prolapse causes pressure on the plexus & pain in parts supplied by sciatic N.

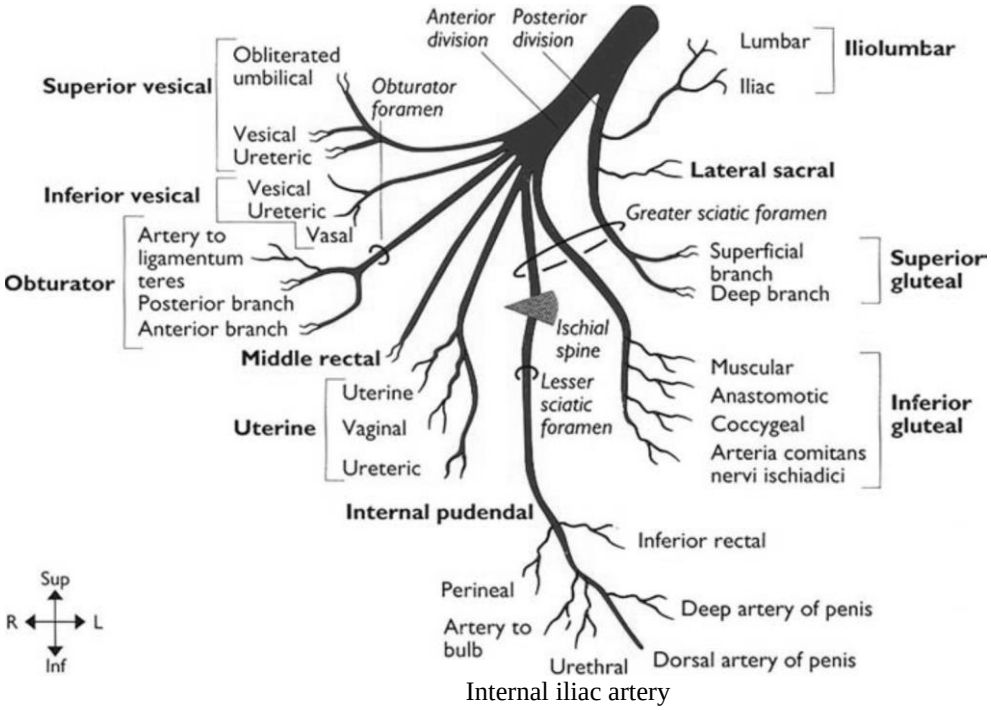
COCCYGEAL PLEXUS

Formation: ant rami of part of S4, S5 & coccygeal Ns.

Branches: supply skin below coccyx.



Aorta, common iliac and external iliac arteries



Internal iliac artery

Whitaker & Borley

SUMMARY OF THE ARTERIES OF THE ABDOMEN AND PELVIS

ABDOMINAL AORTA

Beginning: at lower border of T12 as a continuation of thoracic aorta.
Course: descends ant to the upper 4 lumbar vertebrae with the IVC to its Rt side.
Branches:

Single:

1) ***Coeliac trunk:*** supplies the derivatives of the abdominal foregut.
2) ***Sup mesenteric A:*** supplies the derivatives of the midgut.
3) ***Inf mesenteric A:*** supplies the derivatives of the hind gut.
4) ***Median sacral A:*** descends ant to the sacrum.

paired:

5) ***Lumbar As:*** 4 pairs (5^{th} arises from median sacral A). All supply the post abdominal wall.
6) ***Inf phrenic A:*** begins at the upper border of L1 passes on the under surface of the diaphragm and gives ***sup suprarenal A.***
7) ***Middle suprarenal A:*** begins at lower border of L1.
8) ***Renal A:*** begins at L2, runs post to the ureter and renal V to enter the kidney. It gives ***inf suprarenal A.***
9) ***Gonadal A:*** Begins at L3 and descends to supply the gonads.

End: at lower border of L4 by dividing into 2 common iliac As.

COMMON ILIAC ARTERIES

Beginning: at lower border of L4 as two terminal branches of aorta.
End: at lower border of L5 by dividing into external iliac and internal iliac As.

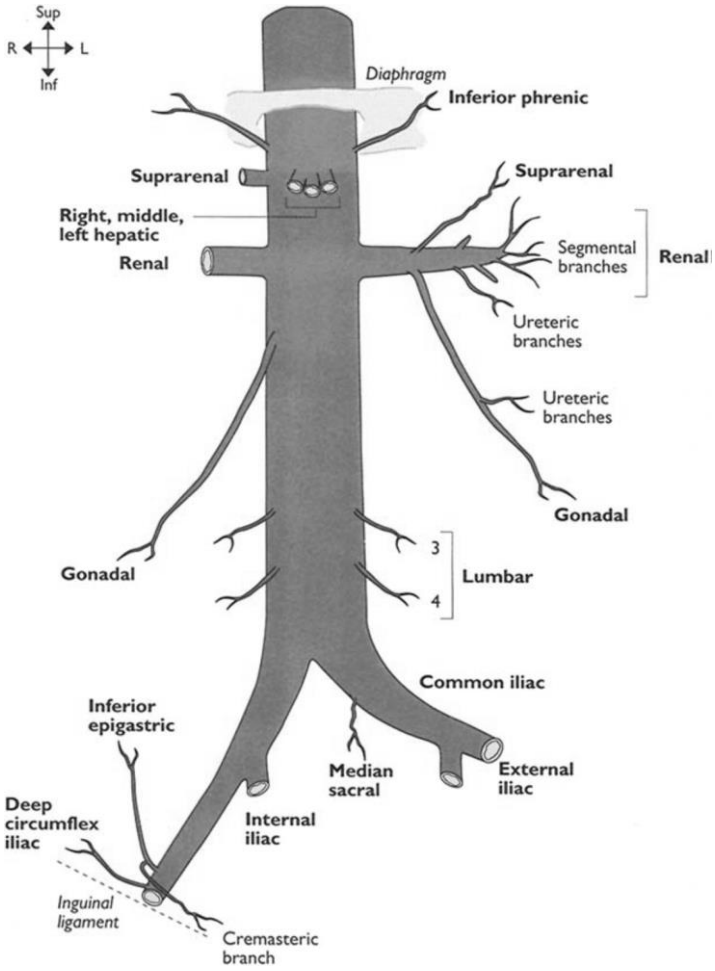
EXTERNAL ILIAC ARTERY

Beginning: at the lower border of L5 as one of 2 terminal branches of common iliac A.
End: deep to inguinal ligament to continue as the femoral A.

INTERNAL ILIAC ARTERY

Beginning: at the lower border of L5 as one of 2 terminal branches of common iliac A.
Course: passes med to external iliac artery.
End: at the level of greater sciatic foramen by dividing into its branches.
Branches:

1) **Iliolumbar A:** supplies post abdominal wall.
2) **2 lat sacral As:** each one divides into 2 branches, each enters an ant sacral foramen, supplies contents of sacral canal, passes from post sacral foramen and supplies the structures on the back of sacrum.
3) **Gluteal arteries (sup & inf):** passes through greater sciatic foramen and supply the gluteal region.
4) **Obturator A:** passes on the side of pelvis → obturator canal.
5) **Internal pudendal A:** passes through greater sciatic foramen → reenters the pelvis through the lesser sciatic foramen to the perineum supplying it and the genitalia. it gives ***inf rectal A.***
6) **Middle rectal A:** supplies the rectum (except its mucosa). It anastomoses with sup and inf rectal As



Inferior vena cava

Whitaker & Borley

7) **Inf vesical (vaginal in females):** supplies the ureter and the base of urinary bladder. ***In males*** it also supplies the structures post to the bladder (vas deference, seminal vesicles, ejaculatory ducts and prostate). ***In females*** it also supplies the vagina and urethra.
8) **Umbilical A:** passes to the sup surface of urinary bladder where it gives 2-3 ***sup vesical As.*** Its distal part is obliterated forming med umbilical ligament which extends to the umbilicus.
9) **Uterine A** (tortuous, only in females): it ascends along the lat border of the uterus supplying it and the uterine tube.

SUMMARY OF THE VEINS OF THE ABDOMEN AND PELVIS

ILIAC VEI NS

❖ Generally correspond to their arteries.

IVC

Beginning: at level of L5 (Rt to the mid line) by union of the two common iliac veins

Course: ascends to the Rt of aorta ant to the post abdominal wall → post to the liver → pierces central tendon of diaphragm at T8 1 inch to the Rt → pierces pericardium to enter the Rt atrium

Tributaries:

- 2 common iliac Vs
- lumbar Vs
- RT suprarenal vein (Lt joins Lt renal V)
- Rt gonadal vein (Lt joins Lt renal V)
- 2 renal Vs
- 2 inf phrenic Vs
- 2-3 hepatic Vs

End: at Rt atrium

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UPPER LIMB

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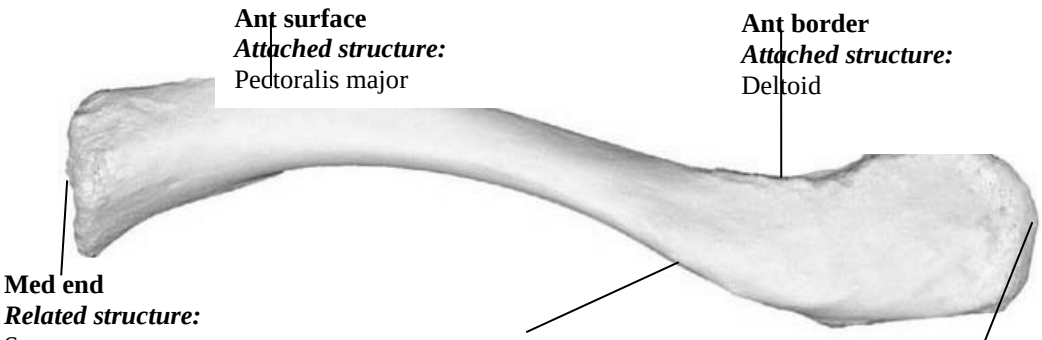
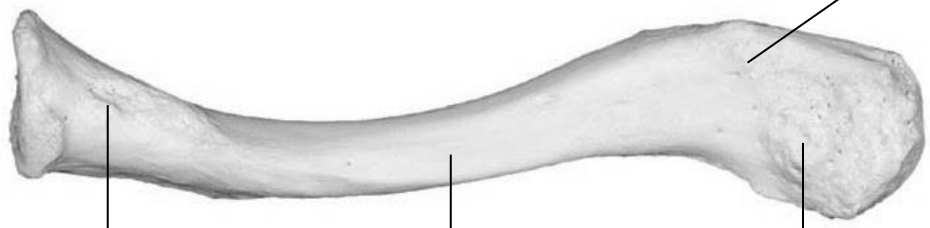
CLAVICLE (SUP)

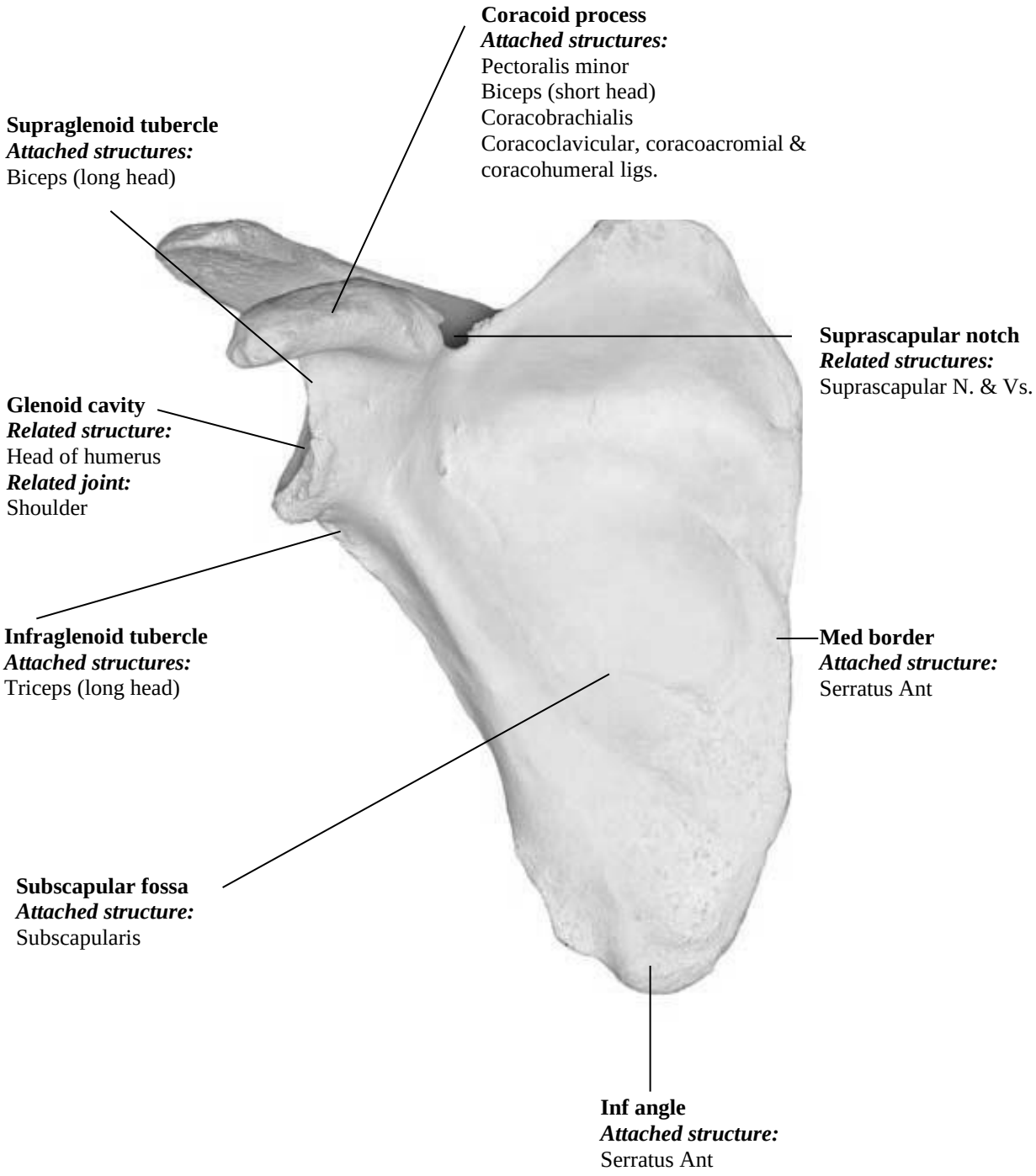


CLAVICLE (INF)



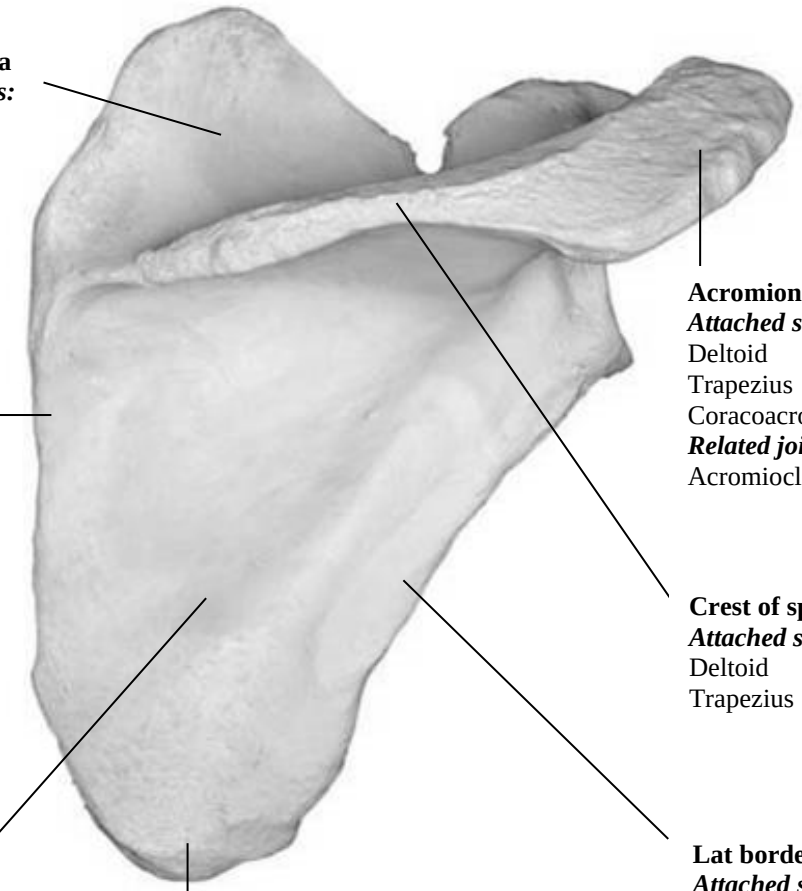
Tortora & Nielsen

SCAPULA (ANT)



Tortora & Nielsen

SCAPULA (POST)



Supraspinous fossa
Attached structures:
Supraspinatus

Acromion process
Attached structures:
Deltoid
Trapezius
Coracoacromial lig
Related joint:
Acromioclavicular joint

Med border
Attached structure:
Levator scapulae,
Rhomboids minor
& Rhomboids
major

Crest of spine
Attached structures:
Deltoid
Trapezius

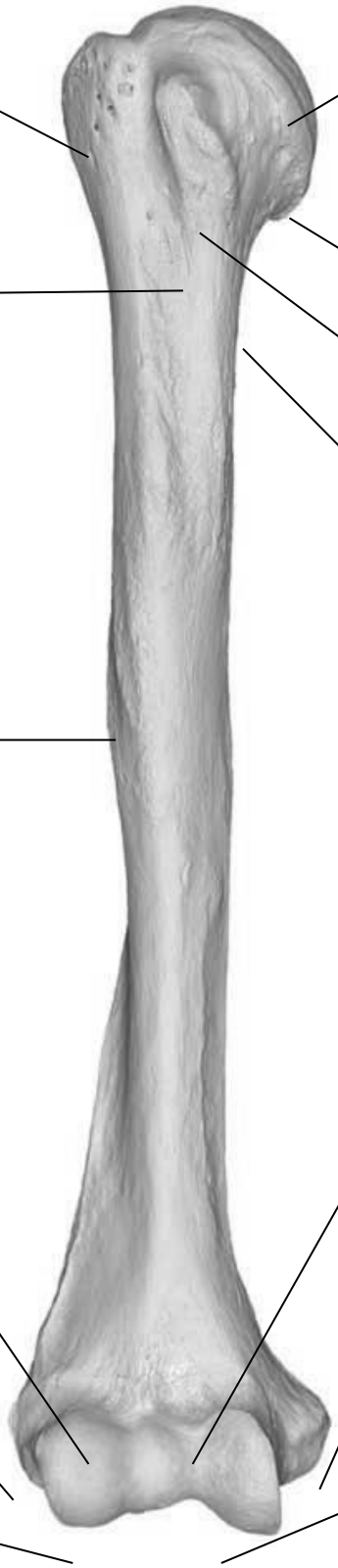
Lat border
Attached structures:
Teres minor

Infraspinous fossa
Attached structures:
Infraspinatus

Inf angle
Attached structures:
Latissimus dorsi
Teres major

Tortora & Nielsen

HUMERUS (ANT)



Greater tubercle
Attached structures:
Supraspinatus
Infraspinatus
Teres minor

Head
Related structure:
Glenoid cavity
Related joint:
Shoulder

Anatomical neck

Bicipital groove
Attached structures:
Teres major
Latissimus dorsi
Pectoralis major
Related structure:
Biceps

Lesser tubercle
Attached structure:
Subscapularis

Surgical neck
Related structure:
Axillary N. (post)
Ant & Post circumflex humeral As.

Deltoid tuberosity
Attached structure:
Deltoid

Coronoid fossa
Related structure:
Coronoid process of ulna
Related joint:
Elbow joint

Radial fossa
Related structure:
Head of radius
Related joint:
Elbow joint

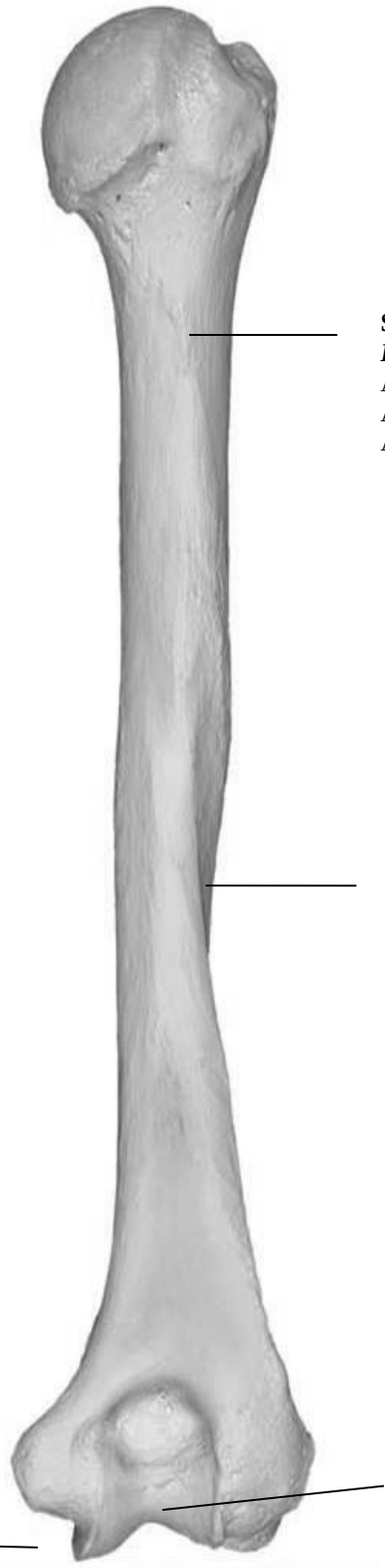
Medial epicondyle
Attached structure:
Common flexor origin (ant)
Related structure:
Ulnar N. (post) & Ulnar collateral As.

Lateral epicondyle
Attached structure:
Common extensor origin

Trochlea
Related structure:
Trochlear notch of ulna
Related joint:
Elbow joint

Capitulum
Related structure:
Head of radius
Related joint:
Elbow joint

HUMERUS (POST)



Surgical neck
Related structure:
Axillary N. (post)
Ant & Post circumflex humeral As.

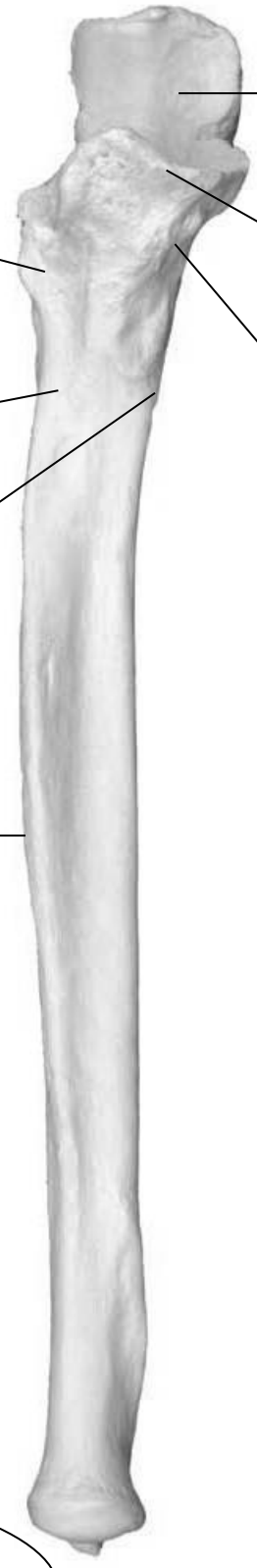
Spiral groove
Related structure:
Radial N.
Profunda A.

Olecranon fossa
Related structure:
Olecranon process of ulna
Related joint:
Elbow joint

Medial epicondyle
Related structure:
Ulnar N. (post) & Ulnar collateral As.

ULNA (ANT)

en



Olecranon process
Related structure:
Olecranon fossa
Related joint:
Elbow joint

Radial notch
Related structure:
Head of radius
Related joint:
Sup radioulnar joint

Trochlear notch
Related structure:
Trochlea
Related joint:
Elbow joint

Supinator fossa
Attached structure:
Supinator

Coronoid process
Related structure:
Coronoid fossa
Related joint:
Elbow joint

Ulnar tuberosity
Attached structure:
Brachialis

Interosseous border
Attached structure:
Interosseous membrane

Head
Related structure:
Ulnar notch (circumference)
Triangular articular disc (inf)
Related joint:
Inf radioulnar joint

Styloid process
Attached structure:
Med collateral lig

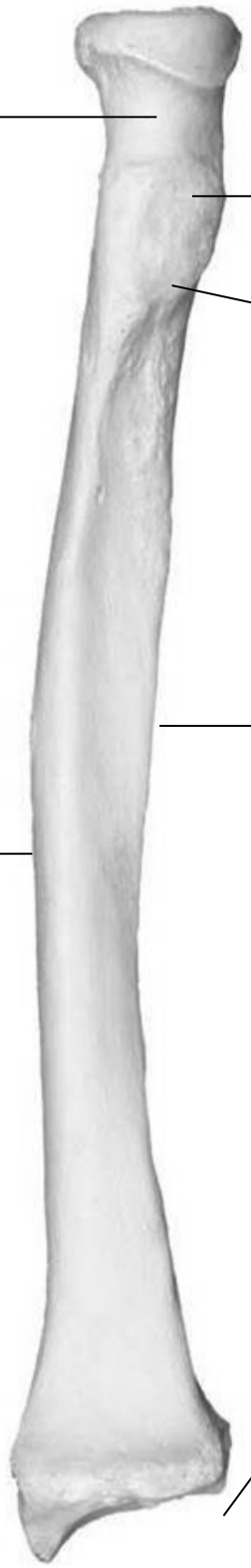
ULNA (POST)

Olecranon process
Attached structure:
Triceps

Radial notch
Related structure:
Head of radius
Related joint:
Sup radioulnar joint

Tortora & Nielsen

RADIUS (ANT)



Head
Related structures:
Capitulum
Radial notch
Related joints:
Elbow joint
Sup radioulnar joint

Neck
Related structure:
End of brachial A.

