

# Anatomy

MARROW E.5

# GAMETOGENESIS

## Basic Timeline

- I. Pre-embryonic period : 0 - 2 week
- II. Embryonic period : 3<sup>rd</sup> - 8<sup>th</sup> week
- III. Fetal period : 9<sup>th</sup> till birth

Primordial germ cell [PGC] :

- It is pluripotent
- Synthesized by Epiblast in 2<sup>nd</sup> week



migrate to endodermal wall yolk sac in 4<sup>th</sup> week



Reach the gonads by 5<sup>th</sup> week

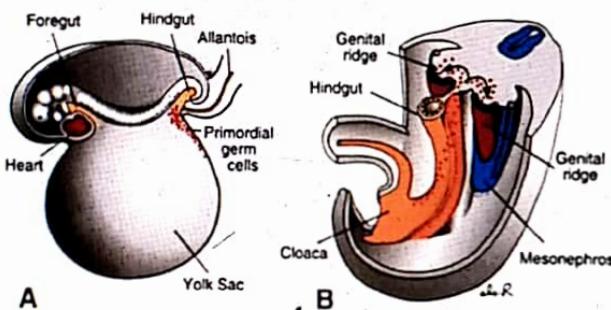


Figure 14.18. A. A 3-week-old embryo showing the primordial germ cells in the wall of the yolk sac close to the attachment of the allantois. B. Migration path of the primordial germ cells along the wall of the hindgut and the dorsal mesentery into the genital ridge.

- Sometimes the PGC reach the neck region (craniopharyngeal teratoma) and sometimes they migrate to the region between sacrum and coccyx (Sacrococcygeal teratoma)
- [Why teratoma? Because of the pluripotency of the PGC]



Sacrococcygeal teratoma



Craniopharyngial teratoma

Active space

PGC - pluripotent cells

Terms :

Totipotency :

- Ability to form entire embryo and extra embryonic tissue
- upto 8 cell stage every cell is totipotent

Pluripotency :

- Ability to form all germ layers

Multipotency :

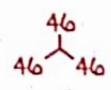
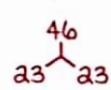
- Form more than one category of cells
- Hematopoietic stem cells

Oligopotency :

- Form one category of cell
- Vascular stem cells

Unipotent cells :

- Form only one type of cell
- Liver cell

	MITOSIS	MEIOSIS
TAKES PLACE IN	Body cells	Gonads (germ cells)
CHROMOSOMAL DIVISION		
EQ. DIVISION	Eq. division	Reduction division haploid
CROSSING OVER	✗	✓
	daughter cells resemble parent	daughter cells do not resemble parent

- meiosis takes place two times mi and ma.
- Prophase → metaphase → Anaphase → Telophase

## Oogenesis

00:10:55

Primordial germ cells reach the ovary in 5<sup>th</sup> week



All PGC converted to oogonium by 3<sup>rd</sup> month



All oogonium converted to primary oocyte by 5<sup>th</sup> - 7<sup>th</sup> month

↓ meiosis I  
Completes only prophase  
↓  
Go to resting phase (Diplotene phase) [remain in resting phase until puberty]

After puberty the primary oocyte  
↓ completes meiosis I  
Secondary oocyte + 1<sup>st</sup> Polar body (formed due to unequal division of the cytoplasm) [polar body : cell without cytoplasm]  
↓ meiosis 2  
Completes prophase and metaphase (metaphase arrest for 24 hours)

↓ Sperm +                            ↓ Sperm -

Secondary oocyte completes meiosis 2 and it forms ovum and 2 <sup>nd</sup> polar body	Corpus luteum persists for 14 days and shrinks and forms white scar called as corpus albicans
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### Spermatogenesis

Primordial germ cells reach the testis in 5<sup>th</sup> week [will remain dormant until puberty]

↓  
After puberty PGC converted to spermatogonium

↓  
Spermatogonium undergo 5 - 7 cycles of division to form primary spermatocyte

↓ meiosis I

Forms two secondary spermatocyte

↓  
Secondary spermatocyte

meiosis 2

↓  
Spermatid

↓  
Spermatid

↓  
Secondary spermatocyte

↓  
Spermatid

↓  
Spermatid

↓ Spermiogenesis (process of rearrangement of organelles)

↓ shedding of excess cytoplasm, formation of Tail, acrosomal cap)

↓  
Spermatozoa

Active space

- Spermatogonium undergoes 5 - 7 cycles of division to form primary spermatocyte
  - So one spermatogonium forms 64 - 512 spermatozoa
- | primary spermatocyte → 4 spermatid

### Difference between spermatogenesis and oogenesis

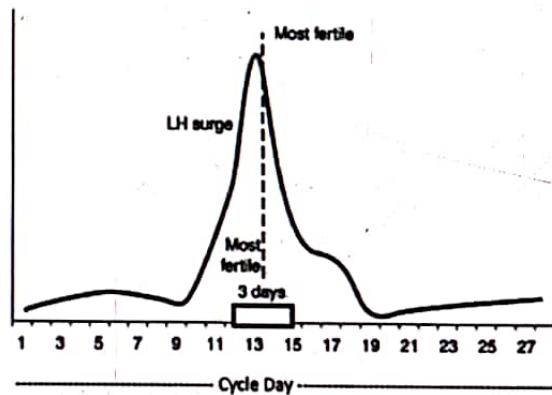
00:21:20

Spermatogenesis	Oogenesis
Process starts only after puberty	Process begins in intrauterine life
Polar body absent	Polar body present
primary spermatocyte → 4 spermatid	primary oocyte → only one ovum

- Spermatogenesis completed in  
74 days > 64 days > 60 days

most fertile period in women : "3 days" [2 days before ovulation + 1 day after ovulation] because sperms viable for 48 hours and secondary oocyte in the metaphase arrest wait for only 24 hours.

- LH surge occurs 36 hours before ovulation
- LH peak : 12 hours before ovulation > at ovulation



Active space

- In males spermatogenesis takes place in seminiferous tubules
- maturation of sperms occurs in epididymis
- Capacitation of sperms occurs in female genital tract for 7 hours

# FIRST WEEK OF DEVELOPMENT

## Fertilisation

00:00:03

In the first week - fertilisation - takes place in **ampulla** of fallopian tube [2020 NEET].

**Zona pellucida[2P]** - a membrane to prevent implantation and polyspermy.

The sperm binds to zona pellucida



Triggers the release of acrosomal enzymes called - **acrosomal reaction**



Acrosin, acid phosphatase, hyaluronidase



The sperm penetrates the zona pellucida



The cortical granules release its secretion called - **cortical reaction**



The cortical enzymes reach the zona



Zona changes permeability of sperms called - **zona reaction**



Fusion of male and female pronucleus



Forms zygote



undergoes 1st cleavage - **2 cells stage**



and cleavage - **4 cells stage**

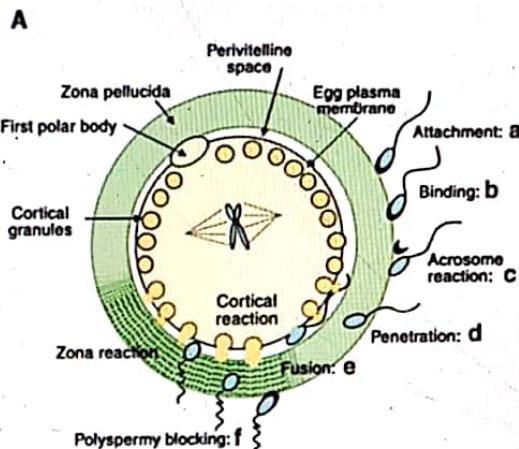


3rd cleavage - **8 cells stage.**

→ cells are loosely arranged

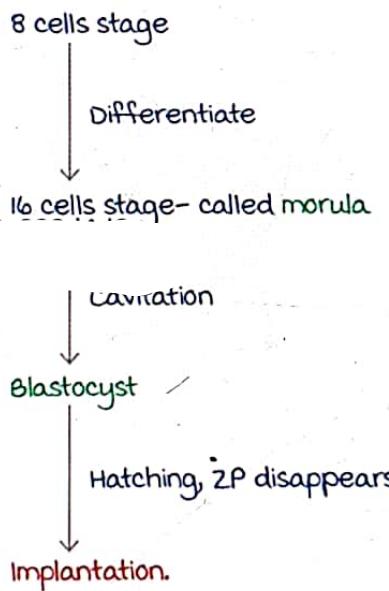
After 8 cells stage, the cells are held together by tight junctions called - **compaction.**

Active space



## Implantation

00:06:41



## Time and site of events

00:08:08

Fertilization - takes place within 12 to 24 hours of ovulation.

One day after fertilization - 2 cell stage.

Third day after fertilization - 8 to 16 cells stage [morula].

Fourth day after fertilization - 32 cells [advanced morula]

↓  
Enters uterine cavity.

Active space

Uterine fluid enters advanced morula forms - blastocyst.

At the time of formation - blastocyst contains 58 cells :

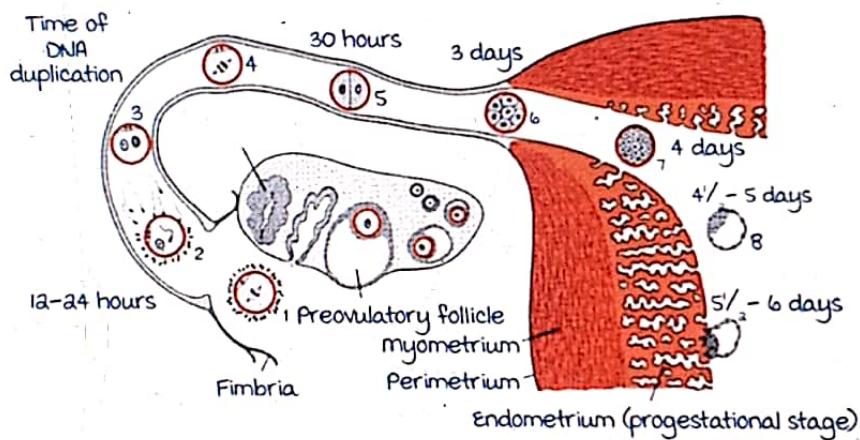
53 cells - outer cell mass forms trophoblast - forms placenta.

5 cells - inner cell mass forms embryoblast - forms embryo proper.

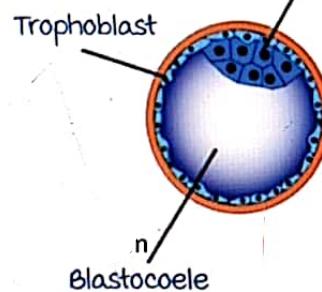
Blastocyst is formed on  $4\frac{1}{2}$  days after fertilization.

5th day after fertilization zona pellucida disappears.

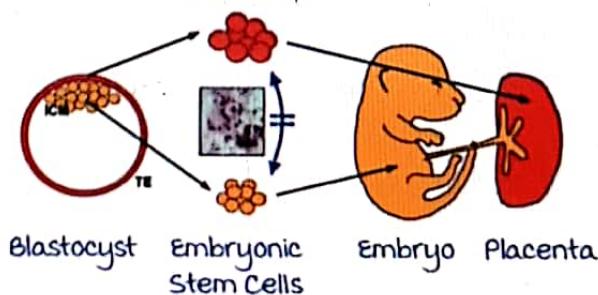
6th to 7th after fertilization implantation occurs.



Inner Cell mass (Embryoblast)



Trophoblast Stem Cells



## Ectopic pregnancy

00:15:31

MC site - fallopian tube [FT] - implantation takes place in FT.

The syncytiotrophoblast is not well developed - HCG levels will be very low.

C/F - similar to appendicitis.

Treatment - termination of pregnancy.

Complication - tubal rupture [if not treated].

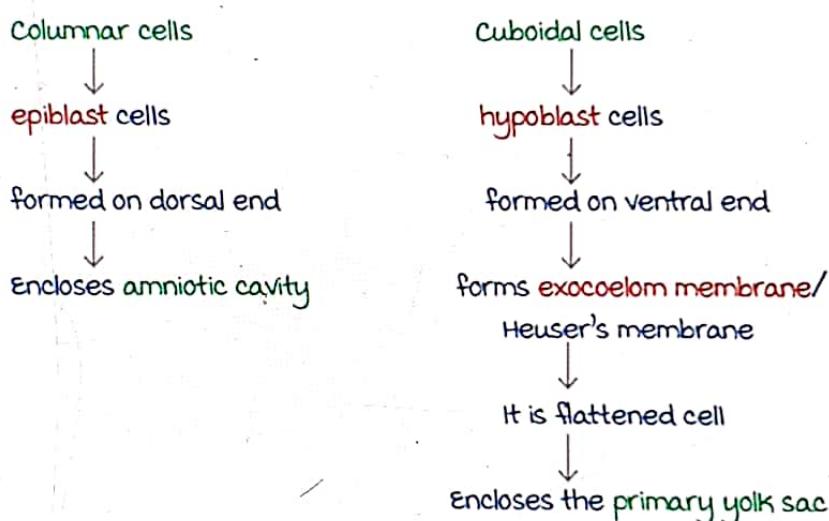
## SECOND WEEK OF DEVELOPMENT

### Development of embryoblast and trophoblast

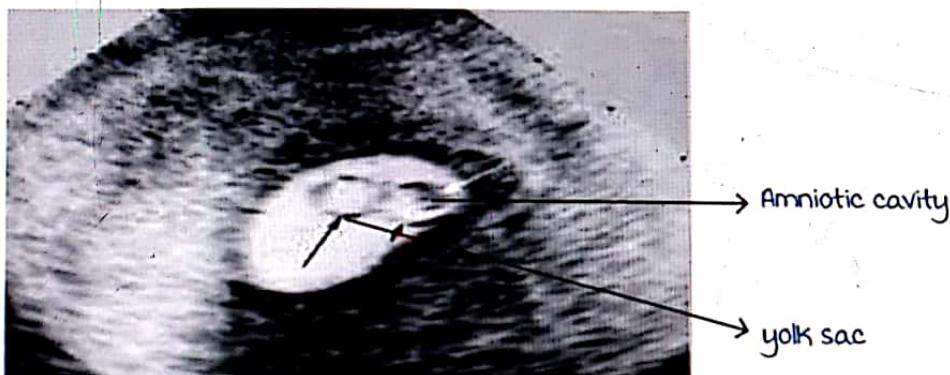
00:00:03

The inner cell mass - forms embryoblast.

The embryoblast forms two layers :



Double bleb sign seen on ultrasound in the second week.



Active space

The outer cell mass - forms trophoblast.

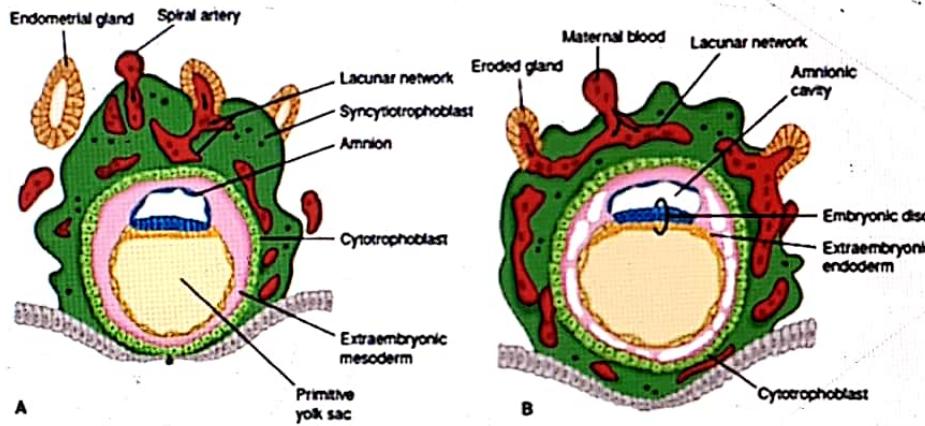
On 8th day trophoblast divided into two layers

Cytotrophoblast

Cells have single nucleus  
And well-defined membrane

syncytiotrophoblast

cells are multinucleated  
no well-defined membrane



### Formation of uteroplacental and fetoplacental circulation

00:05:45

The lacunas are formed in the cytotrophoblast.

The lacunas are filled with blood and erodes the endometrium & vessels.

The uterine [maternal] vessels blood is filled in lacuna

Through diffusion it reaches the inner cell mass

And supplies the inner cell mass

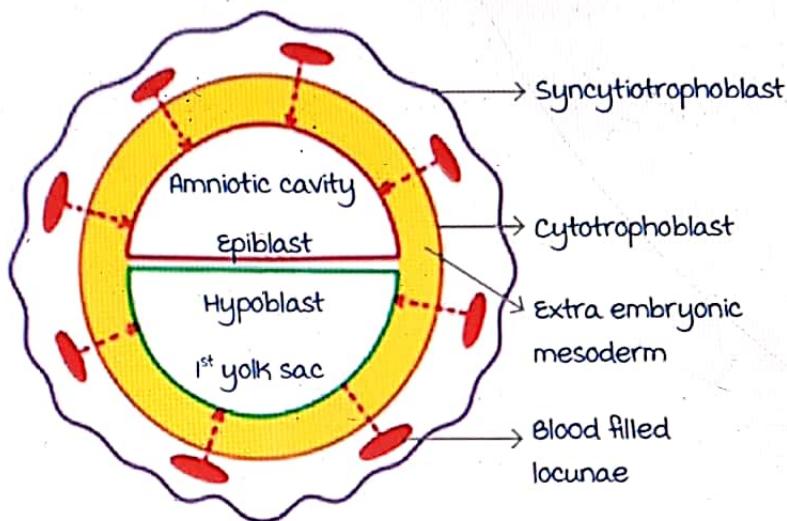
Establishing utero placental circulation.

On the 15th day > 14th day.

The utero placental circulation will be replaced by fetoplacental circulation

On 17th day > 16th day.

The heart tube will be formed which maintains the circulation.



## Chorion and Chorionic villi formation

00:10:09

Extraembryonic mesoderm [EEM]

It is present between the inner cell mass and outer cell mass. It is derived from the primary yolk sac > epiblast, hypoblast [2016 AIIMS]

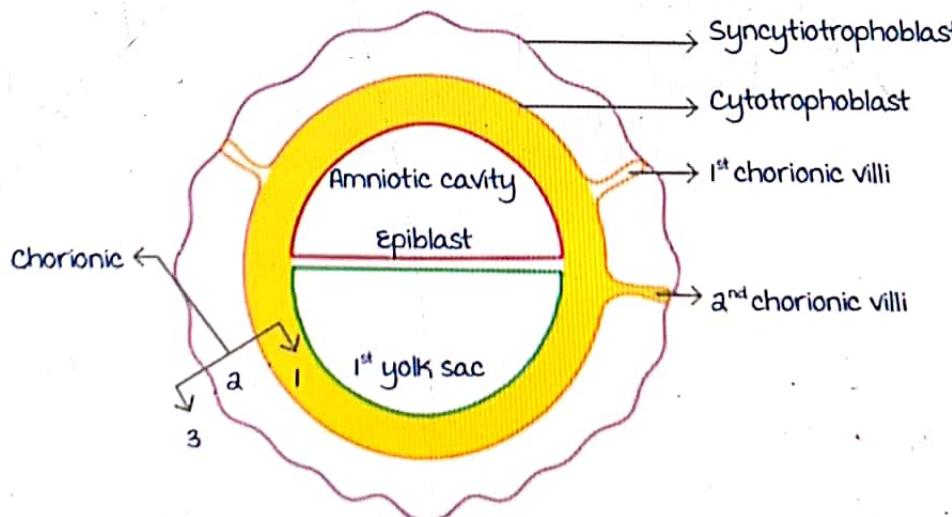
Chorion is formed by three structures:

1. Extraembryonic mesoderm
2. Cytotrophoblast
3. Syncytiotrophoblast

The cytotrophoblast projects into syncytiotrophoblast

Forming primary chorionic villi.

The EEM projects into the primary villi forming secondary chorionic villi.



Active space

## Formation of secondary yolk sac and umbilical cord

00:15:30

The small cavity formed in the EEM joins to form a larger cavity.

The undivided part of EEM - cranial to amniotic cavity

↓  
forms connecting stalk

↓  
which becomes umbilical cord.

The cavity in EEM divides it into :

- Splanchnopleuric layer of EEM - surrounding the yolk sac

↓  
makes the yolk sac smaller in size

↓  
called the secondary yolk sac.

- Somatic layer of EEM is the remaining EEM.

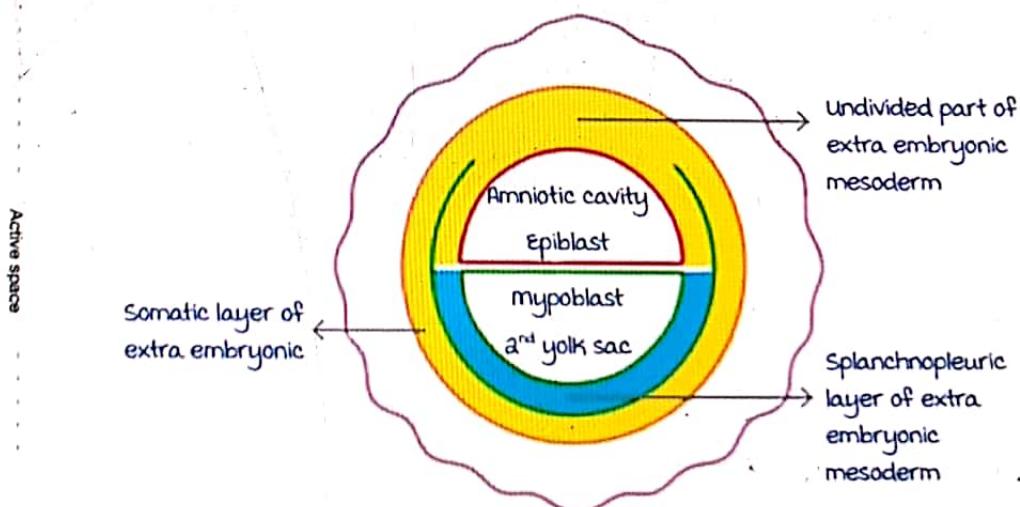
The amniotic cavity -

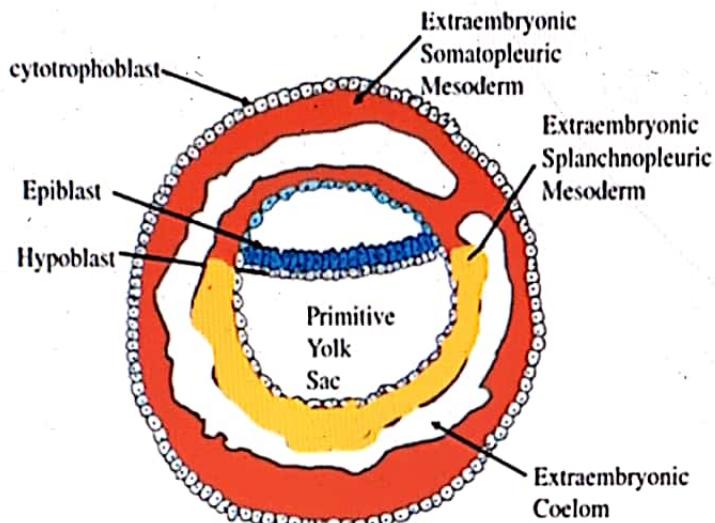
inner surface - lined by amniogenic cells.

Outer surface - lined by somatic layer of EEM.

Summary of second week development

- Two layers of inner cell mass - epiblast  
Hypoblast.
- Two layers of outer cell mass - cytotrophoblast  
Syncytiotrophoblast.
- Amnion and chorion are formed.
- Two layers of EEM somatic and visceral layer.
- Yolk sac divided into primary and secondary yolk sac.





## Human chorionic gonadotropin [HCG]

00:23:31

Clinical correlation :

HCG :

- Initially, it is secreted by the syncytiotrophoblast.
- HCG induces progesterone to maintain the pregnancy.

HCG assay :

On 8th day maternal blood.

On 10th day menstrual urine.

HCG assay can be done on the first day of missed period  
[early morning sample].

Very low HCG conditions

- Ectopic pregnancy.
- Spontaneous abortions.

High HCG conditions

- multiple pregnancy.
- molar pregnancy.
- Gestational trophoblastic neoplasia.

Active space

## THIRD WEEK & PLACENTAL DEVELOPMENT

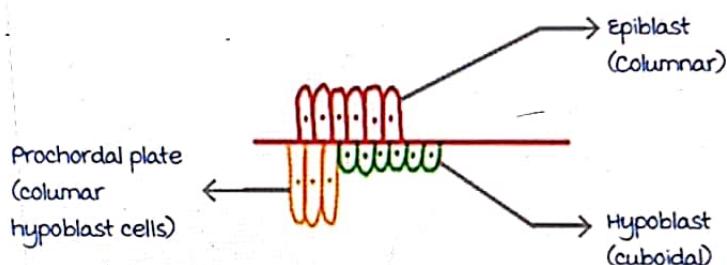
Gastrulation & neurulation occur in the 3rd week.

Gastrulation : formation of germ layer

Neurulation : formation of neural tube.

### Gastrulation

00:01:03



Prochordal plate : columnar hypoblast cell

Forms **Buccopharyngeal membrane** - ruptures & forms **oral cavity**

Head end

Primitive streak : Proliferation of epiblast.