Radial tuberosity
Attached structure:
Biceps

Interosseous border
Attached structure:
Interosseous membrane

Pronator tuberosity
Attached structure:
Pronator teres

Ulnar notch
Related structure:
Head of ulna
Related joint:
Inf radioulnar

Inf surface of lower end
Related structure:
Scaphoid & Lunate
Related joint:
Wrist

Styloid process
Attached structure:
Lat collateral lig

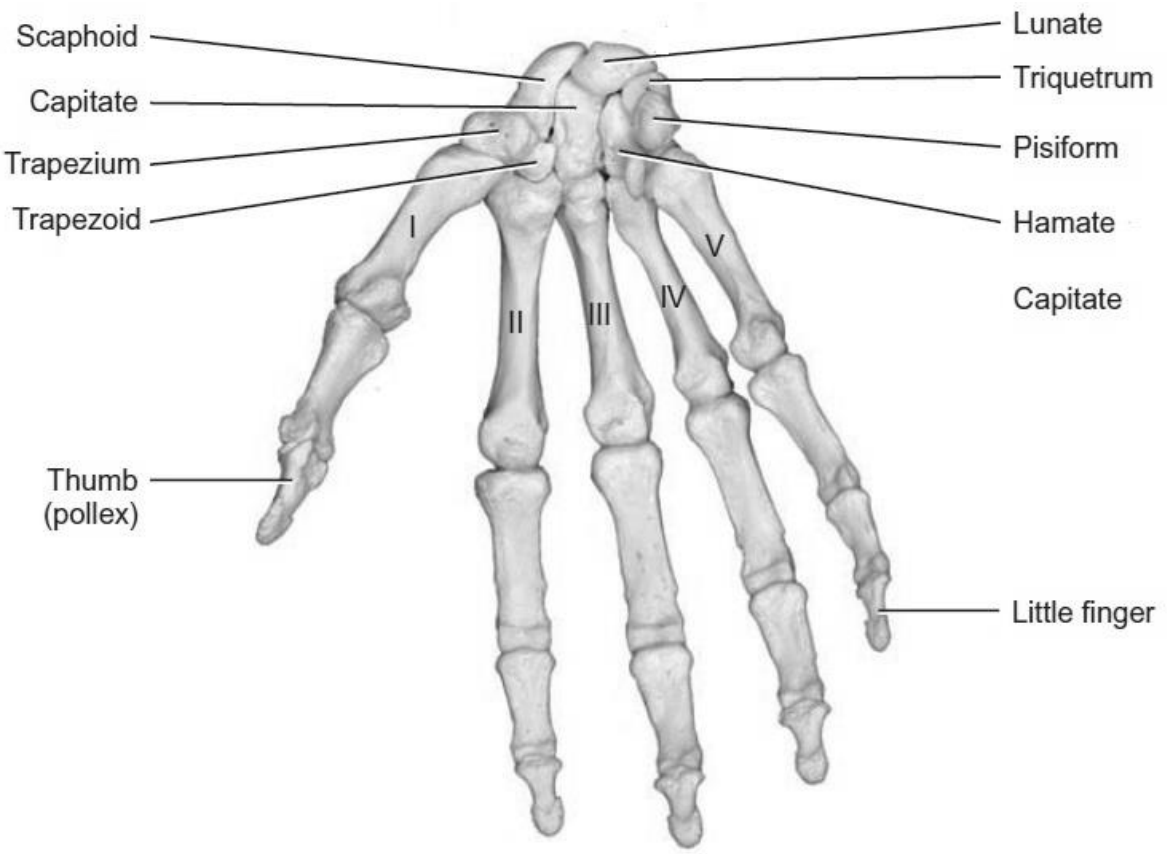
& Nielsen

RADIUS (POST)

Dorsal tubercle

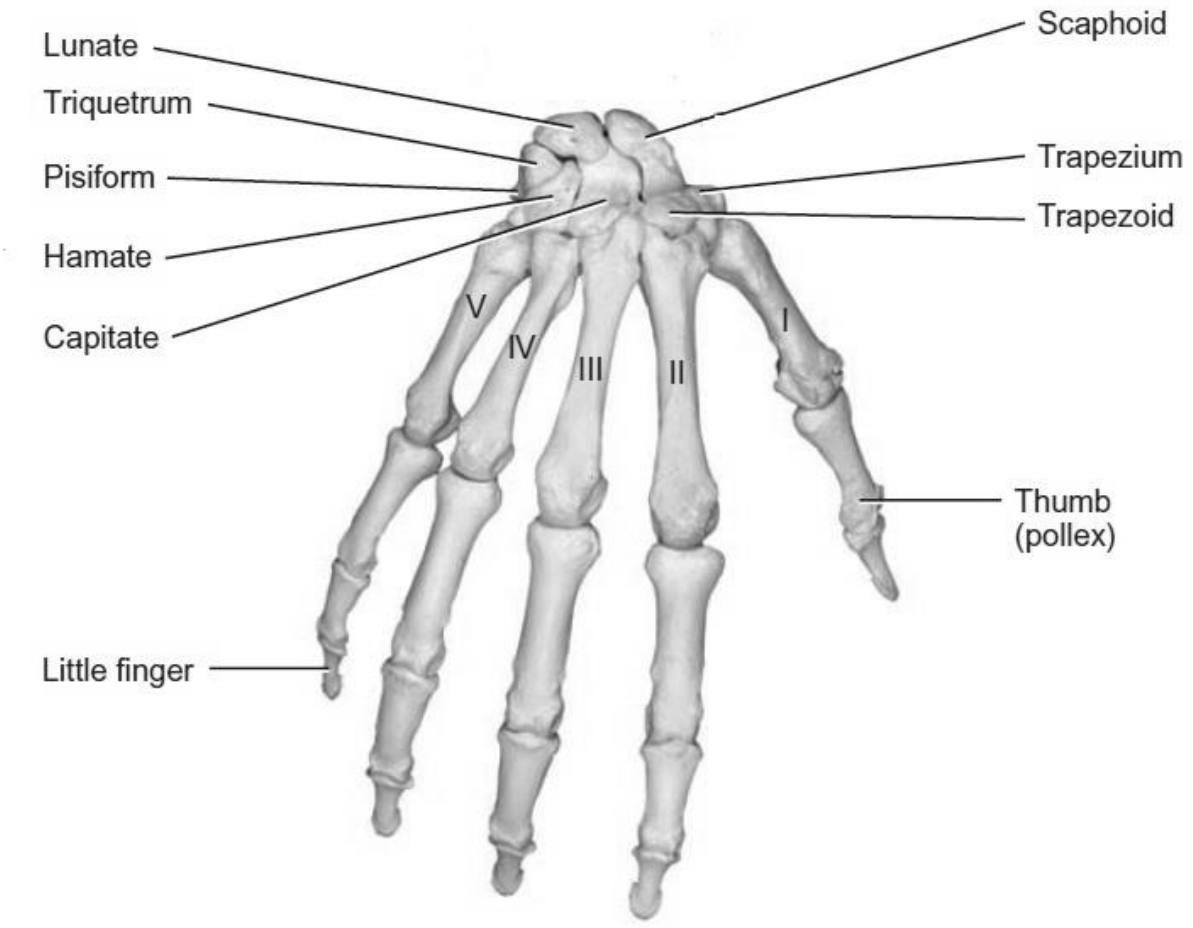
Styloid process
Attached structure:
Lat collateral lig

HAND (ANT)

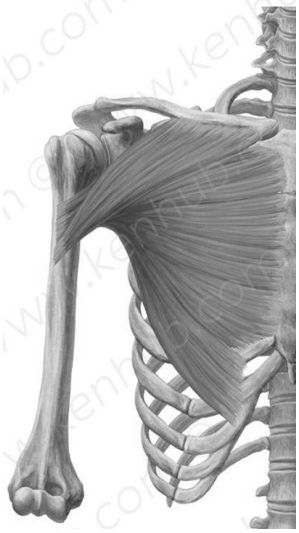


Tortora & Nielsen

HAND (POST)

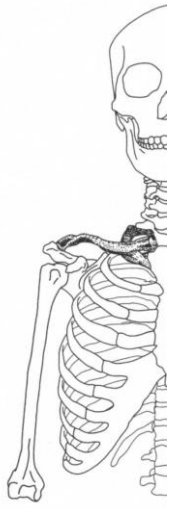


Tortora & Nielsen

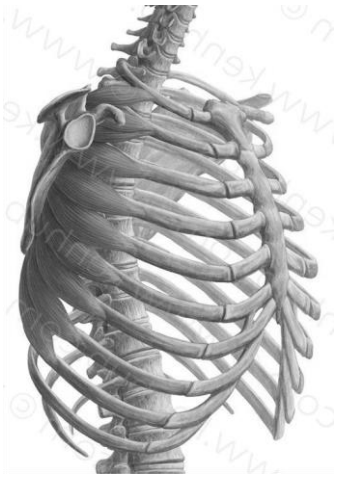


Pectoralis major

Pectorlais minor



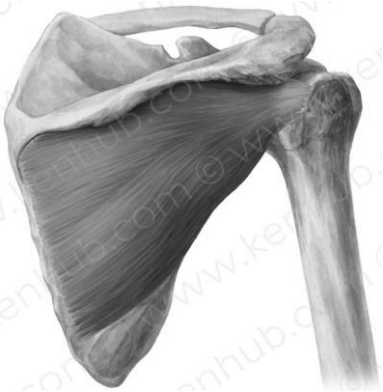
Subclavius



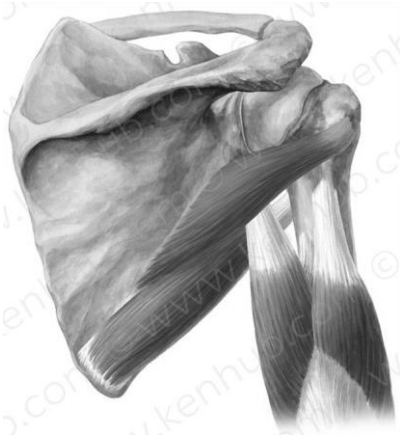
Serratus anterior

Deltoid

Supraspinatus



Infraspinatus



Teres minor

Teres major

Subscapularis

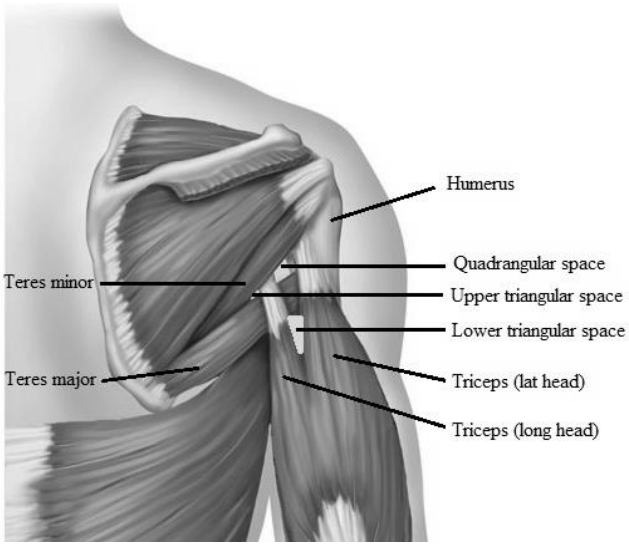
Ken Hub

PECTORAL MUSCLES

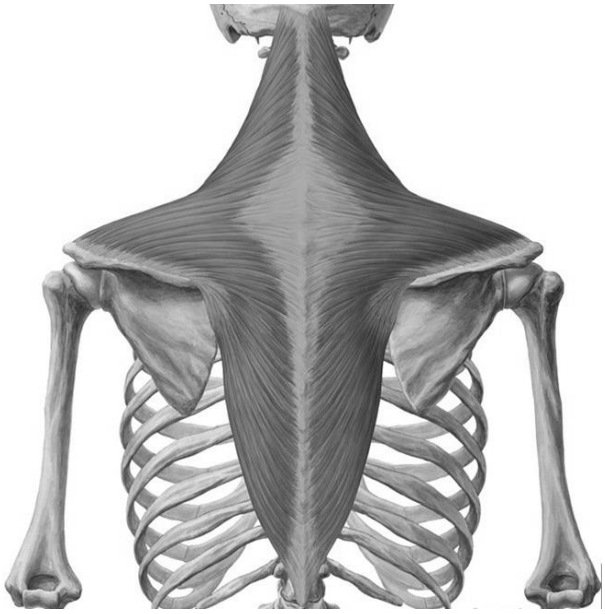
Muscle	*Origin*	*Insertion*	*Action*	*NS*
Pectoralis major	Clavicular head Medial ½ of front of clavicle Sternocastal head • ½ breadth of sternum • upper 6 costal Cartilages	Bicipital groove	• Adduction shoulder • Med rotation shoulder • Flexion shoulder	Med & lat Pectoral Ns
Pectoralis minor	ribs 2-5 near costal cartilages	Coracoid process	• Depression of scapula • protraction of scapula	
Subclavius	1st rib	Inf surface of clavicle (subclavian groove)	Fixation of clavicle during shoulder movements	N to subclavius
Serratus anterior	8 digitations from upper 8 ribs	Med border of scapula (ant lip) - 1st digit → sup angle - 2-3 → med border - 4-8 → inf angle	• Up rotation of scapula → elevation of arm > 90° • protraction of scapula • fixation of scapula (paralysis leads to winging of scapula)	N to serratus ant

SCAPULAR MUSCLES

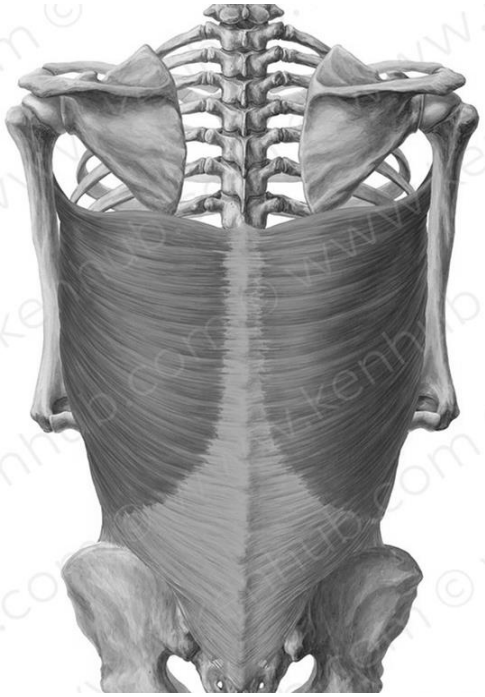
Muscle	*Origin*	*Insertion*	*Action*	*NS*
Deltoid	• lat 1/3 of clavicle (ant border) • acromion (outer border) • crest of spine of scapula (lower border)	Deltoid tuberosity	• Abduction (15-90°) • ant fibers: flexion & med rotation • post fibers: extension & lat rotation	Axillary N
Supraspinatus	Supraspinous fossa	Greater tuberosity	Abduction (0-15°)	Suprascapular N
Infraspinatus	Infraspinous fossa	Greater tuberosity	• Lat rotation • Adduction	Suprascapular N
Teres minor	Lat border of scapula (upper 2/3 of post aspect)	Greater tuberosity	• Lat rotation • Adduction	Axillary N
Teres major	Post surface of scapula (above inf angle)	Bicipital groove	• Med rotation • Adduction • Extension	Lower subscapular N
Subscapularis	Subscapular Fossa	Lesser tuberosity	• Flexion • Adduction	Upper & lower subscapular Ns



Scapular spaces



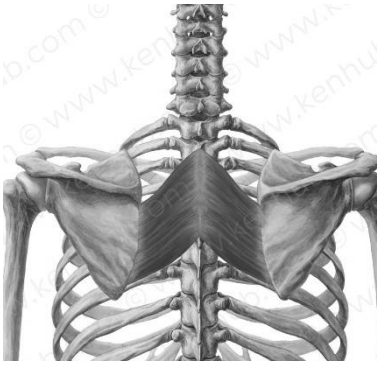
Trapezius



Latissimus dorsi

Levator scapulae

Rhomboids minor



Rhomboids major

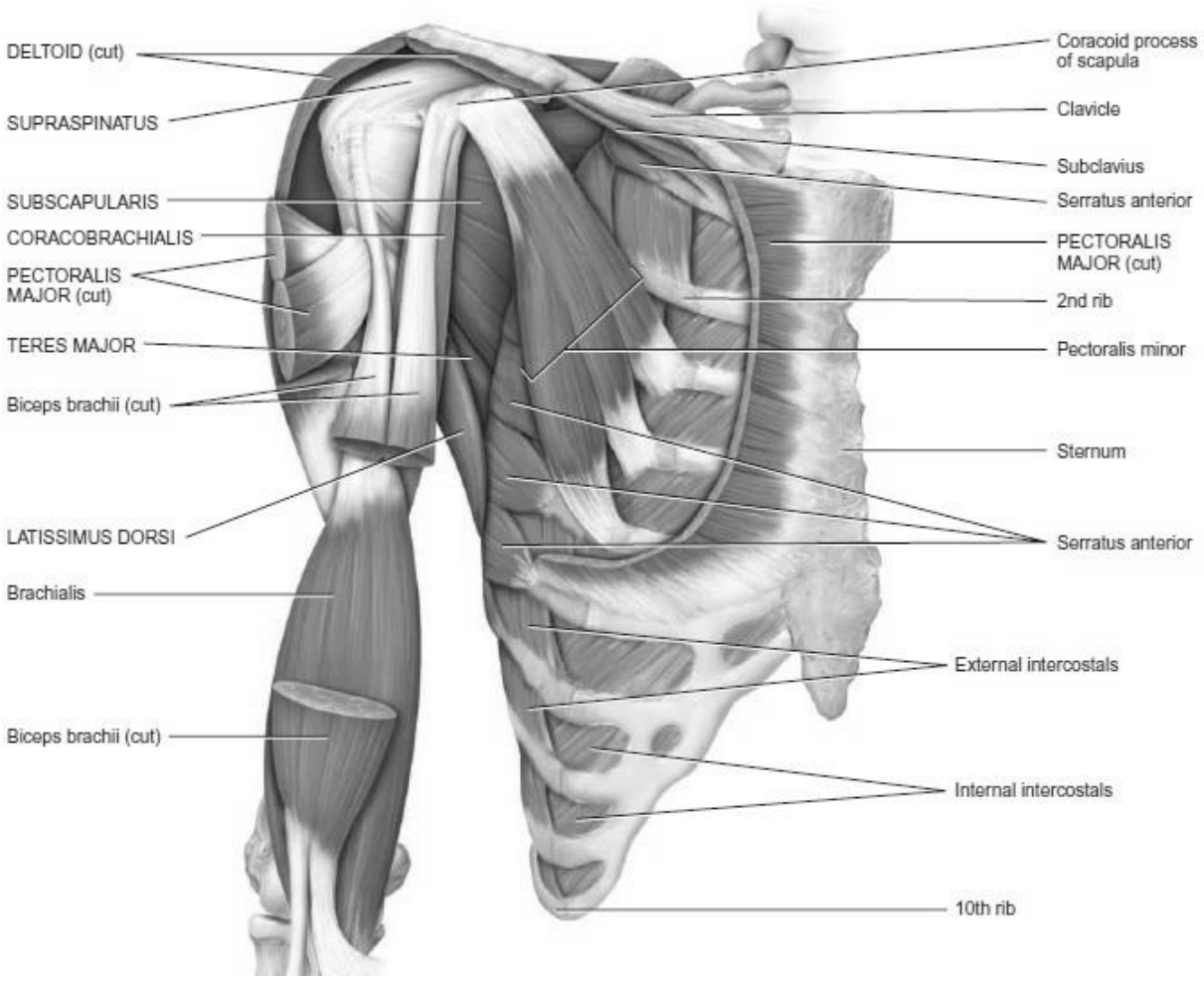
Marieb / Ken Hub

INETERMUSCULAR SPACES

Space	*Boundaries*				*Contents*
	Sup	*Inf*	*Med*	*Lat*	
Quadrangular	Teres minor	Teres major	Triceps (long head)	Humerus	Axillary N
Upper triangular	Teres minor	Teres major		Triceps (long head)	
Lower triangular	Teres major		Triceps (long head)	Humerus	Radial N

MUSCLES OF THE BACK

Muscle	*origin*	*Insertion*	*Action*	*NS*
Trapezius	• Sup nuchal line (med 1/3) • External occipital protuberance • Ligamentum nuchae • C7 spine • All thoracic spines	• Lat 1/3 of clavicle (post border) • Acromion (med border) • Crest of spine (sup border)	• Up rotation of scapula → elevation of arm > 90° • Retraction of scapula • Upper fibers → elevation of scapula • Lower fibers → depression of scapula	Spinal accessory N + C3-4
Latissimus dorsi	• Iliac crest • Lumbar fascia • Lower 6 thoracic spines • Lower 3 ribs • Inf angle of scapula (post)	Bicipital groove	• Adduction • Med rotation • Extension • Elevation of trunk to fixed arm	N to latissimus dorsi
Levator scapulae	C1-4 vertebrae	Med border of scapula (above spine)	• Elevation of scapula • Retraction of scapula	N to rhomboids
Rhomboids minor	C7-T1 vertebrae	Med border (at spine)	• Elevation of scapula • Retraction of scapula • Down rotation of scapula	
Rhomboids major	T2-5 vertebrae	Med border (below spine)		



Axilla

Tortora & Nielsen

AXILLA

Definition: pyramidal space between upper parts of arm & chest.

Boundaries:

Apex (cervicoaxillary canal):

- Connection between neck & apex of axilla.
- Transmits vessels & nerves to upper limb.
- It is bounded by:
  - Medial: 1st rib.
  - Anterior: clavicle.
  - Posterior: scapula.

Ant wall:

- Pectoralis Major.
- Clavipectoral fascia.
- Subclavius.
- Pectoralis minor.

Post wall.

- Subscapularis.
- Latissimus dorsi.
- teres major.

Med wall

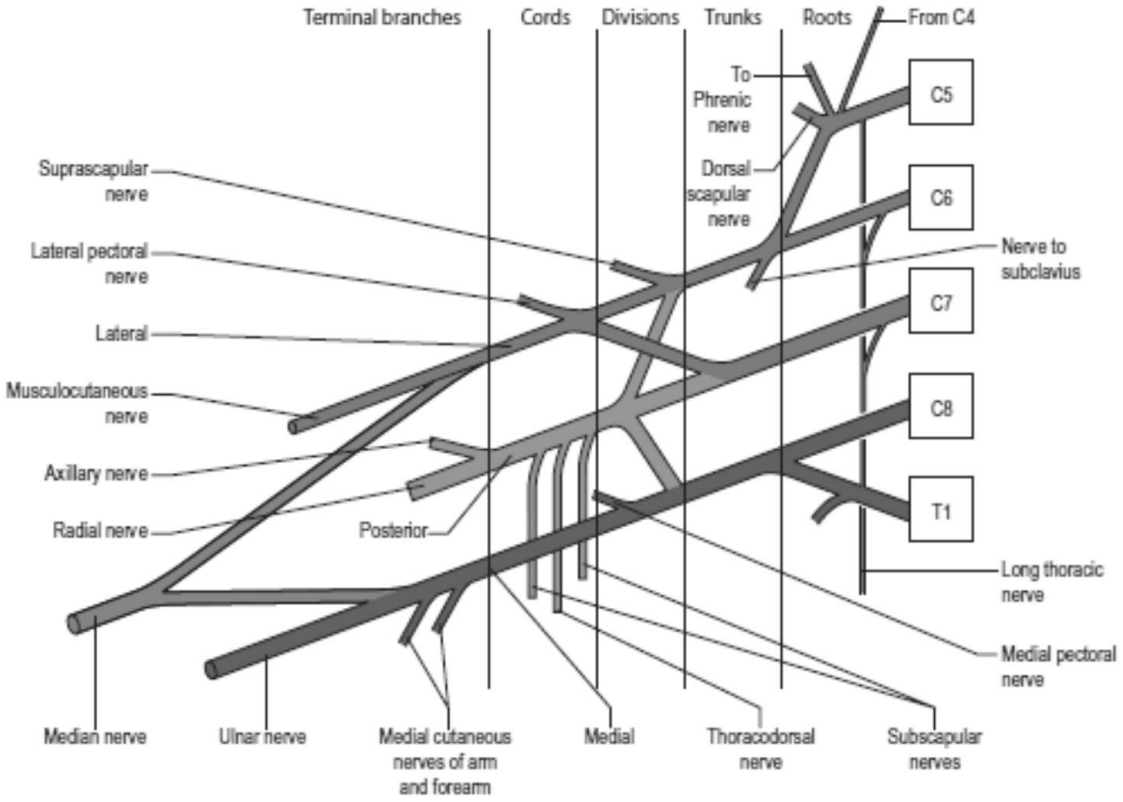
- Upper 5 ribs & intercostal muscles.
- Upper part of serratus anterior.

Lat Wall

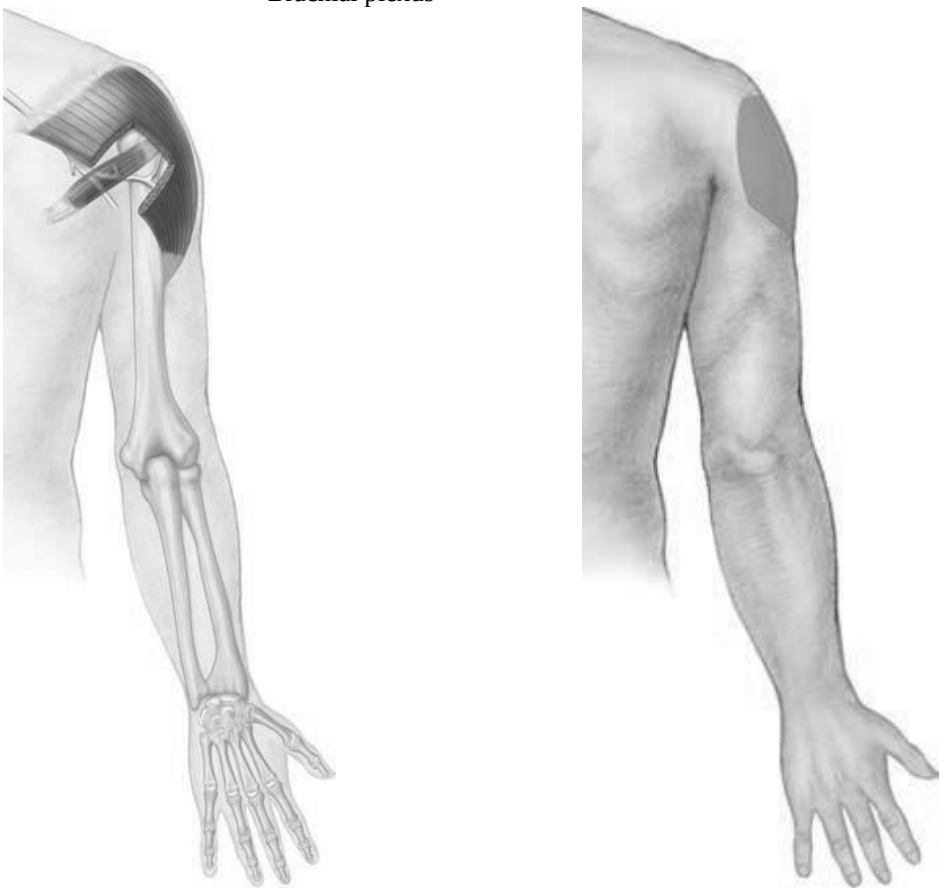
- Upper part of shaft of humerus.
- Coracobrachialis.
- Biceps.

Contents:

- Axillary A.
- Axillary V.
- Brachial plexus.
- Axillary lymph nodes.



Brachial plexus



Axillary nerve

McKinley & O'Loughlin

BRACHIAL PLEXUS

Stage	*Formation*	*Branches*
Roots	Ant rami of C5,6,7,8,T1	• N to rhomboids (C5) • N to serratus ant (C5,6,7)
Trunks	Upper: union of C5 & C6 Middle: C7 Lower: union of C8 & T1	• N to subclavius (upper trunk, C5,6) • Suprascapular N (upper trunk, C5,6)
Divisions	Each trunk divides into ant and post divisions	
Cords	Lat (C5,6,7): union of ant divisions of upper & middle trunks	1) Lat pectoral N (C5,6,7) 2) Lat root of median N (C5,6,7) 3) Musculocutaneous N (C5,6,7)
	Med (C8,T1): ant division of lower trunk	1) Med pectoral N (C8,T1) 2) Med root of median N (C8,T1) 3) Med cutaneous N of arm (C8,T1) 4) Med cutaneous N of forearm (C8,T1) 5) Ulnar N (C7,8,T1)
	Post (C5,6,7,8,T1): union of the 3 post divisions	1) Upper subscapular N (C5,6) 2) Lower subscapular N (C5,6) 3) Axillary N (C5,6) 4) N to latissimus dorsi (C6,7,8) 5) Radial N (C5,6,7,8,T1)

- Branches of brachial plexus supply all the muscles of upper limb except trapezius.
- The ulnar N receives fibers of C7 from the median N.

AXILLARY (CIRCUMFLEX) NERVE

Root value: C5,6.

Beginning: from post cord of brachial plexus.

Course and Relations:

- It passes post to axillary A.
- Passes through quadrangular space.
- Passes post to surgical neck of humerus.

Branches and Distribution:

Ant branch: ant part of deltoid.

Post branch:

- Post part of deltoid & teres minor.
- Upper lat cutaneous N of arm: supply skin over deltoid.

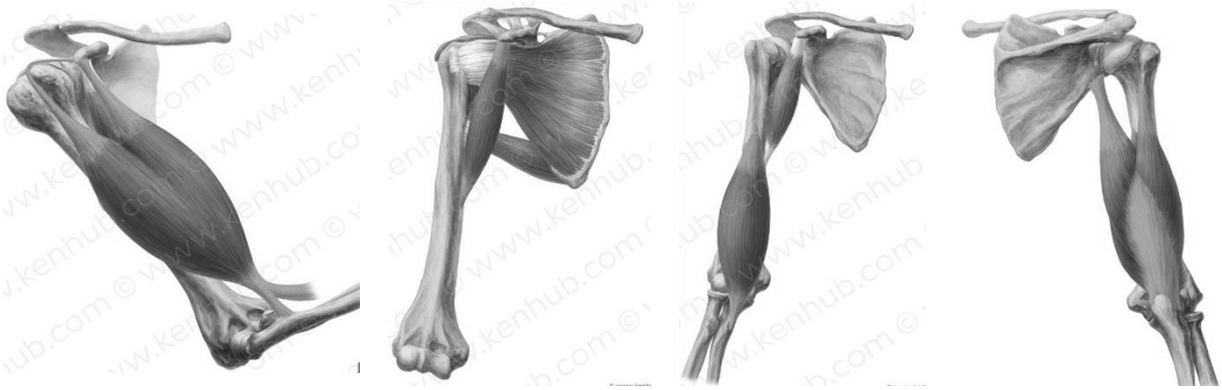
End: deep to deltoid by dividing into ant and post branches.

Injury of axillary nerve:

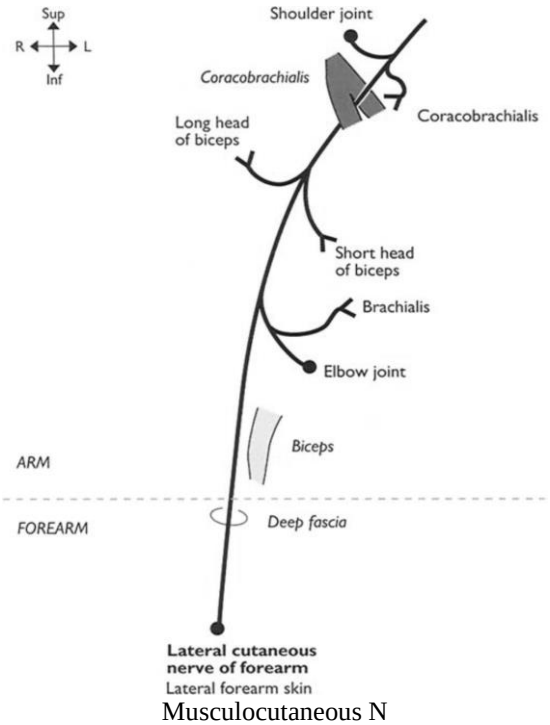
Causes: fracture surgical neck of humerus or dislocation of shoulder.

Motor: Paralysis of deltoid → loss of abduction 15-90°.

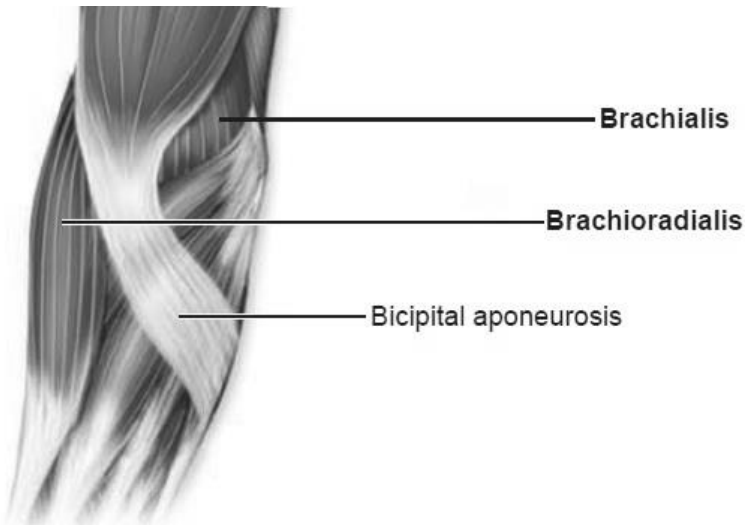
Sensory: loss of sensation over the deltoid



Biceps Coracobrachialis Brachialis Triceps



Musculocutaneous N



Cubital fossa

Ken Hub / Whitaker & Borley / McKinley & O'Loughlin

MUSCLES OF THE ARM

Muscle	*Origin*	*Insertion*	*Action*	*NS*
Biceps	Long head (lat): supraglenoid tubercle → bicipital groove short head (med): Coracoid process	Radial tuberosity	• flexion shoulder • Flexion elbow • Supination.	Musculocutaneous N
Coracobrachialis	Coracoid process	Med border of humerus (middle)	Flexion shoulder	Musculocutaneous N (pierces the muscle)
Brachialis	Lower ½ of shaft of humerus (front)	Ulnar tuberosity	Flexion elbow	• Musculocutaneous N • Radial N (lat fibers)
Triceps	Long head: Infraglenoid tubercle Lat head: back of humerus above radial groove Med head: back of humerus below radial groove	Olecranon process	Extension elbow	Radial N

MUSCULOCUTANEOUS NERVE

Root value: C5,6,7.
Origin: lat cord of brachial plexus.
Course & relations:

- It descends lateral to axillary A.
- Pierces coracobrachialis.
- Passes between coracobrachialis & biceps then between biceps & brachialis.
- Appears lat to biceps & continue as lateral cutaneous N of forearm.

Branches:

A) Muscular: to coracobrachialis, each head of biceps & brachialis.
B) Cutaneous: lat cutaneous N of forearm (terminal branch): supply corresponding skin.

CUBITAL FOSSA

Definition: triangular space in front of elbow.
Boundaries:

Base: imaginary line between 2 humeral epicondyles.
Med: pronator teres.
Lat: brachioradialis.
Roof:

- ***Skin.***
- ***Superficial fascia*** containing med & lat cutaneous Ns of forearm, bicipital aponeurosis & superficial veins (site of injection).
- ***Deep fascia.***

Floor:

Med: brachialis.
Lat: supinator.

Contents:

- Brachial A and its 2 terminal branches: ulnar & radial.
- Lat: biceps tendon and radial N.

- Med: median N.

Pronator teres

Flexor carpi radialis

Palmaris longus

Flexor digitorum superficialis

Flexor carpi ulnaris

Flexor digitorum profundus

Flexor pollicis longus

Pronator quadratus

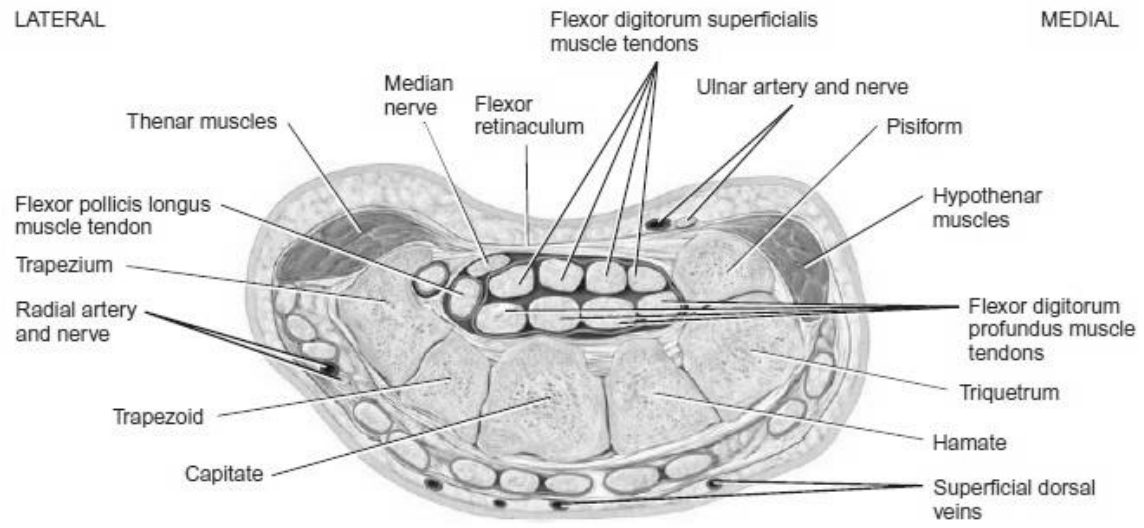
Ken Hub

MUSCLES OF FOREARM (FRONT)

Muscle	*Origin*	*Insertion*	*Action*	*NS*
Pronator teres	Humeral head: med supracondylar ridge Ulnar head: coronoid process	Lat surface of radius (middle)	pronation	Median N
Flexor carpi radialis	CFO	2nd & 3rd metacarpal	• FW • Abduction wrist	
Palmaris longus (may be absent)	CFO	Palmar aponeurosis (apex)	FW	
Flexor digitorum superficialis	Humero-ulnar head: CFO & coronoid process Radial head: ant oblique line	Med 4 fingers (middle phalanges)	• FW • Flexion of med 4 fingers (metacarpophalangeal & proximal interphalangeal joints)	
Flexor carpi ulnaris	Humeral head: CFO Ulnar head: olecranon process & post border	Pisiform then to: • Hamate • 5th metacarpal	• FW • Adduction wrist	Ulnar N
Flexor digitorum profundus	Upper ¾ of ulna (ant surface)	Med 4 fingers (distal phalanges)	• FW • Flexion of med 4 fingers (all joints)	Med ½: ulnar N Lat ½: ant interosseous N
Flexor pollicis longus	Upper ¾ of radius (ant surface)	Distal phalanx of thumb	• FW • Flexion thumb (all joints)	Ant interosseous (median) N
Pronator quadratus	Lower ¼ of ulna (ant surface)	Lower ¼ of radius (ant surface)	Pronation	

CFO = common flexor origin (front of med epicondyle).

FW = flexion wrist.



Flexor retinaculum & carpal tunnel

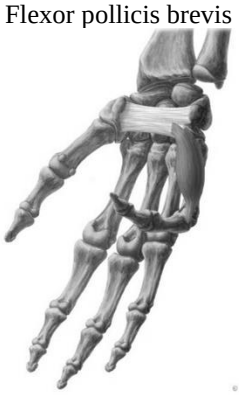
Abductor pollicis brevis

Flexor pollicis brevis

Opponens pollicis

Adductor pollicis

Abductor digitiminimi



Flexor digitiminimi

Opponens digitiminimi

Palmaris brevis

Lumbricals

Palmar interossei

Dorsal interossei

Tortora & Nielsen / Ken Hub

FLEXOR RETINACULUM AND CARPAL TUNNEL

Definition: flexor retinaculum is thickened deep fascia ant to wrist joint. Carpal tunnel is the space between flexor retinaculum and carpal bones.

Attachment:

Lat: scaphoid (tubercle), trapezium (crest).

Med: pisiform, hamate (hook).

Structures passing superficial:

1) Ulnar N.
2) Ulnar A.
3) Palmaris longus.

Structures passing deep:

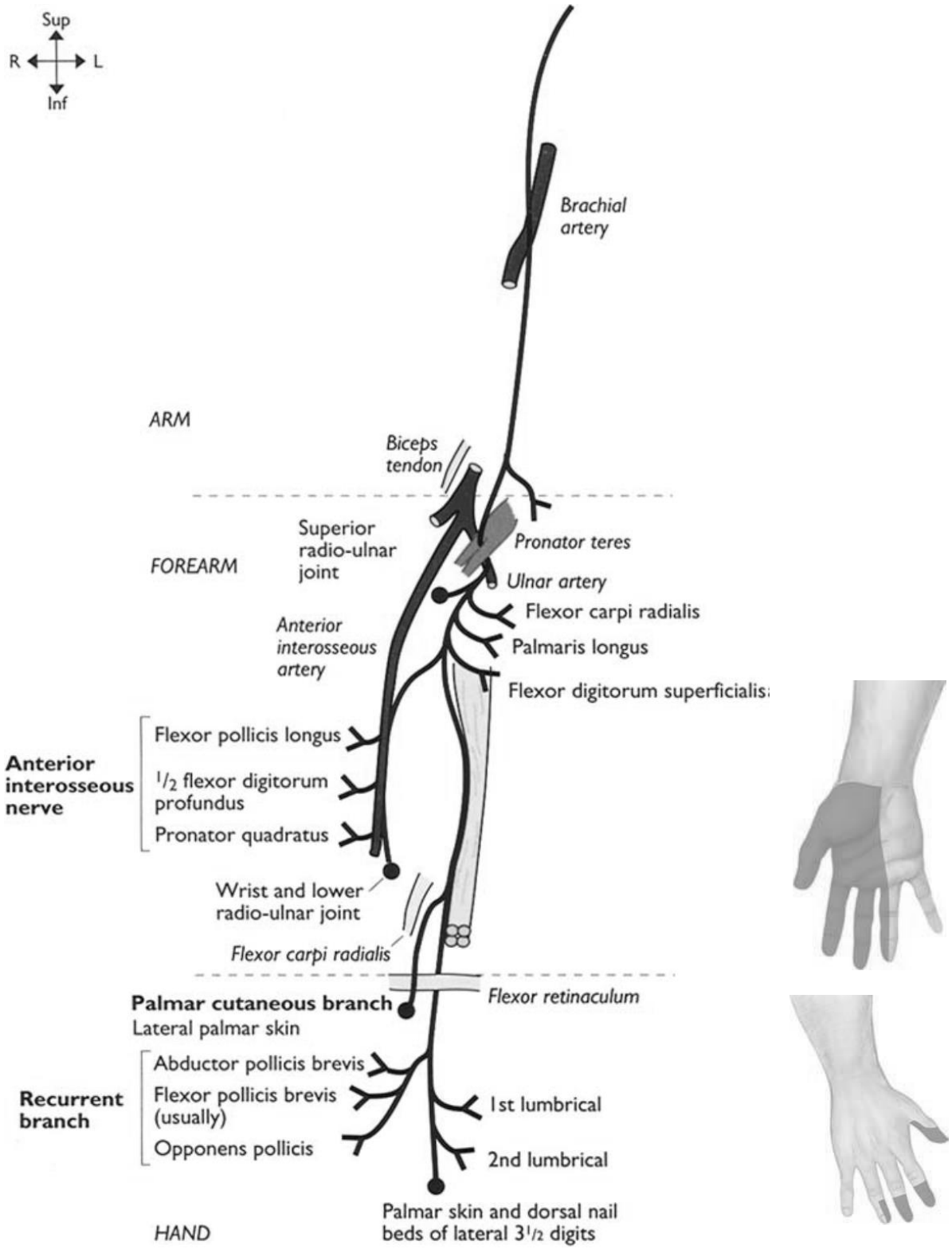
1) Flexor digitorum superficialis.
2) Flexor digitorum profundus.
3) Median N.
4) Flexor pollicis longus.
5) Flexor carpi radialis (in special compartment).

Applied anatomy: Carpal tunnel syndrome: compression of median N in carpal tunnel (usually due to carpal bone dislocation, inflammation of tendons or overstretched hand).

MUSCLES OF THE PALM OF HAND

Group	*Muscle*	*Action*	*NS*
Thenar	**Abductor pollicis brevis**	Abduction of thumb	Median N: • Thenar • 1st (lat) 2 lumbricals Ulnar N: supplies other Ms
	Flexor pollicis brevis	Flexion of thumb	
	Opponens pollicis	Opposition of thumb	
Hypothenar	**Abductor digitiminimi**	Abduction of little finger	
	Flexor digitiminimi	Flexion of little finger	
	Opponens digitiminimi	Opposition of little finger	
Adductor pollicis		Adduction of thumb	
Palmaris brevis		Increase concavity of hand → firm grip	
4 lumbricals		writing position of med 4 fingers • Flexion of metacarpophalangeal joint • Extension of interphalangeal joints	
4 Palmar interossei **(1st may be absent)**		• Adduction of all fingers except middle • Writing position	
4 Dorsal interossei		• Abduction of middle 3 fingers • Writing position	

N.B.: adduction & abduction of fingers is along a line of the 3rd finger.



Median N

Whitaker & Borley / McKinley & O'Loughlin

MEDIAN NERVE

Root value: C5,6,7,8,T1.

Beginning: by 2 roots, Lat root from lat cord & med root from med cord of brachial plexus.

Course and relations:

- Descends lat to axillary & brachial A.
- At the middle of the arm, it crosses the brachial A & passes med to it to enter the cubital fossa.
- Leaves cubital fossa by passing between 2 heads of pronator teres.
- Descends between flexor digitorum superficialis (superficial) & flexor digitorum profundus (deep).
- Passes deep to flexor retinaculum to the hand then divides into terminal branches.

Branches:

Site	*Motor*	*Sensory*
At axilla & arm		
At cubital fossa	• Pronator teres • Flexor carpi radialis • Palmaris longus • Flexor digitorum superficialis	
At forearm	Ant interosseous N: supplies: • Flexor digitorum profundus (lat ½) • Pronator quadratus • Flexor pollicis longus	Palmar cutaneous branch → lat 2/3 of palm (ant)
At hand	• Thenar • Lat 2 lumbrical	Lat 3½ fingers (ant)

Injury of median nerve: (Ape like hand)

A] Injury above cubital fossa:

Motor:

- Paralysis of pronator teres & quadratus → loss of pronation.
- Paralysis of wrist flexors except flexor carpi ulnaris & lat ½ of flexor digitorum profundus → weak flexion accompanied by adduction.
- Paralysis of flexor pollicis longus & brevis → loss of thumb flexion.
- Paralysis of opponens pollicis → loss of opposition (Ape like hand).

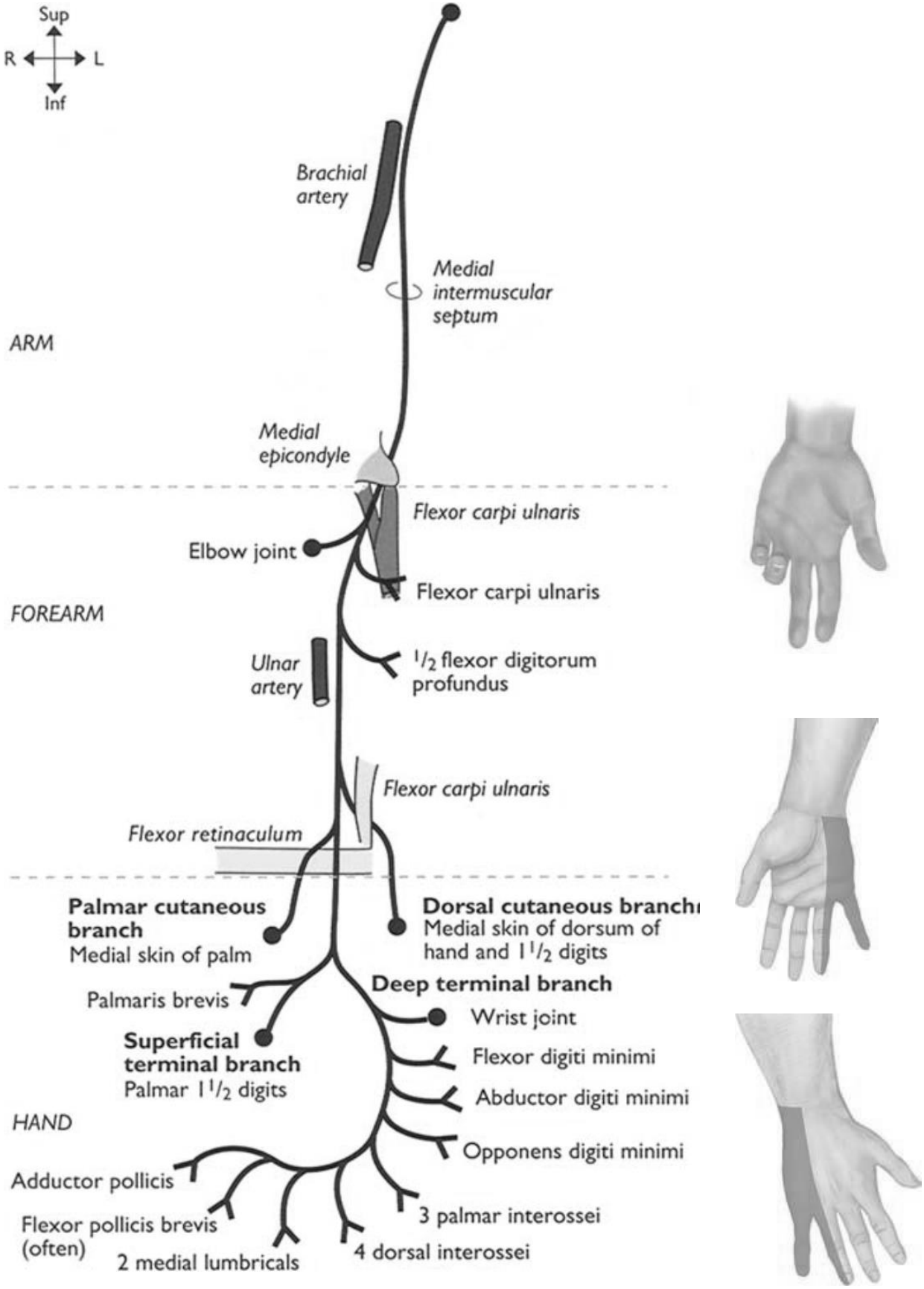
Sensory: loss of sensation of ant side of lat 2/3 of hand & lat 3½ fingers.

B] Injury at wrist:

Cause: carpal tunnel syndrome due to compression by inflammation, bone dislocation or overstretch by extended hands (e.g.: typewriters).

Motor: loss of opposition (Ape like hand).

Sensory: loss of sensation of ant side of lat 3½ fingers.



Ulnar N

Whitaker & Borley / McKinley & O'Loughlin

ULNAR NERVE

Root value: C7,8,T1.

Beginning: from med cord of brachial plexus.

N.B.: med cord of brachial plexus does not contain C7, it reaches the ulnar nerve through lat root of median nerve.

Course and relations:

- Descends med to axillary & brachial A.
- At mid arm it passes to post compartment.
- Passes post to med epicondyle.
- Passes between 2 heads of flexor carpi ulnaris to forearm.
- Descends between flexor carpi ulnaris (superficial) & flexor digitorum profundus (deep).
- Passes superficial to flexor retinaculum to the hand.

Branches:

Site	*Motor*	*Sensory*
At axilla & arm		
At forearm	• Flexor carpi ulnaris • Flexor digitorum profundus (med ½)	Palmar & dorsal cutaneous branches → med 1/3 of hand (ant & post)
At hand	• Hypothenar • Adductor pollicis • Palmaris brevis • Med 2 lumbricals • Palmar & dorsal interossei	Med 1½ fingers (ant & post)

Injury of ulnar nerve: (partial claw hand)

A] Injury above the elbow:

Motor:

- Paralysis of flexor carpi ulnaris → weak flexion of wrist accompanied by abduction.
- Paralysis of adductor pollicis → loss of adduction of thumb.
- Paralysis of interossei → loss of adduction and abduction of med 4 fingers.
- Paralysis of med 2 lumbricals → clawing of ring & little fingers (partial claw hand) = extension of metacarpophalangeal and flexion of interphalangeal joints.

Sensory: loss of sensation of med 1/3 of hand & med 1½ fingers (ant & post).

B] Injury at wrist: differs in:

Motor:

- No affection of wrist flexion
- Claw hand is more severe due to further flexion by flexor digitorum profundus (ulnar paradox).

Sensory: loss of sensation of med 1½ fingers (ant and post).

N.B.: complete claw hand: (clawing of med 4 fingers) occurs due to injury of both median & ulnar nerves or injury of lower trunk or med cord of brachial plexus.

Anconeus

Brachioradialis

Extensor carpi radialis longus

Extensor carpi radialis brevis

Extensor digitorum

Extensor digitiminimi

Extensor carpi ulnaris

Supinator

Abductor pollicis longus

Extensor pollicis brevis

Extensor pollicis longus

Extensor indicis

Ken Hub

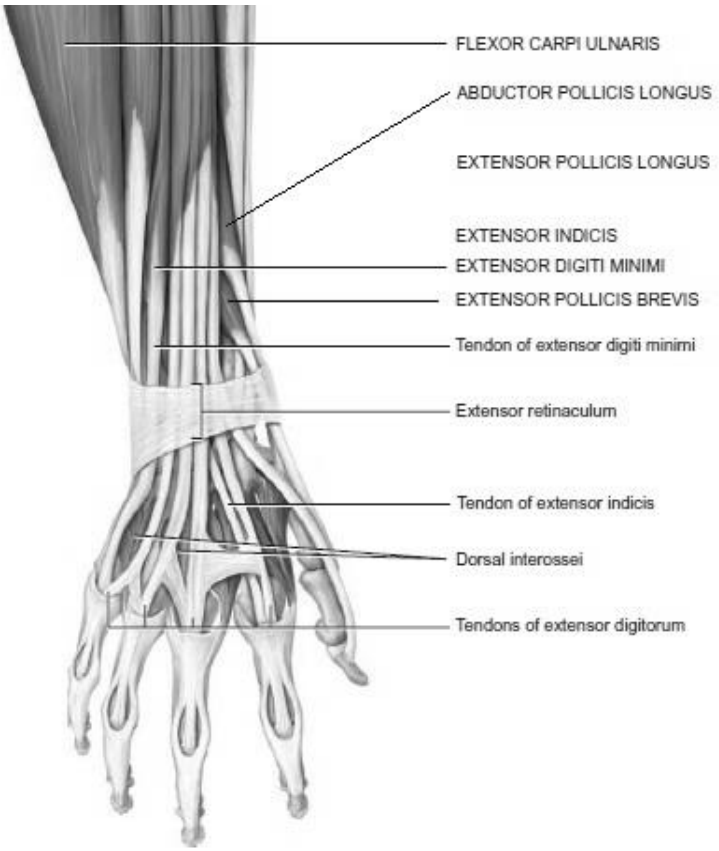
MUSCLES OF FOREARM (BACK)

Muscle	*Origin*	*Insertion*	*Action*	*NS*
Anconeus	Lat epicondyle (post)	Post surface of ulna (upper ¼)	Extension elbow	Radial N
Brachioradialis	Lat supracondylar ridge	Lower end of radius (lat surface)	Initiate supination and pronation	
Extensor carpi radialis longus	Lat supracondylar ridge	2nd metacarpal	• EW • Abduction wrist	
Extensor carpi radialis brevis	CEO	3rd metacarpal	• EW • Abduction of wrist	Post interosseous (Radial) N
Extensor digitorum	CEO	Med 4 fingers (extensor expansion)	• EW • Extension of med 4 fingers (all joints)	
Extensor digitiminimi	CEO	Little finger (extensor expansion)	• EW • Extension little finger (all joints)	
Extensor carpi ulnaris	• CEO • post border of ulna	5th metacarpal	• EW • Adduction wrist	
Supinator	Supinator crest & fossa	upper 1/3 of radius (post, lat & ant surfaces)	Supination	
Abductor pollicis longus	Post surface of radius, ulna & interosseous membrane (upper 1/3)	1st metacarpal	Abduction thumb	
Extensor pollicis brevis	Post surface of radius (middle 1/3)	Proximal phalanx of thumb	Extension thumb (metacarpophalangeal joint)	
Extensor pollicis longus	Post surface of ulna (middle 1/3)	Distal phalanx of thumb	• EW • Extension thumb (all joints)	
Extensor indicis	Post surface of ulna (below extensor pollicis longus)	Index (extensor expansion)	• EW • Extension index (all joints)	

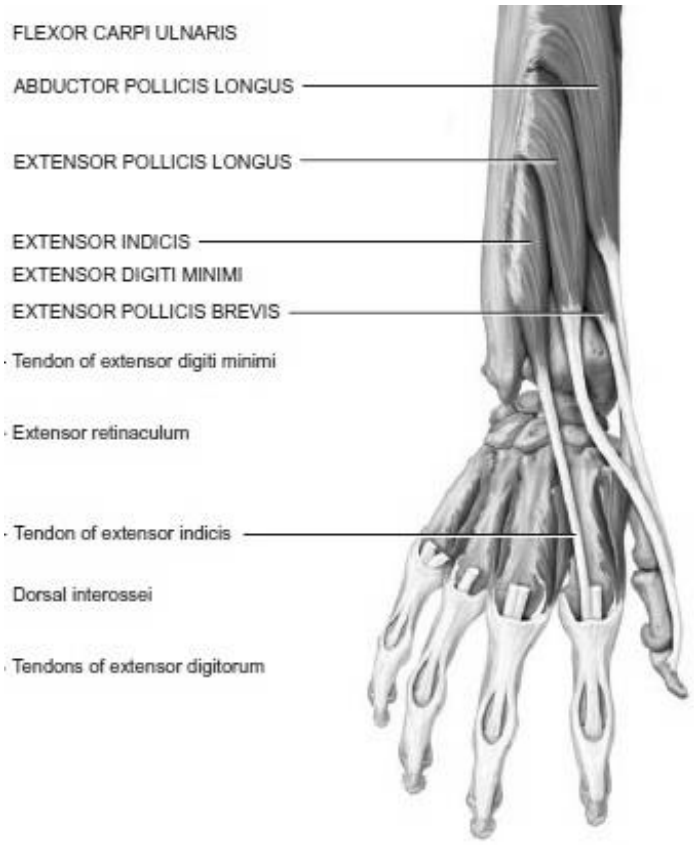
CEO = common extensor origin (front of lat epicondyle).

EW = extension wrist.

Extensor expansion: the tendons expand over the proximal phalanges of fingers, divide into 3 slips & insert into middle & distal phalanges.



Extensor retinaculum



Snuff box

Tortora & Nielsen

EXTENSOR RETINACULUM

Attachments:

Lat: ant border of radius (lower part).

Med: triquetrum and pisiform.

Structures superficial to it: superficial radial N

Structures deep to it: 6 compartments (from lat to med)

Compartment	*Contents*
1	• Abductor pollicis longus • Extensor pollicis brevis
2	• Extensor carpi radialis longus • Extensor carpi radialis brevis
3	Extensor pollicis longus
4	• Extensor digitorum • Extensor indicis • Post interosseous N • Ant interosseous A
5	Extensor digitiminimi
6	Extensor carpi ulnaris

ANATOMICAL SNUFF BOX

Boundaries:

Lat: Abductor pollicis longus & extensor pollicis brevis (1st compartment of extensor retinaculum).