Primitive streak indicates the beginning of gastrulation.

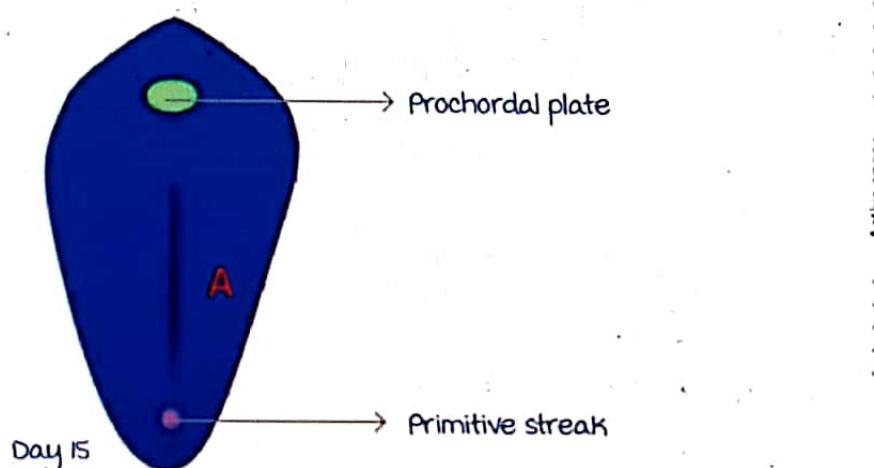
Tail end

End of 2nd week / beginning of 3rd week

Persists at tail end - **sacra-coccygeal teratoma**. (2018 DNB)



(Or due to abnormal migration of primordial germ cells)



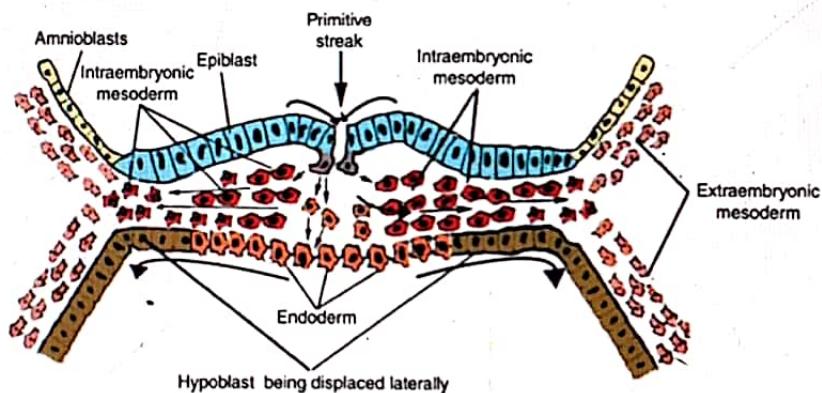
1st germ layer to develop: endoderm (derived from epiblast)  
Endoderm replaces hypoblast

and germ layer: mesoderm  
↑  
derived from primitive streak  
↑  
derived from epiblast

Last germ layer: Ectoderm

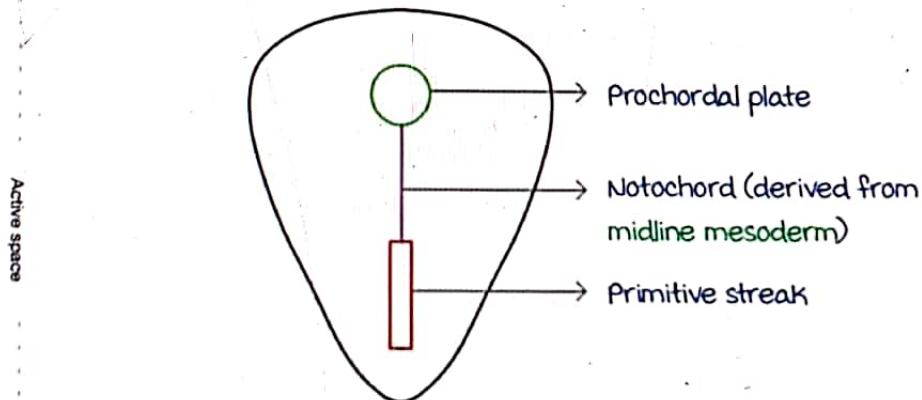
The remains of epiblast after the formation of intraembryonic mesoderm.

All germ layers derived from epiblast > yolk sac



### Midline mesoderm

00:12:26



From primitive streak,

Stimulates formation of neural tube.

Structures derived from notochord :

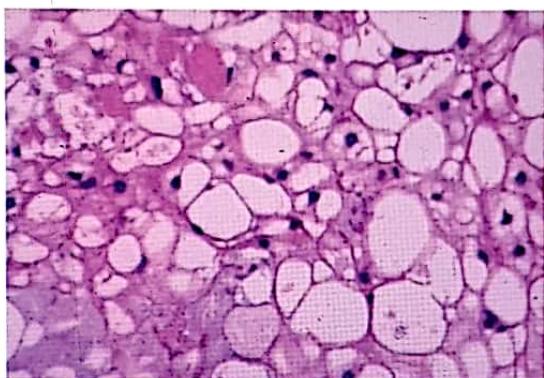
Nucleus pulposus > Apical ligament of dens

Notochord disappears later.



If persists - Chordoma (2018 NEET)

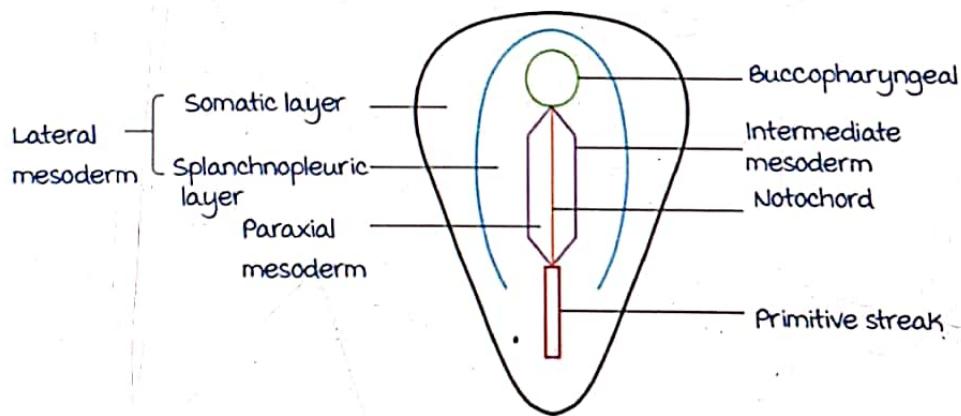
Phagocytotic cells in chordoma



- Large vacuolated cytoplasm
- Nucleus in periphery (2017 JIPMER)

## Subdivisions of intraembryonic mesoderm

00:19:58

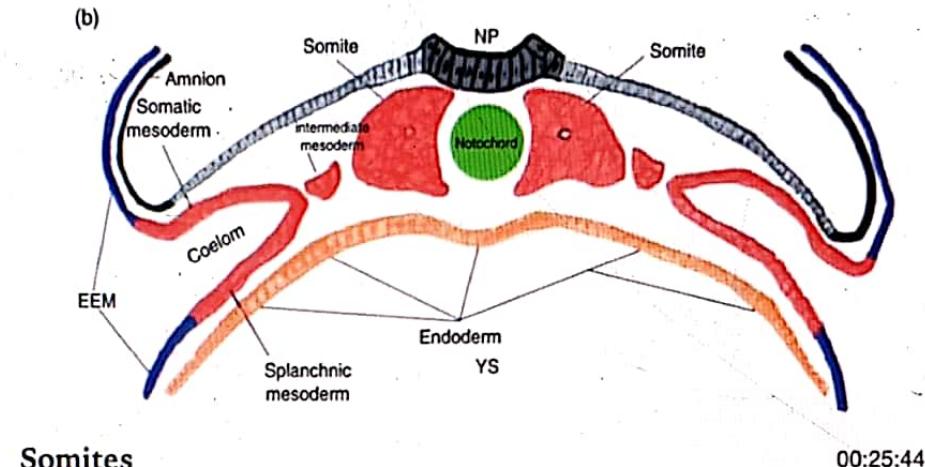


1. Paraxial mesoderm : forms somites
2. Intermediate mesoderm : forms urogenital system
3. Lateral mesoderm

Lateral mesoderm divides into 3a,3b

- 3a. Splanchnopleuric layer(visceral) - cardiac, smooth muscles and Splanchnopleuric layer of body cavities.
- 3b. Somatic layer(parietal) - appendicular skeleton upper limb & lower limb bones Somatic layers of body cavities.

Active space



1st pair : occipital region - 20th day

3 pairs added each day

21st day - 4 pairs, 27th day - 7 pairs

On 35th day (5th week) - 42-44 pairs.

Order of appearance of somites : **cranio-caudal sequence.**

1. Occipital
2. Cervical
3. Thoracic
4. Lumbar
5. Sacral
6. Coccygeal

After 5th week - some somites from occipital & coccygeal region disappear.

So total 37 pairs (approx) after 5th week

**Sclerotome** : forms axial skeleton

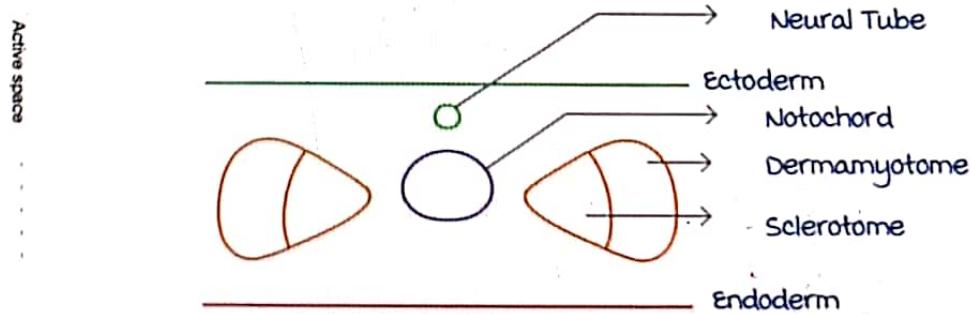
**Ventral** - body of vertebra

Fails to fuse : Hemi vertebra

**Dorsal** - spine of vertebra

Fails to fuse : spina bifida anomalies

**Lateral** - vertebral arch



**Spina bifida occulta:**

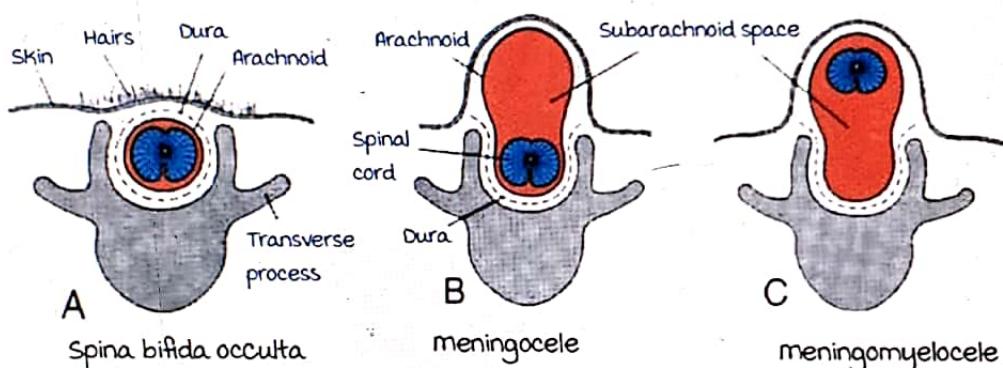
Dorsal sclerotome fails to fuse  
Tuft of hair present over defect

**meningocele:**

Dorsal sclerotome fails to fuse  
Meninges protrude over the defect

**myelomeningocele:**

Dorsal sclerotome fails to fuse  
The protruded meninges contains spinal cord.

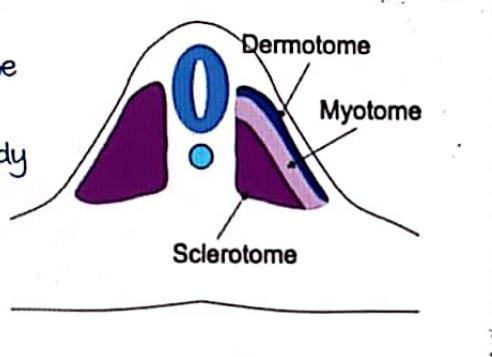


**Dermomyotome:**

Subdivided into Dermatome & myotome

myotome - skeletal muscles of the body

Dermatome - dermal layer of skin



**Note:**

Smooth muscle over dorsal aorta - splanchnopleuric layer of lateral mesoderm > paraxial mesoderm

Smooth muscle over pharyngeal arch arteries - Neural crest cells

Smooth muscle in the iris - Neuro ectoderm

Smooth muscles over sweat & mammary glands - Surface ectoderm

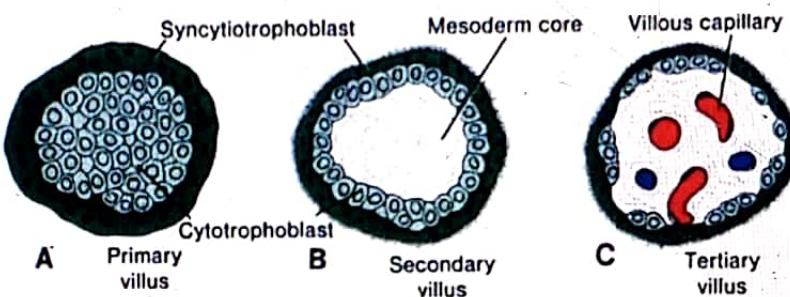
Angiogenesis and hematopoiesis

00:42:56

## Synthesis of blood vessels

mesoderm differentiates into blood vessel

Tertiary villi is formed by the end of 3rd week



Tertiary villi contains :

- Blood vessels
- Somatic layer of EEM
- Cytotrophoblast
- Syncytiotrophoblast

splanchnopleuric layer of extra embryonic mesoderm(EEM)  
differentiates first

Then, somatic layer of extra embryonic mesoderm

Then intraembryonic mesoderm

Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

Hematopoiesis :

## Synthesis of blood cells

3rd week - splanchnopleuric layer of extra embryonic mesoderm

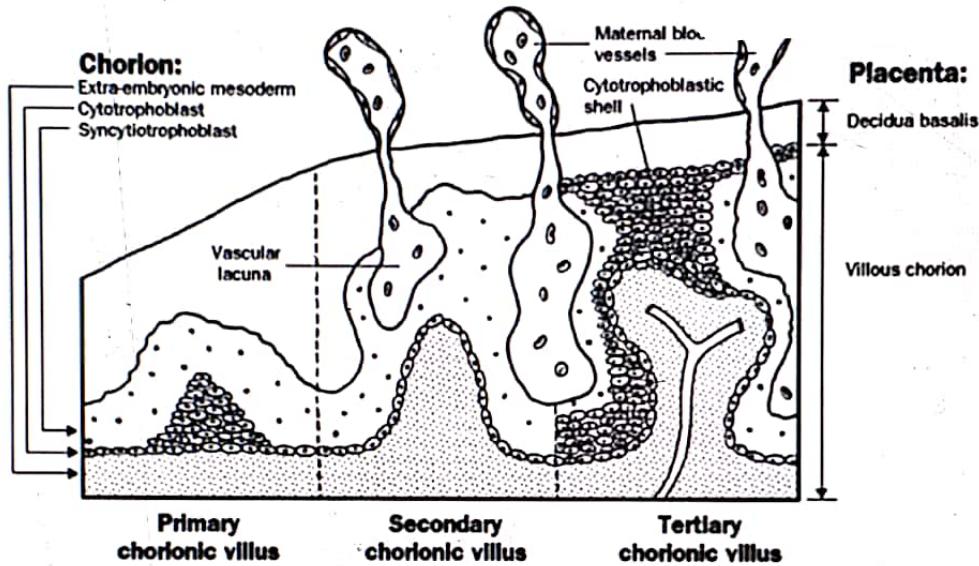
After 3rd week, Liver (upto 7th month)  
Thymus  
Spleen  
Bone marrow

## Development of placenta

00:46:58

maternal component: decidua basalis

Fetal component: villus chorion

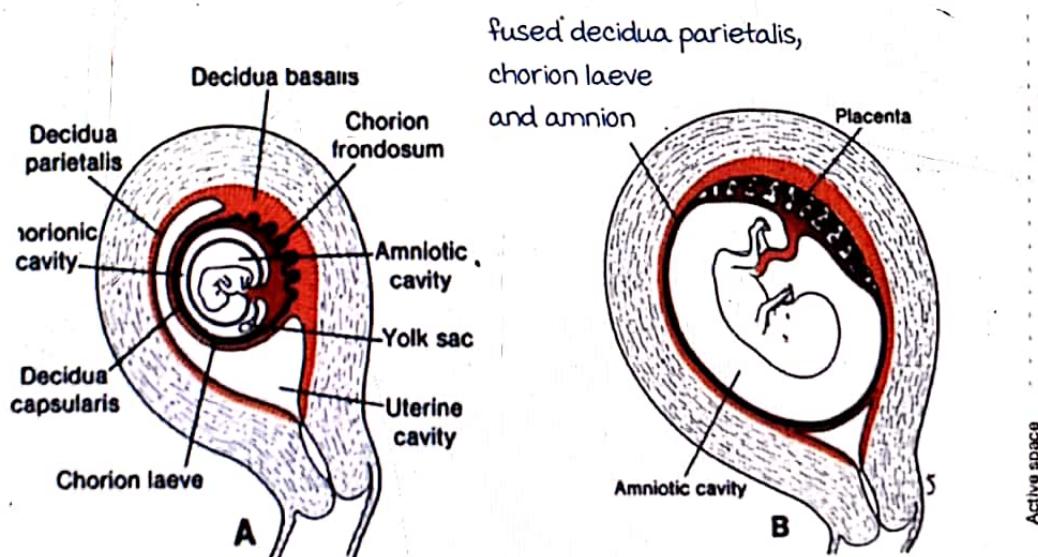


**Decidua:** uterine endometrium during pregnancy.

Decidua basalis – between foetus and myometrium

Decidua capsularis – between uterine cavity & foetus

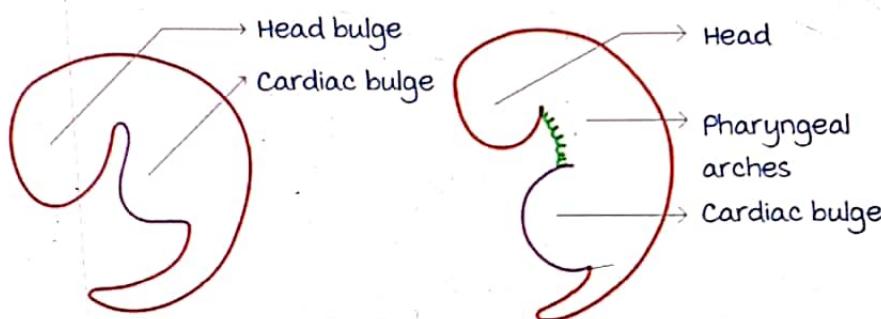
Decidua parietalis – rest of the decidua



## DEVELOPMENT OF HEAD AND NECK

By 4th week the neural crest cells [NCC] migrates to future neck

which forms pharyngeal arches.



- A. Pharyngeal arch
- B. Head bulge
- C. Cardiac bulge
- D. Limb bud

### Pharyngeal arches

00:02:32

It is the mesenchymal condensation.

The mesenchyme is derived from the NCC and paraxial & lateral mesoderm.

There are 5 pharyngeal arches - I, II, III, IV, V, VI.

The 5<sup>th</sup> pharyngeal arch disappears.

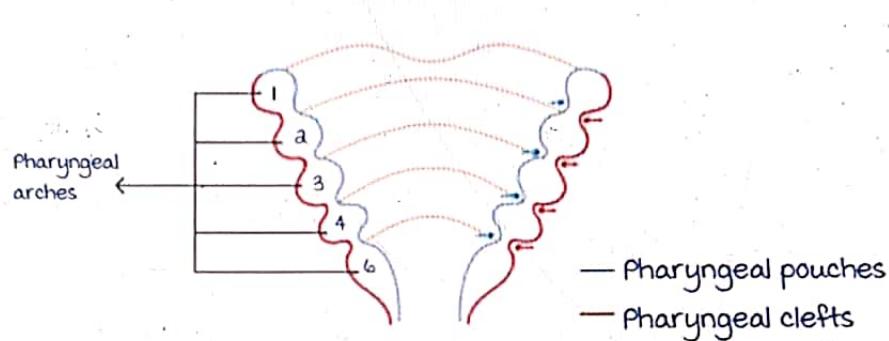
The outer layer - ectoderm

The inner layer - endoderm

The spaces between the ectoderm - cleft.

The spaces between the endoderm - pouches.

Active space



## Derivatives of pharyngeal arches

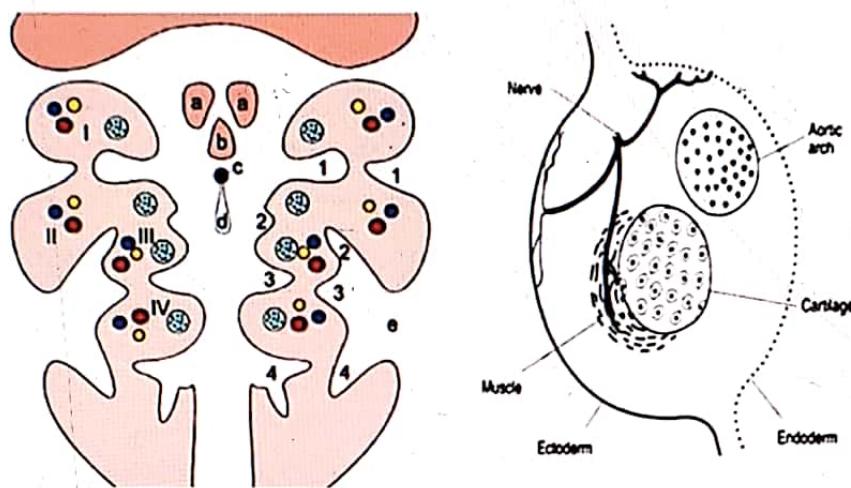
00:05:06

The components of pharyngeal arches :

1. Cartilage
2. muscle
3. Nerve
4. Artery

	Cartilage	nerve	muscles	artery
I arch	meckel's - malleus, incus , anterior ligament of malleolus, sphenomandibular ligament, maxilla, mandible, zygomatic, sphenoid & temporal bones	mandibular nerve	muscles of mastication, temporalis, masseter, medial & lateral pterygoïd, anterior belly of digastric, mylohyoid, tensor palatini & tensor tympani	maxillary artery
II arch	Richert cartilage - Stagé, styloid process, stylohyoid ligament, small horn of hyoid, superior surface of hyoid	Facial nerve / 7 <sup>th</sup> nerve	muscles of the face, posterior belly of digastric, stylohyoid, auricular muscle & stapedius	Stapedial artery
III arch	Inferior surface of hyoid, greater horn of hyoid	Glossopharyngeal nerve / 9 <sup>th</sup> nerve	stylopharyngeus	Common carotid artery, internal and external carotid artery
IV arch	Cartilage of larynx except epiglottis	Superior laryngeal nerve	muscles of pharynx, palate, cricothyroid	right side - Right subclavian artery, left side - Arch of aorta
V arch	Cartilage of larynx except epiglottis	Recurrent laryngeal nerve	muscles of larynx except cricothyroid	Pulmonary artery Distal part on left side ductus arteriosus

Epiglottis - is derived from the mesoderm of hypobranchial eminence of IV arch



### Treacher Collins and Pierre Robin syndrome

Treacher Collins syndrome :

The I arch derivatives fail to differentiate.

c/F - facial asymmetry.

Coloboma of lower eyelid.

External ear anomalies.



Pierre Robin syndrome :

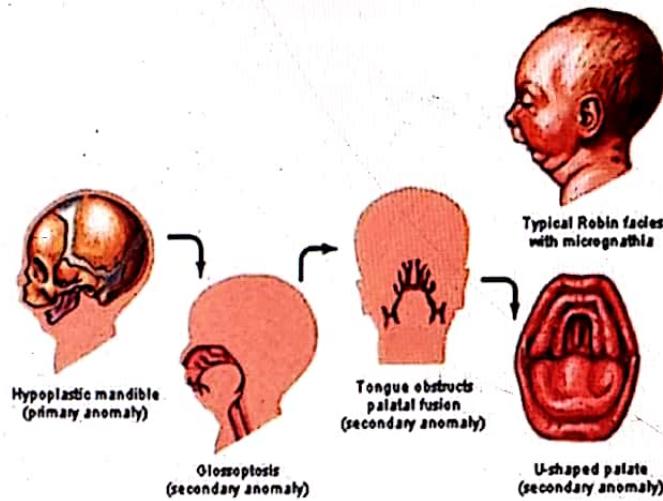
Only the mandible is not well developed.

c/F - Hypoplastic mandible

↓  
Causes posteriorly displaced tongue - glossoptosis

↓  
Obstructs the palate fusion causes - cleft palate

Active space



### Derivatives of endodermal/pharyngeal pouches

00:19:29

I pouch - middle ear

Eustachian tube.

II pouch - tonsillar fossa

Tonsillar epithelium.