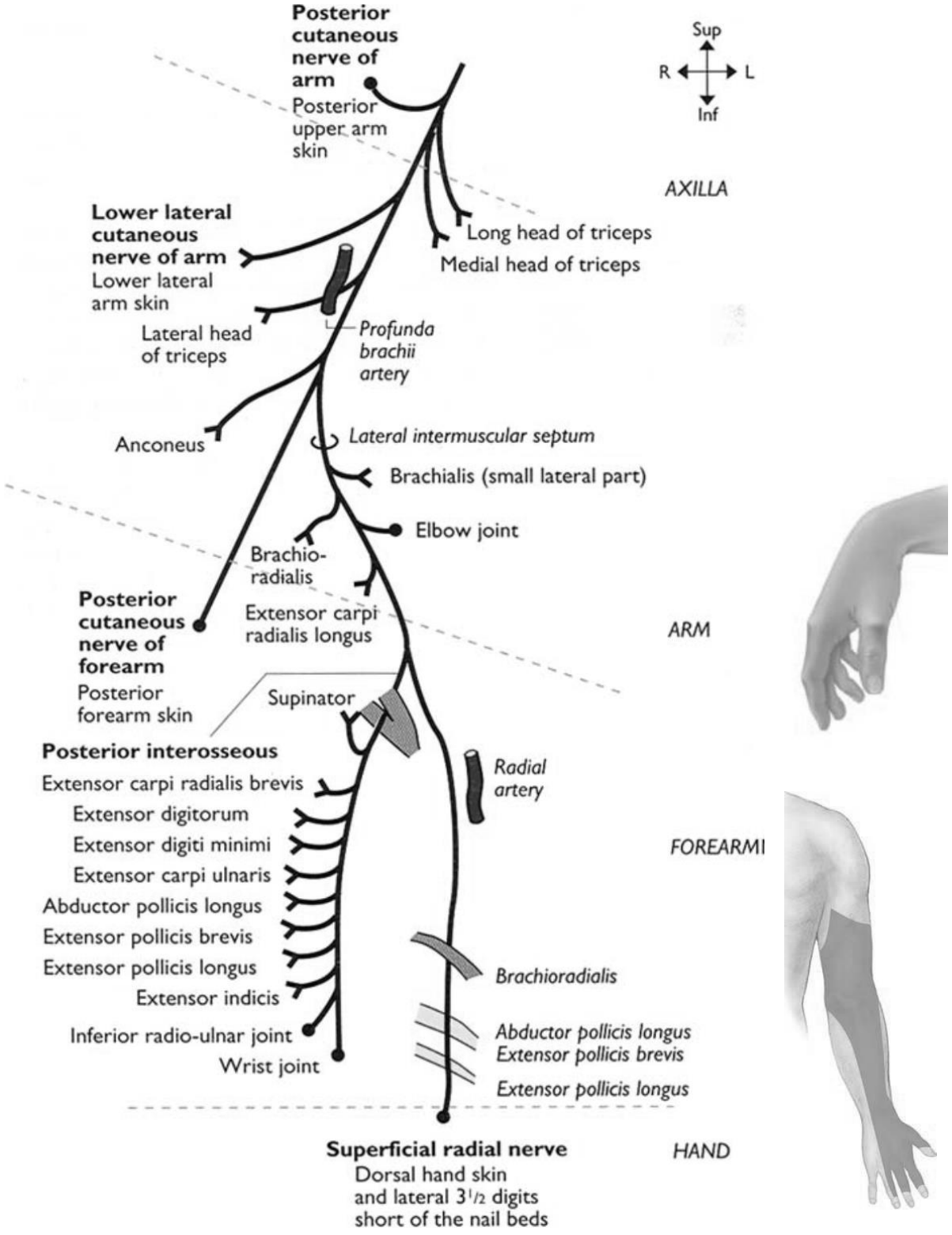
Med: extensor pollicis longus (3rd compartment of extensor retinaculum).

Floor: styloid process of radius & scaphoid bone.

Roof: superficial fascia containing superficial radial N.

Contents:

- Radial A.
- Ext carpi radialis longus and brevis (2nd compartment of extensor retinaculum).



Radial N

Whitaker & Borley / McKinley & O'Loughlin

RADIAL NERVE

Root value: C5,6,7,8,T1.
Beginning: from post cord of brachial plexus.
Course and relations:

- Lies post to axillary and brachial A.
- Passes in lower triangular space.
- Runs in spiral groove.
- Descends in cubital fossa between brachialis and brachioradialis & divides into 2 terminal branches.

Branches:

Site	*Motor*	*Sensory*
At axilla	•Triceps (long head) •Triceps (med head)	Post cutaneous N of arm
At spiral groove	•Triceps (med head) •Triceps (lat head) •Anconeus	•Lower lat cutaneous N of arm •Post cutaneous N of forearm
Between brachialis & brachioradialis	•Brachialis (lat fibers) •Brachioradialis •Extensor carpi radialis longus	
Terminal	Post interosseous N: supplies: • extensor carpi radialis brevis • extensor digitorum • extensor digitiminimi • extensor carpi ulnaris • abductor pollicis longus • extensor pollicis brevis • extensor pollicis longus • extensor indicis • supinator	Superficial terminal branch: supply skin of dorsum of hand (lat 2/3) & lat 3½ fingers

Injury of radial nerve: (wrist drop)

A] Injury above spiral groove:

Motor:

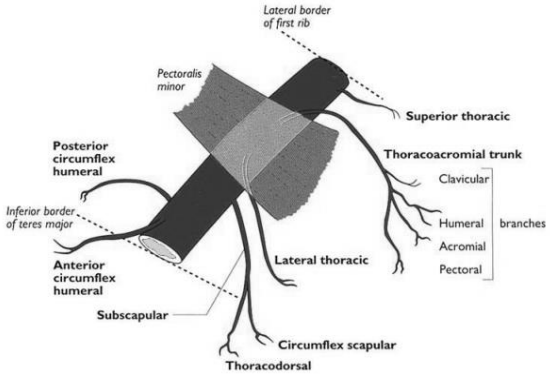
- Paralysis of triceps & anconeus → loss of elbow extension.
- Paralysis of muscles of back of forearm → wrist drop.
- Paralysis of fingers extensors → fingers drop.

Sensory: loss of sensation of 1st interdigital cleft (post).

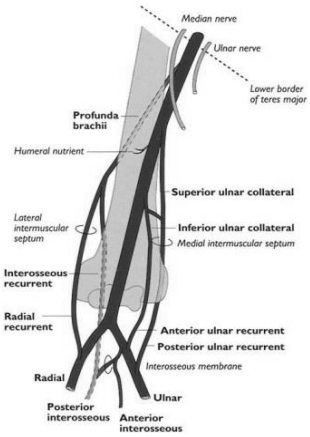
B] Injury in Spiral Groove: differs in:
No loss of elbow extension.

C] Injury of Posterior Interosseous N: differs in:

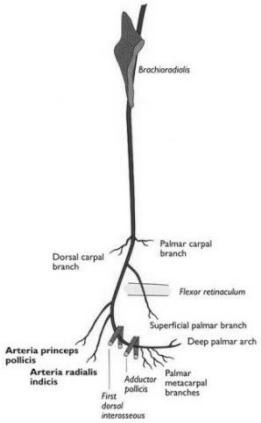
- No loss of elbow extension.
- Weak extension of wrist (only by extensor carpi radialis longus) accompanied by abduction.
- No sensory loss.



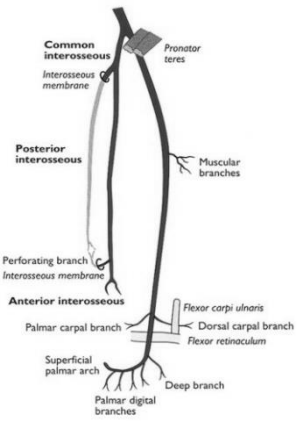
Axillary A



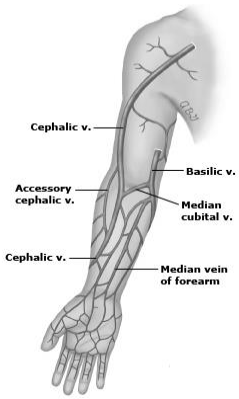
Brachial A



Radial A



Ulnar A



Veins of upper limb

Whitaker & Borley

SUMMARY OF THE ARTERIES OF THE UPPER LIMB

AXILLARY ARTERY

Beginning: at the outer border of 1st rib as a continuation of subclavian A .

Important branches:

1) **Sup thoracic & lat thoracic As:** supplies thoracic wall.
2) **Acromiothoracic A:** supplies clavicle, scapula and nearby muscles.
3) **Ant & post Circumflex Humeral As:** passes ant & post to surgical neck of humerus, and ends by anastomosing with each other.

End: at the lower border of teres major by becoming brachial A .

BRACHIAL ART

Beginning: at the lower border of teres major as a continuation of axillary A.

Important branch: profunda brachii: runs in the spiral groove with the radial N.

End: in cubital fossa, at the level of the neck of radius by dividing into 2 terminal branches (radial & ulnar).

ULNAR ARTERY

Beginning: at the level of neck of radius as one of 2 terminal branches of brachial A.

Course &relations: passes obliquely then vertically in forearm → superficial to flexor retinaculum → hand.

Important branches:

1) **Ant & post carpal As:** anastomose with ant & post carpal As of radial A.
2) **Deep palmar branch:** anastomose with deep palmar arch of radial A.

End: by forming **superficial palmar arch** which anastomose with superficial palmar branch of radial A.

RADIAL ARTERY

Beginning: at the level of neck of radius as one of 2 terminal branches of brachial A.

Course: leaves cubital fossa at its apex → descends to pass superficial to lower end of radius (site for pulse examination) → anatomical snuff box → palm.

Important branches:

1) **Ant & post carpal As:** anastomose with ant & post carpal As of ulnar A.
2) **Superficial palmar A:** anastomose with superficial palmar arch of ulnar A.

End: by forming **deep palmar arch** which anastomose with deep palmar branch of ulnar A.

SUMMARY OF THE VEINS OF THE UPPER LIMB

DEEP VEINS

❖ Deep to the deep fascia. They follow the arteries as regards course & distribution.

SUPERFICIAL VEINS

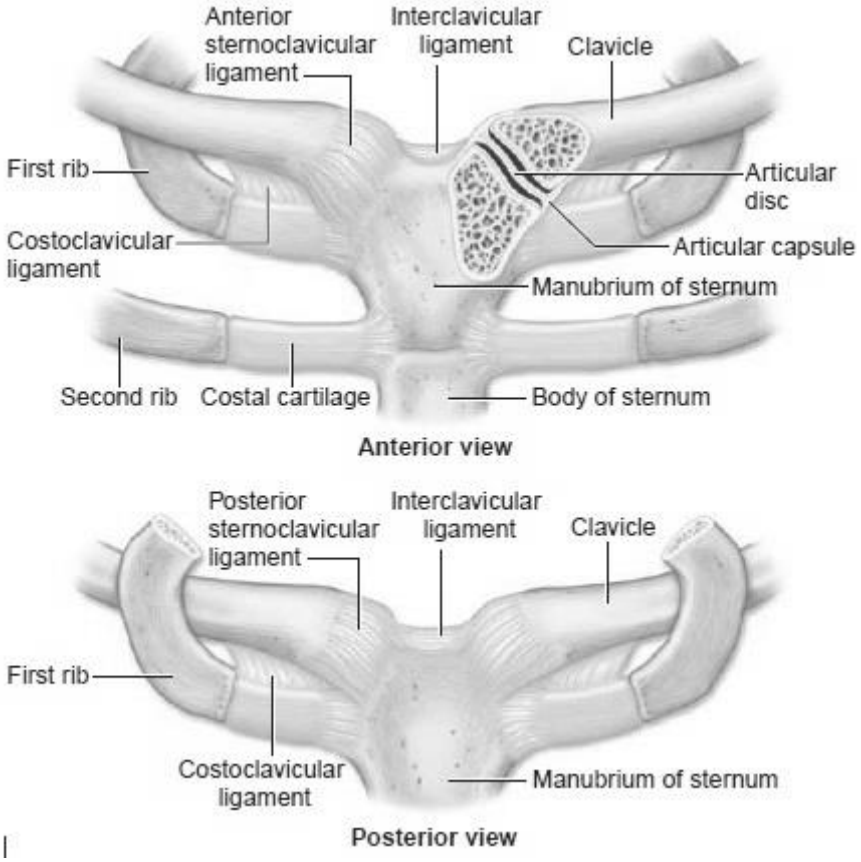
❖ Superficial to the deep fascia.

Dorsal venous arch: on the dorsum of the hand.

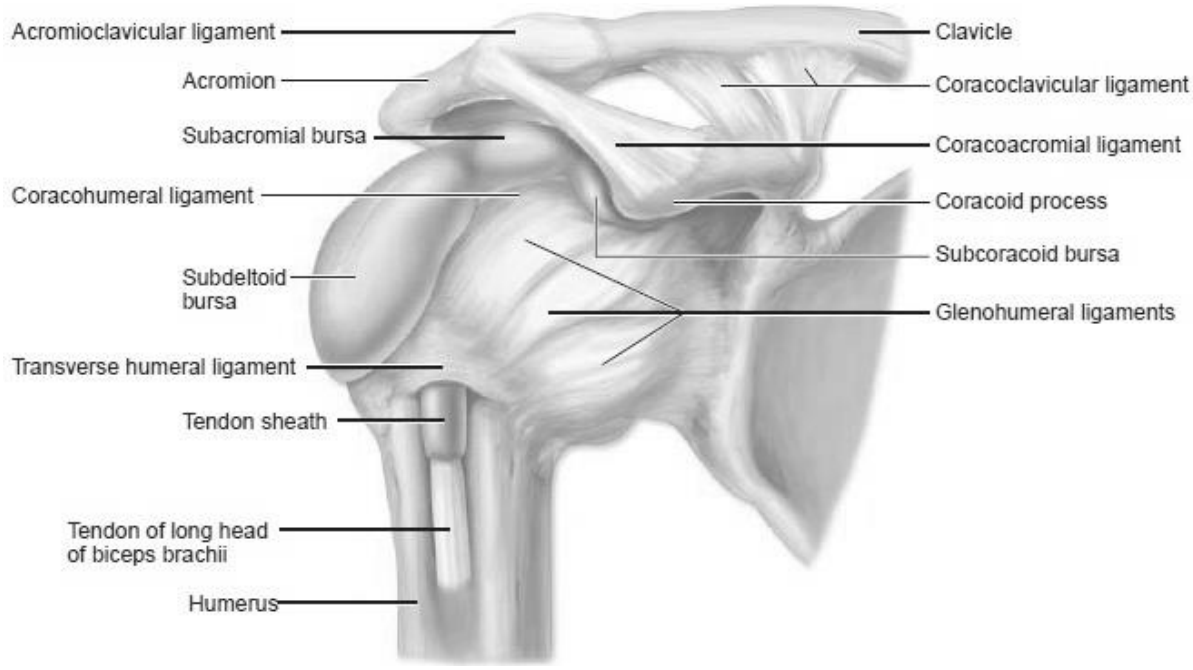
Cephalic vein: begins from lat end of dorsal venous arch → lat side of forearm → ant to elbow → Lat side of arm → ends in axillary vein.

Basilic vein: begins from med end of dorsal venous arch → med side of forearm → ant to elbow → med side of arm → end at the lower border of teres major by becoming axillary V.

Median cubital V: communicates cephalic V (1 inch below elbow) with the basilic V (1 inch above elbow). It is the usual site for injection.



Sternoclavicular joint



Acromioclavicular joint

McKinley & O'Loughlin

STERNECLAVICULAR JOINT

Type & variety: synovial, saddle.

Articular surfaces: clavicle (sternal end) & sternum (clavicular notch).

Capsule: attached to margins of articular surfaces.

Intracapsular structures: ***cartilaginous articular disc***

Synovial Membrane:

- Lines the capsule.
- Covers intracapsular non articular structures.

Ligaments:

- Costoclavicular.
- Interclavicular.

ACROMIOCLAVICULAR JOINT

Type: synovial, plane.

Articular surfaces: clavicle (acromial end), acromion (clavicular facet).

Capsule:

- Attached to the margin of articular surfaces.

Synovial membrane:

- Lines the capsule.
- Covers intracapsular non articular structures.

Ligaments:

Coracoclavicular ligament

- 2 parts: conoid (attached to conoid tubercle) & trapezoid (Attached to trapezoid ridge). Both extends to coracoid process.
- Strong ligament transmits upper limb weight to the clavicle & axial skeleton.

SHOULDER GRIDLE

Definition: Movement of scapula and clavicle through sternoclavicular and acromioclavicular joints.

Movement & muscles:

Elevation: trapezius (upper fibers), levator scapulae, rhomboids minor & major.

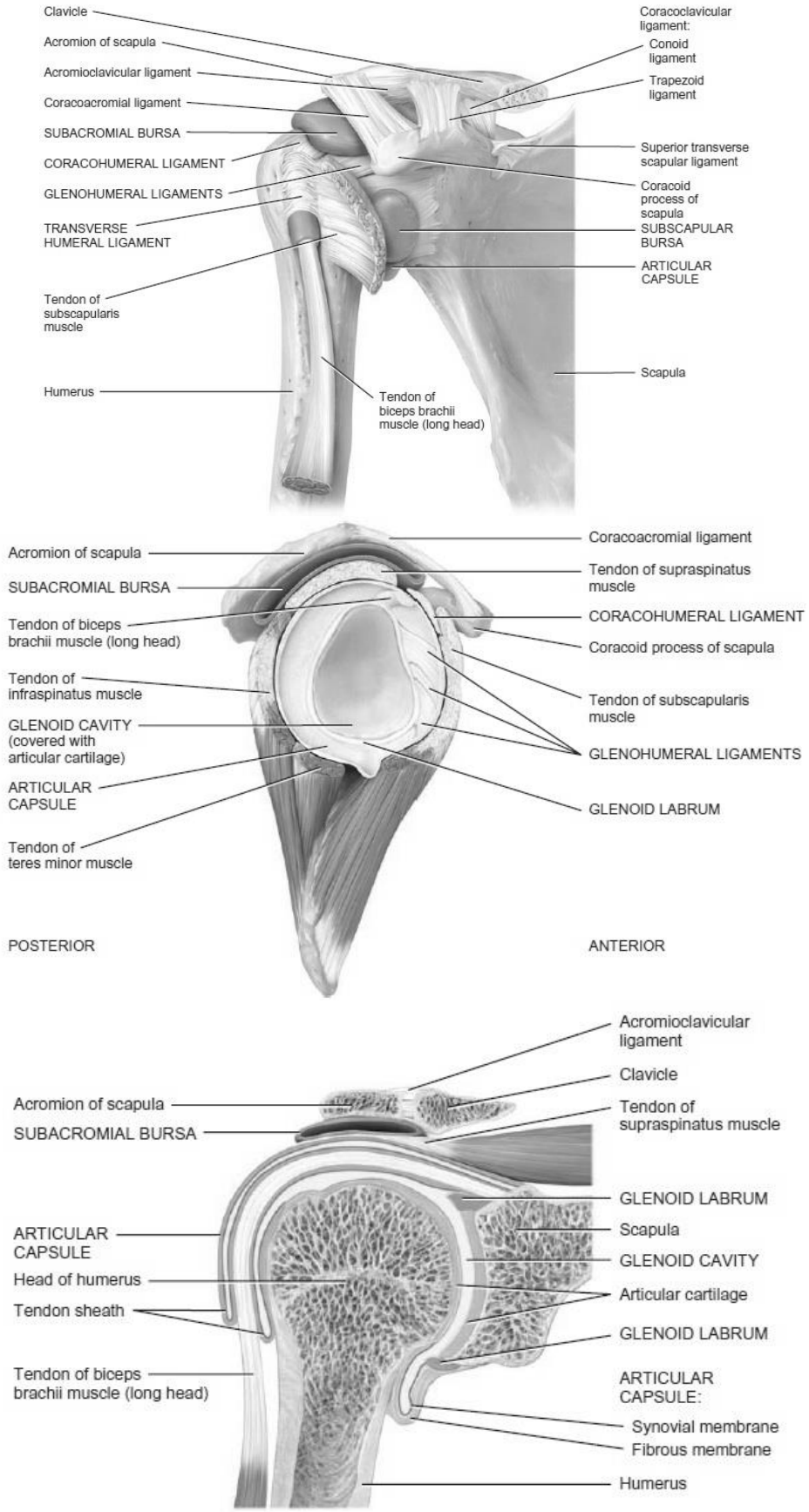
Depression: trapezius (lower fibers) & pectoralis minor.

Protraction: serratus ant & pectoralis minor.

Retraction: trapezius, levator scapulae, rhomboids minor & major.

Up (lat) rotation (elevation of arm > 90°): trapezius & serratus ant.

Down (med) rotation: pectoralis minor, rhomboids minor & major.



Shoulder joint

Tortora & Nielsen

SHOULDER JOINT

Type and variety: synovial (ball& socket).

Articular surfaces: scapula (glenoid cavity) & humerus (head).

Capsule:

Attachments: at the margins of articular surfaces except inferiorly where it reaches surgical neck.

Intracapsular structures:

Labrum glenoidal: fibrocartilage ring attached to the margin of glenoid cavity to deepen it.

Long head of biceps

Synovial membrane:

- Lines the capsule.
- Covers the intracapsular non articular structures (labrum glenoidal & long head of biceps).

Ligaments:

Coracohumeral ligament: from coracoid process to greater tuberosity.

Glenohumeral ligament: from glenoid cavity to lesser tuberosity.

Coracoacromial ligament: from coracoid to acromial processes. The 2 processes & the ligament form coracoacromial arch. It prevents sup dislocation.

Transverse humeral ligament: between greater & lesser tuberosities. It controls the movement of the long head of biceps.

Movements and muscles:

Flexion: pectoralis major, deltoid (ant fibers), biceps & coracobrachialis.

Extension: deltoid (post fibers), teres major & latissimus dorsi.

Adduction: pectoralis major, latissimus dorsi & teres major (TLP).

Abduction:

- 0-15°: supraspinatus.
- 15-90°: shoulder joint deltoid.

N.B.: elevation of arm > 90°: trapezius & serratus ant (shoulder girdle).

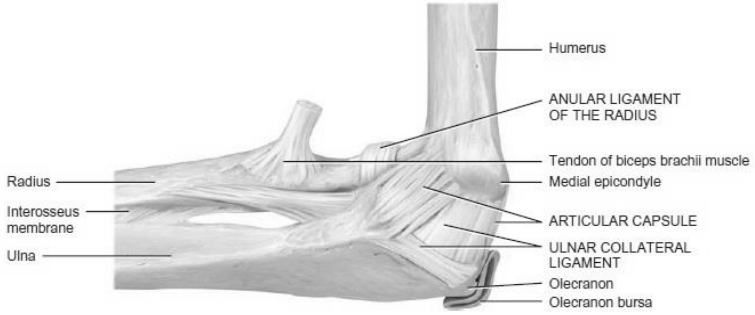
Med rotation: pectoralis major, latissimus dorsi, teres major (TLP), deltoid (ant fibers) & subscapularis.

Lat rotation: infraspinatus, teres minor & deltoid (post fibers).

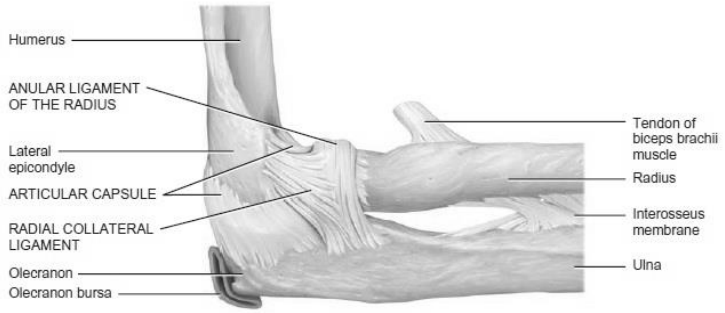
Circumduction

Stability:

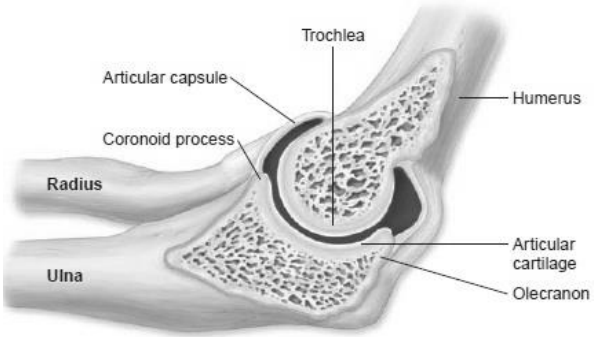
- Weak joint due to shallow articular surfaces & weak ligaments.
- Mainly supported by rotator cuff muscles; supraspinatus (sup), infraspinatus and teres minor (post) & subscapularis (ant). It is also supported by coracoacromial arch (sup).
- Frequently dislocated inferiorly, usually with abducted arm. Its dislocation may lead to axillary nerve injury.



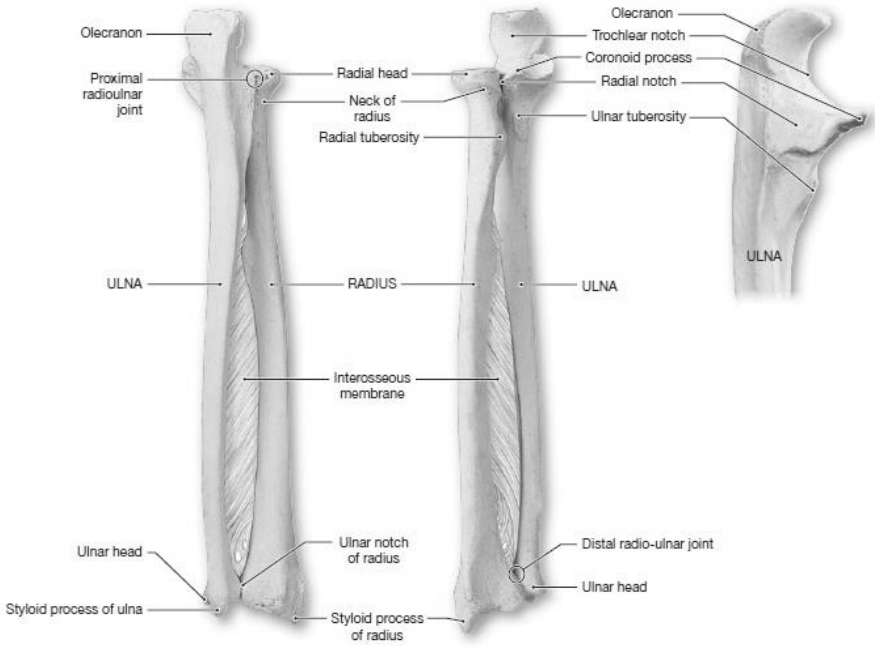
(a) Medial aspect



(b) Lateral aspect



Elbow joint



Radioulnar joints

Tortora & Nielsen / McKinley & O'Loughlin / Martini

ELBOW JOINT

Types & variety: synovial, hinge.
Articular surfaces:

- Trochlea of humerus with trochlear notch of ulna.
- Capitulum of humerus with head of radius (sup surface).

Capsule: attached to margins of articular surfaces.
Synovial membrane:

- Lines the capsule.
- Covers intracapsular nonarticular structures.

Ligaments:

Med (ulnar) collateral ligament: between med epicondyle & med margin of coronoid & olecranon processes.
Lat (radial) collateral ligament: between lat epicondyle & annular ligament.

Movements and muscles:

Flexion: biceps, brachialis & brachioradialis.
Extension: triceps & anconeus.

SUPERIOR RADIOULNAR JOINT

Type & variety: synovial, pivot.
Articular surfaces: head of radius (circumference) & radial notch of ulna.
Capsule: attached to margins of articular surfaces.
Synovial membrane:

- Lines the capsule.
- Covers intracapsular non articular structures.

Ligaments:

Annular ligament: attached to margins of radial notch & surrounds head of radius.
Quadrate ligament: between neck of radius & ulna.

Movement: supination & pronation.

MIDDLE RADIOULNAR JOINT (INTEROSSEOUS MEMBRANE)

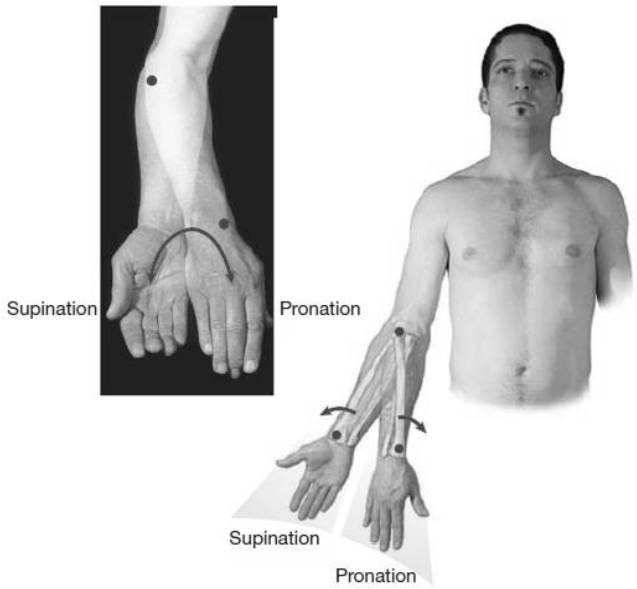
Type & variety: fibrous, syndesmosis.
Attachment: interosseous borders of radius & ulna.
Direction of fibers: med (from radius to ulna) & downwards.

INFERIOR RADIOULNAR JOINT

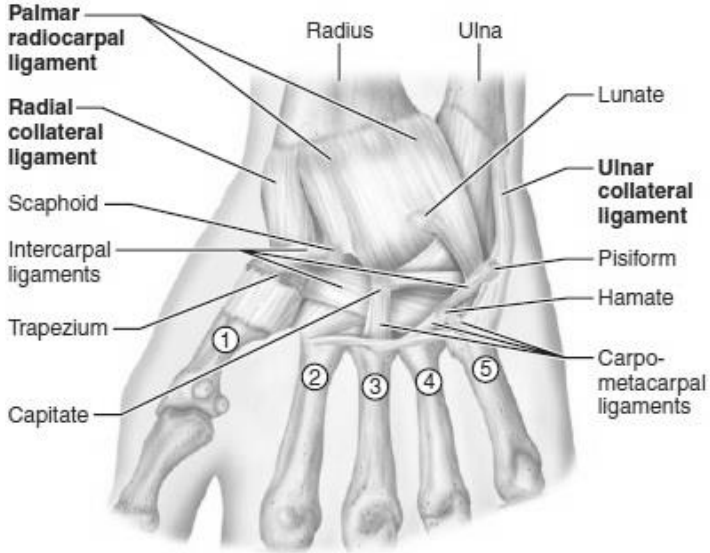
Type & variety: synovial, pivot.
Articular surfaces: head of ulna and ulnar notch of radius.
Capsule: attached to the margins of articular surfaces.
Synovial membrane:

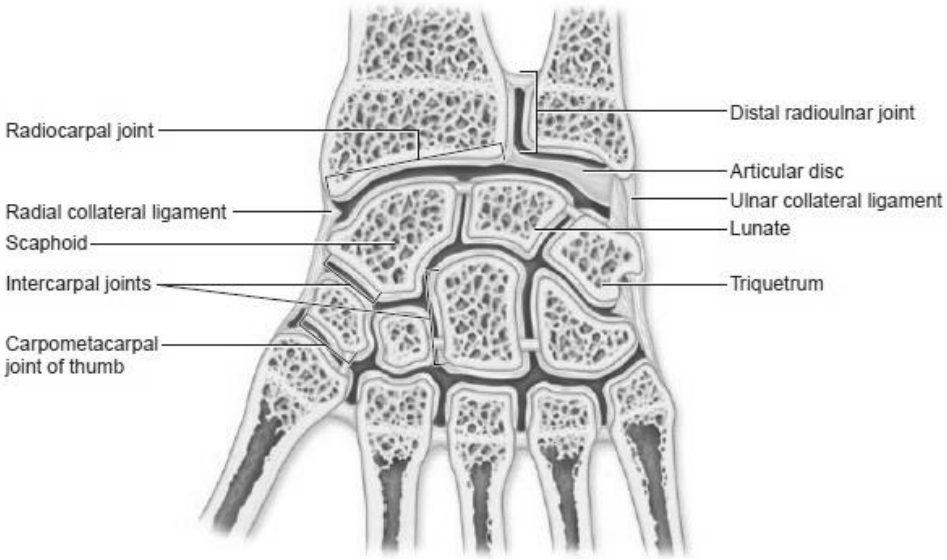
- Lines the capsule.
- Covers intracapsular non articular structures.

Movement: supination and pronation.
N.B.: triangular articular disc: attached between lower end of ulnar notch of radius & styloid process of ulna. It separates ulna from the carpal bones.



Supination & pronation





Wrist joint

Tortora & Nielsen / Marieb / McKinley & O'Loughlin

SUPINATION AND PRONATION

Definition:

Supination: is lat rotation of forearm so that the palm faces anteriorly & the thumb is directed laterally.

Pronation: is med rotation of forearm so that the palm faces posteriorly & the thumb is directed medially.

- In both movements the radius moves while the ulna is fixed.

Joints concerned: radioulnar joints.

Muscles:

Supination: biceps (with flexed elbow) & supinator.

Pronation: pronator teres and pronator quadratus.

N.B.: Brachioradialis initiates both movements.

❖ Supination is stronger than pronation, supination with semi flexed elbow is stronger than with extended elbow. Both due to the action of biceps).

WRIST (RADIOCARPAL) JOINT

Type & variety: synovial, ellipsoid.

Articular surfaces:

Proximal: lower end of radius & triangular articular disc.

Distal: scaphoid, lunate & triquetrum.

Capsule: attached to the margins of articular surfaces.

Synovial membrane:

- Lines the capsule.
- Covers intracapsular non articular structures.

Ligaments:

Ant radiocarpal: between lower ends of radius & ulna & carpals (ant).

Post radiocarpal: between lower ends of radius & ulna & carpals (post).

Med (ulnar) collateral ligament: between styloid process of ulna & pisiform & triquetrum.

Lat (radial) collateral ligament: between styloid process of radius & scaphoid & trapezium.

Movements and muscles:

Flexion: flexor carpi radialis, flexor carpi ulnaris, palmaris longus, flexor digitorum superficialis & profundus & flexor pollicis longus.

Extension: extensor carpi radialis longus and brevis, extensor carpi ulnaris, extensor digitorum, extensor digitiminimi, extensor pollicis longus & extensor indicis.

Adduction: flexor carpi ulnaris, extensor carpi ulnaris.

Abduction: flexor carpi radialis, extensor carpi radialis longus & brevis.

Circumduction.

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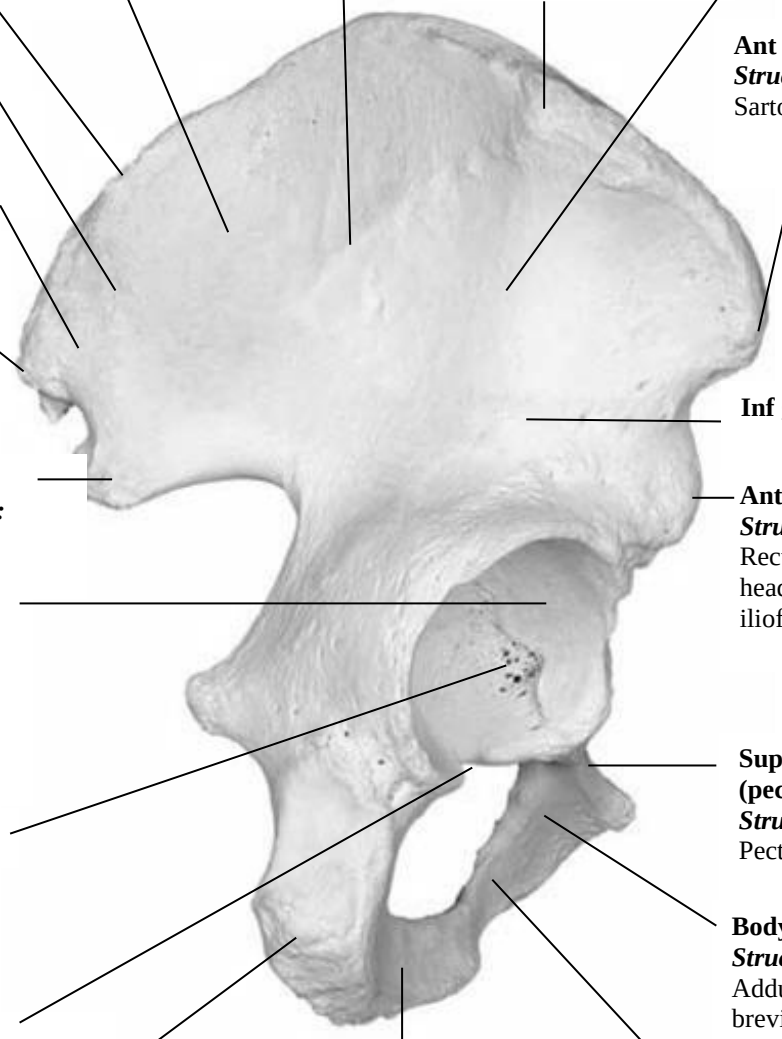
LOWER LIMB

HIP BONE (OUTER)



Ant gluteal line

Iliac crest

Gluteal surface
Structure attached:
Gluteus medius

Iliac tubercle
Structures attached:
Iliotibial tract

Gluteal surface
Structure attached:
Gluteus minimus

Post gluteal line

Ant sup iliac spine
Structures attached:
Sartorius + inguinal lig

Gluteal surface
Structure attached:
Gluteus maximus

Post sup iliac spine
Structures attached:
Sacrotuberous lig

Inf gluteal line

Post inf iliac spine
Structures attached:
Sacrotuberous lig

Ant inf iliac spine
Structures attached:
Rectus femoris (straight head)
iliofemoral lig

Acetabulum (lunate surface)
Structure related:
Head of femur
Joint related:
Hip

Sup pubic ramus (pectineal surface)
Structure attached:
Pectineus

Acetabular fossa

Body of pubis
Structure attached:
Adductor longus, brevis & gracilis

Acetabular notch

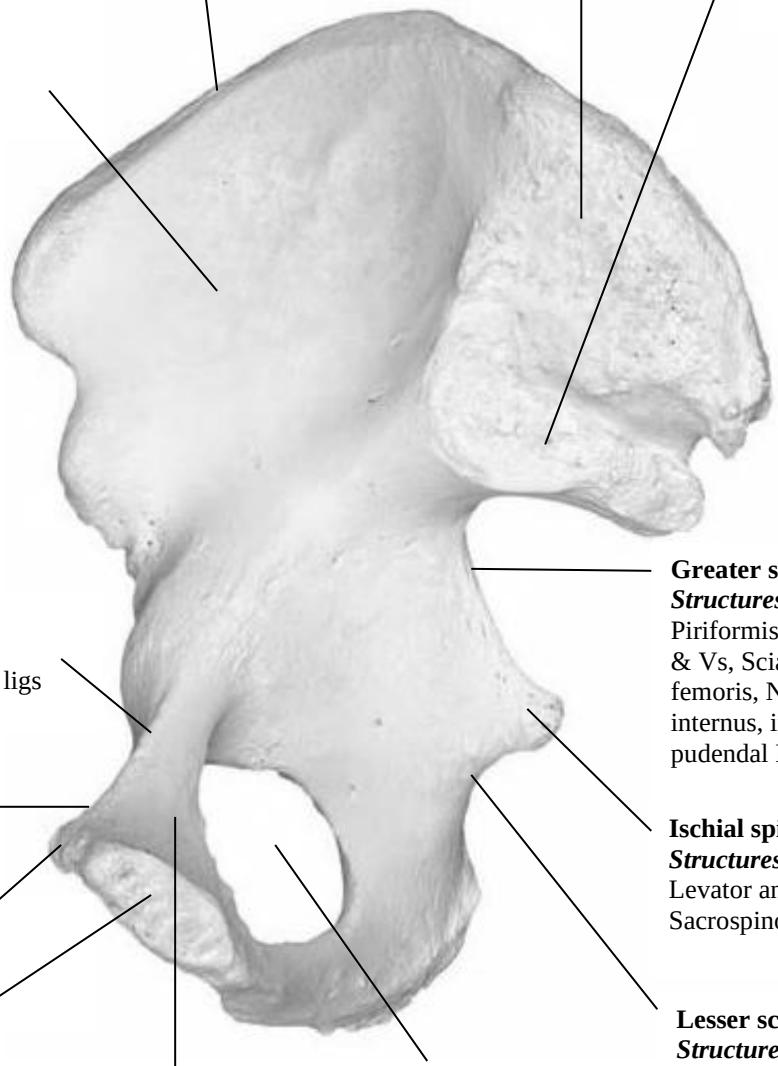
Ischial tuberosity
Structures attached:
Semitendinosus, semimembranosus, biceps, adductor magnus (ischial part), Bursa Quadratus femoris, sacrotuberous lig

Ischial ramus
Structure attached:
Adductor magnus (pubic part)

Inf pubic ramus
Structure attached:
Adductor brevis & gracilis

Tortora & Nielsen

HIP BONE (INNER)



Iliac crest
Structures attached:
External oblique (ant ⅔ outer lip)
Internal oblique (ant ⅔ intermediate lip)
Transversus abdominis (ant ⅔ inner lip)
Quadratus lumborum (post ⅓)

Iliac tuberosity
Structure attached:
Interosseous sacroiliac ligament

Auricular surface
Related joint:
sacroiliac joint

Iliac fossa
Structure attached:
Iliacus

Greater sciatic notch
Structures related:
Piriformis, sup & inf gluteal N & Vs, Sciatic N, N to quadrates femoris, N to obturator internus, int pudendal Vs & pudendal N.

Pectineal line
Structure attached:
Pectineal & lacunar ligs

Pubic crest

Ischial spine
Structures attached:
Levator ani, coccygeus, Sacrospinous lig

Pubic tubercle
Structure attached:
Inguinal lig

Lesser sciatic notch
Structures related:
Obturator internus tendon, N. to obturator internus, int pudendal Vs., pudendal N.

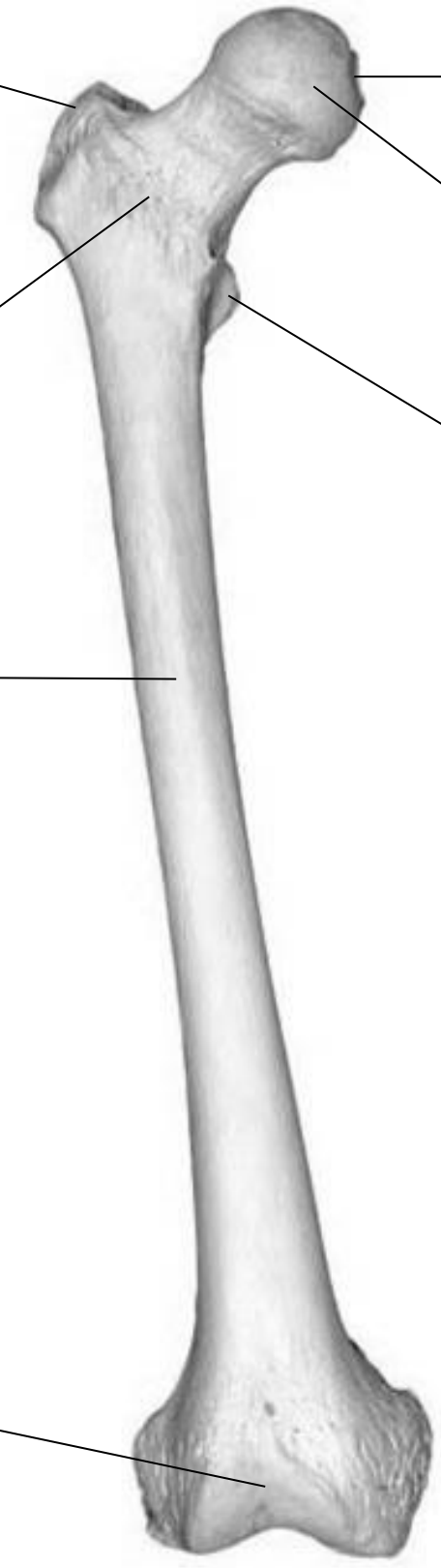
Symphysial surface
Related joint:
Symphysis pubis

Body of pubis
Structures attached:
Levator ani

Obturator foramen
Structures passing:
Obturator N & Vs

Tortora & Nielsen

FEMUR (ANT)



Greater trochanter
Structures attached:
Gluteus medius, gluteus minimus Piriformis, Obturator externus & internus, sup & inf gemelli

Fovea (pit)
Structure attached:
Ligament of head (ligamentum teres)

Head of femur
Structure related:
Acetabulum
Joint related:
Hip

Intertrochanteric line
Structures attached:
Vastus medialis & lateralis
Hip capsule, iliofemoral lig

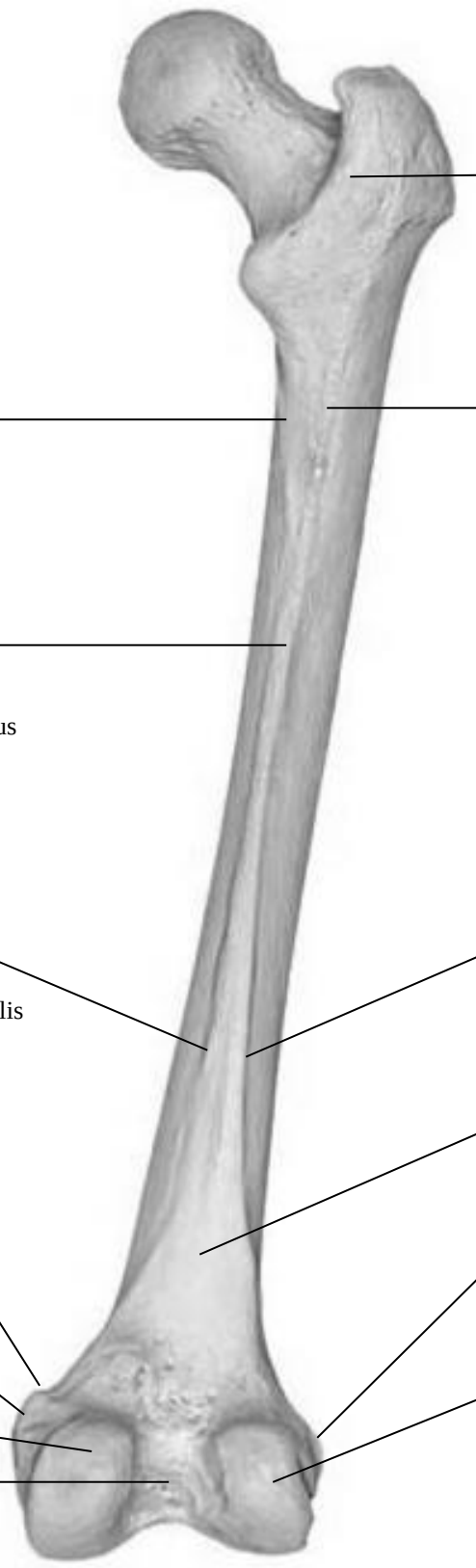
Lesser trochanter
Structure attached:
Iliopsoas

Shaft (ant surface)
Structure attached:
Vastus intermedius

Patellar surface
Structure related:
Patella
Joint related:
Knee

Tortora & Nielsen

FEMUR (POST)



Quadrate tubercle
Structure attached:
Quadratus femoris

Spiral line
Structure attached:
Vastus medialis

Gluteal tuberosity
Structures attached:
Gluteus maximus, vastus lateralis & adductor magnus

Linea aspera
Structures attached:
Vastus medialis & lateralis
Adductor longus, brevis & magnus
Biceps (short head)
Med & lat intermuscular septum

Med supracondylar line
Structures attached:
Adductor magnus & vastus medialis
Med intermuscular septum

Lat supracondylar line
Structure attached:
Biceps (short head) &
Plantaris
Lat intermuscular septum

Adductor tubercle
Structure attached:
Adductor magnus

Popliteal surface
Structure attached:
Gastrocnemius (med head)

Med epicondyle
Structure attached:
Med collateral lig

Lat epicondyle
Structure attached:
Lat collateral lig

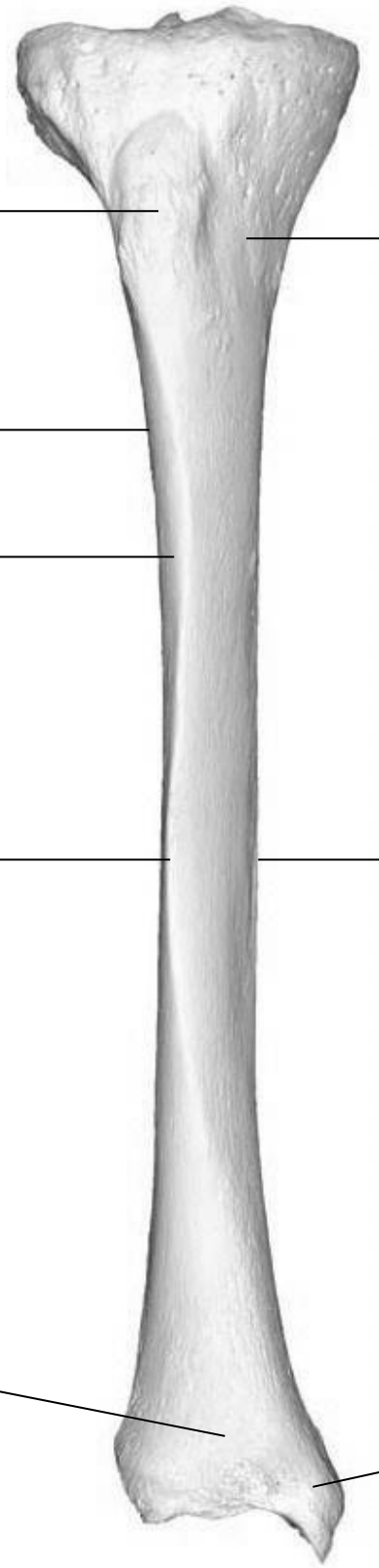
Med condyle

Lat condyle
Structures attached:
Gastrocnemius (lat head) &
popliteus

Intercondylar fossa
Structures attached:
Ant & post cruciate ligs

Tortora & Nielsen

TIBIA (ANT)



Tibial tuberosity
Structure attached:
Patellar lig + superficial infrapatellar bursa

Med surface
Structures attached:
Sartorius, **G**racilis & **S**emitendinosus

Lat border

Lat surface
Structures attached:
Tibialis ant

Ant border

Med border

Lower end (ant surface)
Structures related:
Tibialis ant, ext **H**allucis longus, ant tibial **Vs & N**, ext **D**igitorum longus and **P**eroneus tertius

Med malleolus
Structure attached:
Deltoid lig

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TIBIA (POST)

Intercondylar eminence

Med condyle
Structure related (sup):
Med meniscus
Structure attached (post):
Semimembranosus (post groove)

Post surface
Structure attached:
Popliteus

Soleal line
Structure attached:
Soleus

Lat condyle
Structure related (sup):
Lat meniscus

Fibular facet
Structure related:
Head of fibula
Joint related:
Sup tibiofibular joint

Lower end (post surface)
Structure related:
Tendocalcaneus

Med malleolus (post surface)
Structures related:
Tibialis post (in a groove), flex **D**igitorum longus, post tibial **Vs & N,** and flex **H**allucis longus

Fibular notch
Structure related:
Lower end of fibula
Joint related:
Inf tibiofibular joint

Lower end
(inf surface)
Structure related:
Talus
Joint related:
Ankle

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FIBULA (ANT)

Styloid process

Head of fibula
Structure attached:
Biceps
Structure related:
Fibular facet
Joint related:
Sup tibiofibular joint

Neck of fibula
Structure related:
Common peroneal N

Post border

Lat surface
Structures attached:
Peroneus longus & brevis

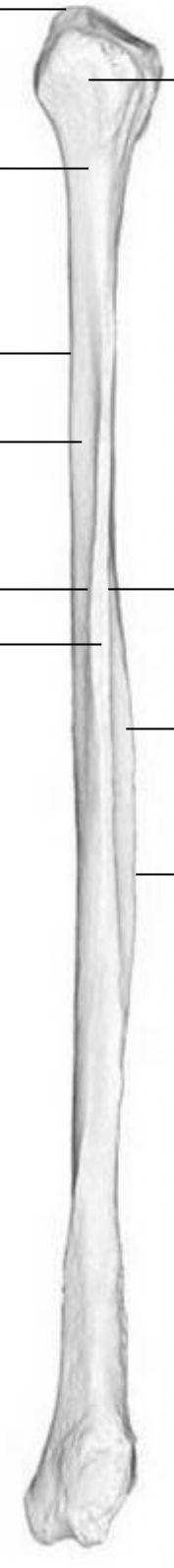
Ant border

Med border

Ant surface
Structures attached:
Ext hallucis longus, ext digitorum longus and peroneus tertius

Post surface
Structure attached:
Tibialis post

Median crest



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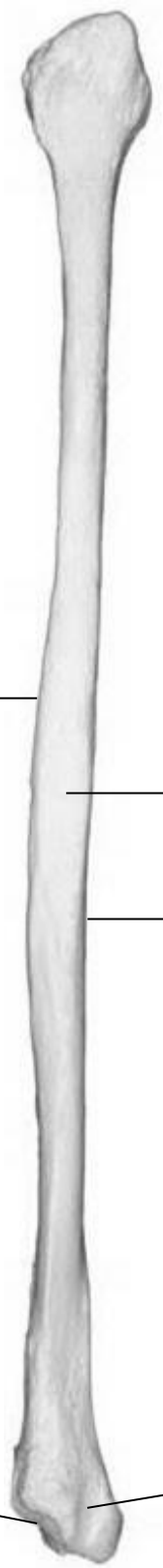
FIBULA (POST)