III pouch - ventral - thymus

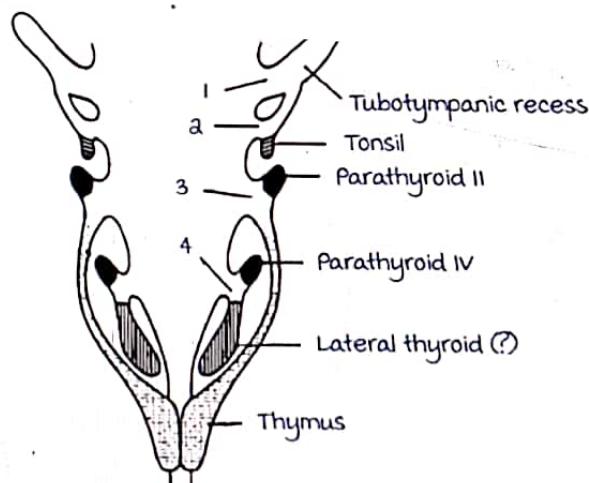
Dorsal - parathyroid III becomes inferior parathyroid.

IV pouch - ventral - ultimobranchial body parafollicular cells

Dorsal - parathyroid IV/superior parathyroid.

Parafollicular cells are derived from:

Neural crest cells > ultimobranchial body.



Clinical correlation:

Digeorge syndrome:

aaqII deletion.

III pouch fails to differentiate.

Thymus and inferior parathyroid poorly developed.

## Derivatives of ectodermal/pharyngeal cleft

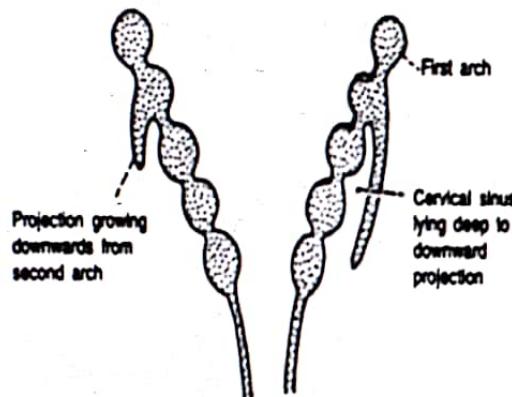
00:23:41

I cleft - external auditory meatus.

II Second arch - growth from II arch fuse with VI arch

Forms cervical sinus - obliterates later.

The remaining clefts obliterates.



Bronchial sinus/cyst:

Cause - Persistent cervical sinus

Location - present on anywhere along the anterior sternocleidomastoid

MC - below the angle of mandible.



## Development of tongue

00:26:40

Active space

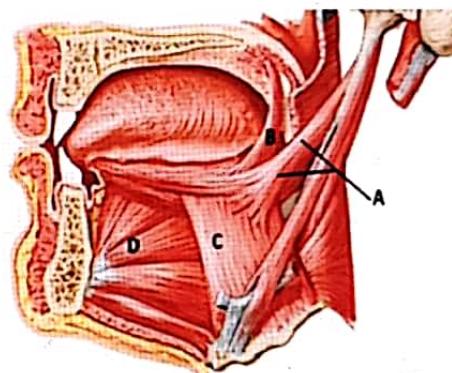
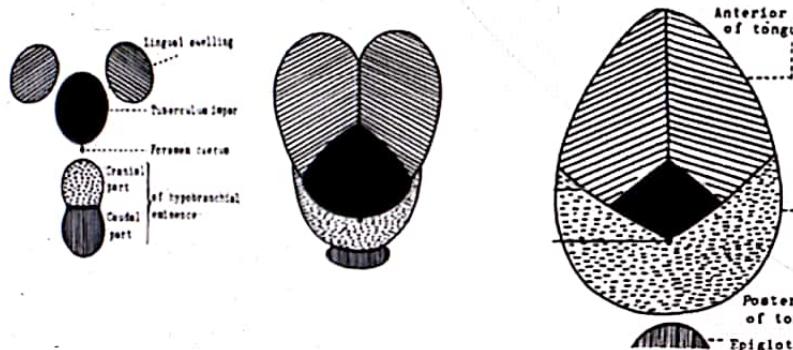
Epithelium of the tongue :

Anterior 2/3<sup>rd</sup> - surface ectoderm.

Posterior 1/3<sup>rd</sup> - endoderm.

muscles

- All the muscles are derived from myotome of **occipital somites** [paraxial mesoderm].
- Except **palatoglossus** [IV pharyngeal arch].



- A. Styloglossus
- B. Palatoglossus
- C. Hyoglossus
- D. Genioglossus

- On the floor of I arch there are three swellings :
  - Two** lingual swellings
  - One** tuberculum impar

↓

Forms anterior  $2/3$ rd of tongue

for of II, III, IV arches - hypobranchial eminence
- The III arch mesoderm of hypobranchial eminence forms

↓

posterior  $1/3$ rd of the tongue.

- The IV arch mesoderm of hypobranchial eminence forms

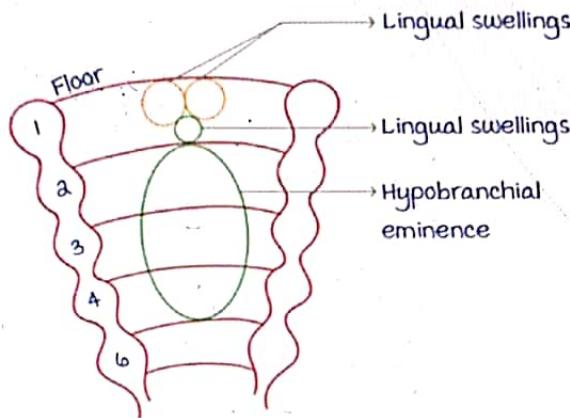
↓

Posterior most part of the tongue and epiglottis.

- The II arch mesoderm does not contribute to tongue development

↓

Because mesoderm of III arch over grows II  
fuse with anterior  $2/3$ rd of tongue.



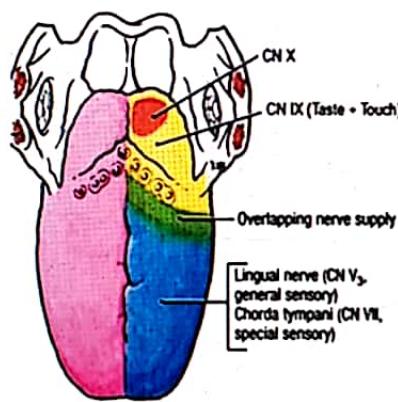
### Nerve supply of the tongue

00:33:43

Anterior 2/3<sup>rd</sup> tongue - mandibular nerve-lingual nerve.

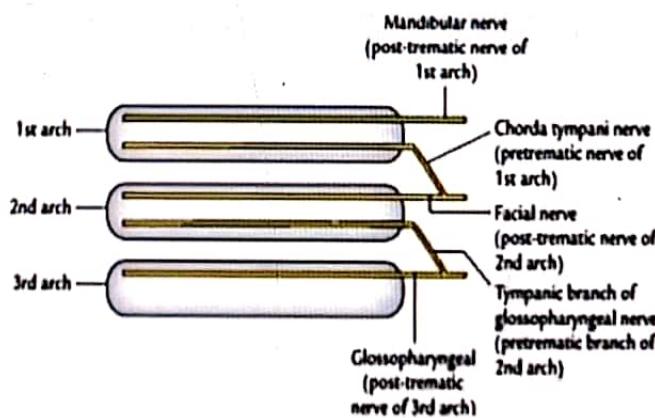
Posterior 1/3<sup>rd</sup> tongue - 9<sup>th</sup> nerve/glossopharyngeal nerve.

Posterior most part of tongue - 1<sup>st</sup> nerve.



Pretrematic and post trematic nerves

arch	Posttrematic nerve	Pretrematic nerve
I arch	mandibular nerve	Chorda tympani
II arch	facial nerve	Tympanic branch of glossopharyngeal nerve
III arch	glossopharyngeal nerve	

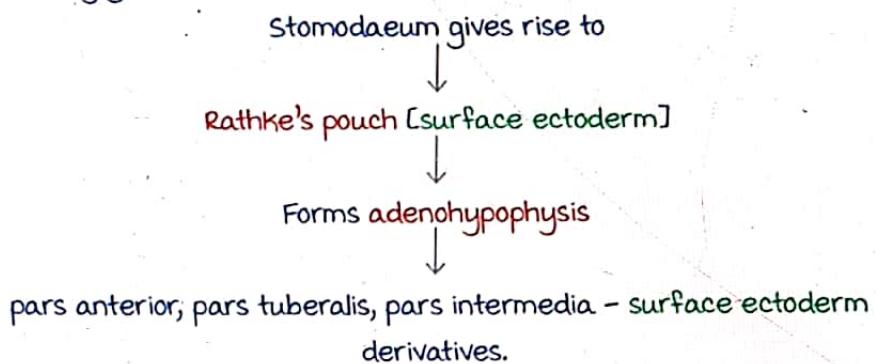


Active space

Development of pituitary

00:36:58

Pituitary gland:

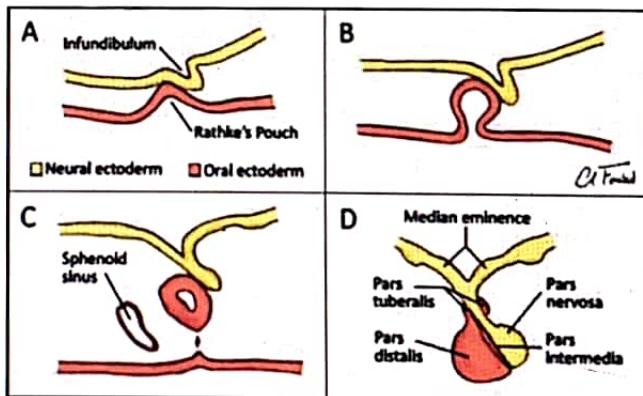


Pars nervosa:

From the diencephalon - neuroectoderm derivative.

a downgrowth called infundibulum

Forms pars nervosa - neuroectoderm derivative

Development of face

00:39:36

Face:

Derived from - frontonasal process

medial &amp; lateral process

maxillary process

mandibular process

Lateral nasal process

Frontonasal process - forms forehead.

medial Nasal Process [mNP] - fuse with each other

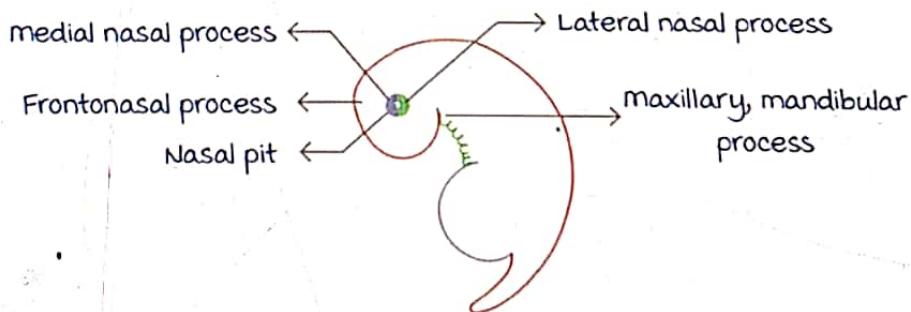
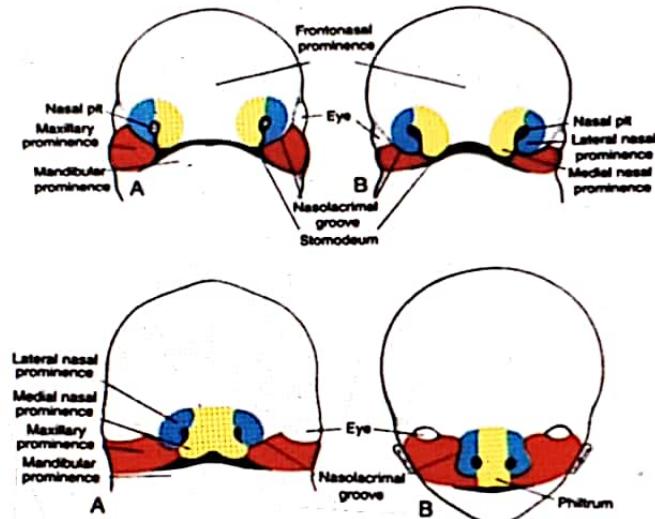
↓  
Forms philtrum and primitive palate.

Lateral Nasal process [LNP] - forms ala of the nose.

maxillary process - upper lip and cheek.

mandibular process - lower lip and chin.

The maxillary process fuses with mNP and LNP.



Clinical correlation :

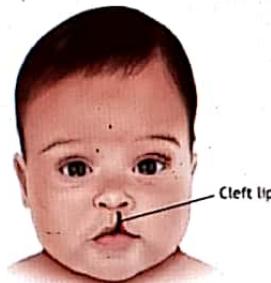


midline cleft upper lip :

Philtrum is absent.

Failure of fusion of mNP

Active space



Cleft upper lip/hare lip  
Failure of fusion of maxillary process with mNP

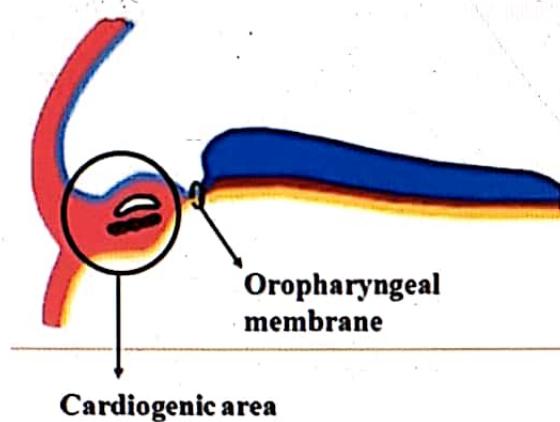


Oblique facial cleft  
Failure of fusion of maxillary process with LNP



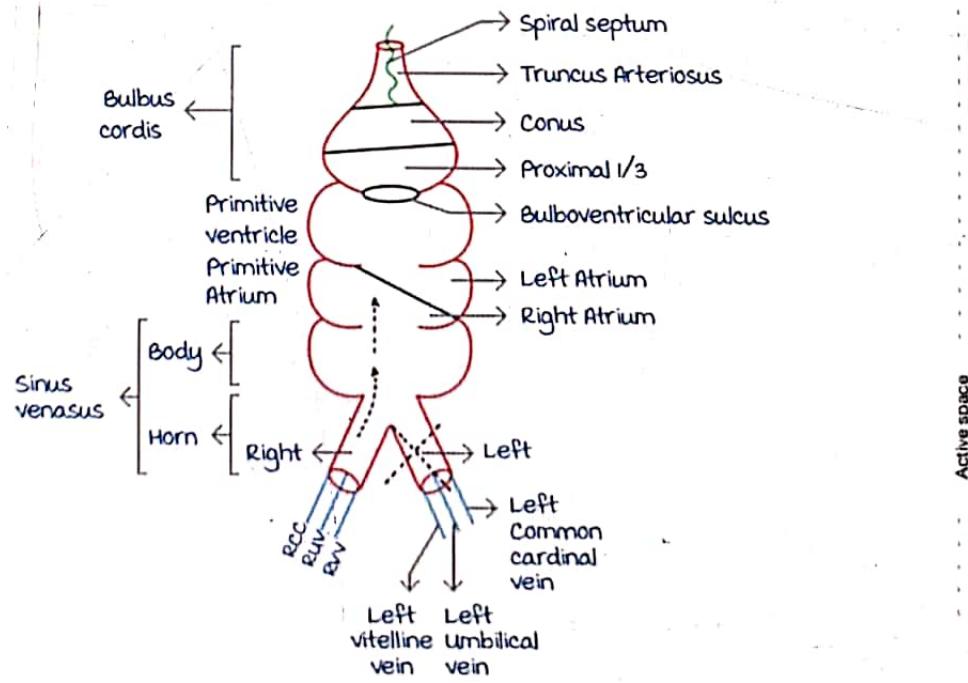
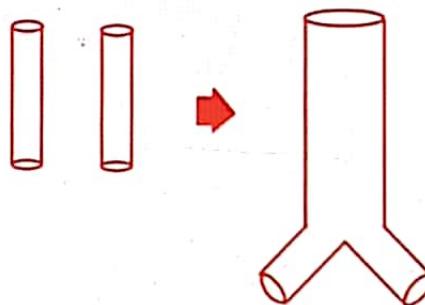
Cleft lower lip  
Failure of fusion of mandibular process

## DEVELOPMENT OF CVS



Cardiogenic area is splanchnopleuric part of lateral mesoderm cranial to oropharyngeal membrane

### Heart Tube formation



## A) Bulbous cordis :

- Proximal 1/3 will form the rough part of the right ventricle
- Conus part will form infundibulum of both right ventricle and left ventricle
- Spiral septum [derived from neural crest cell] is developed in truncus arteriosus and divides it into aorta and pulmonary trunk

B) Primitive ventricle : develops into rough part of left ventricle

C) Bulbo ventricular sulcus : filled with septum which forms interventricular septum

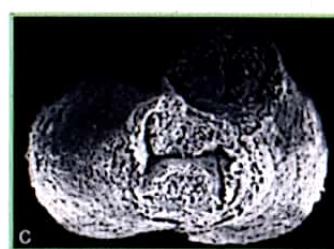
D) Primitive atrium : will form the rough part of both right and left atrium

## E) Sinus venosus :

- Body absorbed into right atrium along with right horn
- Left horn obliterates and forms coronary sinus
- Right common cardinal vein will form superior vena cava
- Right vitelline vein will form inferior vena cava (cranial part)

## Looping of heart :

Due to Dextro looping atrial chamber goes above and behind, ventricle chamber moves front and below

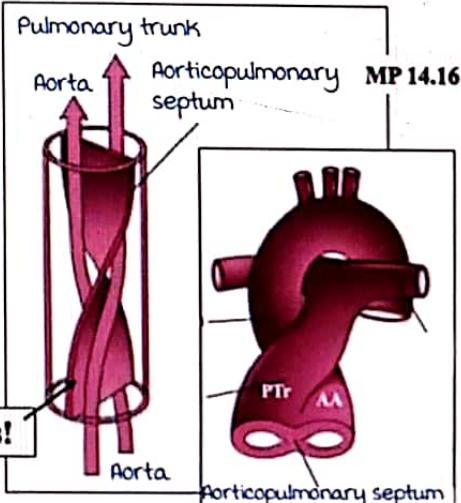


AP septum does NOT form a straight longitudinal septum down the length of the CT region.

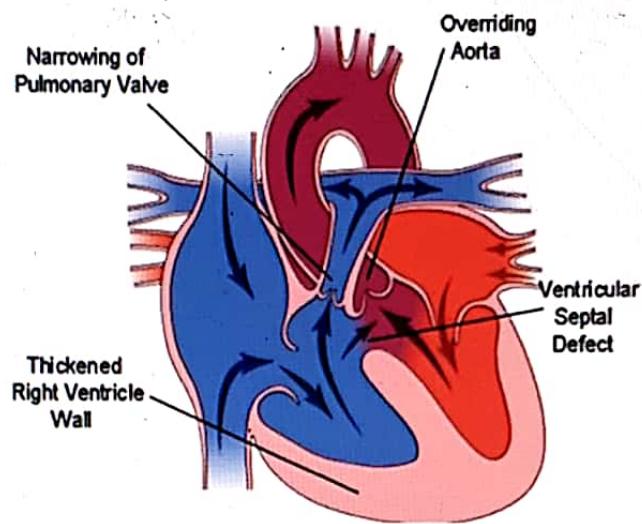


CTCs fuse to form AP septum.  
Divides lumen into equal halves

Spirals!



### Tetralogy of Fallot:

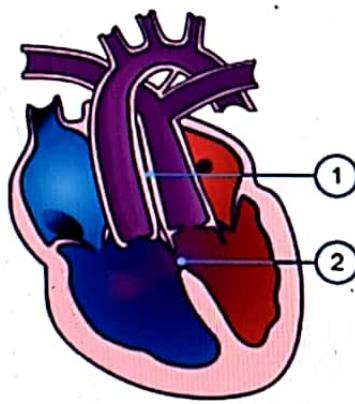


Anterior displacement of spiral septum : pulmonary stenosis

↓  
Overriding of aorta

↓  
Right ventricular hypertrophy  
↓  
ventricular septal defect

### Transposition of great vessels:



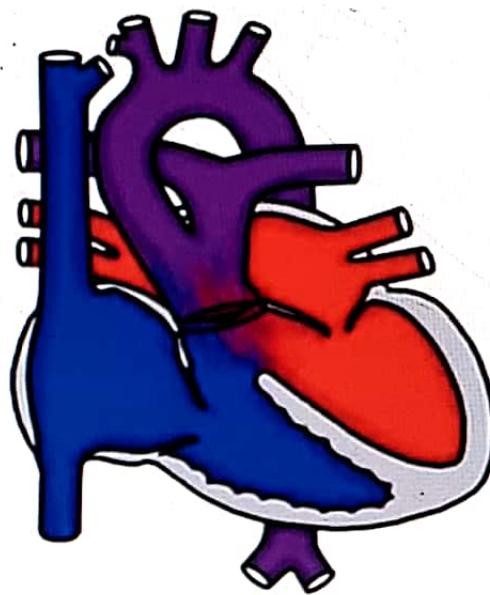
Non spiral course of spiral septum :

Blood from right ventricle → Aorta

Blood from left ventricle → pulmonary trunk

Active space

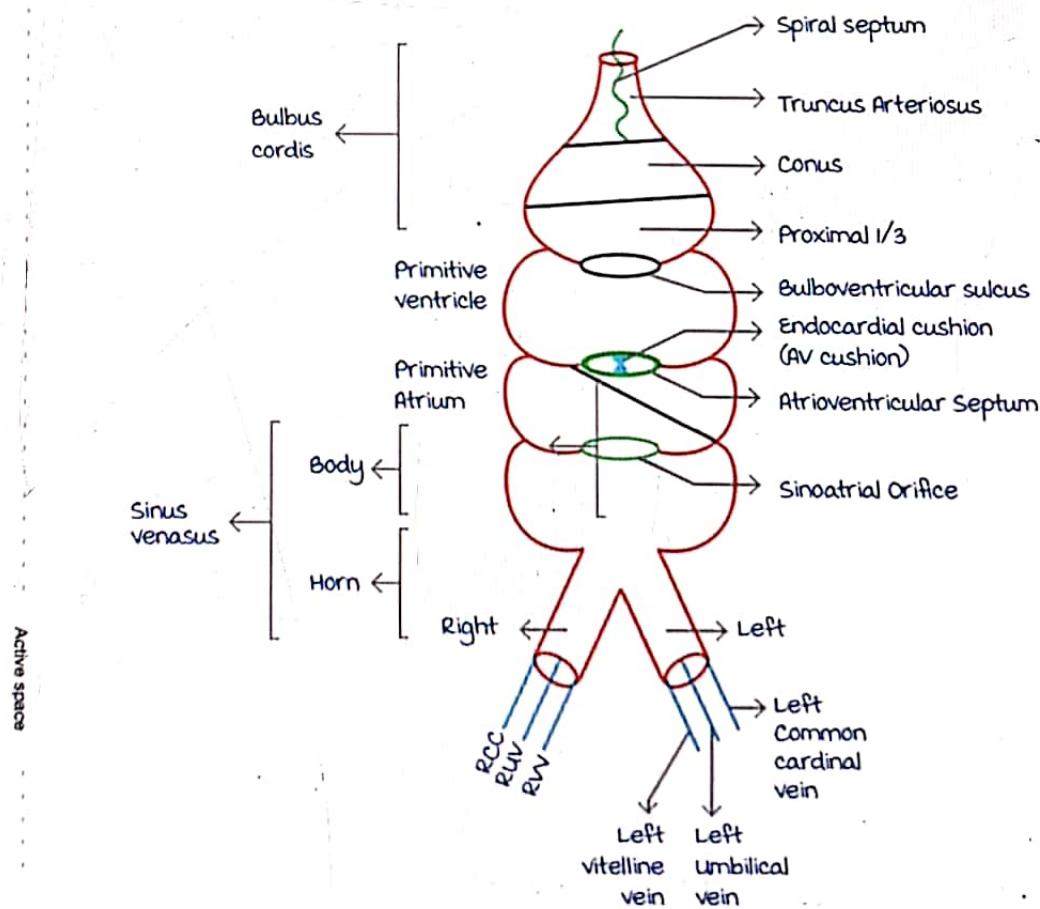
## Persistence of Truncus arteriosus:



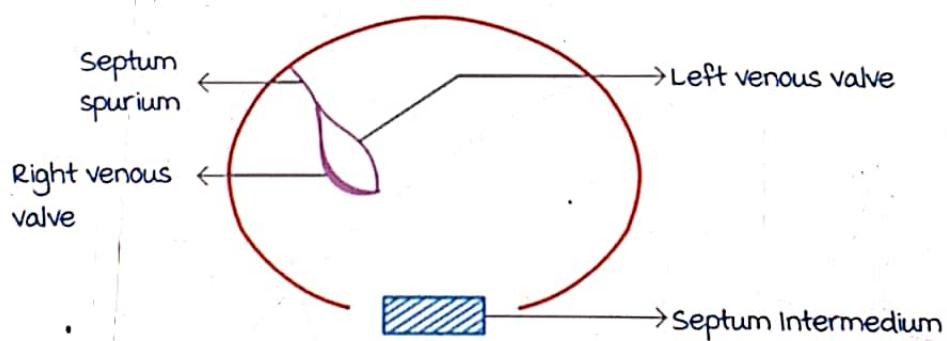
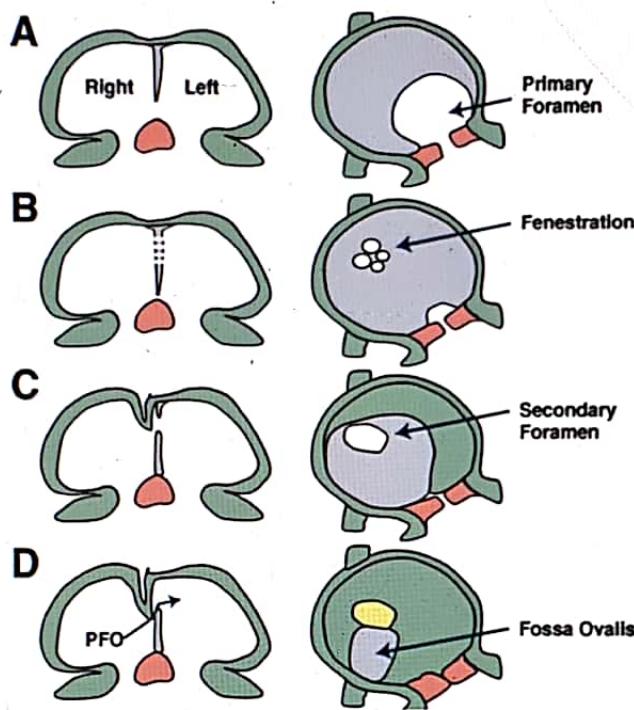
Spiral septum is **not** formed due to non-migration of neural crest cells

Interatrial septum formation

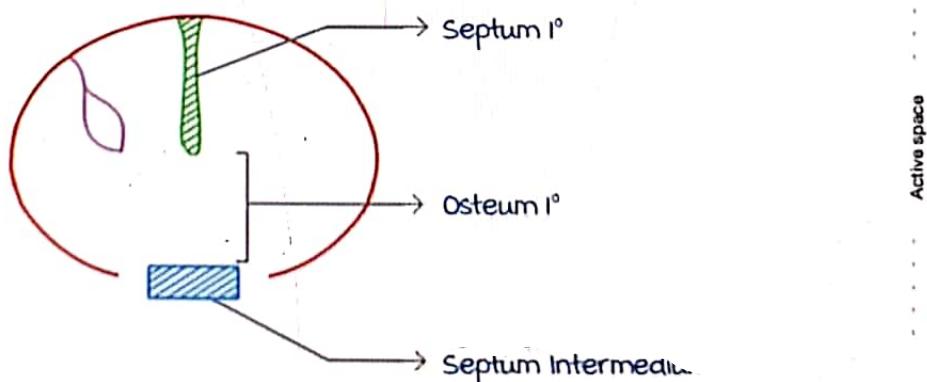
00:15:30



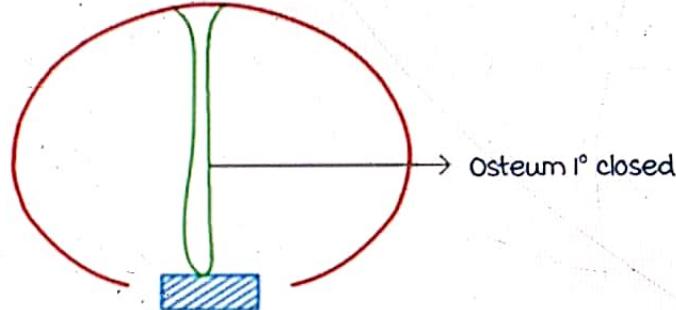
- Sino atrial orifice : absorbed into Right atrium
- AV orifice : Endocardial cushion/AV cushion appear at two ends and join to form septum intermedium



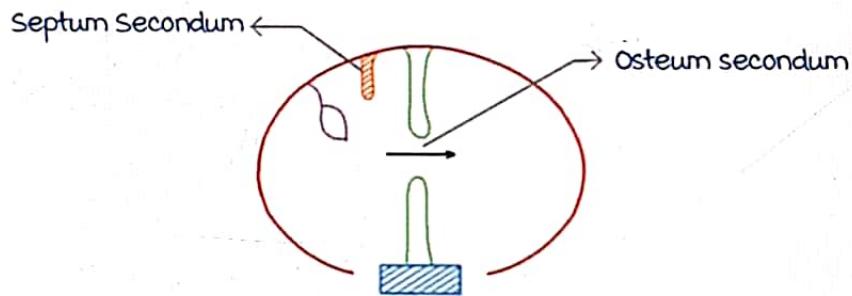
Right venous valve and left venous valve join to form septum spurium



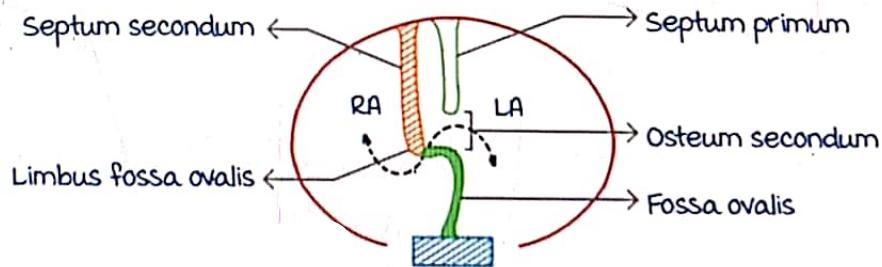
Septum primum will appear and grow toward the septum intermedium.  
The gap between these two is called osteum primum



Septum primum fuses with septum intermedium and osteum primum is closed. Septum primum breaks in the middle



Septum secundum grows till lower level of osteum secundum. Septum secundum is rigid (because left venous valve and septum spurium fuse with septum secundum) whereas septum primum is flap like



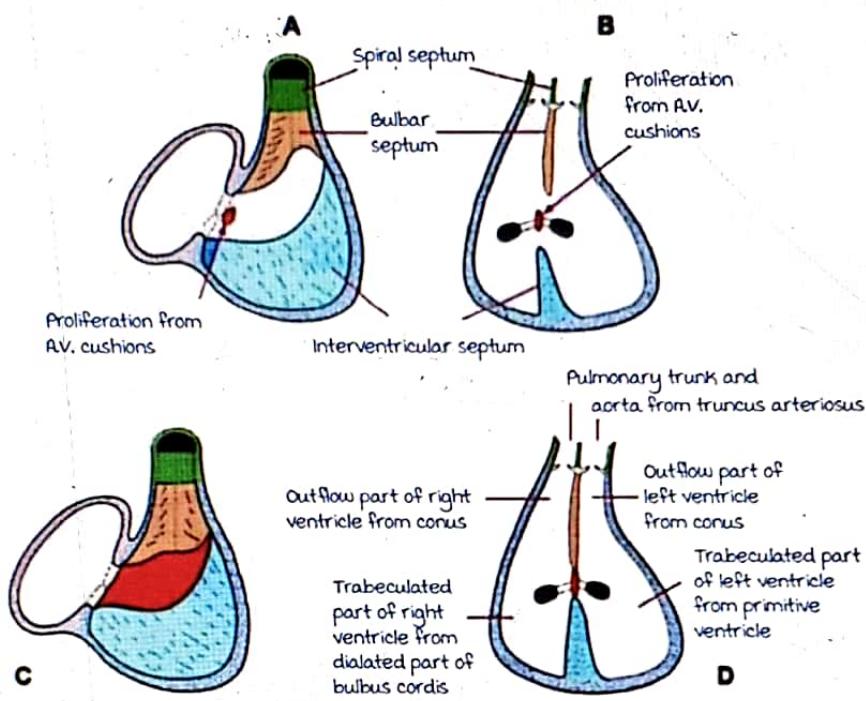
Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

Septum primum → Fossa ovalis

Septum secundum → Limbus fossa ovalis

## Interventricular septum formation

00:28:05



- muscular part: forms from the muscular proliferation of bulb ventricular cavity
- membranous part: derived from proliferation of AV cushion
- Bulbar part: derived from spiral septum

Proximal 1/3 of bulbous cordis (RV) + Primitive ventricle (LV)



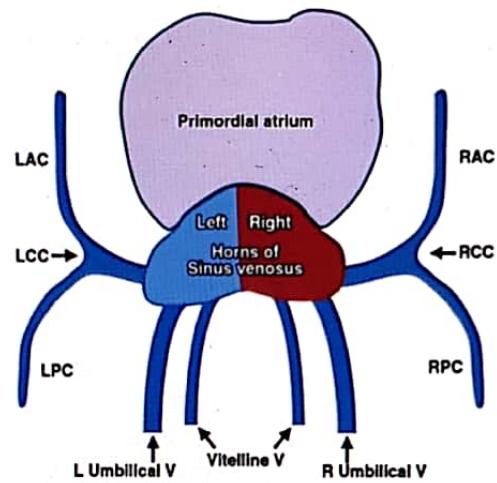
Common ventricular chamber

Active space

# DEVELOPMENT OF VEINS

## Introduction

00:00:01



By the end of 5th week :

Vitelline vein – carries blood from yolk sac into sinus venosus.

Umbilical vein – carries oxygenated blood from placenta to sinus venosus.

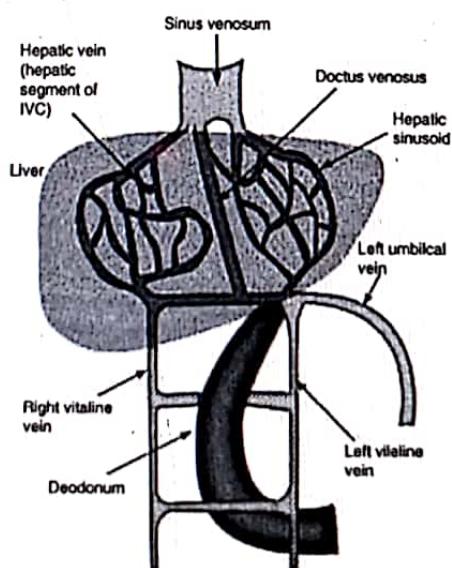
Common cardinal vein – drains from embryo proper into sinus venosus.

Anterior cardinal vein – drains upper part of body to sinus venosus.

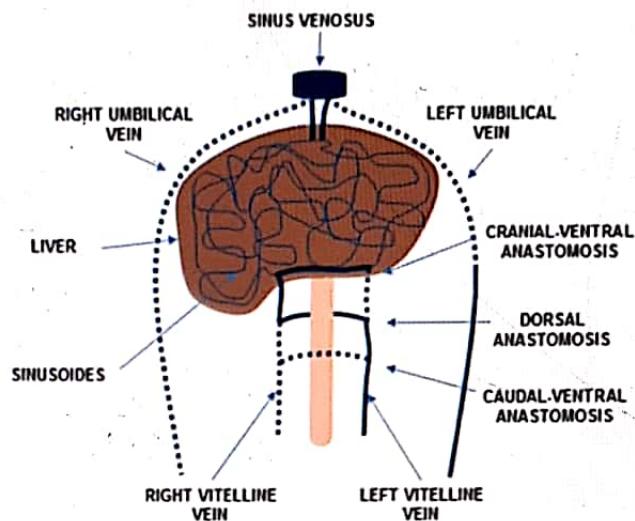
Posterior cardinal vein – drains lower part of body to sinus venosus.

## Vitelline Vein

00:02:05



Active space



Vitelline vein forms plexus (anastomosis) around the duodenum.

- Proximal ventral anastomosis.
- Dorsal anastomosis.
- Distal ventral anastomosis.

This plexus passes through septum transversum and drains into right and left horn of sinus venosus.

Vitelline vein (*in the liver*) – forms sinusoids.

Hepato-cardiac channels – vitelline vein distal to septum transversum.

Right hepato-cardiac channel – *forms cranial part of IVC*.

### Umbilical vein

00:08:00

Right umbilical vein – degenerates.

Gastroschisis – hernia at the site of regression of right umbilical vein.

Left umbilical vein :

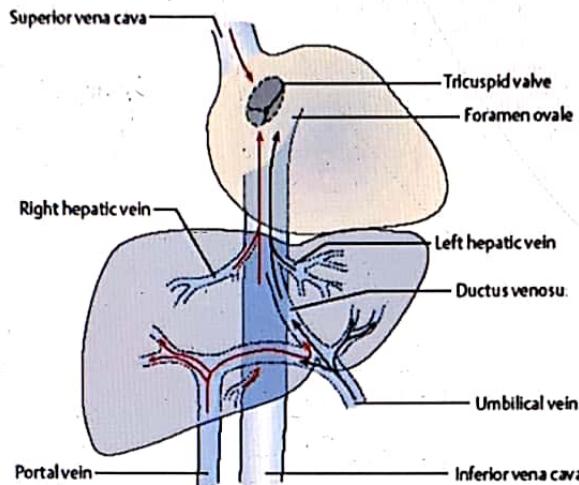
Only source of oxygenated blood.

Drains into left horn of sinus venosus.

Part of left umbilical vein distal to septum transversum obliterates.

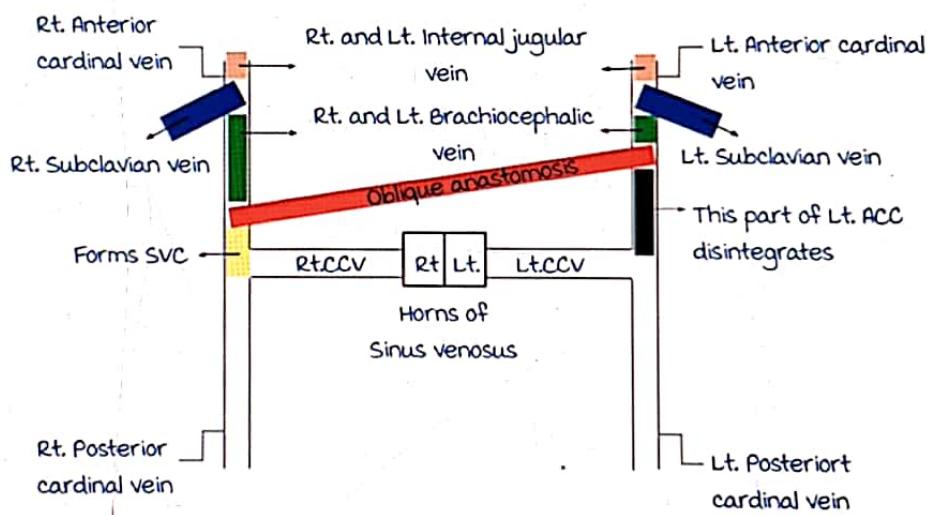
Ductus venosus – shunt from left umbilical vein to right hepato-cardiac channel.

After formation of portal vein, left branch of portal vein connects to IVC via ductus venosus.



## Common cardinal vein

00:12:21



### Subclavian vein:

Derived from intersegmental veins and drains into anterior cardinal veins.

Drains upper and lower limb bud.

### Internal jugular vein:

Derived from anterior cardinal vein (above the subclavian vein opening).

space

### Right brachiocephalic vein:

Derived from right anterior cardinal vein.

Present between right subclavian vein opening and oblique anastomosis opening.

Left brachiocephalic vein:

Derived from oblique anastomosis and left anterior cardinal vein.

Present between left subclavian vein opening and oblique anastomosis opening.

Left anterior cardinal vein - present below oblique anastomosis disappears/disintegrates.

Superior venacava (SVC):

Derived from right anterior cardinal vein (below the oblique anastomosis) and right common cardinal vein.

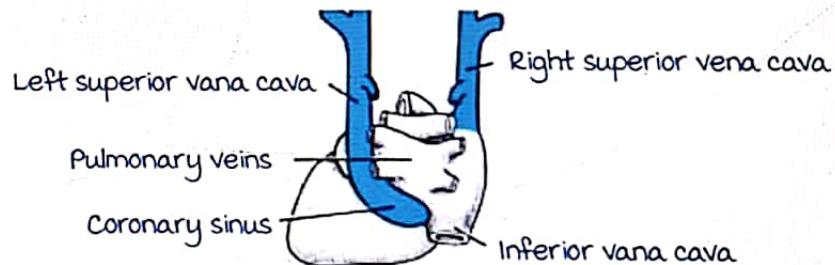
### Double Superior Vena Cava

00:19:43

Occurs due to persistence of left anterior cardinal vein (below oblique anastomosis) and no oblique anastomosis formation.

Right SVC - opens into right atrium.

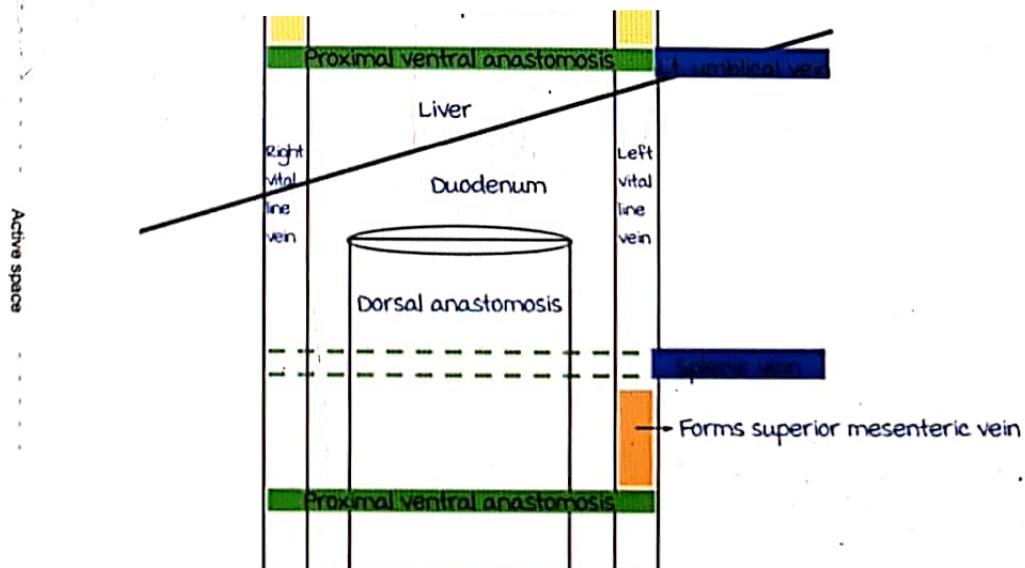
Left SVC - opens into coronary sinus.



Double superior vena cava. The communicating (brachiocephalic) vein between the two anterior cardinals has failed to develop (dorsal view)

### Portal Vein formation

00:22:03



2 ventral anastomosis and 1 dorsal anastomosis.

Splenic vein - joins at dorsal anastomosis.

Left umbilical vein - joins at proximal ventral anastomosis.

Superior mesenteric vein - derived from left vitelline vein (between dorsal anastomosis and distal ventral anastomosis).

**Portal vein formed by 2 structures:**

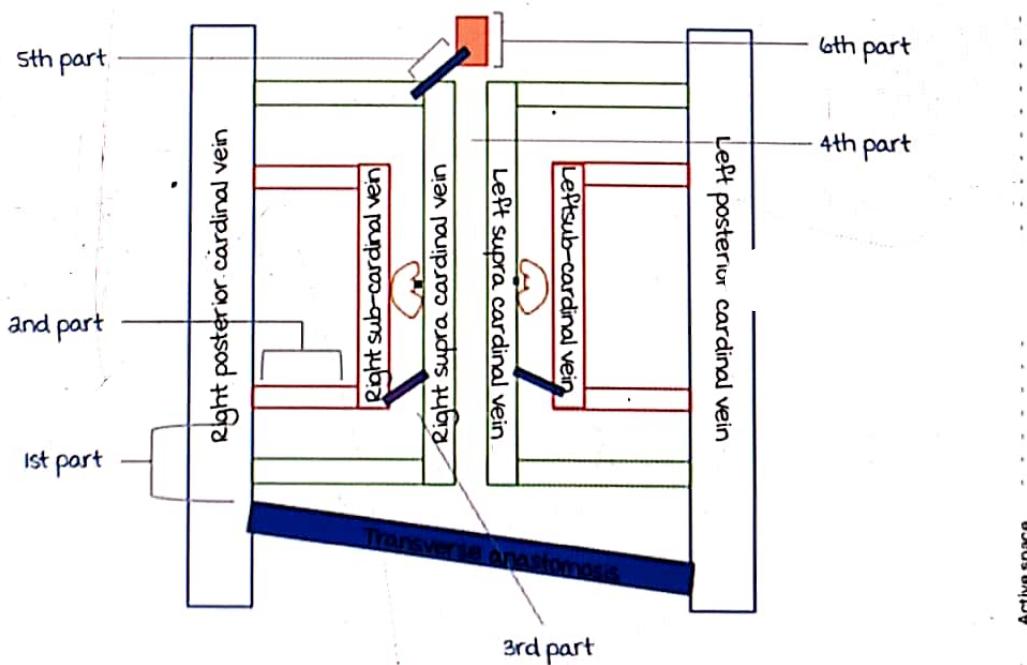
- Dorsal anastomosis.
- Right vitelline vein (present between proximal ventral anastomosis and dorsal anastomosis).

Right branch of portal vein - derived from right vitelline vein (distal to proximal ventral anastomosis).

Left branch of portal vein - derived from proximal ventral anastomosis and left vitelline vein (distal to proximal ventral anastomosis).

## Inferior Vena Cava formation

00:29:07



IVC is derived from:

1<sup>st</sup> part - derived from right posterior cardinal vein (present between transverse anastomosis and caudal opening of right supra cardinal vein).

This part is also known as **sacro-cardinal vein**.

2<sup>nd</sup> part - derived from right supra cardinal vein.

3<sup>rd</sup> part - derived from anastomosis between right supra cardinal vein and sub-cardinal vein.

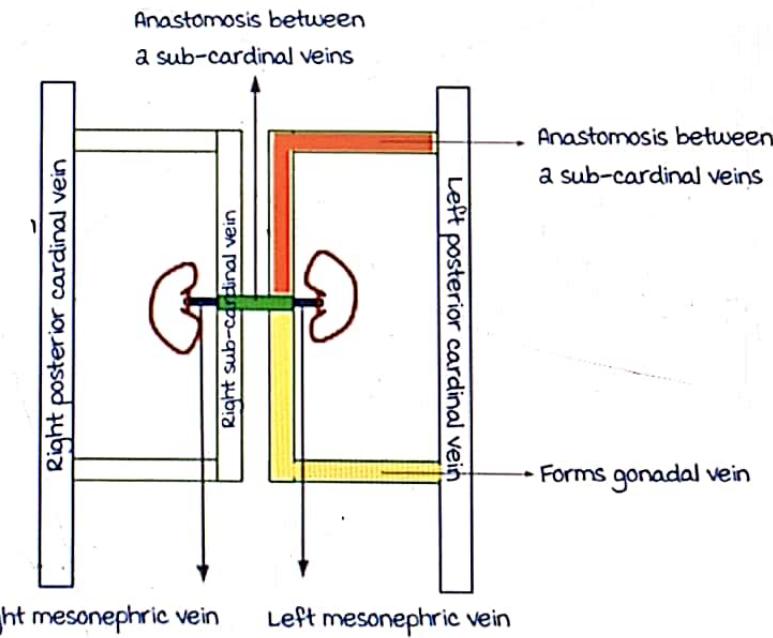
4<sup>th</sup> part - derived from right sub-cardinal vein.

5<sup>th</sup> part - derived from anastomosis between right sub-cardinal vein and right hepato-cardiac channel.

6<sup>th</sup> part - derived from right hepato-cardiac channel.

## Renal vein

00:35:53



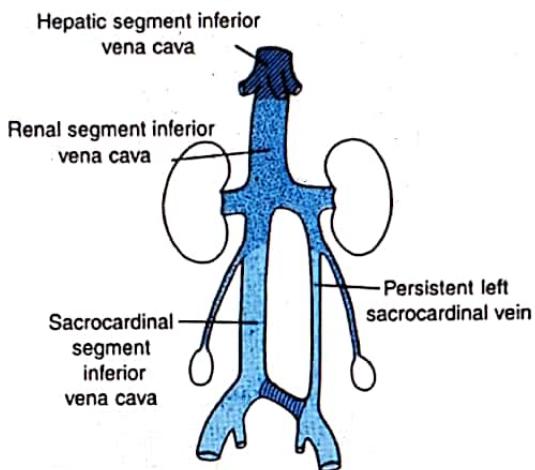
Right renal vein - derived from right mesonephric vein.

Left renal vein - derived from left mesonephric vein + left subcardinal vein + right subcardinal vein + anastomosis between right subcardinal vein.

Left suprarenal vein and left gonadal vein – drains into left renal vein.