Median crest

Post surface
Structures attached:
Flexor hallucis longus

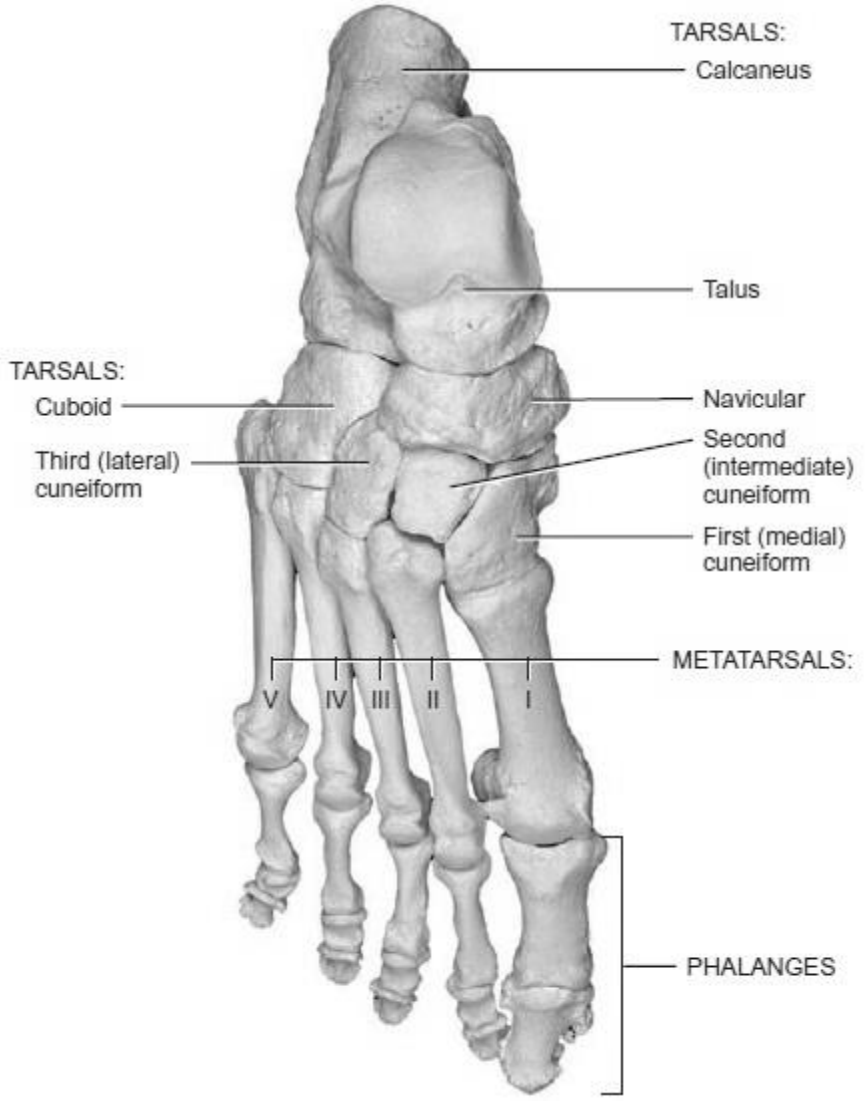
Post border

Malleolar fossa
Structures attached:
Tibiofibular & talofibular ligs

Lat malleolus
Structures related:
Peroneus longus & brevis

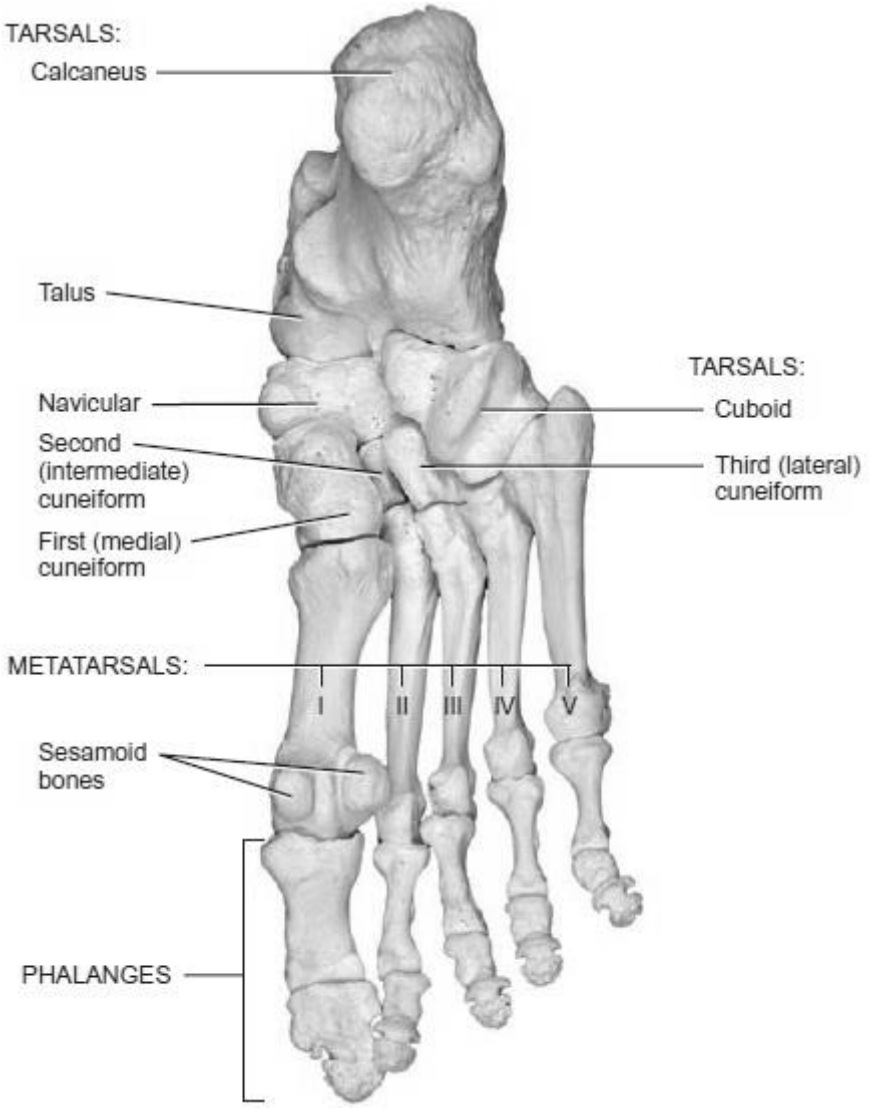
Tortora & Nielsen

FOOT (SUP)



Tortora & Nielsen

FOOT (INF)



Tortora & Nielsen

Psoas major

Iliacus

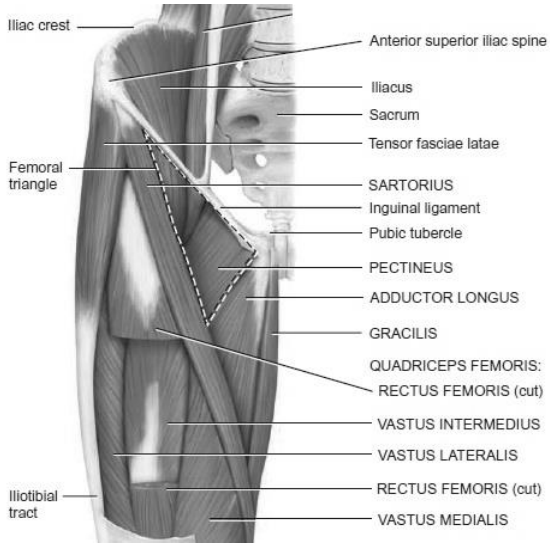
Sartorius

Vastus lateralis

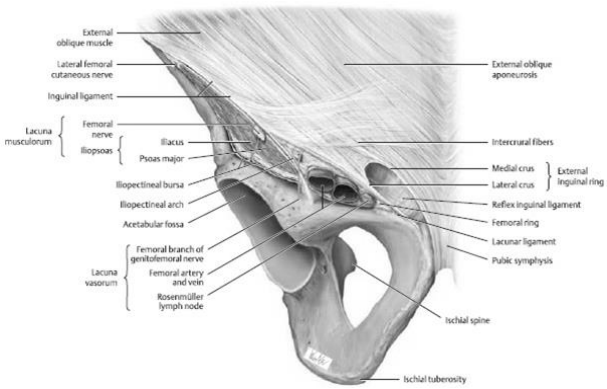
Vastus medialis

Vastus intermedius

Rectus femoris



Femoral triangle



Femoral sheath

Ken Hub / Tortora & Nielsen / Schuenke

MUSCLES OF ANTERIOR COMPARTMENT OF THIGH

Muscle		*Origin*	*Insertion*	*Action*	*NS*
Iliopsoas	**Psoas major**	• T12-L5 vertebrae (bodies) & intervertebral discs • L1-L5 vertebrae (transverse processes)	Lesser trochanter	Flexion of hip	L1-4 Ns (ant rami)
	Iliacus	Iliac fossa			Femoral N
Sartorius		ASIS	med surface of tibia (upper part) (SGS)	• Flexion & lat rotation of hip • Flexion & med rotation of knee	
quadriceps	**Vastus lateralis**	• intertrochanteric Line (upper part) • greater trochanter (root) • gluteal tuberosity • Linea aspera	Patella → ligamentum patellae → tibial tuberosity	• Extension of knee • Rectus femoris → Flexion of hip	
	Vastus medialis	• intertrochanteric Line (lower part) • spiral line • linea aspera • med supracondylar line			
	Vastus intermedius	ant & lat surfaces of femur (upper 2/3)			
	Rectus femoris	Straight head: AIIS Reflected head: above acetabulum			

FEMORAL TRIANGLE

Definition: pyramidal space in front of upper 1/3 of thigh.

Boundaries:

Sup (base): inguinal ligament (lower border of external oblique, extending from ASIS to pubic tubercle).

Lat: Sartorius (med border).

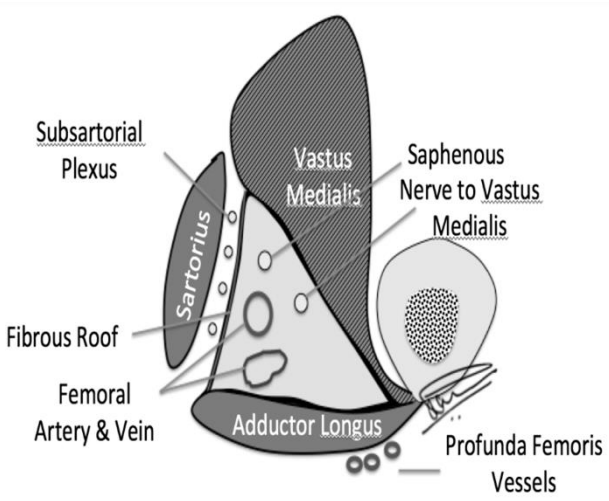
Med: adductor longus (med border).

Roof: skin, superficial fascia & deep fascia.

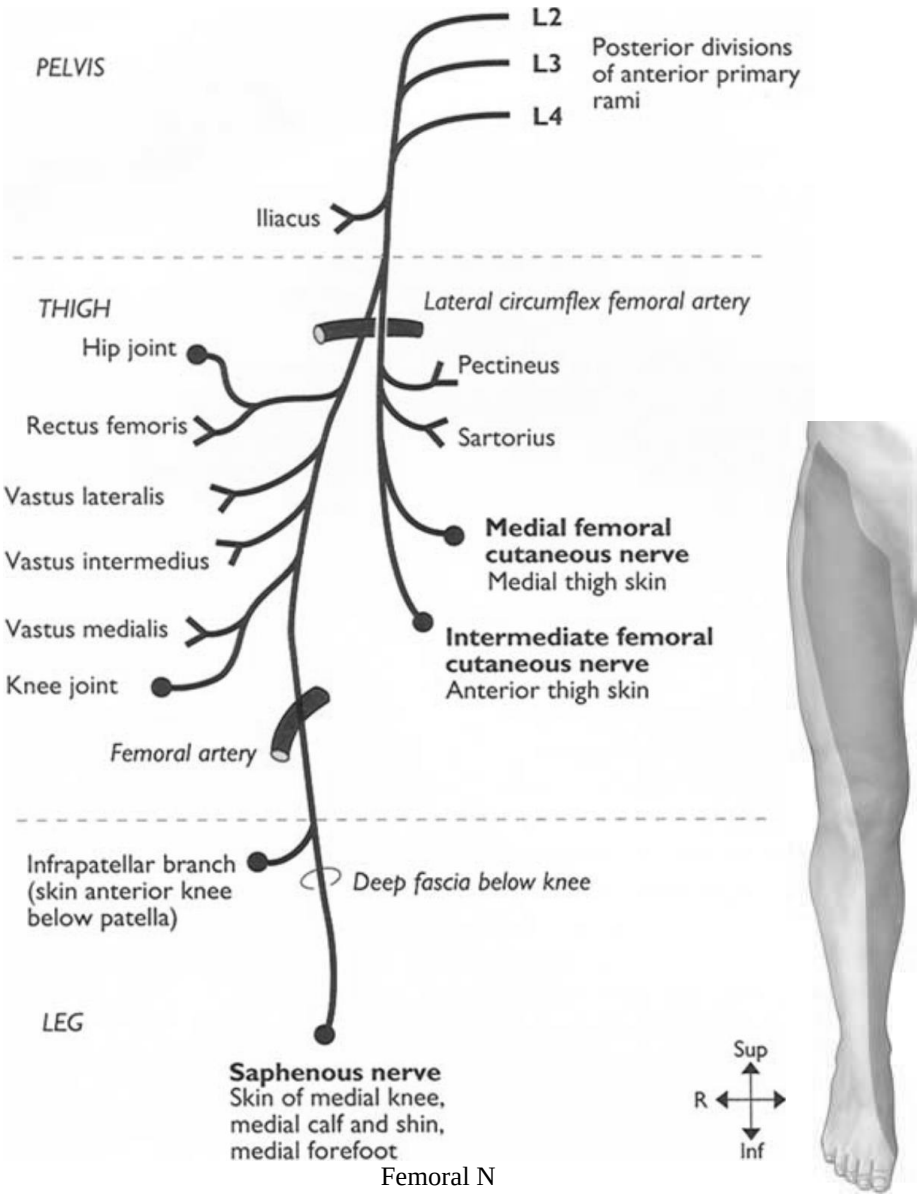
Floor: (med to lat): adductor longus, pectineus, psoas major & iliacus.

Contents:

1) **Femoral sheath:** fascial sheath surrounding upper part of femoral vessels. It contains:
   Med: femoral canal: conical compartment to allow expansion of femoral V.
   Intermediate: femoral V.
   Lat: femoral A and femoral branch of genitofemoral N.
2) **Femoral N.**
3) **Deep inguinal Lymph nodes.**



Adductor canal



Femoral N

Singh / Whitaker & Borley / McKinley & O'Loughlin

ADDUCTOR (SUBSARTORIAL) CANAL

Definition: tunnel in the middle 1/3 of thigh.

- ❖ Begins at the apex of femoral triangle.
- ❖ Ends at the opening of adductor magnus (sup angle of popliteal fossa).

Boundaries:

Anterolateral: vastus medialis.

Anteromedial (roof): fibrous roof and Sartorius.

Post (floor): adductor longus & magnus.

Contents:

1) **Femoral A.**
2) **Femoral V.**
3) **Saphenous N (of femoral).**
4) **N to vastus medialis:** passes through upper end to vastus medialis.
5) **Descending genicular A** (of femoral).

FEMORAL NERVE

Root value: Lumbar plexus, L2,3,4 (ant rami, post division).

Course & relations:

- ➢ Descends between psoas major & iliacus.
- ➢ Passes deep to inguinal ligament to enter femoral triangle (outside femoral sheath).

End: 4 cm (1½ inches) below inguinal ligament as muscular & cutaneous branches.

Branches:

Muscular: iliacus (in abdomen), pectineus, Sartorius & quadriceps.

Articular:

- To hip joint.
- To knee joint.

Cutaneous:

Med cutaneous N of thigh: skin of med side of thigh.

Intermediate cutaneous N of thigh: skin of front of thigh.

Saphenous N:

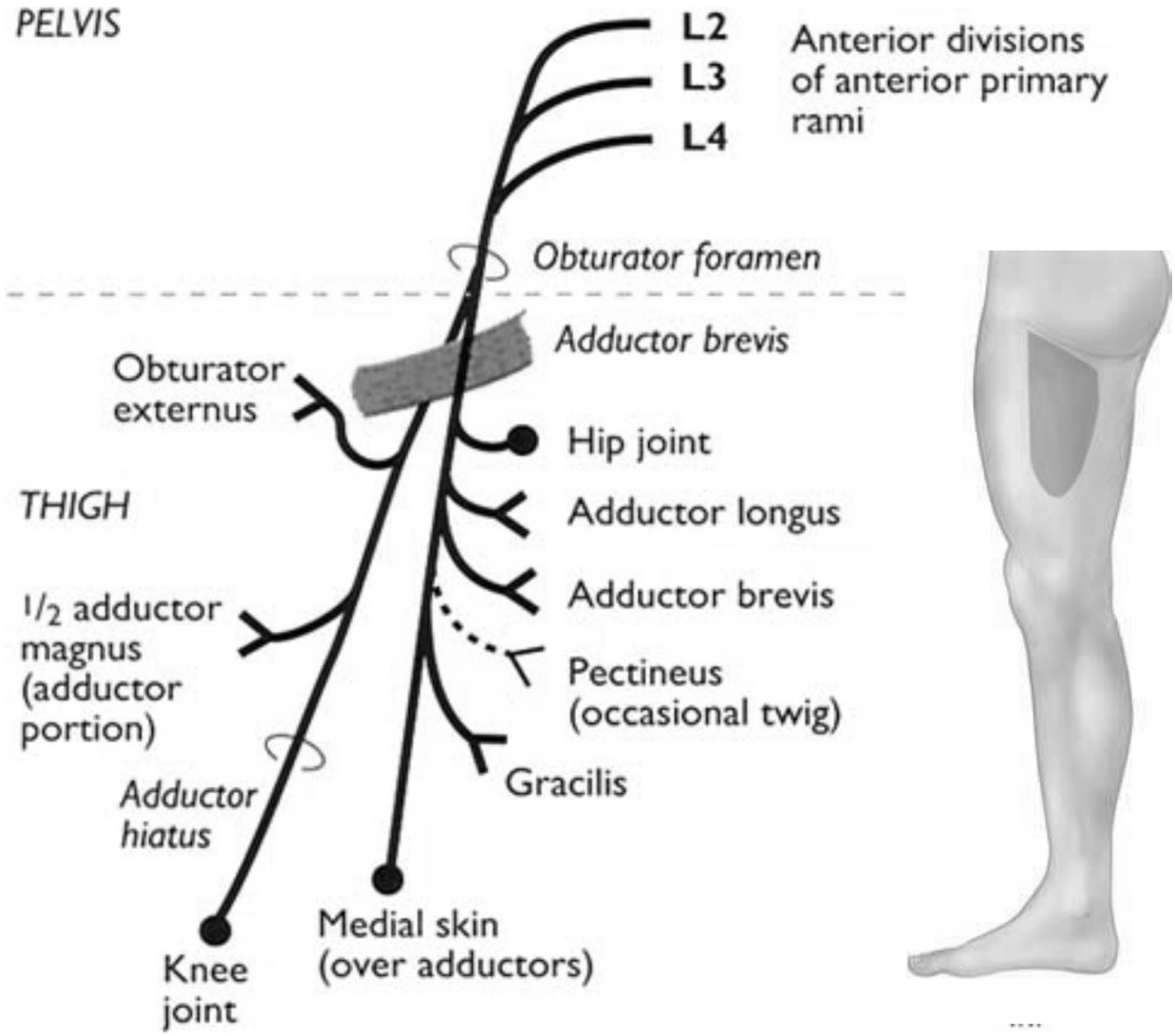
- Descends in femoral triangle → adductor canal → passes behind Sartorius → pierces deep fascia & becomes cutaneous.
- Supplies the skin of med side of leg & foot.

Injury of femoral N (in the thigh):

Motor: paralysis of quadriceps → loss of knee extension.

Sensory: loss of sensation of the ant & med sides of thigh & med side of leg & foot.

Pectineus Adductor longus Adductor brevis Adductor magnus Gracilis



Obturator N

Ken Hub / Whitaker & Borley / McKinley & O'Loughlin

MUSCLES OF MEDIAL COMPARTMENT OF THIGH

Muscle		*origin*	*Insertion*	*action*	*NS*
Pectineus		Superior pubic ramus	Upper part of pectineal line (between lesser trochanter & linea aspera)	Adduction hip	Femoral N
Adductor longus		Body of pubis	Linea aspera (middle 2/4)		Obturator N
Adductor brevis		• Body of pubis • Inf pubic ramus	• Lower part of pectineal line • Linea aspera (upper 2/4)		
Adductor magnus	**pubic part**	• Inf pubic ramus • Ischial ramus	• Gluteal tuberosity • Linea aspera • Med supracondylar line		
	ischial part	Ischial tuberosity	Adductor tubercle	Extension hip	Sciatic N
Gracilis		• Body of pubis • Inf pubic ramus	Med surface of tibia (upper part) (SGS)	• Adduction hip • Flexion & med rotation of knee	Obturator N

OBTURATOR NERVE

Root value: Lumbar plexus, L2,3,4 (ant rami, ant division).

Course & relations:

- It passes med to psoas major (in abdomen).
- Passes through obturator foramen.
- It divides into ant & post divisions.

Branches:

Ant division: descends between adductor longus & brevis.

Muscular: gracilis, adductor longus & adductor brevis.

Cutaneous: med side of the thigh.

Articular: hip.

Post division: descends between adductor brevis & magnus.

Muscular: adductor magnus (pubic part) & obturator externus.

Articular: knee.

Injury:

Motor: impaired adduction.

Sensory: loss of sensation of small area on med side of thigh.

Gluteus maximus

Gluteus medius

Gluteus minimus

Tensor fascia lata

Piriformis

Obturator externus

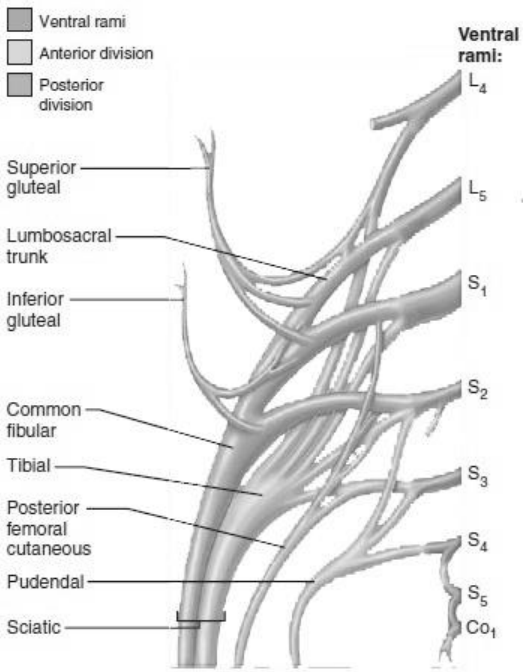
Obturator internus

Sup gemillus

Inf gemillus

Quadratus femoris

Iliotibial tract



Gluteal nerves

Ken Hub / Marieb

GLUTEAL MUSCLES

muscle	*Origin*	*insertion*	*action*	*NS*
Gluteus maximus	• Gluteal surface of ilium (behind post gluteal line) • Back of sacrum & coccyx • Sacrotuberous ligament	Deep ¼: gluteal tuberosity Superficial ¾: iliotibial tract	• Extension hip (climbing & running) • Stabilization of hip on femur & femur on tibia (through iliotibial tract)	Inf gluteal N
Gluteus medius	Gluteal surface of ilium (between middle & post gluteal lines)	Greater trochanter	• Abduction hip • on standing on one limb: it prevents tilting of opposite side of pelvis (if paralyzed → drop of opposite side of pelvis) • Med rotation	Sup gluteal N
Gluteus minimus	Gluteal surface of ilium (between middle & inf gluteal lines)			
Tensor fascia lata	Iliac crest (ant part)	Iliotibial tract	Stabilization of hip on femur & femur on tibia (through iliotibial tract)	

ILIOTIBIAL TRACT

Definition: strong thickened deep fascia on the lat side of thigh.
Attachments: from tubercle of iliac crest to front of lat condyle of tibia.

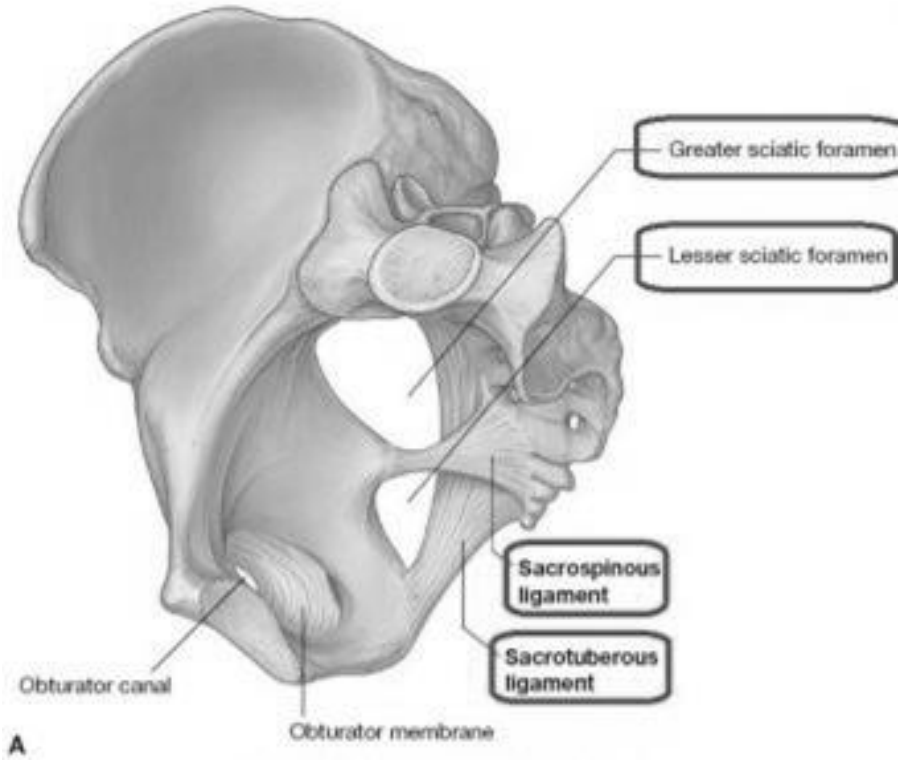
- ❖ Receives insertion of superficial ¾ of glut maximus & tensor fascia lata.
- ❖ Helps in maintenance of erect position by stabilization of the hip on femur & the femur on tibia.

SUP GLUTEAL N

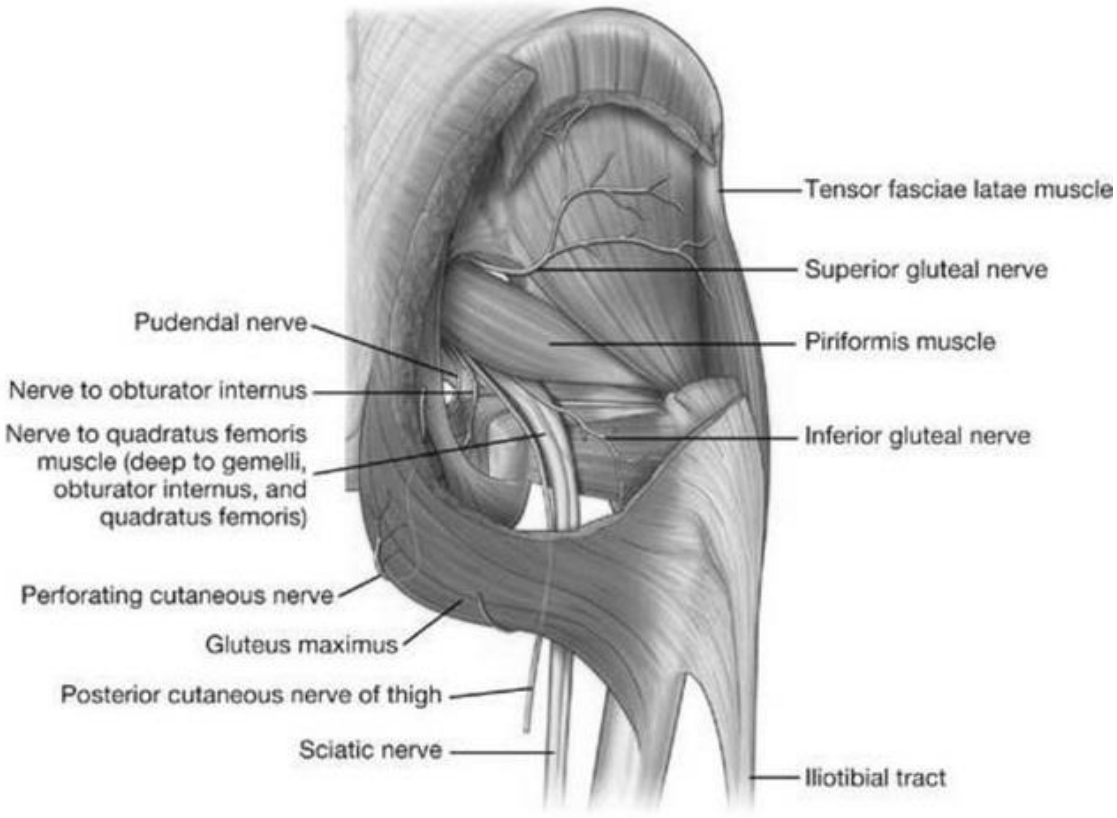
- ❖ Sacral plexus, L4,5,S1.
- ❖ Passes through greater sciatic foramen.
- ❖ Supplies gluteus medius, gluteus minimus & tensor fascia lata.

INF GLUTEAL N

- ❖ Sacral plexus, L5,S1,2.
- ❖ Passes through greater sciatic foramen.
- ❖ Supplies gluteus maximus.



Sacrotuberous & sacrospinous ligaments



Greater & lesser sciatic foramina

Gray's anatomy for student / Clinical gate

SACROTUBEROUS LIGAMENT

- Attached from sacrum, coccyx, PSIS & PIIS to ischial tuberosity.

SACROSPINOUS LIG

- Deep to sacrotuberous ligament.
- It is the dorsal fibrosed surface of coccygeus muscle.
- Attached from S5 and 1st Coccygeal vertebrae to ischial spine.

Sacrotuberous & Sacrospinous ligaments transmit greater & lesser sciatic notches into foramina.

GREATER SCIATIC FORAMEN

Boundaries:

- Greater sciatic notch.
- Sacrotuberous & sacrospinous ligaments.

Structures passing through it:

- Piriformis muscle.
- Sup glut N and vessels (the only structures above piriformis).
- Inf glut N and vessels.
- Sciatic N.
- N to quadratus femoris (sacral plexus, L4,5,S1).
- Post cutaneous N of thigh.
- N to obturator internus (sacral plexus, L5,S1,2).
- Internal pudendal vessels.
- Pudendal N (sacral plexus, S2,3,4).

LESSER SCIATIC FORAMEN

Boundaries:

- Lesser sciatic notch.
- Sacrotuberous & sacrospinous ligaments.

Structures passing through it:

- Tendon of obturator internus.
- N to obturator internus.
- Internal pudendal vessels.
- Pudendal N.