## Double Inferior Vena Cava

00:37:58



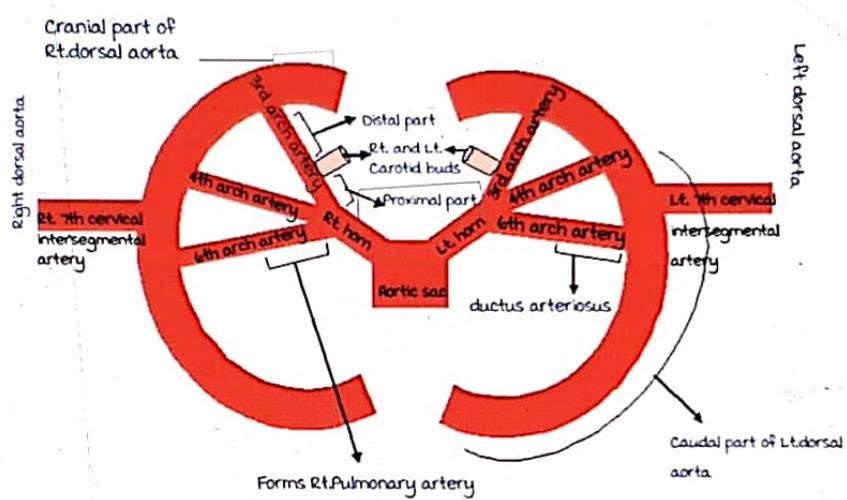
Occurs due to persistence of Sacrocardinal vein > subcardinal vein and supracardinal vein

Active space

# DEVELOPMENT OF PHARYNGEAL ARCH ARTERIES

## Aortic Arches

00:00:01



Aortic sac - cranial part of the truncus arteriosus.

1<sup>st</sup> arch artery - disappears and leaves remnant that forms maxillary artery.

2<sup>nd</sup> arch artery - disappears and leaves remnant that forms stapedial artery

Arch of aorta is derived from:

- Left horn of aortic sac.
- 4<sup>th</sup> arch artery.
- Left dorsal aorta (caudal part).

Brachiocephalic trunk - derived from right horn of aortic sac.

Common carotid artery - derived from 3<sup>rd</sup> arch artery (proximal part).

Internal carotid artery - derived from 3<sup>rd</sup> arch artery (distal part) and dorsal aorta (cranial part).

External carotid artery - derived from carotid bud.

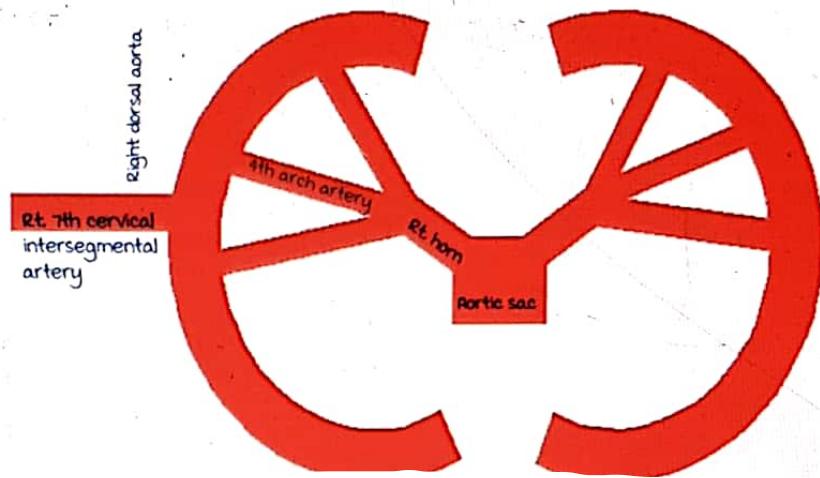
Pulmonary artery - derived from 6<sup>th</sup> arch artery (proximal part).

Ductus arteriosus - derived from left 6<sup>th</sup> arch artery (distal part).

Active space

## Formation of Subclavian Vein

00:07:21



Right subclavian artery is derived from:

- Right 4<sup>th</sup> arch artery.
- Right dorsal aorta (cranial to 7<sup>th</sup> cervical intersegmental artery).
- Right 7<sup>th</sup> cervical intersegmental artery.

Abnormal right subclavian artery/Lusorian artery :

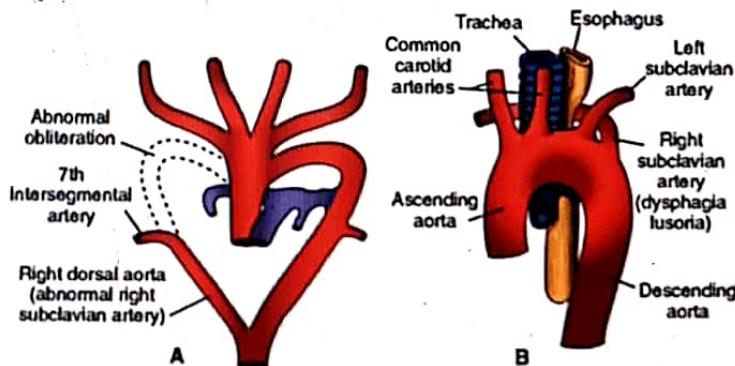
- Right 4<sup>th</sup> arch artery and right dorsal aorta (cranial to 7<sup>th</sup> cervical intersegmental artery) – disappears.
- Right 7<sup>th</sup> cervical intersegmental artery and right dorsal aorta (caudal to 7<sup>th</sup> cervical intersegmental artery) – persists.

Abnormal right subclavian artery passes behind oesophagus and compresses it causing dysphagia (condition is known as **dysphagia lusoria**).

Note:

- Right 4<sup>th</sup> arch artery – forms right subclavian artery.
- Left 4<sup>th</sup> arch artery – forms arch of aorta.

Active space



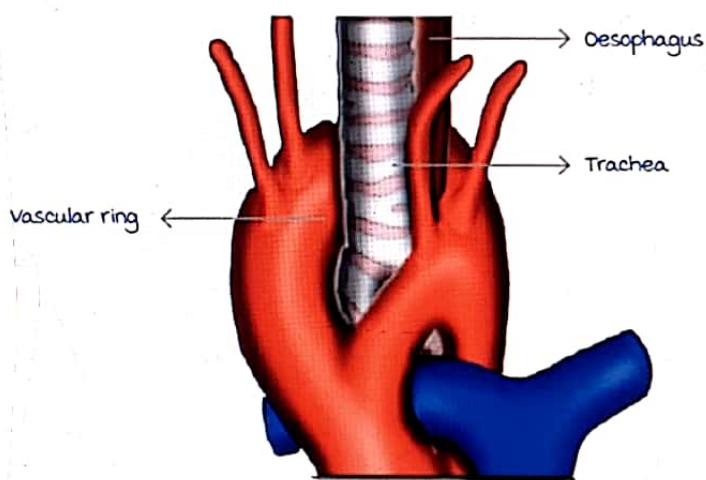
## Summary of Aortic Arches

00:14:50

- 1<sup>st</sup> arch artery - disappears and forms maxillary artery.
- 2<sup>nd</sup> arch artery - disappears and forms stapedial artery.
- 3<sup>rd</sup> arch artery - forms common carotid, external carotid and internal carotid arteries.
- 4<sup>th</sup> arch artery - right subclavian artery (on right side) and, arch of aorta (on left side).
- 6<sup>th</sup> arch artery - proximal part forms pulmonary artery and, distal part (on left side) forms ductus arteriosus.

## Double aortic arch

00:16:22



Normally right dorsal aorta (caudal part) - disappears.  
But, in double aortic arch - both sides dorsal aorta (caudal part) persists and, forms a vascular ring around trachea and oesophagus.

## Ductus Arteriosus

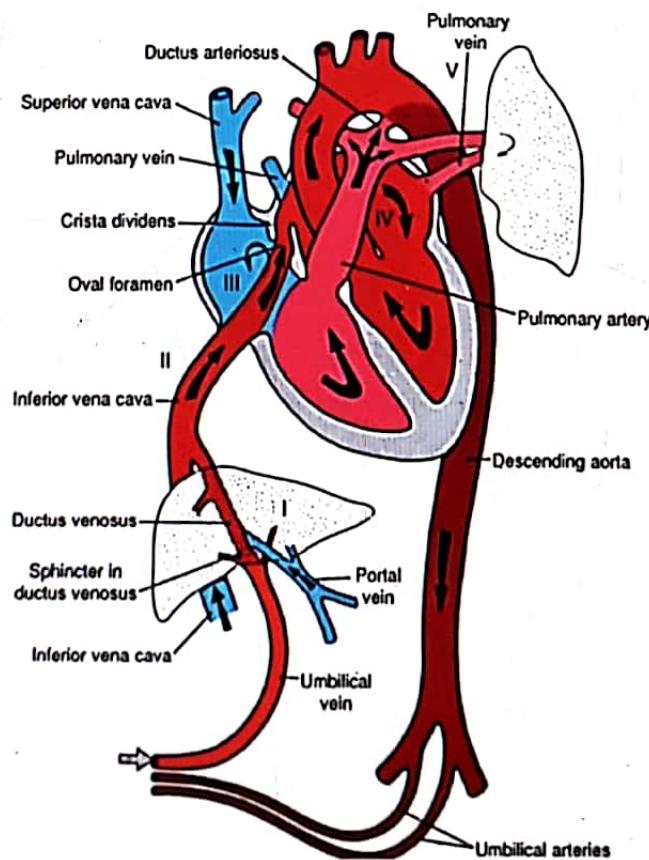
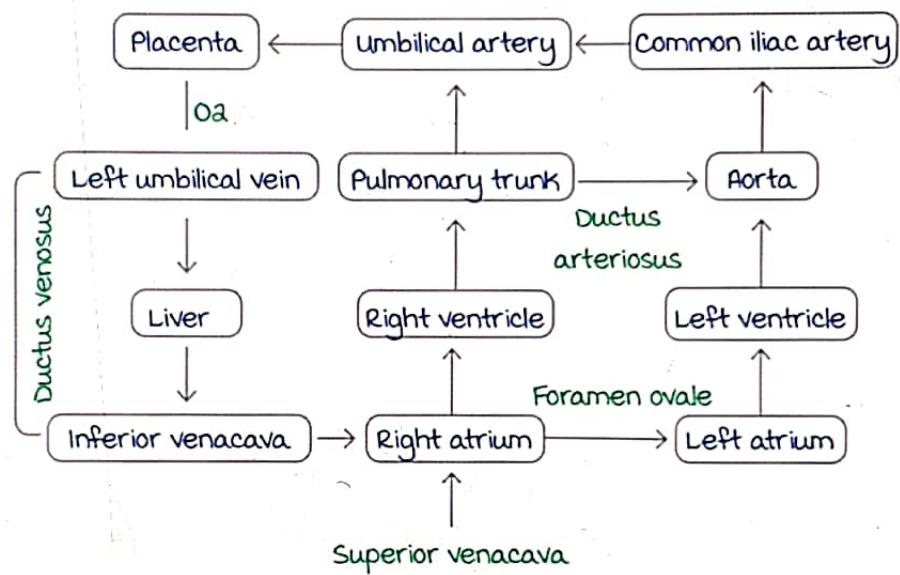
00:18:53

Derived from left 6th arch artery (distal part).  
Connects left pulmonary artery to arch of aorta.  
Normally closes within 10-15 hours after birth.  
Persistent ductus arteriosus (PDA) - failure of closing of ductus arteriosus, leading to Acyanotic heart disease.

# FETAL CIRCULATION

## Fetal circulation pathway

00:00:03



Active space

## Changes after birth and derived remnants

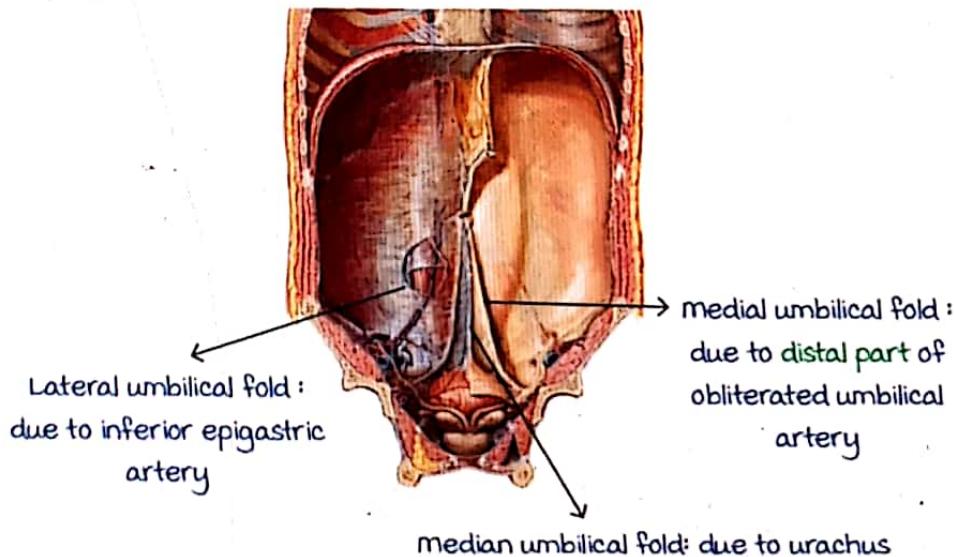
00:02:28

Changes occurring	Remnants derived
Closure of umbilical artery	Proximal part of umbilical artery forms superior vesicle artery Distal part of umbilical artery forms medial umbilical artery
Closure of ductus venosus and umbilical vein	Left umbilical vein forms ligamentum teres Ductus venosus forms ligamentum venosum
Closure of ductus arteriosus	It may persist as patent ductus arteriosus (PDA)
Closure of foramen ovale	Septum primum forms fossa ovalis Septum secundum forms limbus fossa ovalis

## Timeline for closure of various structures

00:05:56

Structure	Functional closure	Anatomical closure
Ductus venosus	After removal of placenta	7 <sup>th</sup> day
Foramen ovale	Immediately after birth	1 month - 1 year
Ductus arteriosus	10-15 hours after birth	10-21 days

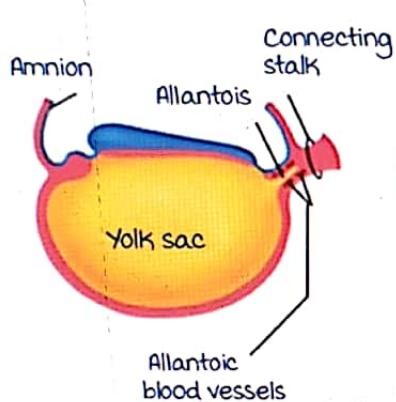


# DEVELOPMENT OF FOREGUT

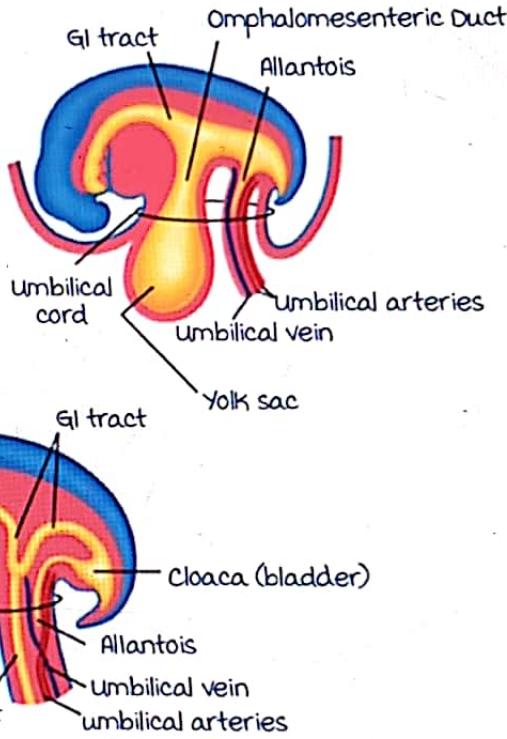
## Basics of Development

00:00:07

A. Three-week embryo



B. Four-week embryo



C. Five-week embryo

Gut tube epithelium derived from endoderm of yolk sac.

		Artery	Sympathetic supply	Parasympathetic Supply
Foregut	upto and part of Duodenum (Ampulla of vater)	Celiac trunk	Greater splanchnic nerve (T5 – T9)	Vagus nerve
midgut	upto transverse colon right a/3rd	Superior mesenteric artery (SMA)	Lesser splanchnic nerve T10 – T11	Vagus nerve
Hindgut	Rest of the gut till anal canal	Inferior mesenteric artery (IMA)	Least splanchnic nerve (T12) Lumbar splanchnic nerve (L1 – L2)	S2,S3,S4 <b>Nervi erigentes</b>

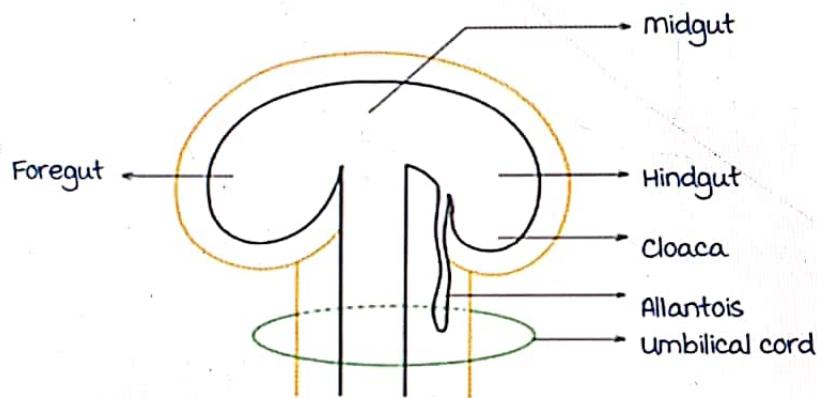
Active space

Pain fibres are carried by sympathetic fibres.

Appendix - midgut. (T10-T11)

Umbilicus - level of L3-L4 - Dermatome

In appendicitis, referred pain is in umbilical area due to common Dermatome - same segmental innervation.

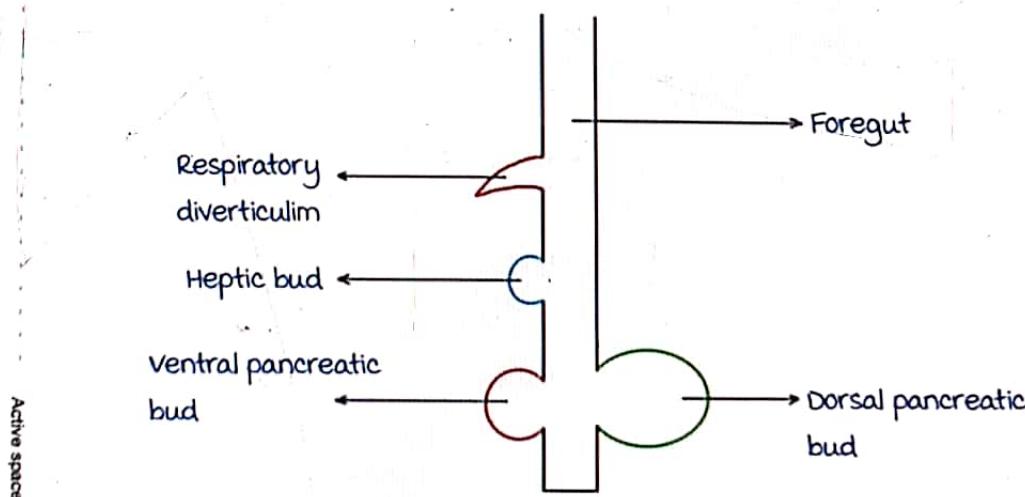


Contents of umbilical cord :

- Right and left umbilical artery
- Left umbilical vein
- Vitellointestinal duct
- Allantois
- Wharton's jelly

### Development of foregut

00:07:57



Foregut tube :

- Respiratory diverticulum
- Hepatic bud
- Ventral pancreatic bud
- Dorsal pancreatic bud

Laryngotracheal diverticulum is the first sign of respiratory system development.

Esophagus :

Separated from trachea by tracheo-esophageal septum.

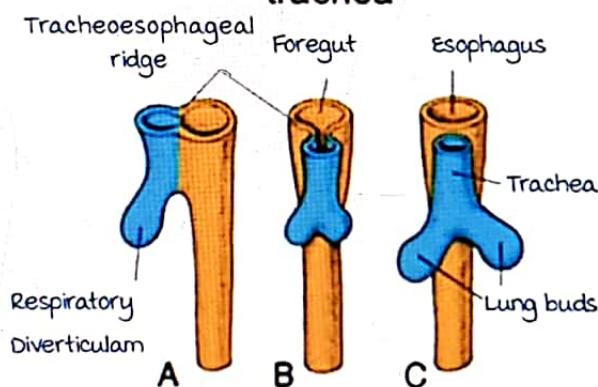
Tracheo-esophageal fold deviates posteriorly

Esophageal atresia

Foetus unable to swallow

Polyhydramnios

### Splitting of foregut into esophagus and trachea



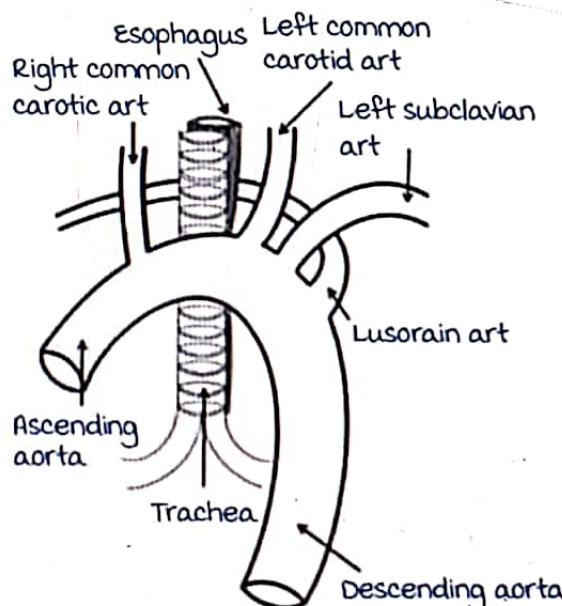
Tracheo-esophageal ridges : longitudinal ridges that eventually fuse to separate trachea from esophagus.

Lusorian artery :

Abnormal Right subclavian artery goes behind the esophagus

Compresses esophagus

Dysphagia lusoria



## Development of stomach

00:12:52

Rotates 2 times in clockwise direction.

1st rotation- vertical axis

Anterior border becomes right border.

Posterior border becomes left border.

Left border - grows rapidly, becomes superficial

Right border - grows slowly, more posterior

Left vagus : superficial- Anterior vagal trunk

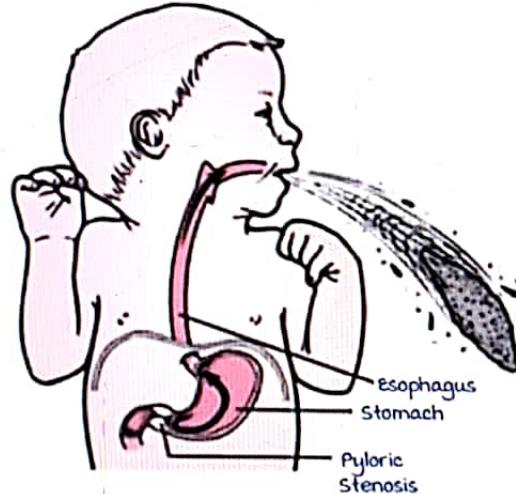
Right vagus : posterior vagal trunk

2nd rotation- Antero-posterior axis

Upper end (cardiac end) becomes left side

Lower end (pylorus) becomes right side

Hypertrophic pyloric stenosis :



muscularis externa in the pyloric part - hypertrophy



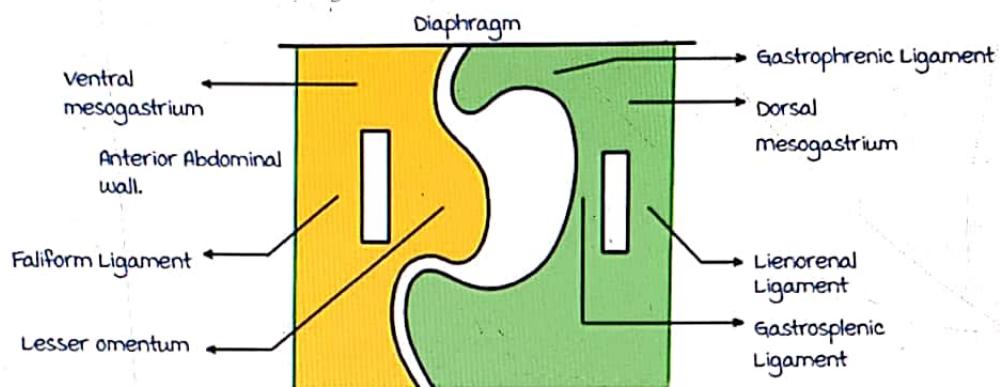
Palpable mass in right costal margin



Obstruct lumen & projectile vomiting  
Immediately after feeding

## Peritoneal folds of stomach

00:17:53



Ventral mesogastrium :

Mnemonic - Lesser FACT

- Lesser omentum
- Falciparum ligament
- Coronary ligament
- Triangular ligament

Dorsal mesogastrium :

- Gastroplenic ligament
- Lienorenal ligament
- Gastrophrenic ligament
- Greater omentum

## Duodenum and liver

00:23:25

Derived from foregut + midgut

Supply : celiac trunk & superior mesenteric artery

During rotation of stomach, duodenum comes to right side, forms a C shaped loop

mesoduodenum : suspends duodenum from Posterior abdominal wall.

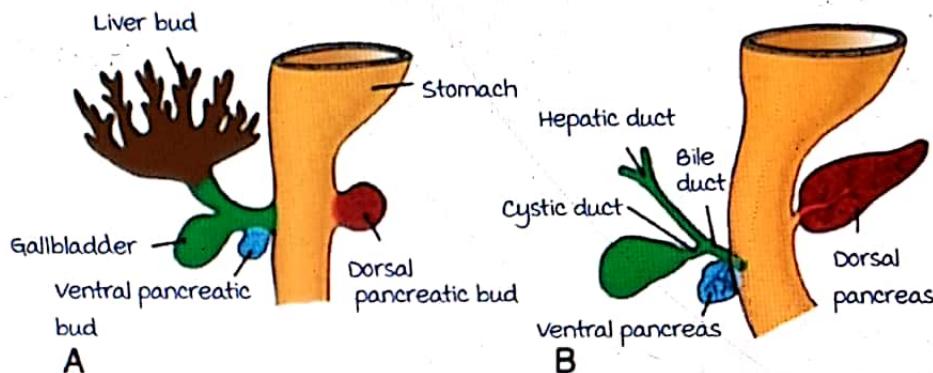


Disappears - duodenum becomes retroperitoneal.

Active space

Duodenum retroperitoneal except the 1st proximal part of duodenum

## Liver:



From 2 sources - liver bud and septum transversum

Liver bud -

In foregut tube

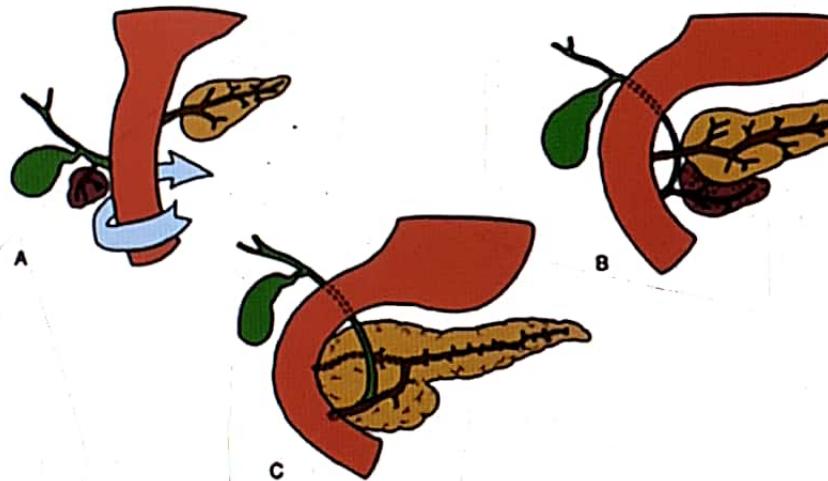
Forms parenchyma of liver & biliary system

Septum transversum -

Forms connective tissue of liver, capsule, sinusoids, Kupffer cells.

## Pancreas

00:28:07



Two buds :

Dorsal pancreatic bud

Ventral pancreatic bud

Ventral bud moves dorsally, lies below the dorsal bud.

Ventral bud - part of head of pancreas + uncinate process

Dorsal bud - remaining entire pancreas

Main pancreatic duct derived from distal part of dorsal bud & whole of

ventral bud

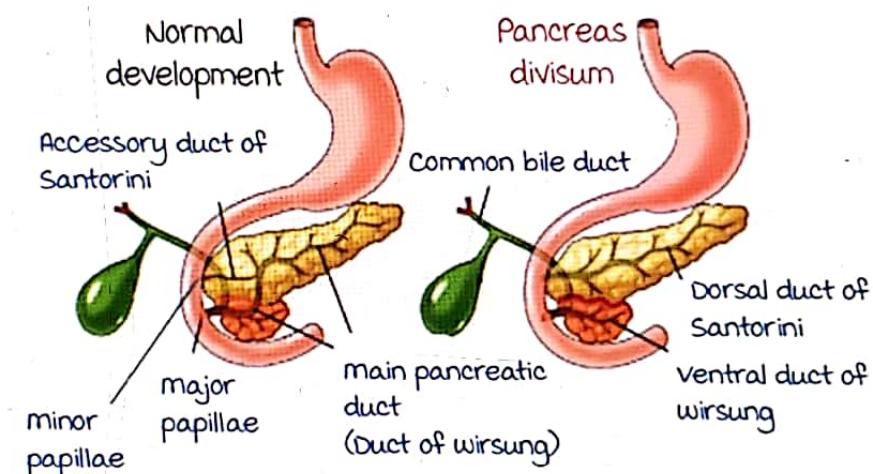
Common bile duct + pancreatic bud - **ampulla of vater.**

**Pancreatic divisum:** most common anomaly in development of pancreas.

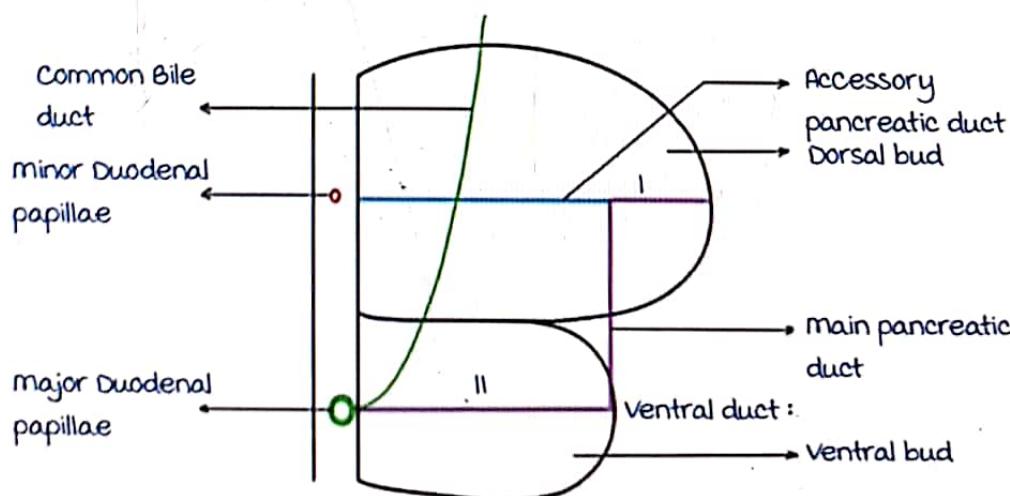
pancreas - divided

Ventral bud : drained by ventral duct - opens into major duodenal papillae

Dorsal bud :- drained by dorsal duct - minor duodenal papillae



**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.



Annular pancreas

00:34:35

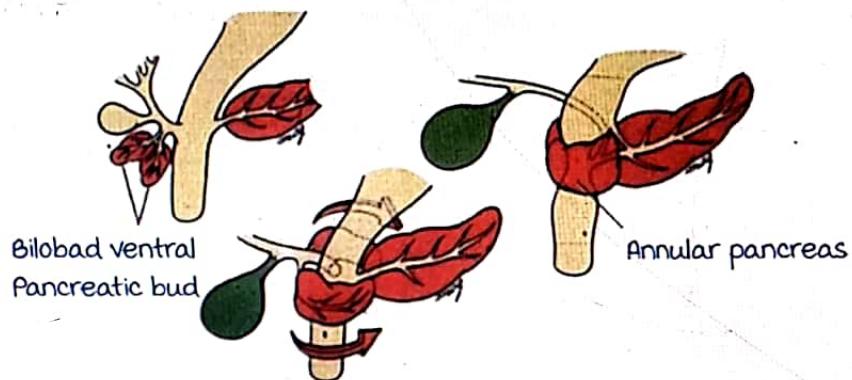
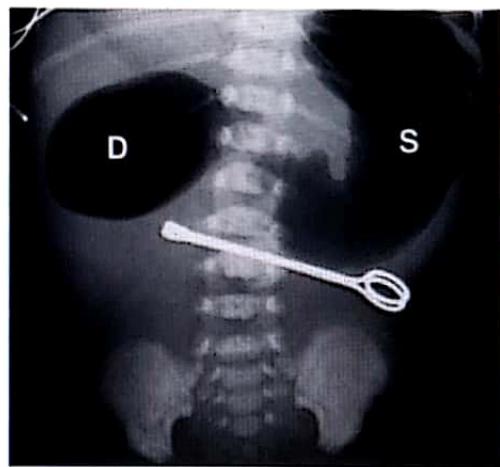


Figure 9-7. The ventral pancreas may consist of two lobes. If the lobes migrate around the duodenum in opposite directions to fuse with dorsal pancreatic bud, an annular pancreas is formed.

Bilobed ventral bud forms a ring around duodenum

One lobe migrates along usual pathway and  
other migrates along opposite direction.

Double bubble sign :



X Ray : Annular pancreas



Loss of continuity of duodenum

Due to pancreas surrounding  
that part

(double bubble sign)

# DEVELOPMENT OF MIDGUT

## Development of midgut

00:00:03

Extent/contents - 2<sup>nd</sup> part of duodenum (below the opening of ampulla of Vater), 3<sup>rd</sup> part of duodenum, 4<sup>th</sup> part of duodenum, jejunum, ileum, caecum, appendix, ascending colon, and transverse colon (righta/3<sup>rd</sup>).

Arterial supply - superior mesenteric artery.

Sympathetic supply - T10 to T11 (lesser splanchnic nerves).

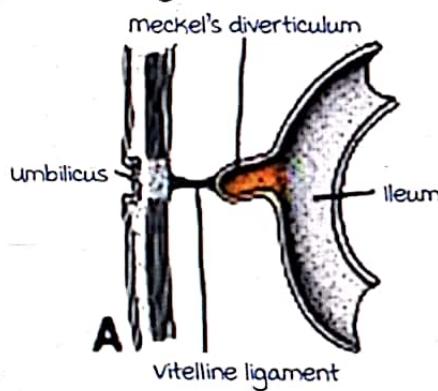
Parasympathetic supply - vagus nerve.

### Physiological hernia:

Herniation of contents of midgut into yolk sac through vitello-intestinal duct (VID).

Occurs by - 6<sup>th</sup> week.

Reduction occurs by - 10<sup>th</sup> week.



### Meckel's diverticulum:

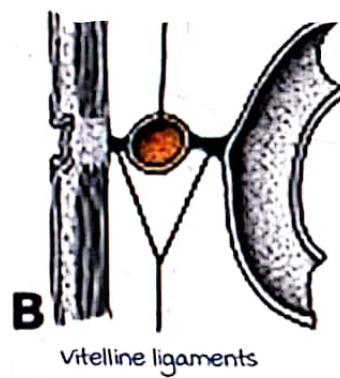
Remnant of some part of VID.

Size - 2 inches.

Location - 2 feet from ileocecal valve.

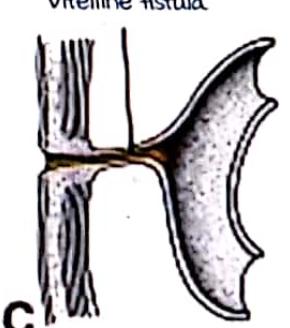
Contents - 2 types of tissues (gastric and pancreatic).

Seen in - 2% of population.



### Vitelline cyst:

2 ends of VID forms fibrous cord with a cyst in midline, known as vitelline cyst or enterocystoma.



### Vitelline fistula:

Entire VID is patent, establishing communication between intestine and umbilicus.

Faeces are seen at umbilicus due to vitelline fistula.

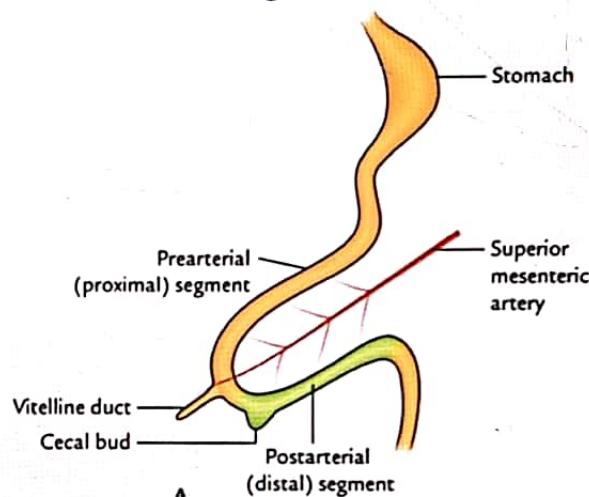
Active space

## Segments of midgut

00:04:13

Pre arterial segment – duodenum, jejunum, ileum (except the terminal part).

Post arterial segment – terminal part of ileum, appendix, caecum, ascending colon and transverse colon (right 2/3<sup>rd</sup>).



## Rotation of midgut

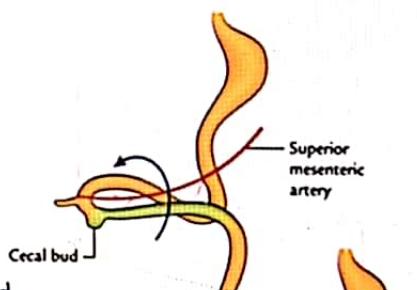
00:05:20

During reduction, midgut rotates 3 times, each time by 90° in counter clockwise/ anti-clockwise manner.

1<sup>st</sup> rotation:

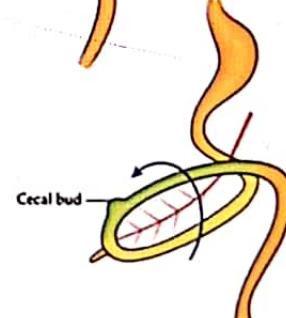
Pre arterial segment – right side.

Post arterial segment – left side.



2<sup>nd</sup> rotation:

Pre arterial segment – elongates and enters abdominal cavity and rotates by 90° anti-clockwise.

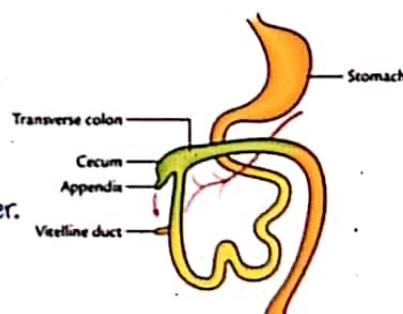


Pre arterial segment comes to lie behind the superior mesenteric artery.

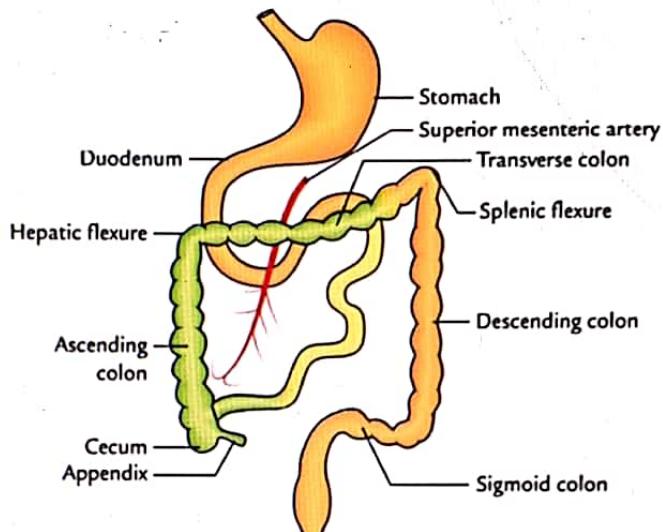
3<sup>rd</sup> rotation:

Post arterial segment – enters abdominal cavity and rotates by 90° anti-clockwise.

Caecum comes on right side, below the liver.



Final outcome after the three rotations of midgut:



## Gastroschisis and omphalocele

00:13:47

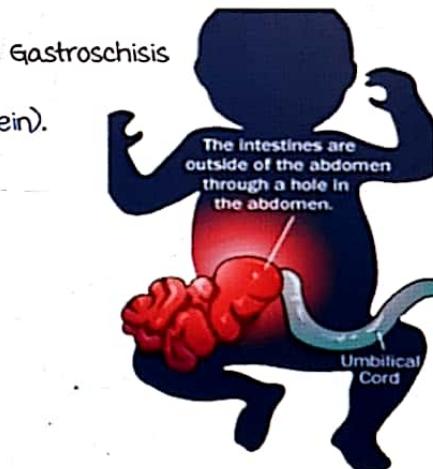
Gastroschisis:

Hernia at the **weak point**

(site of regression of right umbilical vein).

Sac - **absent**.

Organs involved - only intestine.



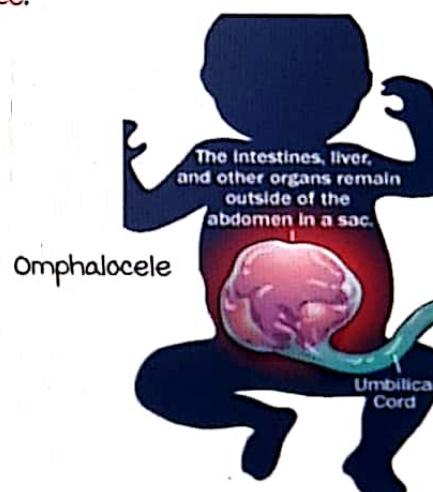
Omphalocele:

Physiological hernia that fails to reduce.

Sac - **present**.

Organs involved

initially intestines, but later  
any abdominal organ.



**Note :**

1. Intestinal obstruction is most commonly seen in **gastroschisis**.
2. Omphalocele is most commonly associated with other congenital anomalies.

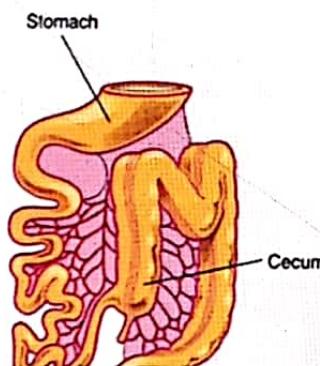
**Rotational anomalies of midgut**

00:16:48

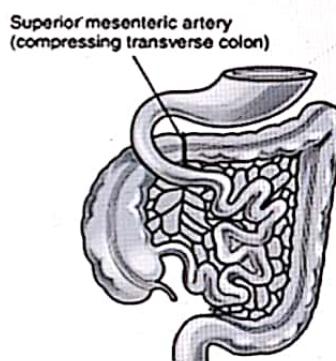
**Non rotation of midgut :**

Large intestine – enters cavity on left side.

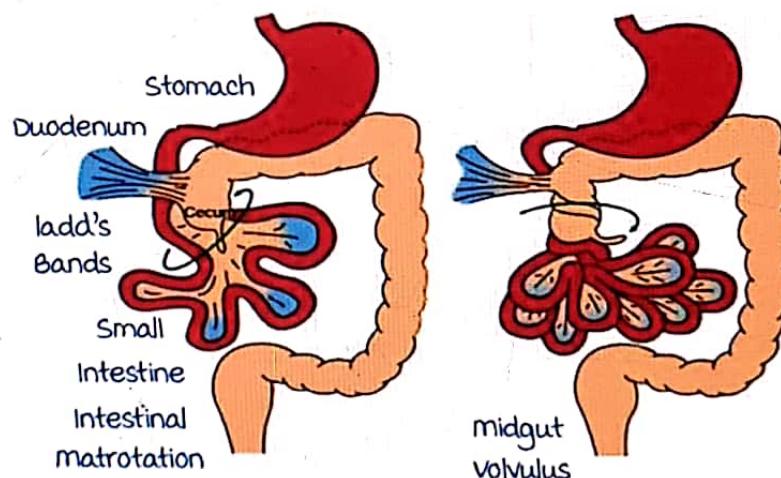
Small intestine – enters cavity on right side.

**Reverse rotation of midgut :**1<sup>st</sup> rotation – clockwise (instead of anti-clockwise).

Results in compression of transverse colon by superior mesenteric artery.

**Mixed rotation of midgut :**

First two rotations – normal.

Last rotation – **doesn't occur**.**Features of mixed rotation :**

1. Sub-pyloric caecum.
2. Ladd's band (caecum to posterior abdominal wall).



Obstructs duodenum

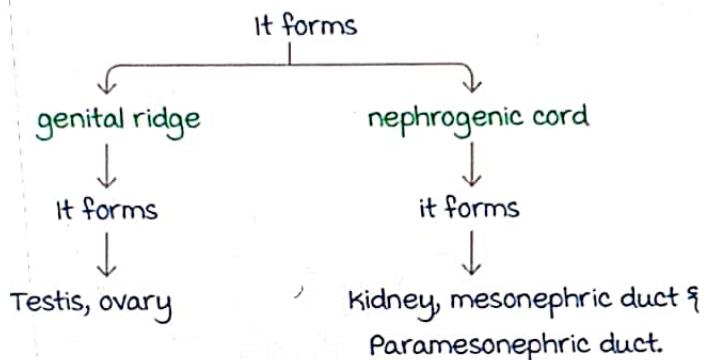
Results in **bile vomiting** (in new born)

# DEVELOPMENT OF RENAL SYSTEM AND HINDGUT

## Development of kidney

00:00:03

The intermediate mesoderm forms the urogenital system.



At 4<sup>th</sup> week - pronephros appear function as the kidney & disappears by end of 4<sup>th</sup> week.

By the end of 4<sup>th</sup> week - mesonephros appear function as interim kidney up to 2 months.

By 5<sup>th</sup> week - metanephros appear and starts its function by 3<sup>rd</sup> month.

metanephros forms the excreting component of the kidney.

A diverticulum arises from the mesonephric duct called ureteric bud

↓  
which forms metanephric blastema.

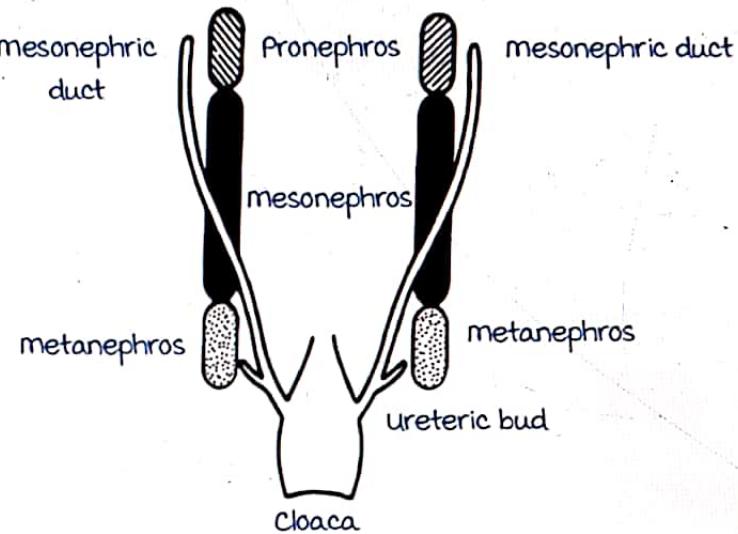
The kidneys are derived from two sources :

Excreting component - derived from metanephros

Collecting component - derived from ureteric bud.

The kidney's become functional from 12<sup>th</sup> week.

Urine is the main component of amniotic fluid.



#### Clinical correlation :

In renal agenesis amniotic fluid decreases causes oligohydramnios.

#### The connecting tubule :

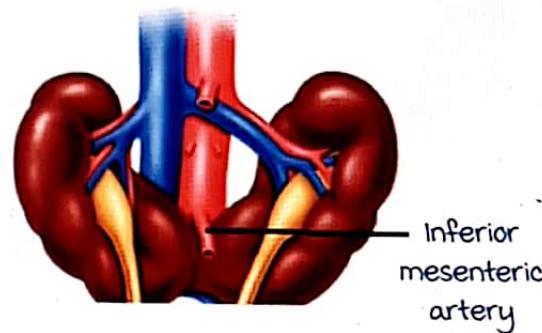
derived from metanephros

It connects the distal convoluted tubule to collecting duct.

#### Horseshoe Kidney :

MC anomaly

- The lower poles of the kidney fuse together.
- The kidneys are formed in the pelvis and ascend up to the abdomen
- The inferior mesenteric artery prevents the ascension of kidneys.



## Development of hindgut

00:09:08

The diverticulum arising from hindgut is called allantois.

The cloaca is a part of hindgut distal to allantois.

The urorectal septum - separates the cloaca and cloacal membrane.

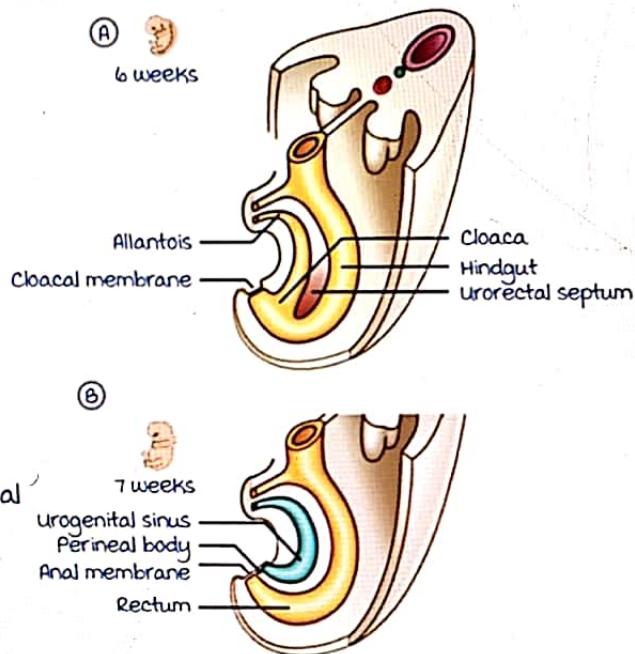
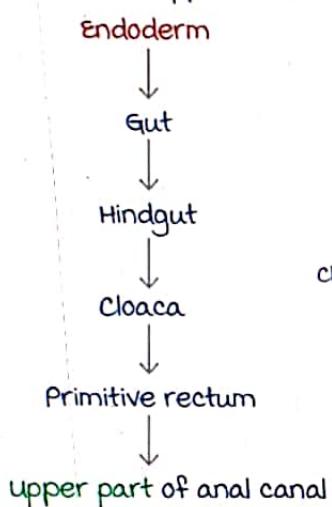
The cloaca divides into - primitive urogenital sinus [UGS]  
Primitive rectum.