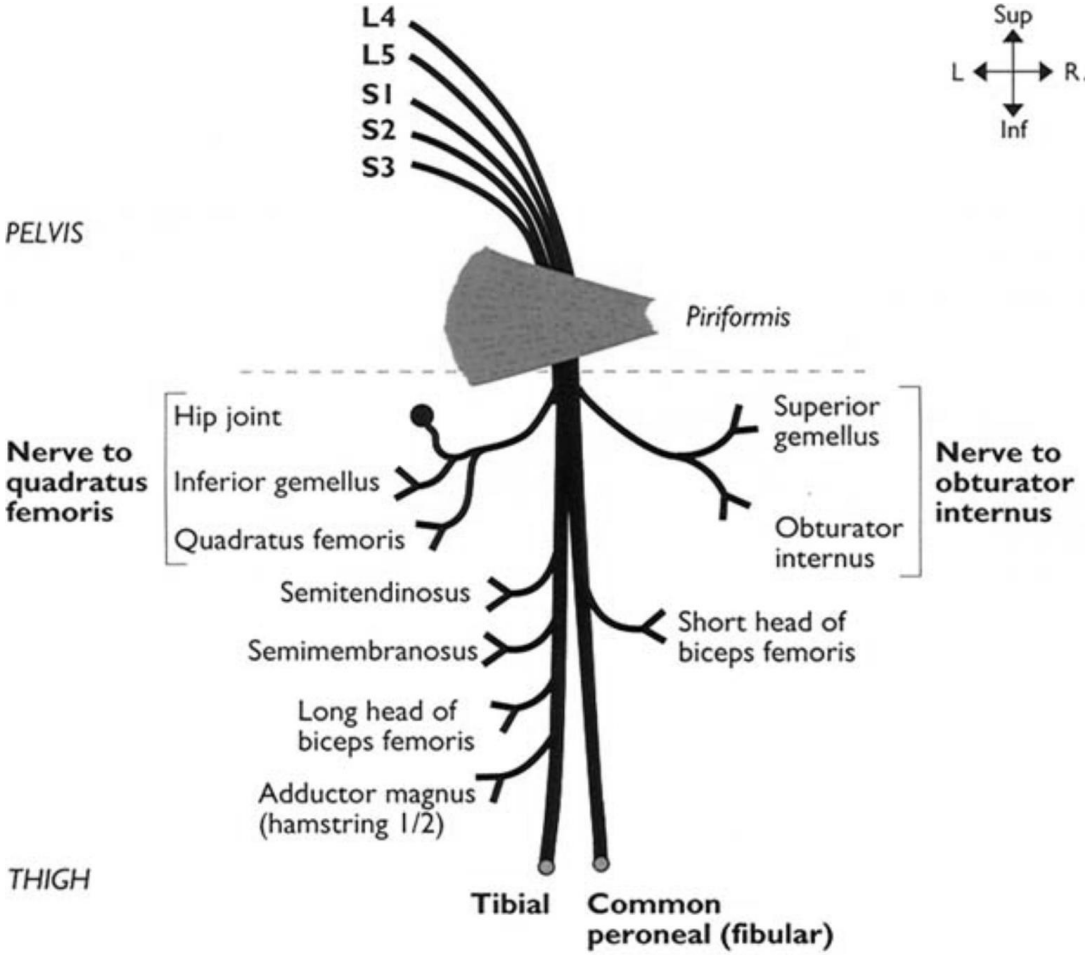
STRUCTURES PASSING FROM GREATER TO LESSER SCIATIC FORAMINA

- N to obturator internus.
- Internal pudendal vessels.
- Pudendal N.

Semimembranosus

Semitendinosus

Biceps



Sciatic N

Ken Hub / Whitaker & Borley

MUSCLES OF THE BACK OF THIGH

Muscle	*Origin*	*Insertion*	*Action*	*NS*
Semimembranosus	Ischial tuberosity	Med condyle of tibia (groove on the back)	• Extension hip (except short head of biceps) • flexion knee • 2 Semi: med rotation • Biceps: lat rotation	Sciatic N (all from its med side, Short head of biceps from its lat side)
Semitendinosus	Ischial tuberosity	Med surface of tibia (upper part) (SGS)		
Biceps femoris	Long head: Ischial tuberosity Short head: linea aspera	Head of fibula		

SCIATIC NEVRE

Root value: sacral plexus (L4,5, S1,2,3).

Course & relations:

- It passes through the greater sciatic foramen (below piriformis).
- Passes deep to glut maximus.
- Passes deep to hamstrings.

Branches:

Muscular:

From med side: biceps (long head), semitendinosus, semimembranosus, adductor magnus (ischial part).

From lat side: biceps (short head).

End: at lower 1/3 of thigh (sup angle of popliteal fossa) by dividing into:

1) Tibial N.

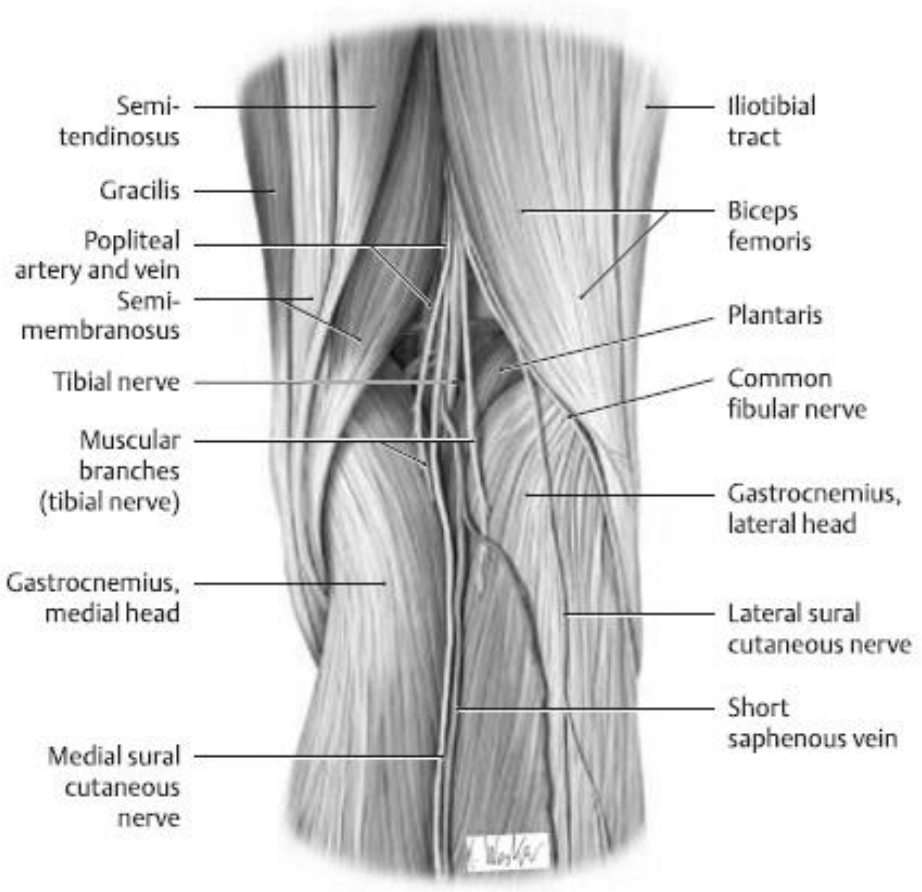
2) Common peroneal N.

Injury of sciatic N:

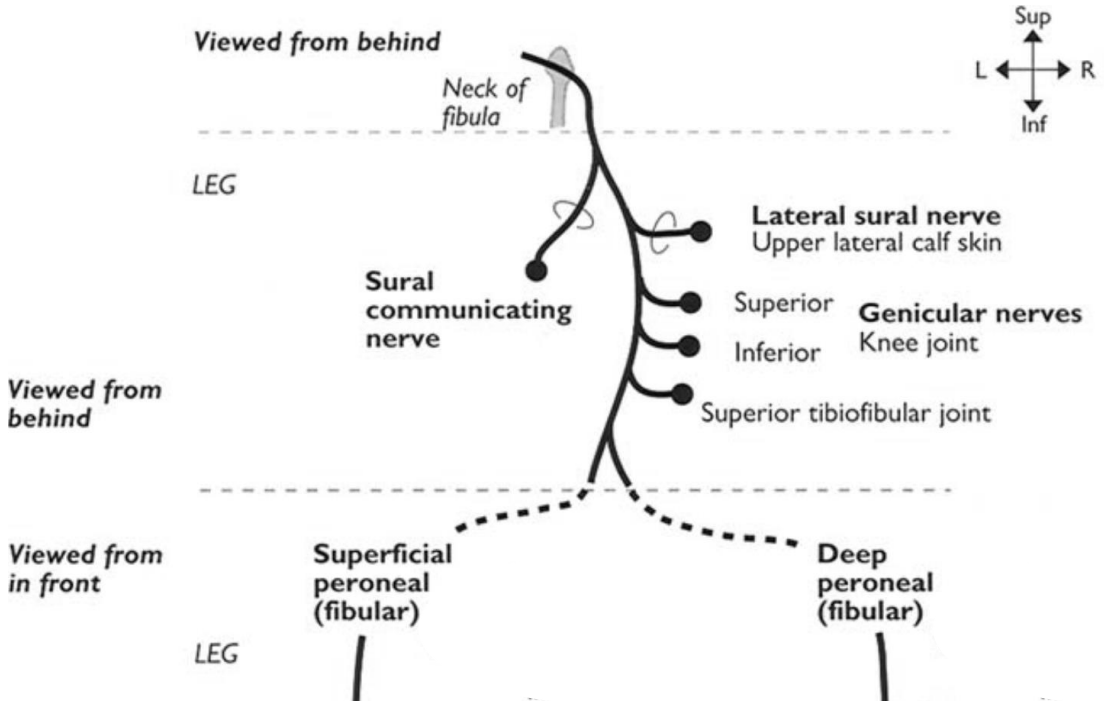
Motor:

- paralysis of hamstrings → impaired knee flexion (still performed by sartorius (femoral N & gracilis (obturator N)).
- paralysis of all muscles below knee (tibial & common peroneal Ns) → foot drop.

Sensory: loss of sensation below knee (tibial & common peroneal Ns) except med side of leg & foot (saphenous N of femoral).



Popliteal fossa



Common peroneal nerve

Quizlet / Whitaker & Borley

POPLITEAL FOSSA

Definition: diamond shaped space at the back of the knee.

Boundaries:

Superolateral: biceps.
Superomedial: semitendinosus & semimembranosus.
Inferolateral: gastrocnemius (lat head).
Inferomedial: gastrocnemius (med head).
Roof: skin, superficial fascia & deep fascia.
Floor:
Sup 1/3: femur (popliteal surface).
Middle 1/3: knee capsule.
Inf 1/3: popliteus muscle.

Contents:

1) **Popliteal A:** the deepest structure.
2) **Popliteal V:** superficial to the artery.
3) **Tibial (med popliteal) N:** passes superficial to popliteal vessels from sup to inf angles.
4) **common peroneal (lat popliteal) N:** passes from sup to lat angles near biceps.
5) **Popliteal lymph nodes.**

COMMON PERONEAL (LATERAL POPLITEAL) NERVE

Root value: Sacral plexus, L4,5,S1,2 (ant rami, post divisions).

Beginning: one of 2 terminal branches of sciatic N at lower 1/3 of back of thigh (sup angle of popliteal fossa).

Course & relations :

- It enters popliteal fossa through the sup angle.
- Descends near the biceps.
- Leaves the fossa through the lat angle.
- Curves on the lat side of neck of fibula where it ends.

Branches:

Cutaneous:

1) ***Lat cutaneous N of calf:*** skin of lat & ant surfaces of the upper part of leg.
2) ***Sural communicating N:*** joins the sural N (of tibial).

Articular: knee.

Terminal branches: superficial & deep peroneal Ns.

End: it ends by dividing on the lat side of neck of fibula into superficial peroneal (musculocutaneous) & deep peroneal (ant tibial) Ns.

Injury:

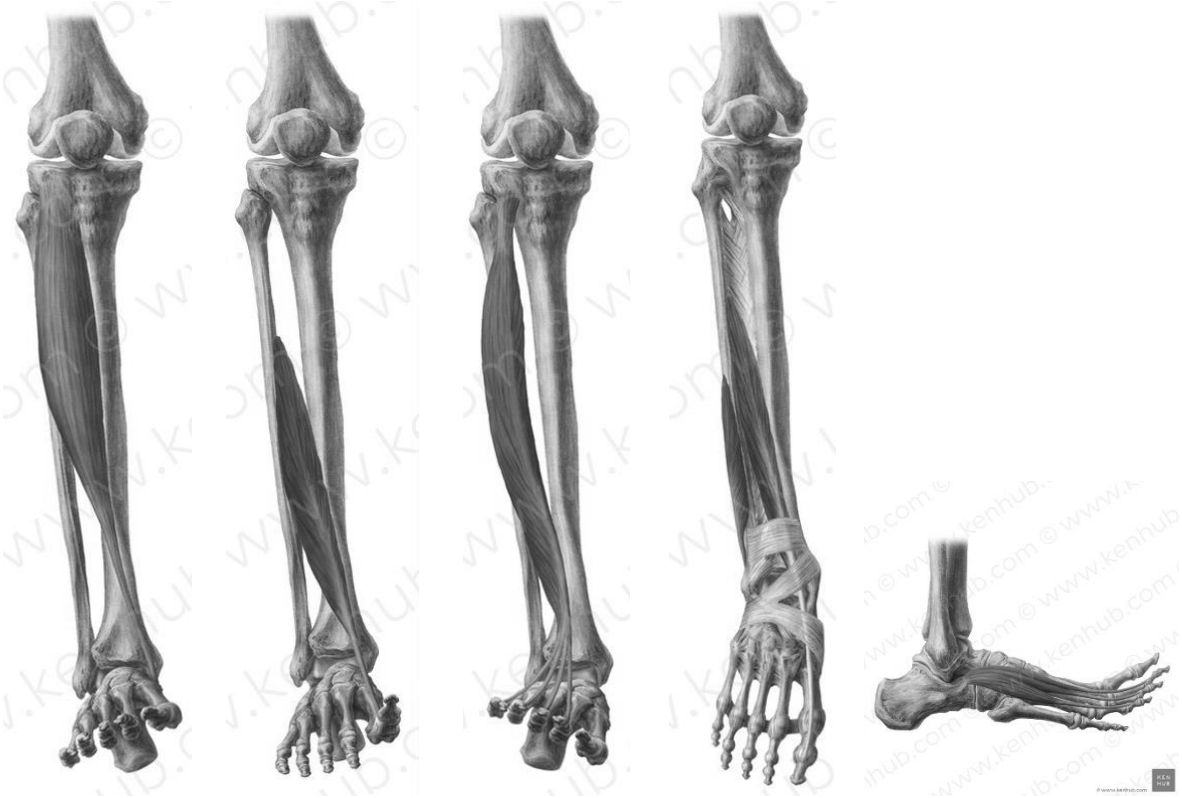
Cause: usually fracture neck of fibula.

Motor:

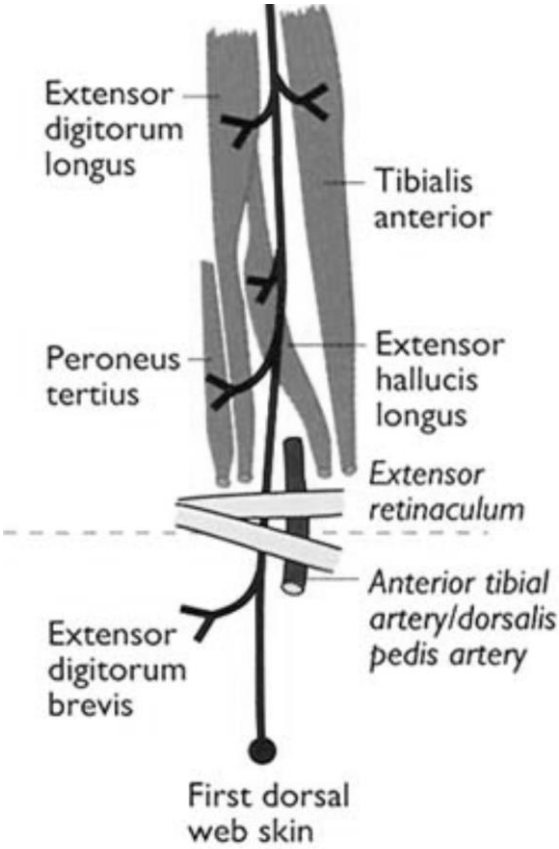
- Paralysis of extensors of leg → foot drop.
- Paralysis of peroneal muscles → loss of eversion.

Sensory: loss of sensation of:

- Ant & lat sides of leg.
- Dorsum of foot except med & lat borders.
- Dorsum of toes except lat side of little toe.



Tibialis anterior | Extensor halluces longus | Extensor digitorum longus | Peroneus tertius | Extensor digitorum brevis



Deep peroneal N

Ken Hub / Whitaker & Borley / McKinley & O'Loughlin

MUSCLES OF FRONT OF LEG & DORSUM OF FOOT

Muscle	*Origin*	*Insertion*	*Action*	*NS*
Tibialis ant	lat surface of tibia (sup ½)	1st metatarsal	• Dorsiflexion • Inversion	Deep peroneal N
Extensor hallucis longus	ant surface of fibula (middle 2/4)	Terminal phalanx of big toe	• Dorsiflexion • Extension of big toe (all joints)	
Extensor digitorum longus	ant surface of fibula (sup 3/4)	Lat 4 toes (extensor expansion)	• Dorsiflexion • Extension of lat 4 toes (all joints)	
Peroneus tertius	ant surface of fibula (inf 1/4)	5th metatarsal	• Dorsiflexion • Eversion	
Extensor digitorum brevis	Calcaneus (sup surface)	Med 4 toes	Extension of med 4 toes	

Extensor expansion: the tendons expand over the proximal phalanges of toes, divide into 3 slips & insert into middle & distal phalanges.

DEEP PERONEAL (ANTERIOR TIBIAL) NERVE

Beginning: on lat side of neck of fibula, as one of 2 terminal branches of common peroneal (lat popliteal) N.

Course and relations :

- Passes ant to interosseous membrane.
- Passes between the muscles of front of leg.
- Passes deep to extensor retinacula.

Branches:

Muscular: tibialis ant, extensor hallucis longus, extensor digitorum longus & peroneus tertius.

Articular: ankle.

Lat terminal branch: supplies extensor digitorum brevis & joints of foot.

Med terminal branch: supplies the skin of 1st interdigital cleft.

Injury:

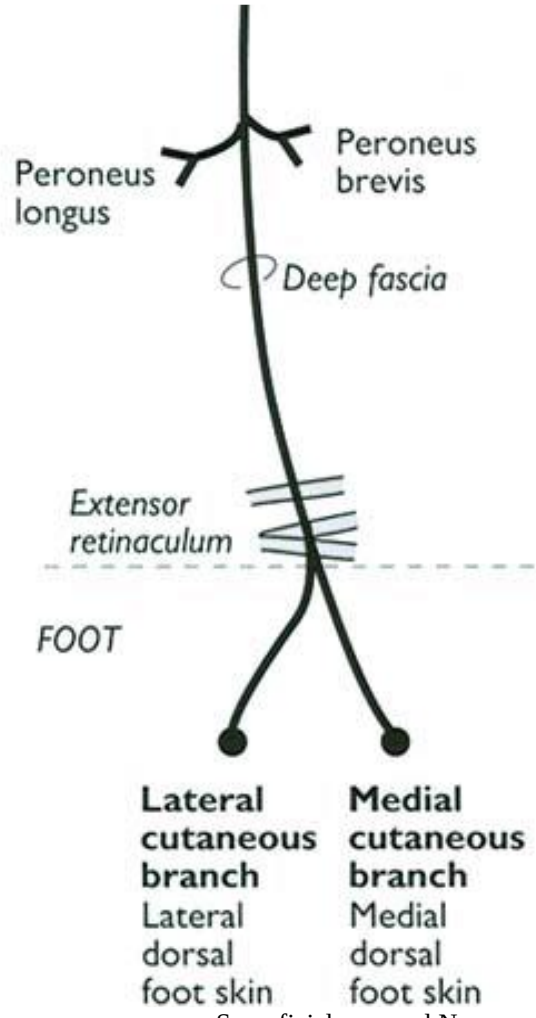
Motor:

- Paralysis of extensors of leg → foot drop & toes drop.
- Paralysis of tibialis ant → weak inversion
- Paralysis of peroneus tertius → weak eversion.

Sensory: loss of sensation of 1st interdigital cleft

Peroneus longus

Peroneus brevis



Superficial peroneal N

Ken Hub / Whitaker & Borley / McKinley & O'Loughlin

MUSCLES OF LATERAL COMPARTMENT OF LEG

Muscle	*Origin*	*Insertion*	*Action*	*NS*
Peroneus longus	lat surface of fibula (sup 2/3)	1st metatarsal	• Plantar flexion • Eversion	Superficial peroneal N
Peroneus brevis	lat surface of fibula (inf 2/3)	5th metatarsal		

SUPERFICIAL PERONEAL (MUSCULOCUTANEOUS) NERVE

Beginning: on lat side of neck of fibula, as one of 2 terminal branches of common peroneal (lat popliteal) N.

Course and Relations:

- It passes between peroneus longus & brevis.
- At the lower part of the leg, it pierces deep fascia & becomes superficial.

Branches:

Muscular: peroneus longus & brevis.

Cutaneous:

- Front of leg (lower 1/3).
- Dorsum of foot.
- Med side of big toe & 2nd, 3rd & 4th interdigital clefts.

Injury:

Motor:

- Paralysis of peroneus longus & brevis → Weak eversion.

Sensory: loss of sensation of:

- Front of leg (lower 1/3).
- Dorsum of foot.
- Med side of big toe & 2nd, 3rd & 4th interdigital clefts.

Gastrocnemius

Soleus

Plantaris

Popliteus

Tibialis posterior

Flexor digitorum longus

Flexor halluces longus

Ken Hub

MUSCLES OF POSTERIOR COMPARTMENT OF LEG

Muscle	*Origin*	*Insertion*	*Action*	*NS*
Gastrocnemius	Med head: above med femoral condyle Lat head: lat femoral condyle	tendocalcaneus • 15 cm • Strongest tendon in the body • Inserted in calcaneus (middle ⅓) separated from upper ⅓ by bursa	• Plantar flexion • Elevation of heel during walking • Flexion knee	Tibial N
Soleus	• Head and upper ⅓ of fibula (post surface) • tendinous arch (between fibula & tibia) • Soleal line • med border of tibia (middle 1/3)		• Plantar flexion • Elevation of heel during walking • Antigravity muscle	
Plantaris	lat supracondylar line of femur		• Plantar flexion • Flexion knee	
Popliteus	lat femoral condyle	post surface of tibia (above soleal line)	• Unlocking of knee (lat rotation of femur or med rotation of tibia) • Flexion knee	
Tibialis post	• post surface of tibia (lat part) • post surface of fibula (med part) • Post surface of interosseous membrane	• All tarsals except talus • Middle 3 metatarsals	• Plantar flexion • Inversion	
Flexor digitorum longus	post surface of tibia (med part)	Terminal phalanges of lat 4 toes	• Plantar flexion • Flexion of lat 4 toes (all joints)	
Flexor hallucis longus	post surface of fibula (lat part)	Terminal phalanx of big toe	• Plantar flexion • Flexion of big toe (all joints)	

TIBIAL NERVE

Root value: Sacral plexus, L4,5,S1,2,3 (ant rami, ant divisions).

Beginning: one of 2 terminal branches of sciatic N, at the lower 1/3 of back of thigh (sup angle of popliteal fossa).

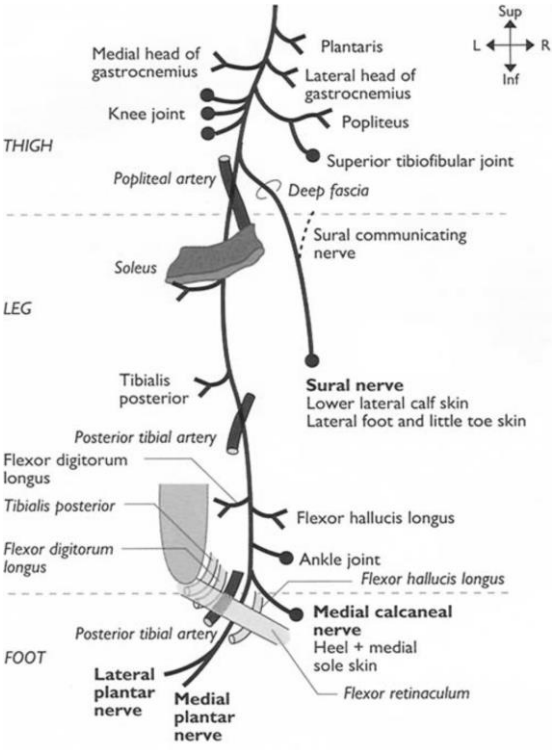
Course & relation: it could be divided into 2 parts; med popliteal (in the popliteal fossa) & post tibial (in the back of leg).

In popliteal fossa (med popliteal N):

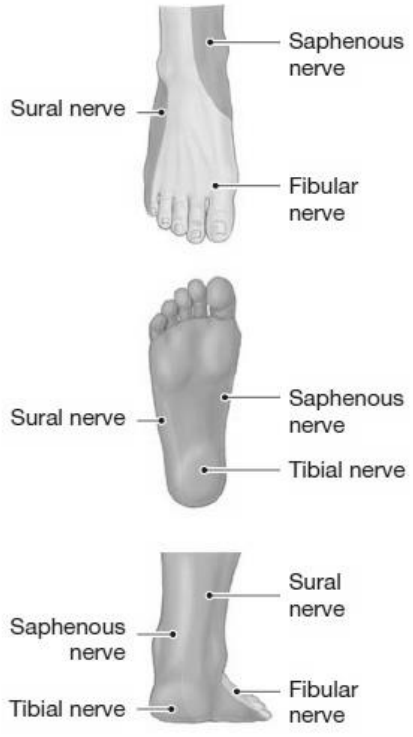
- It enters through the sup angle (covered by biceps).
- It bisects the fossa as the most superficial structure.
- Leaves the fossa through the inf angle.

In the back of leg (post tibial N):

- Descends between soleus (superficial) & tibialis post (deep).
- It becomes subcutaneous on the post surface of tibia.



Tibial N



Sensory innervation of foot

Abd H

FDB

Abd D

FDA

Lumb

FDL

FHL

FHB

Add H

FDB

PI

DI

PL

TP

Muscles of the sole

Whitaker & Borley / Martini / Ken Hub

Branches:

In popliteal fossa (med popliteal N):

Muscular: gastrocnemius, plantaris, soleus & popliteus.

Cutaneous: ***Sural N:***

- Joined by sural communicating N.
- Supplies lat side of foot & little toe.

Articular: knee.

In the back of leg (post tibial N):

Muscular: soleus, tibialis posterior, flexor digitorum longus & flexor hallucis longus.

Cutaneous: ***med calcanean nerves:*** supply skin of the heel.

Articular: ankle.

End: deep to flexor retinaculum by dividing into med & lat plantar Ns (supplying the skin and muscles of the sole of the foot).

Injury:

Motor:

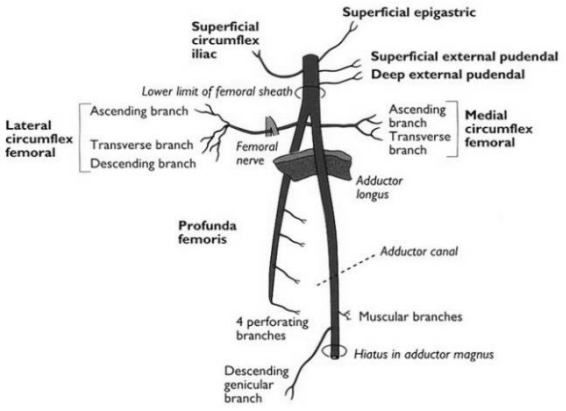
- paralysis of all muscles of the back → very weak plantar flexion accompanied by eversion (performed by peroneus longus & brevis).
- Paralysis of tibialis post → weak inversion.
- Paralysis of toes flexors → loss of flexion of toes.

Sensory: loss of sensation of lat side of foot & little toe (sural N) & sole of the foot (plantar nerves).