The cloacal membrane divides into - anal membrane  
Urogenital membrane.

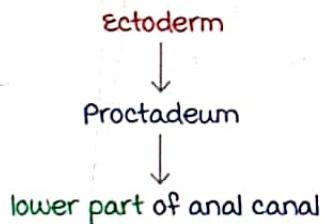
The primitive rectum forms - rectum

Anal canal up to pectinate line

Derivation of upper anal canal:



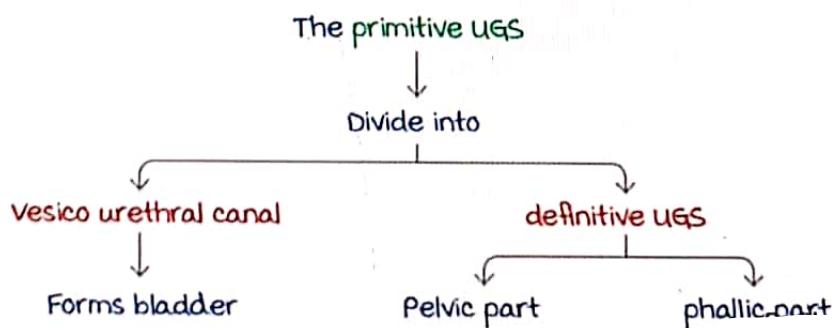
Derivation of lower part of anal canal:



The **anal membrane** is formed at the junction of upper and lower anal canal.

It ruptures by the 9<sup>th</sup> week therefore, upper and lower anal canal communicate.

The **pectinate line** is formed at the site of formation of anal membrane.



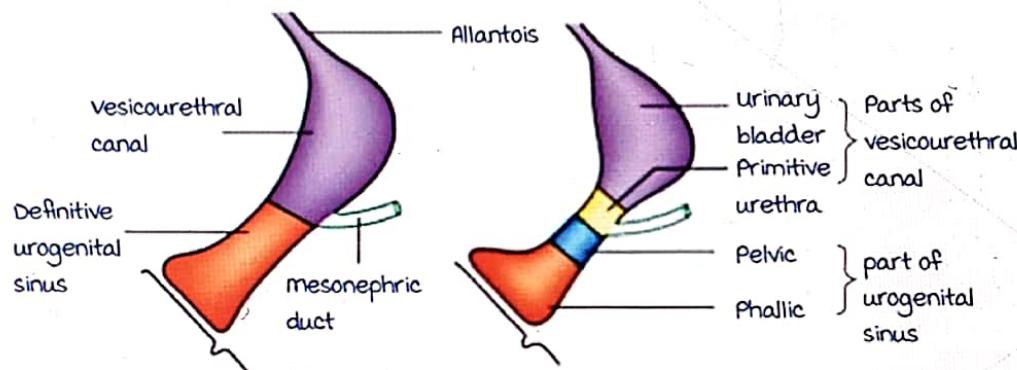
**Bladder :**

It is the endodermal derivative

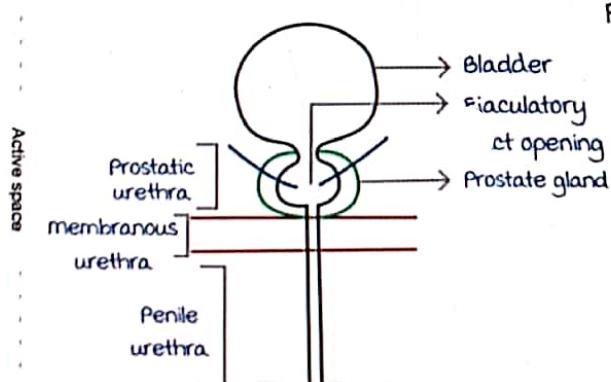
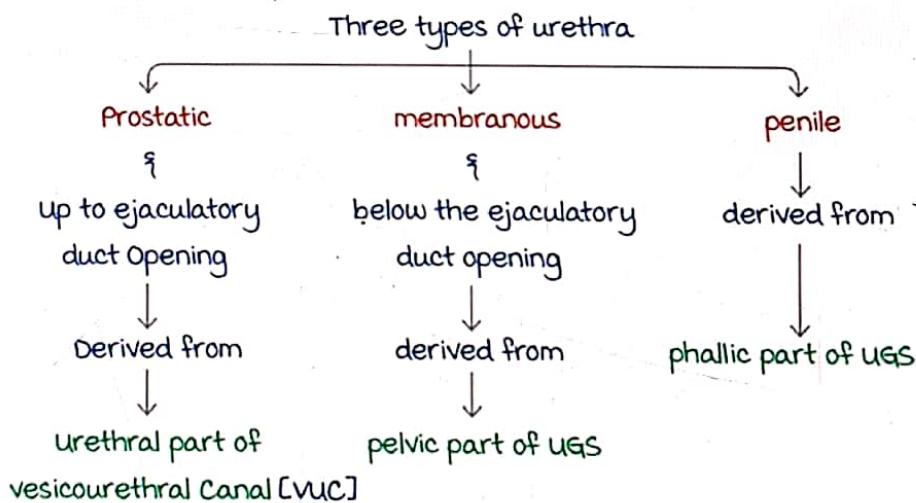
Except trigone of the bladder

mesodermal derivative

It is formed due to absorption of mesonephric duct.

**The female and male urethra**

00:20:38

**male urethra development :****Female urethra development :**

1. It is derived from the urethral part of VUC and **pelvic part of definitive UGS**.

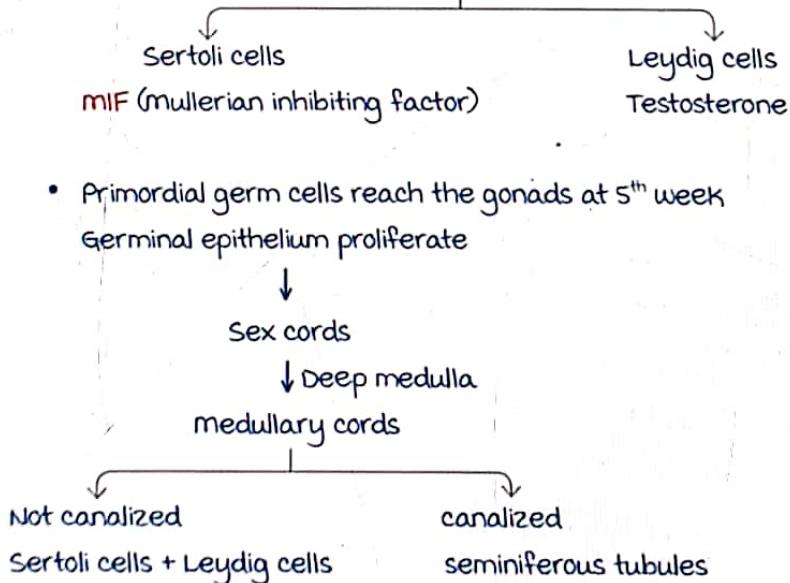
2. The **phallic part of definitive UGS** forms vestibule in females.

## DEVELOPMENT OF GONADS

- Genotype that is **XX/XY** is determined at the time of fertilization itself
- Phenotypic differentiation will start only at **7<sup>th</sup>** week
- until **6<sup>th</sup>** week gonads are indifferent gonads
- Primordial germ cells reach the gonads at **5<sup>th</sup>** week
- Gonads :
  - Testis develops at **7<sup>th</sup>** week
  - Ovary develops at **8<sup>th</sup> - 10<sup>th</sup>** week
- External genitalia :
  - In males : **14<sup>th</sup>** week
  - In females : **11<sup>th</sup>** week
- Sex determination can be done at **15<sup>th</sup>** week (**illegal** to reveal)

### Factors responsible for male development

- "SRY"** Gene : will stimulate TDF (testis determining factor)

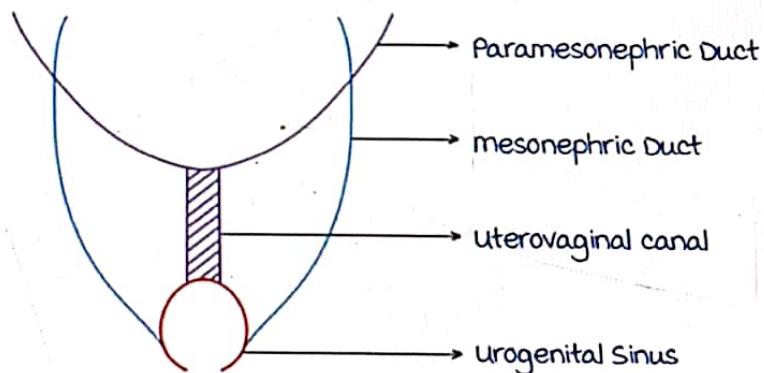


Active space

Structures	male derivative	Female derivative
1. Gonadal ridge	Testis	Ovary
2. Genital Tuberclle	Penis	Clitoris
3. Genital swelling	Scrotum	Labia majora
4. mesonephros	efferent tubules/ aberrant tubules	Epoophoron Paroophoron
5. mesonephric duct (Wolffian duct)	Appendix of epididymis vas deferens Epididymis ejaculatory duct Seminal vesicle	Appendix of ovary Gartner's duct
6. Paramesonephric duct (mullerian duct)	Appendix of Testis Prostatic utricle	Fallopian tube uterus Vagina (upper part)
7. Genital fold	ventral aspect of penis	Labia minora

### Development of Female system

00:15:30



Vagina derived from :

uterovaginal canal (the upper part)

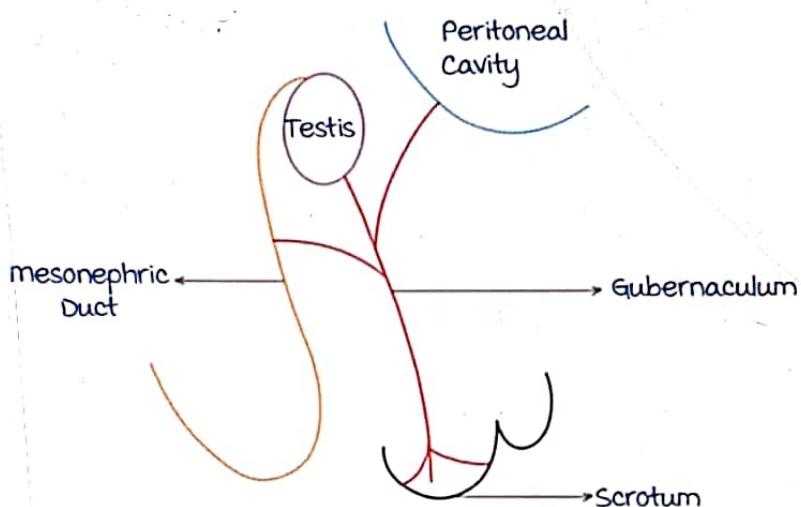
: Paramesonephric duct-mesoderm

urogenital sinus (the lower part)

: Cloaca- Hind gut- Gut- Endoderm

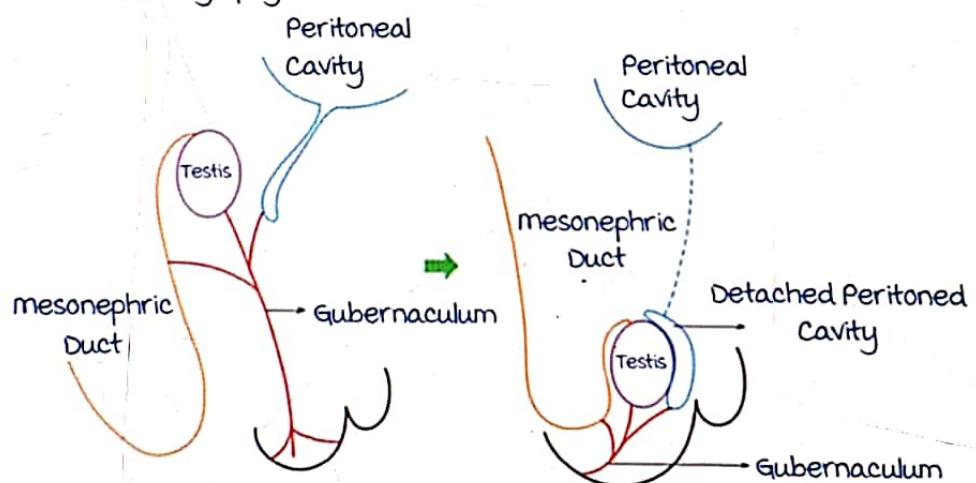
## Descent of Testis

00:19:20



## Tail of Lockwood:

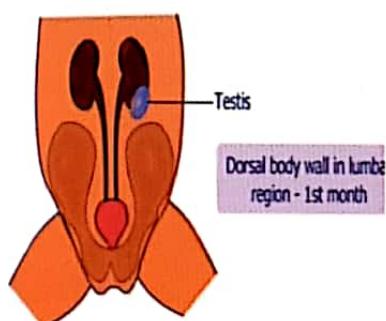
- Scrotum
- Saphenous opening of thigh
- Perineum
- Pubic symphysis



## Gubernaculum in Female:

- Proximal : ligament of ovary  
Distal : Round ligament of uterus

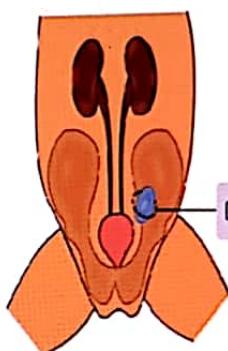
## Chronology of descend:



Active space



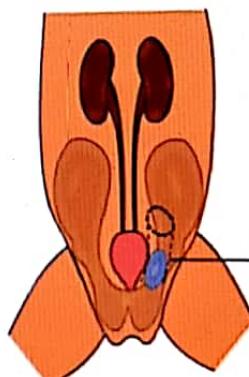
Iliac fossa - 3rd month



Deep inguinal ring - 7th month



Inguinal canal - 8th month



Inguinal canal - 8th month

Active space

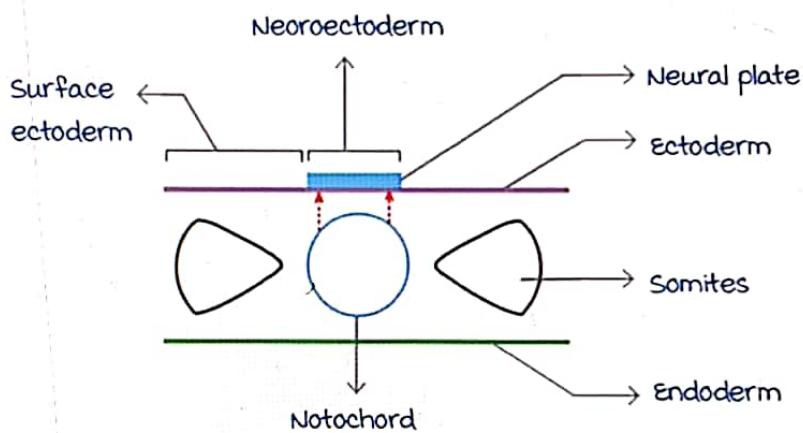
Undescended Testis : "Cryptorchidism"

# DEVELOPMENT OF CNS

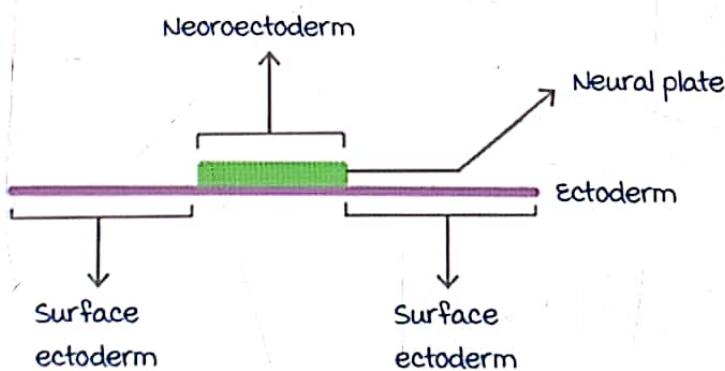
## Neurulation

00:00:12

- Takes place at 3rd week (along with gastrulation)
- Formation of neural tube
- Process :

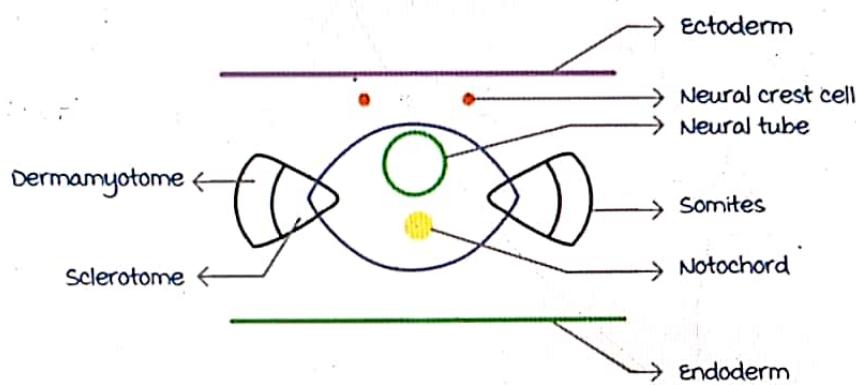


- Notochord gives signal to Ectoderm  
↓  
Ectoderm forms the Neural Plate → Neural tube
- Ectoderm divides into Surface and Neuro ectoderm



- Neural plate will invaginate due to signal from the notochord  
↓  
Neural groove

Active space

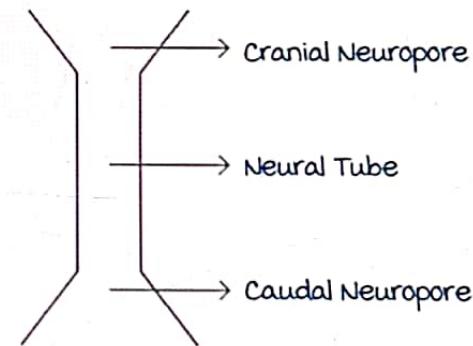


### Neural Crest cells (NCC)

00:06:47

Neural Crest Cells [NCC] :

- Called as **4<sup>th</sup> germ layer**
- Also called as **a<sup>°</sup> mesenchyme**
- Neural tube formation initially occurs at : **cervical region**

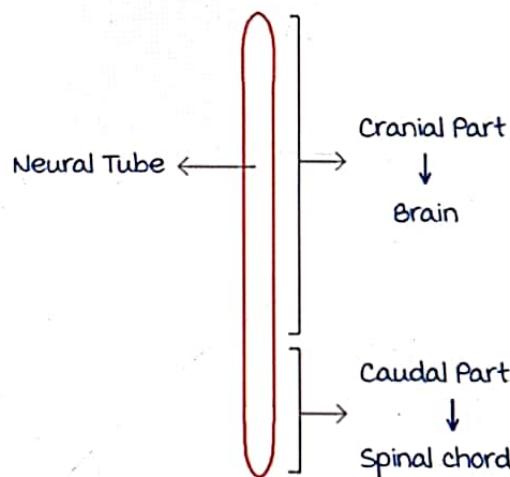
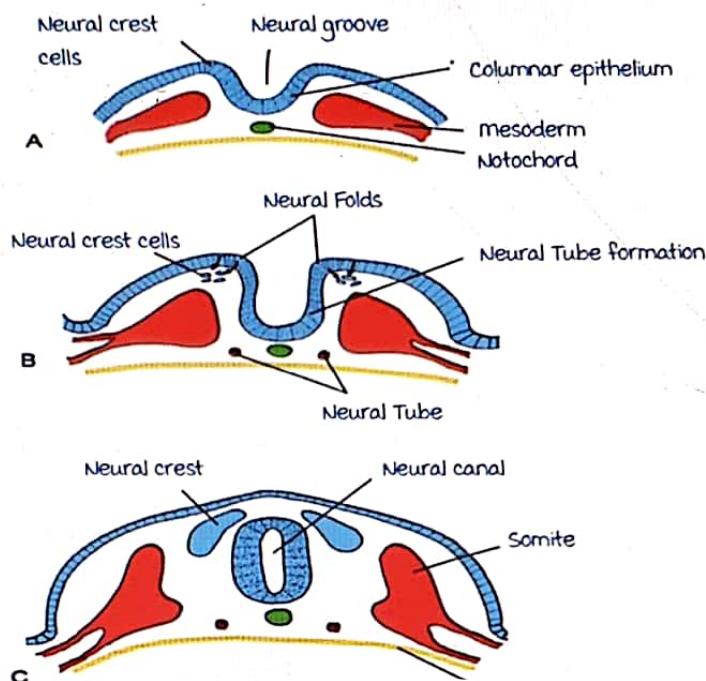


- Neural tube communicates with amniotic cavity
- Cranial neuropore :
  - closes by **25th day**
  - Remnant of cranial neuropore is lamina terminalis (situated in the anterior wall of 3rd ventricle)
  - If fails to close before 25th day: **Anencephaly**
- Caudal neuropore :
  - closes by **28th day**
  - Remnant is terminal ventricle
  - If fails to close by 28th day: **Rachischisis**

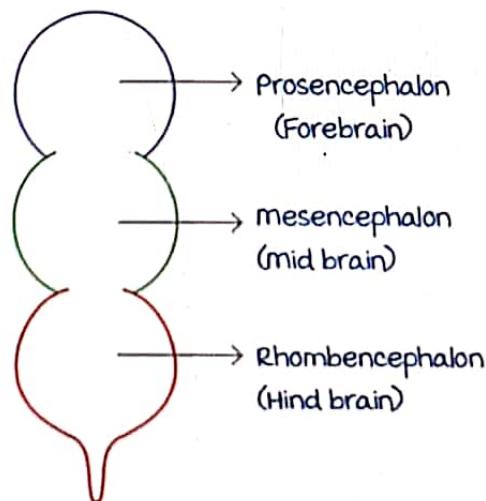
### Neural tube defects (NTD)

00:00:12

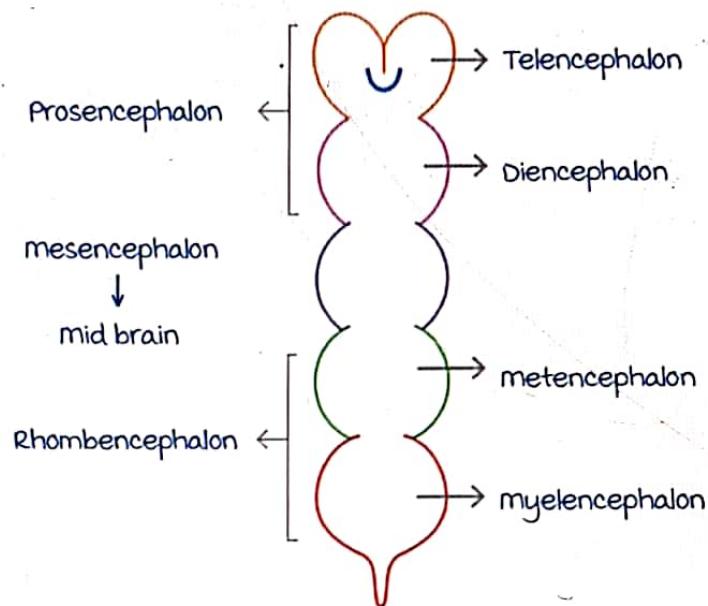
- Due to deficiency of folic acid
- E.g. **Anencephaly** and **Rachischisis**
- Folic acid tablets given from **1st semester** as soon as pregnancy is confirmed (these days given once a girl is married)



- Cranial part of neural tube will form some vesicles here



Active space



## Ventricles

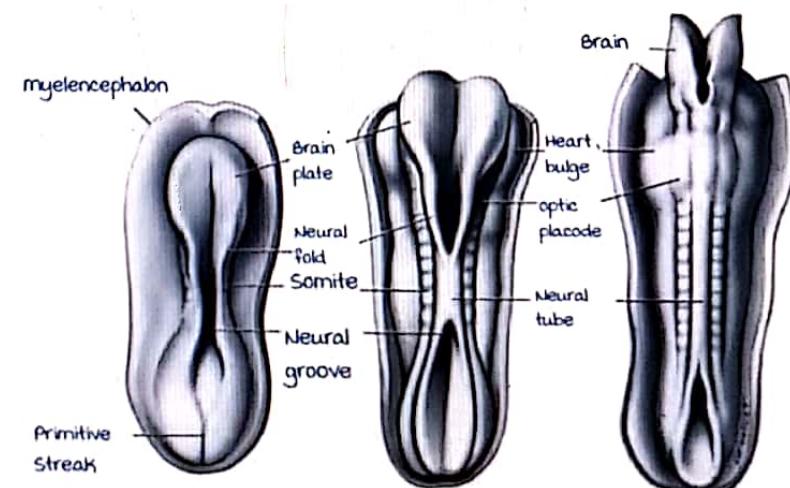
00:17:58

- Cavities inside the brain
- Cavity in the :
  - Telencephalon : Lateral ventricle
  - Diencephalon : 3rd ventricle
  - midbrain : Cerebral aqueduct of Sylvius
  - metencephalon and myelencephalon : 4th ventricle

## Source of structure

00:19:36

1. Pineal gland (part of Epithalamus) : diencephalon
2. medial and lateral geniculate body (part of metathalamus) : diencephalon
3. Substantia nigra: mesencephalon
4. Corpus striatum: telencephalon



## Cranio Rachischisis

00:21:19

- entire neural tube is open
- **Severe** form of NTD



# EPITHELIUM

## Simple Epithelium

00:00:56

### Classification of epithelium

- Simple epithelium : Single layered.
- Compound epithelium : multi-layered.