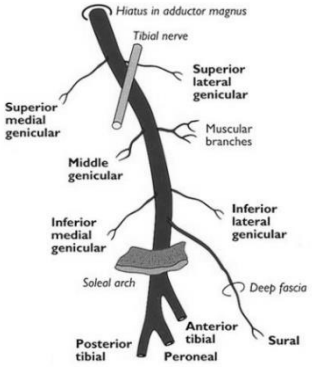
MUSCLES OF THE SOLE OF FOOT

Layer	*Muscle*	*Action*	*NS*
1st	**Abductor hallucis**	Abduction of big toe	Med Plantar N: supplies • Abductor hallucis • Flexor digitorum brevis • 1st lumbrical • Flexor hallucis brevis Lat plantar N: supplies other short Ms
	Abductor digitiminimi	Abduction of little toe	
	Flexor digitorum brevis	Flexion of lat 4 toes	
2nd	**Flexor digitorum accessories**	Modify the angle of flexor digitorum longus	
	4 lumbricals	• Flexion of metatarsophalangeal joints of lat 4 toes • Extension of interphalangeal joints of lat 4 toes	
	Tendon of flexor digitorum longus		
	Tendon of flexor hallucis longus		
3rd	**Flexor hallucis brevis**	Flexion of big toe	
	Flexor digitiminimi	Flexion of little toe	
	Adductor hallucis	Adduction of big toe	
4th	**3 plantar interossei**	Adduction of lat 3 toes	
	4 dorsal interossei	Abduction of middle 3 toes	
	Tendon of peroneus longus		
	Tendon of tibialis post		

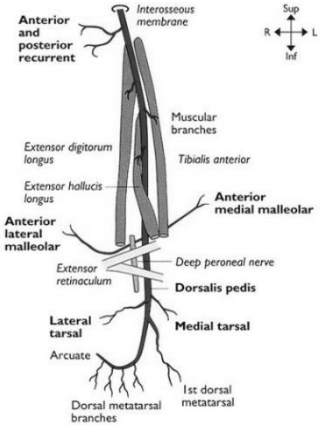
N.B.: adduction & abduction of toes is along a line of the middle of 2nd toe.



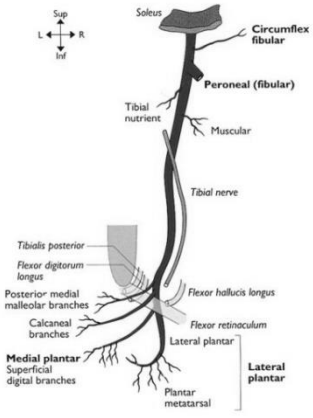
Femoral A



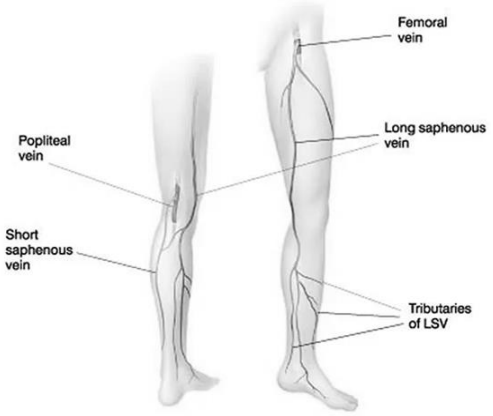
Popliteal A



Ant tibial A



Post tibial A



Veins of lower limb

Whitaker & Borley / IndiaMart

SUMMARY OF THE ARTERIES OF THE LOWER LIMB

FEMORAL ARTERY

Beginning: deep to inguinal ligament as a continuation of external iliac A.
Course and relations: passes in the femoral triangle → adductor canal.
Important branch: Profunda femoris A:. begins 4 cm below inguinal ligament → passes intramuscular → gives circumflex and perforating branches encircling the thigh (the main blood supply of the thigh).
End: at the adductor opening to become popliteal A.

POPLITEAL ARTERY

Beginning: at the adductor opening as a continuation of femoral A.
Course and relations: passes as the deepest structure in the popliteal fossa
Important branches: Articular to the knee.
End: at the lower border of popliteus by dividing into ant and post tibial As.

ANTERIOR TIBIAL ARTERY

Beginning: at the lower border of popliteus as one of two terminal branches of popliteal A.
Course & relations: Passes between the muscles of front of leg
Important branches: anastomotic branches to knee and ankle.
End: by becoming dorsalis pedis deep to extensor retinacula.

DORSALIS PEDIS ARTERY

Beginning: deep to extensor retinacula as a continuation of ant tibial A.
End: descends to the sole of the foot and anastomose with plantar As.

POSTERIOR TIBIAL ARTERY

Beginning: at the lower border of popliteus as one of two terminal branches of popliteal A.
Course & relations: passes between the muscles of back of leg.
Important branches:

1) **Anastomotic branches:** to knee and ankle
2) **Peroneal A:** supplies the lateral compartment of the leg

End: deep to flexor retinaculum by dividing into med and lat plantar As.

SUMMARY OF THE VEINS OF THE UPPER LIMB

DEEP VEINS

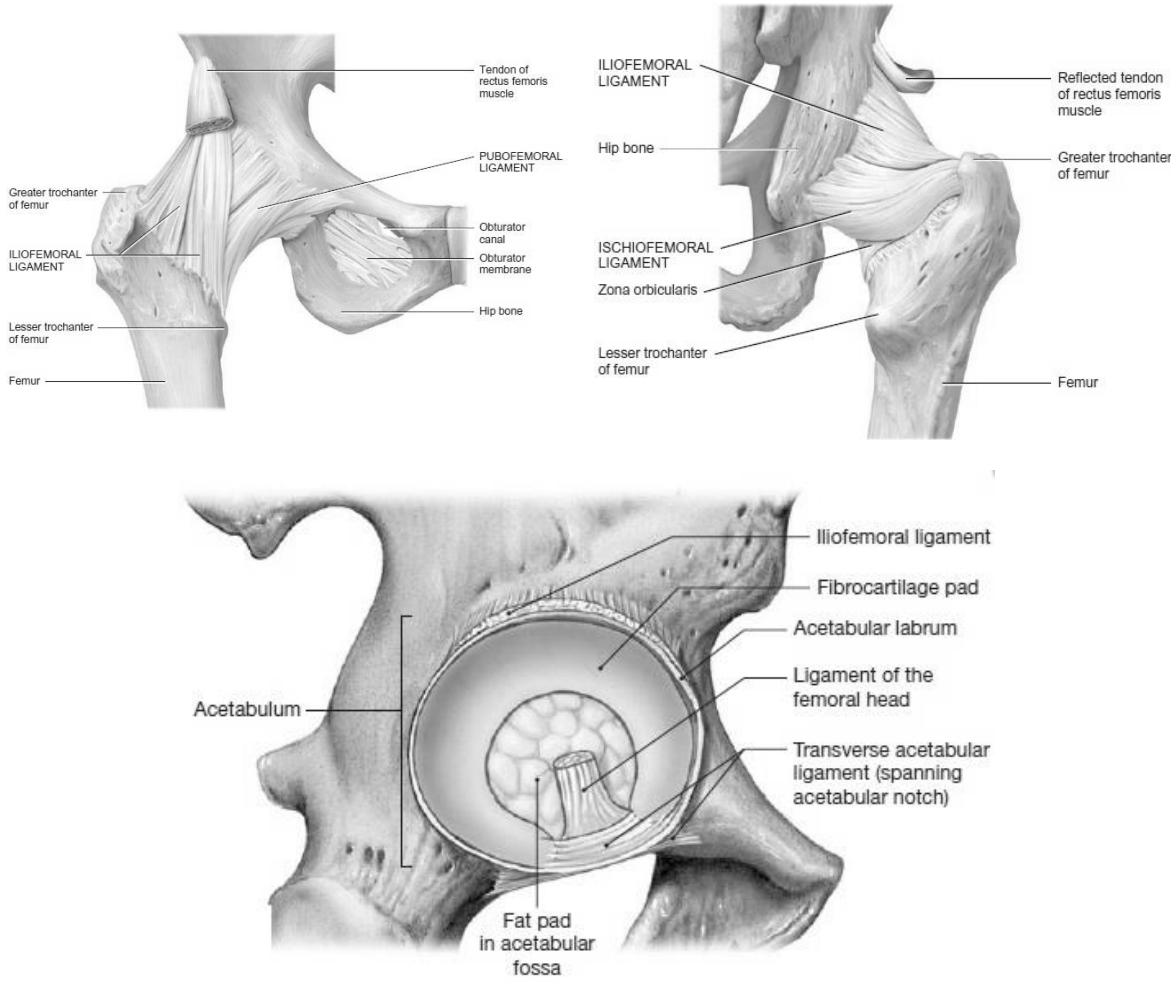
❖ Deep to the deep fascia. They follow the arteries as regards course & distribution

SUPERFICIAL VEINS

❖ Superficial to the deep fascia
Dorsal venous arch: on the dorsum of the foot.
Great saphenous vein: begins from med end of dorsal venous arch → med side of leg → posteromedial to knee → med side of thigh→ pierces deep fascia and end in femoral V.
Small saphenous vein: begins from lat end of dorsal venous arch → lat side of leg → pierces deep fascia of popliteal fossa and ends in popliteal V.

PERFORATING VEINS

Importance: They connect superficial Vs to deep Vs. During muscle contraction, the deep veins are compressed, and the venous blood is stored in the superficial Vs. When the muscles relax, the blood is directed from superficial Vs through the perforating Vs to the deep Vs. To allow a unidirection flow of blood, the superficial and perforating Vs contain valves. Injury to these valves (usually due to high pressure) may lead to varicose veins.



Hip joint

Tortora & Nielsen

HIP JOINT

Type & variety: synovial, ball & socket.
Articular surfaces: acetabulum of hip & head of femur.
Capsule:

Attachments:

Hip: acetabular margin.

Femur: intertrochanteric line (ant) & medial to intertrochanteric crest (post).

Intracapsular structures:

Labrum acetabular: fibrocartilage ring attached to the margin of acetabulum to increase depth.

Transverse acetabular ligament & ***Ligament of the head***

Synovial membrane:

- Lines the capsule.
- Covers intracapsular nonarticular structures (part of neck of femur, labrum acetabular, transverse acetabular ligament & ligament of head).

Ligaments:

Iliofemoral ligament:

- Inverted Y shaped.
- Attached to ant inf iliac spine & intertrochanteric line.
- Strongest ligament in the body.

Pubofemoral ligament: from iliopubic eminence to capsule.

Ischiofemoral ligament: from ischium (below acetabulum) to capsule.

Transverse acetabular ligament: attached to margins of acetabular notch (in the inf part of acetabulum) transferring it into acetabular foramen.

Ligament of the head (ligamentum teres):

- Lies inside the capsule.
- Attached to the pit of the head & transverse acetabular ligament.

Movements & muscles:

Flexion: iliopsoas, rectus femoris & Sartorius.

Extension: gluteus maximus & hamstrings (semimembranosus, semitendinosus & biceps).

Adduction: adductors longus, brevis & magnus, pectineus & gracilis.

Abduction: gluteus medius & minimus.

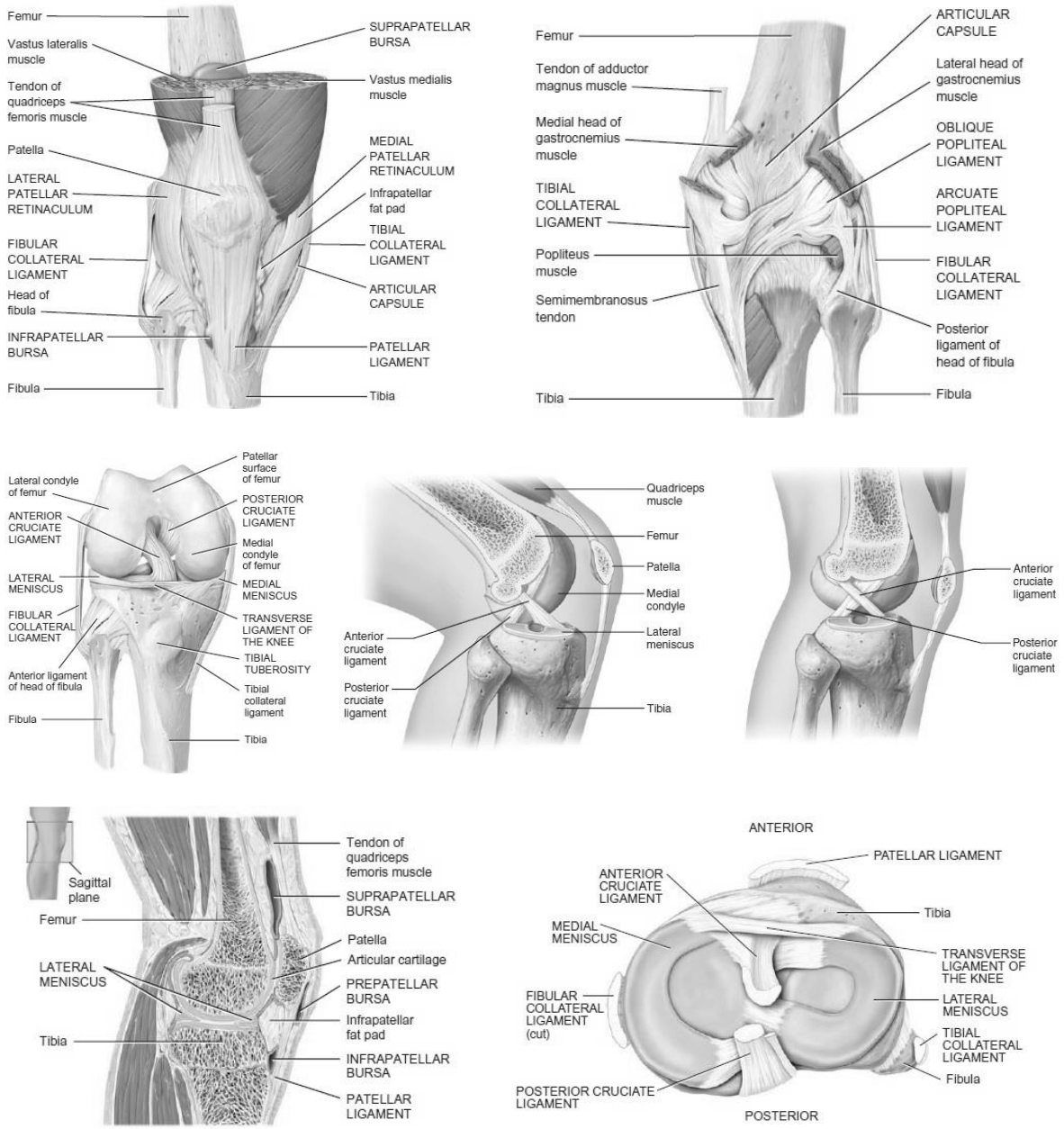
Med rotation: gluteus medius & minimus.

Lat rotation: 6 lat rotators (obturator internus & externus, sup & inf gemelli, piriformis & quadratus femoris) & Sartorius.

Circumduction

Stability: Stable joint due to:

- Deep acetabulum.
- Labrum acetabular.
- Strong ligaments.
- Strong muscles.



Knee joint

Tortora & Nielsen

KNEE JOINT

Type & variety: synovial, modified hinge (bicondylar).

Articular surfaces: condyles of femur, condyles of tibia & patella.

Capsule:

Attachments: near the margins of articular surfaces, anteriorly it is replaced by quadriceps, patella & ligamentum patellae.

Intracapsular structures:

Popliteus muscle

Cruciate ligaments

Menisci: semicircular fibrocartilages which deepens articular surfaces.

Med meniscus	*Lat meniscus*
Larger	Smaller
Oval (C-shaped)	Circular (O-shaped)
Attached to capsule	Separating from capsule by popliteus
Less mobile	More mobile, it moves with popliteus
liable to injury (adherent to capsule)	less liable to injury

Synovial membrane:

- Lines the capsule.
- Covers intracapsular non articular structures.

Ligaments:

Ligamentum patellae: from patella to middle part of tibial tuberosity.

Med (tibial) collateral ligament: triangular in shape from med epicondyle (apex) to med condyle of tibia (base).

Lat (fibular) collateral ligament: cord like from lat epicondyle to head of fibula.

Cruciate ligaments:

Anterior cruciate	*Post cruciate*
From ant intercondylar area to lat condyle of femur (post part of med surface)	From post intercondylar area to med condyle of femur (ant part of lat surface)
Prevents ant displacement of tibia	Prevents post displacement of tibia
Stretched during extension	Stretched during flexion
Injured in hyperextension	Injured in hyperflexion

Movements & muscles :

Flexion: hamstrings, sartorius, gracilis, gastrocnemius, plantaris & popliteus.

Extension: quadriceps.

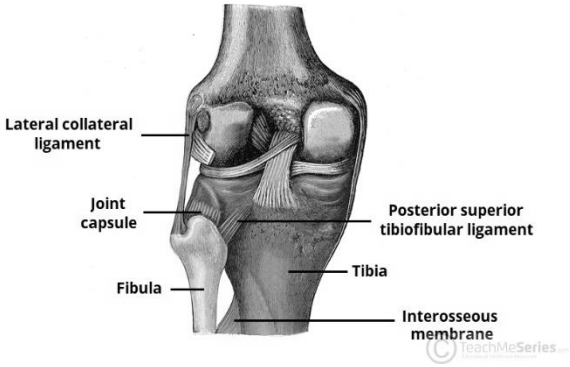
Med rotation: semitendinosus, semimembranosus, sartorius, gracilis & popliteus.

Lat rotation: biceps.

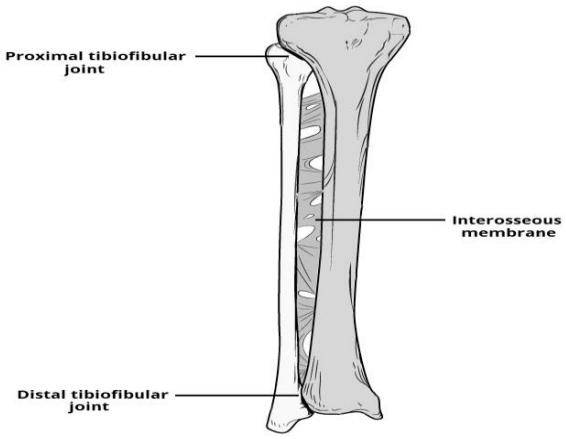
Locking & unlocking of the knee:

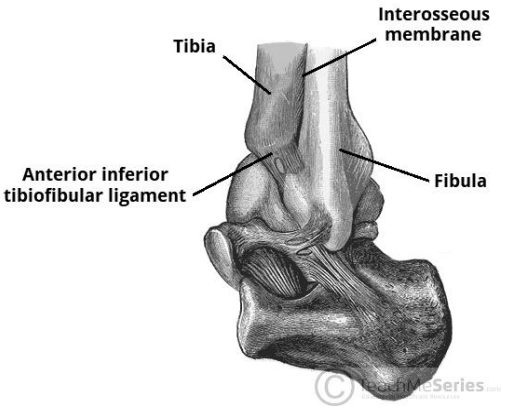
Locking: in full extension of the knee, femur rotates medially (limb on the ground), or tibia rotates laterally (limb off the ground). It allows knee extension with relaxed quadriceps to save energy.

Unlocking: to flex the joint the popliteus produces lat rotation of femur or med rotation of tibia.

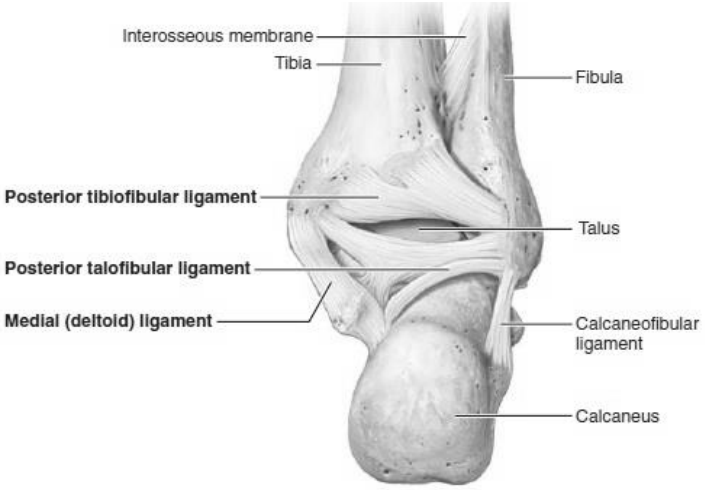


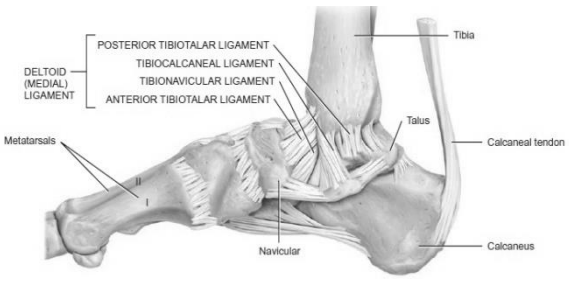
Sup tibiofibular joint



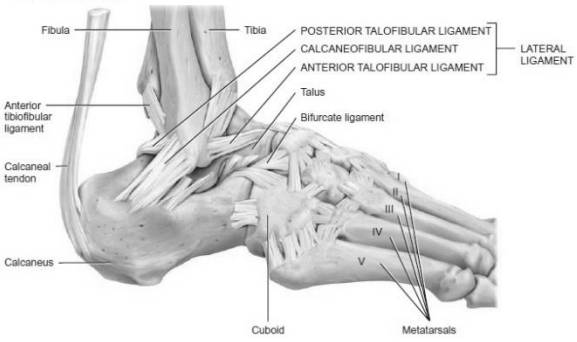


Tibiofibular joints





Med



Lat

Ankle joint

TeachMeAnatomy / Tortora & Nielsen / Marieb

SUPERIOR TIBIOFIBULAR JOINT

Type & variety: synovial, plane.
Articular surfaces: fibular facet of tibia (back of lat condyle) & articular surface of head of fibula.
Capsule: at margins of articular surfaces.
Synovial membrane: lines the capsule.
Ligaments: ant & post tibiofibular ligaments.

MIDDLE TIBIOFIBULAR JOINT (INTEROSSEOUS MEMBRANE)

Type & variety: fibrous, syndesmosis.
Articulation: extends between interosseous borders of tibia & fibula (its fibers directed downwards & lat).

INFERIOR TIBIOFIBULAR JOINT

Type & variety: fibrous, syndesmosis.
Articular surfaces: fibular notch of tibia & rough area on the lower part of shaft of fibula (med side).
Ligaments: ant & post tibiofibular ligaments.

ANKLE JOINT

Type & variety: synovial, hinge.
Articular surfaces: lower end of tibia, lower end of fibula & talus (trochlea).
Capsule: attached to the margins of articular surfaces except ant where it reaches neck of talus (part of talus is intracapsular).
Synovial membrane:

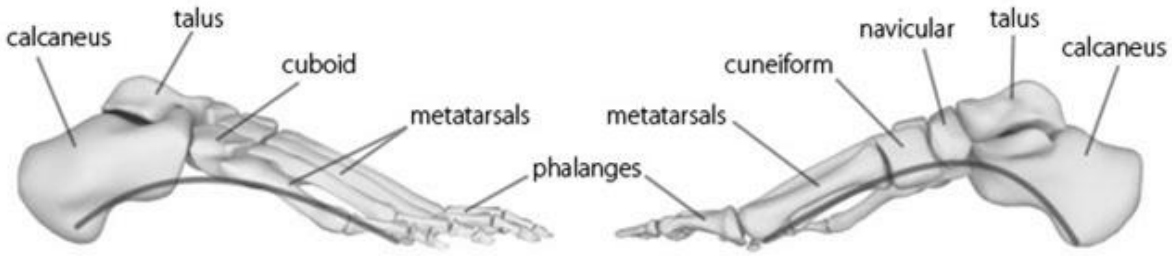
- Lines the capsule.
- Covers the intracapsular non articular structures.

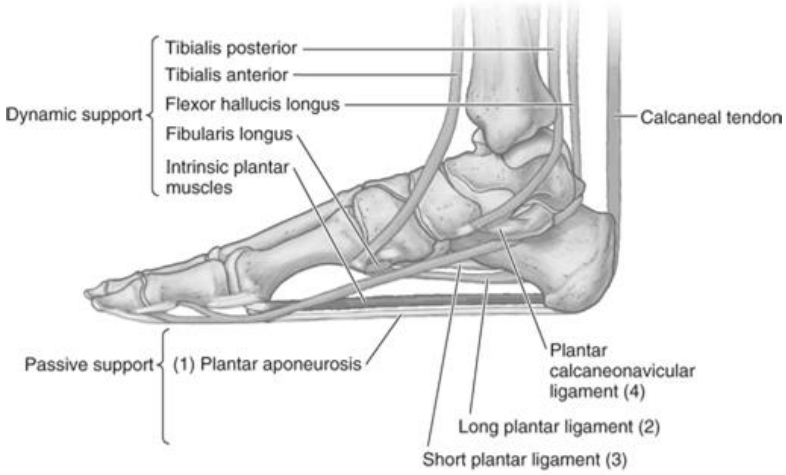
Ligaments:

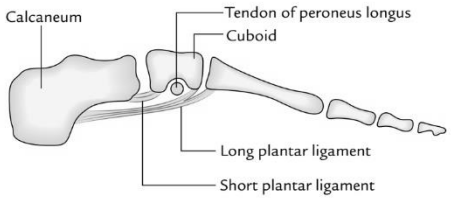
Med ligament (deltoid ligament): triangular, with the apex attached to med malleolus & the base to navicular, talus & calcaneus.
Lat ligament: 3 bands from lat malleolus to ant side of talus, post side of talus & calcaneus.
Ant ligament: from distal end of tibia to ant side of talus.
Post ligament: from distal end of tibia to post side of talus.
Transverse tibiofibular ligament: from distal end of tibia to malleolar fossa.

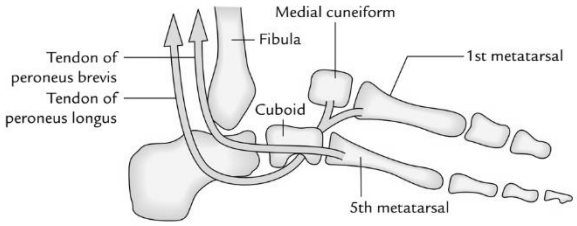
Movements & muscles:

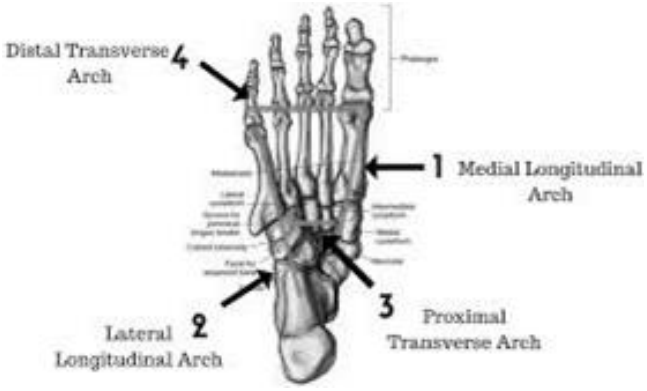
Dorsiflexion (extension): tibialis ant, extensor hallucis longus, extensor digitorum longus & peroneus tertius (ant compartment of leg).
Planter flexion (Flexion): soleus, gastrocnemius, plantaris, tibialis post, flexor digitorum longus & flexor hallucis longus (post compartment of leg), peroneus longus & brevis (lat compartment of leg)











Arches of the foot

Physiopedia

INVERSION AND EVERSION

Definition:

Inversion: is the movement of the sole of foot medially

Eversion: is the movement of the sole of foot laterally.

Joints concerned: talocalcanean & talocalcaneonavicular joints.

Muscles producing it:

Inversion: tibialis anterior & post.

Eversion: peroneus longus, brevis & tertius.

Importance: allow walking on uneven ground.

N.B.: Inversion has a wider range of movement than eversion.

ARCHES OF THE FOOT

Definition: arrangement of tarsal & metatarsal bones in an arch manner.

Functions of arches:

- Support & distribution of weight to the heel posteriorly & heads of metatarsals anteriorly (if lost → lead to flat foot).
- Protect foot from pressure by body weight.
- Shock absorption.

Arch	*Supporting factors*		
	Shape & arrangement of bones	***Ligaments***	***Muscles***
Med longitudinal arch	Apex: talus Post limb: calcaneus Ant limb: navicular, 3 cuneiforms & med 3 metatarsal	Spring ligament	• Flexor hallucis longus • Tibialis post • Flexor digitorum longus & brevis (med ½) • Abductor hallucis
Lat longitudinal arch	Post limb: calcaneus Ant limb: cuboid & lat 2 metatarsal	Long & short planter ligaments	• peroneus longus • Flexor digitorum longus & brevis (lat ½) • Abductor digitiminimi
Transverse arch	Convex superiorly	Interosseous ligaments	• Peroneus longus • Adductor hallucis

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