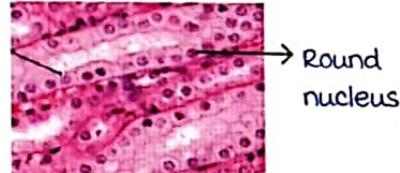
Simple Epithelium :

Simple Squamous Epithelium :

- Breadth of cell > Length of cell.
- Nucleus : Flat.
- Function : Exchange.
- Location : mnemonic : 3B - A :
  - Bowman's capsule
  - Blood vessels.
  - Body cavity.
  - Alveoli

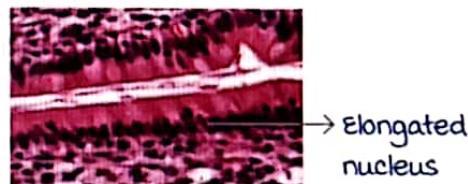
Simple Cuboidal Epithelium :

- Breadth of cell = Length of nucleus
- Nucleus : Round.
- Function : Secretion
- Location : mnemonic : T-OK
  - Thyroid follicles.
  - Germinal epithelium of Ovary.
  - Kidney tubules.



Simple Columnar Epithelium :

- Length of cell > breadth of cell.
- Nucleus : Elongated.
- Function : Secretion.
- Location :
  - Stomach.
  - Large intestine.



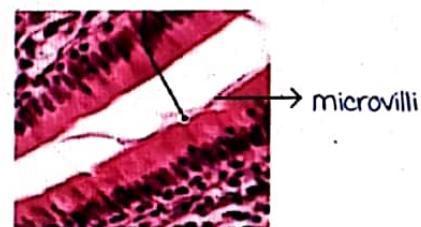
### Simple Columnar with microvilli :

- microvilli (brush border) increase the surface area.

- Location :

Gall bladder.

Small intestine.



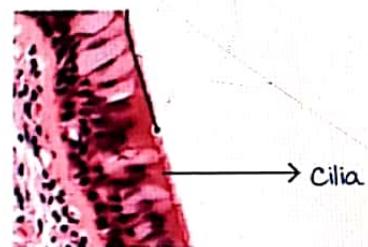
### Ciliated Columnar Epithelium :

- Cilia are motile structures.

- Location :

Fallopian tube.

Eustachian tube.



### Pseudostratified Ciliated Columnar Epithelium :

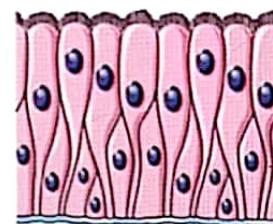
- The ciliated columnar epithelium is single layered but appears to be arranged in multiple layers.

- All the cells are attached to the basement membrane.

- Location :

Trachea

Bronchus.



## Compound Epithelium

00:10:29

### Stratified Squamous Epithelium :

- The apical layer is squamous.

- Function : Barrier.

- It may be Keratinized or non-Keratinized.

- Location of non-Keratinized stratified squamous epithelium :

Oral cavity.

Tonsils.

Esophagus.

Tongue.

Vocal cord.

Vagina.



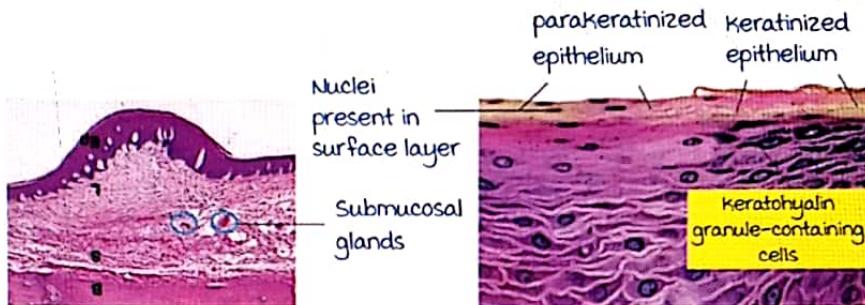
- Location of Keratinized stratified squamous epithelium :

Thick skin.

Anal verge of anal canal.

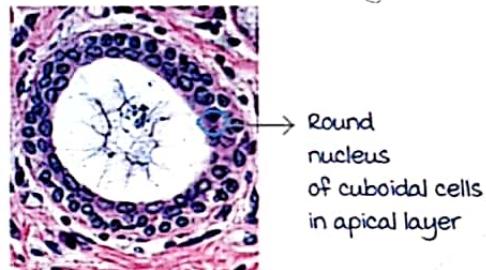
**Para-keratinized stratified squamous epithelium :** The surface layer has nuclei.

- Hard palate is lined by Para-keratinized stratified squamous epithelium with submucosal glands (NEET 2018).



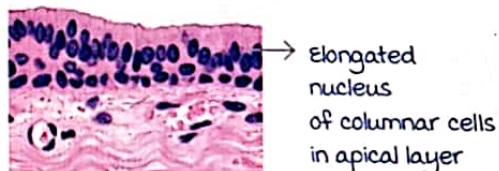
**Stratified Cuboidal Epithelium :**

- The apical layer is cuboidal.
- Location : Ducts of exocrine glands and sweat glands.



**Stratified columnar epithelium :**

- The apical layer is columnar.
- membranous and Penile urethra is lined by stratified columnar epithelium > Pseudostratified columnar epithelium.

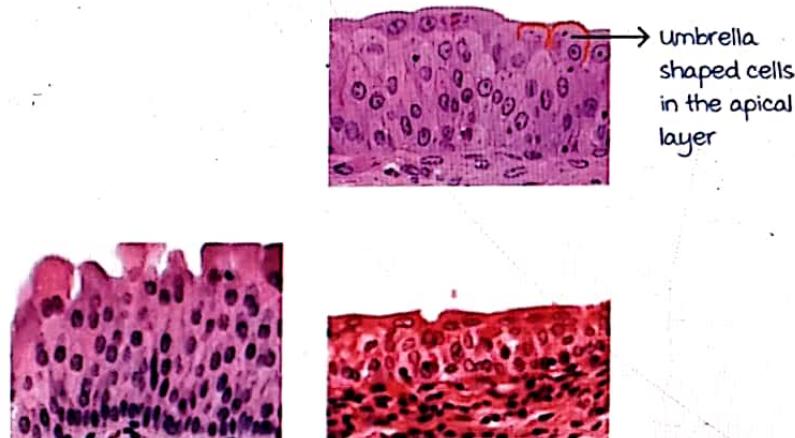


**Transitional Epithelium (urothelium) :**

- The epithelium transitions from one shape to the other.
- It is mainly seen in the urinary system.
- The apical most layer has umbrella shaped cells
- Location : (AIIMS 2020) From tip of collecting duct up to prostatic urethra :

Tip of collecting duct.  
major and minor calyces.  
Pyramids.  
Renal pelvis.  
Ureter  
Bladder  
Prostatic urethra.

Active space



Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

### Lining of the Female Reproductive System and of the Nephron

00:21:17

#### Lining of Female Reproductive system :

Fallopian Tube : Ciliated columnar epithelium

Uterus : (Simple columnar > ciliated columnar).

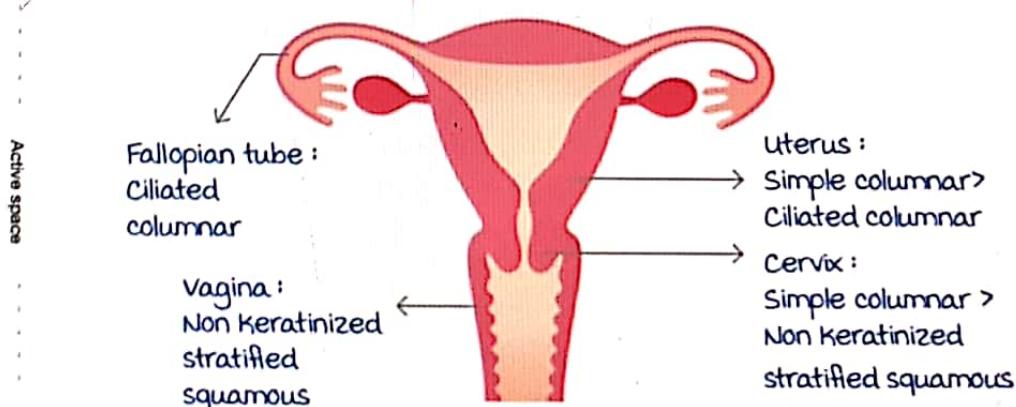
- major portion is lined by simple columnar epithelium.
- Ciliated columnar epithelium in the portion close to Fallopian tube.

#### Cervix :

• Upper part : Simple columnar epithelium.

• Lower part : Stratified squamous non keratinized epithelium  
(Same as vagina)

Vagina : Stratified squamous non keratinized epithelium.



**Lining of Nephron**

Bowman's capsule : Simple squamous epithelium.

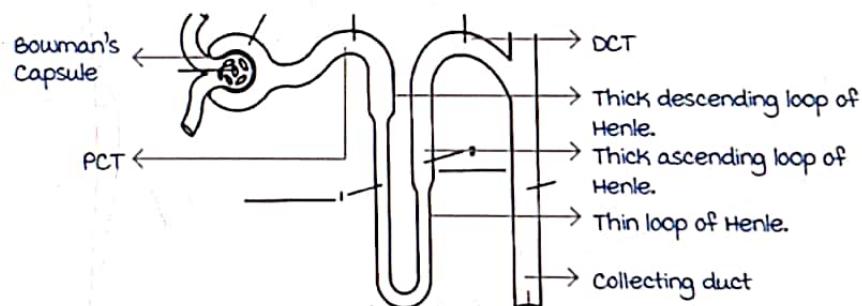
Proximal Convoluted Tubule (PCT): Simple cuboidal epithelium with microvilli.

Distal Convoluted Tubule (DCT): Simple cuboidal epithelium.

Henle's Loop or Ansa Nephroni: Simple squamous + Simple cuboidal epithelium.

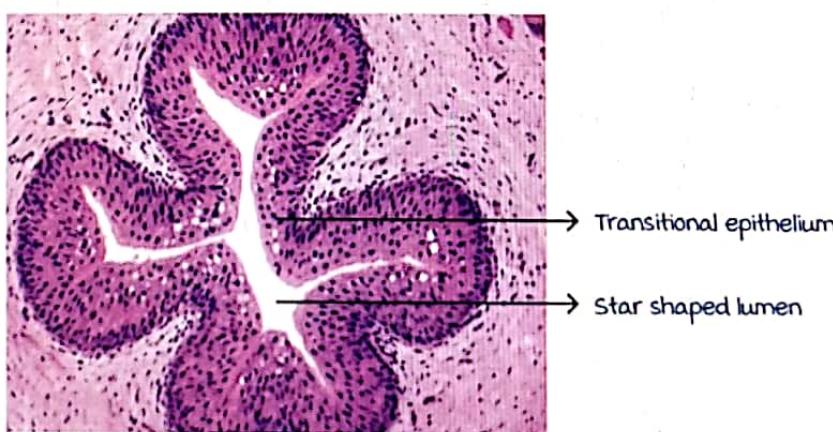
- Thick part of descending limb of Henle's loop : Simple cuboidal epithelium with microvilli.
- Thick part of ascending limb of Henle's loop : Simple cuboidal epithelium.
- Thin part of Henle's loop : Simple squamous epithelium with microvilli.

Collecting duct : Simple cuboidal or simple columnar epithelium.



Star shaped lumen may be seen in ureter or vas deferens.

ureter : Star shaped lumen + Transitional epithelium.



Active space

# GLANDS

## Endocrine and Exocrine glands

00:00:03

### Formation of glands :

The epithelium with secretory function invaginates the connective tissue.

The invaginating portion of the epithelium has two parts :

- Gland : Secretory part.
- Duct : Conducting part.

### Exocrine glands

Exocrine glands have both secretory and conducting parts.

Secretions of exocrine glands : Enzymes.

Exocrine glands may be :

- unicellular (Goblet cells).
- multicellular

Exocrine glands may also be classified as :

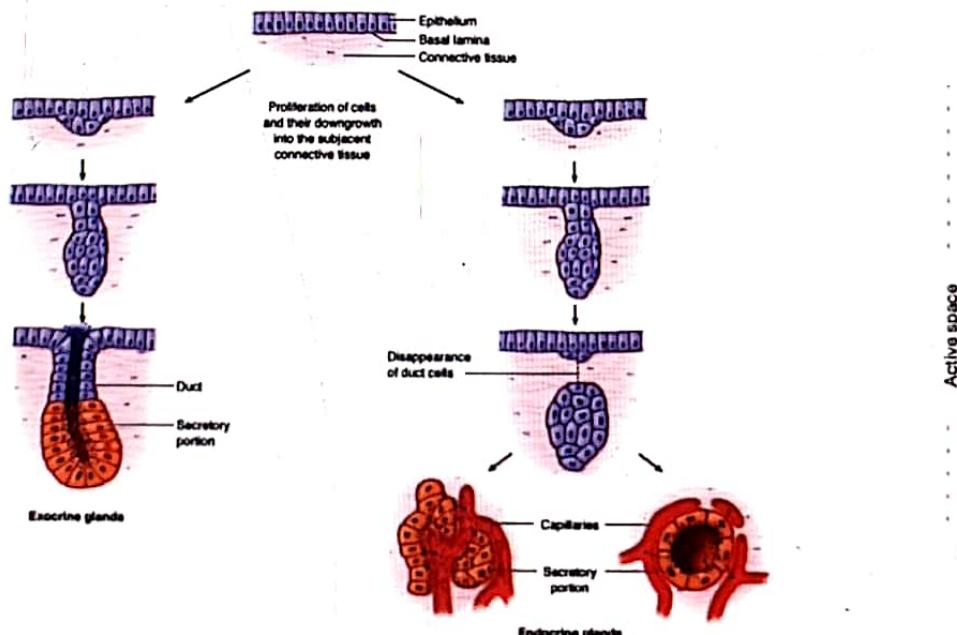
- Simple glands.
- Compound glands.

### Endocrine glands

Endocrine glands are known as ductless glands.

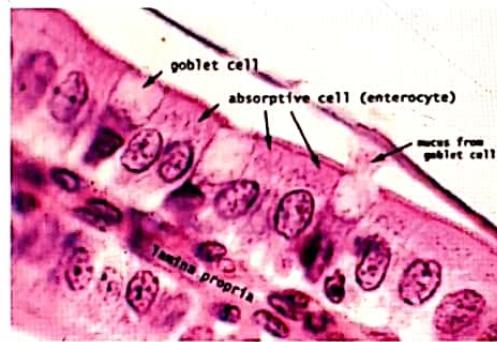
- These glands only have a secretory part.
- The duct disappears after invagination.
- The secretions are directly released into the bloodstream thus endocrine glands are highly vascularized.

Secretions of endocrine glands : Hormones.



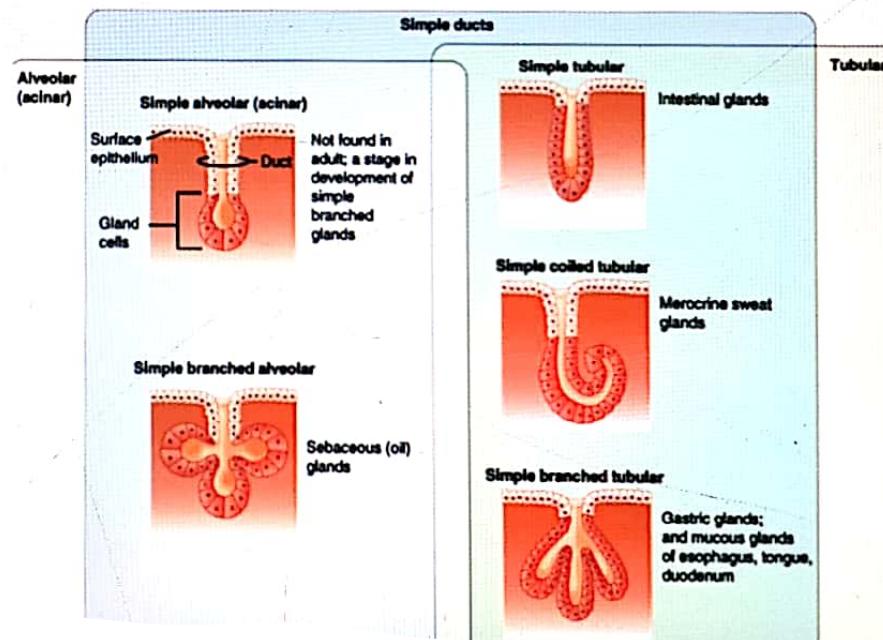
### Goblet cells

- Goblet cells are unicellular exocrine glands.
- Goblet cells release secretions by means of **Exocytosis**.
- They secrete mainly **mucus**.
- mucus stains poorly with Hematoxylin and Eosin hence appear pale.



### Simple glands :

Secretions are poured into a **single duct**.

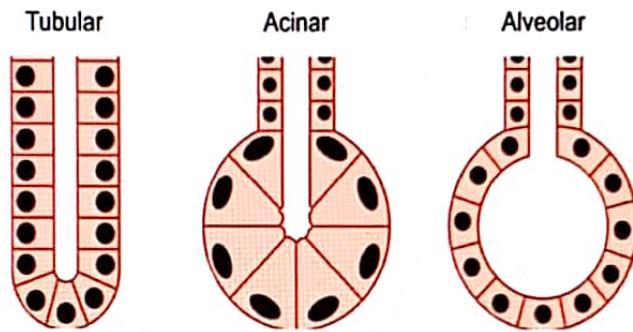
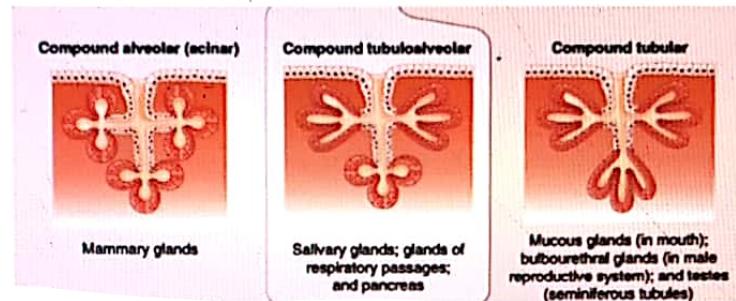


### Compound glands :

A group of cells, each draining into a duct which drains into a larger common duct.

The secretory part may be

- Tubular
- Acinar
- Alveolar



## Serous glands and Mucous glands

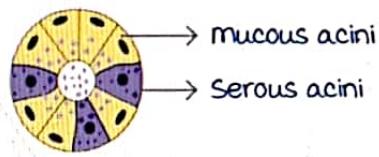
00:05:52

Serous Glands	mucous Glands
Secretions : Water like.	Secretions : Thick, mucous like.
Cells : Pyramidal shaped	Cells : Columnar or cuboidal shaped
Nucleus : Round in shape.	Nucleus : Flat and pushed to the base by the thick mucus.
Lumen : very small.	Lumen : Large.
Apical eosinophilia : Eosinophilic appearance due to numerous secretions that collect at the apex	The glands appear pale on Hematoxylin and Eosin staining.

Active space

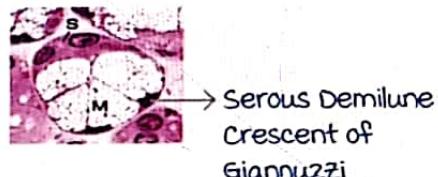
**mixed Glands :**

Both **serous** and **mucous** acini are present.



#### Serous Demilune

Present in mixed glands. mucous acini are **capped** with **serous** acini in order to decrease the thickness of the secretion.



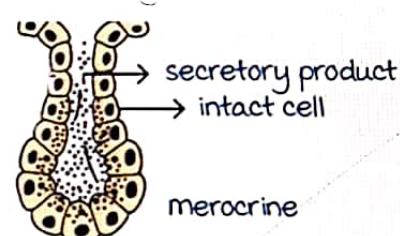
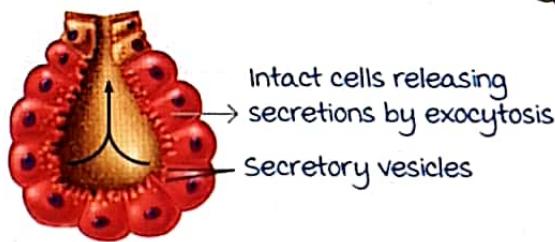
### Classification of glands based on mode of secretion

00:10:04

- merocrine gland :**

Cells are **intact**.

Location : majority of **sweat glands** and exocrine glands are merocrine glands.

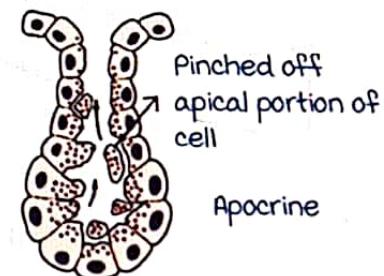


- Apocrine gland :**

Cells are **not intact** : Secretions are collected in the apical part and the apical part is pinched off.

Location : mnemonic : "MAP"

- **Mammary gland.**
- **Atypical sweat glands in the Axilla and Pubis.**



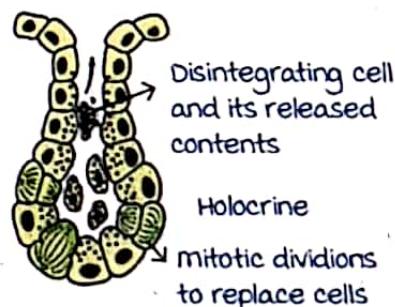
- Holocrine glands**

The **whole cell disintegrates** and releases the secretions.

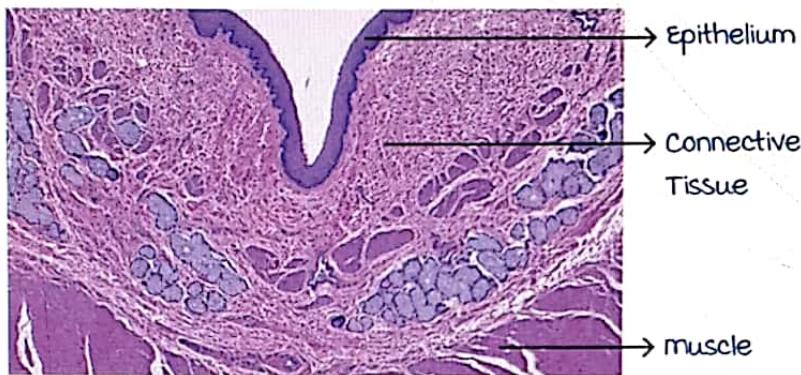
There are several layers of cells present in holocrine glands.

The **basal layer** is **mitotic** in nature and replaces the disintegrated cells.

Location : **Sebaceous gland (AIIms).**



# CONNECTIVE TISSUE

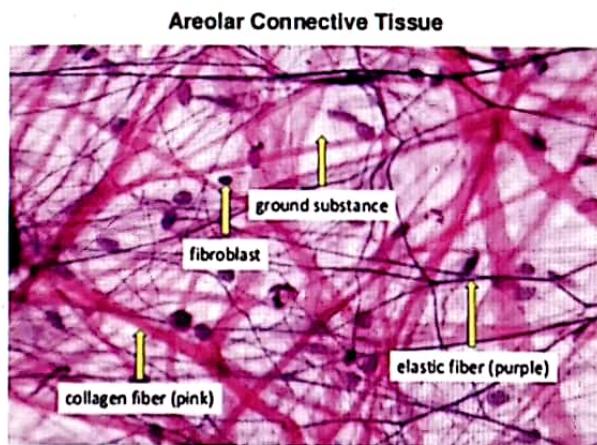


General info on Connective Tissue [CT]:

- Gives support and connects
- Two types :
  - Generalized CT
  - Special CT
- Cells [chondrocyte] + matrix [ground substance + fibre (collagen + elastic)]

## Collagen fibre

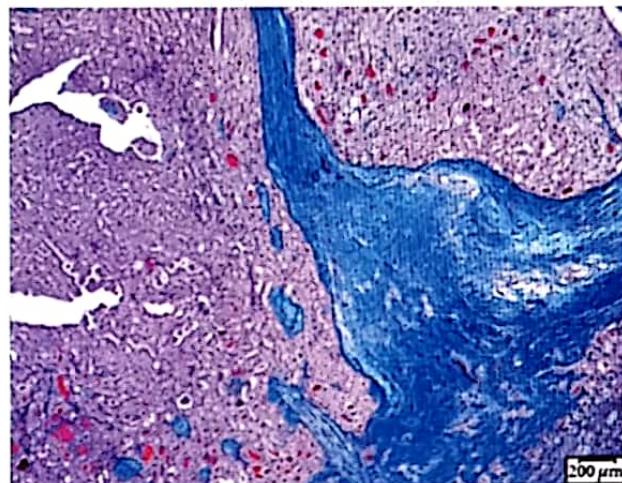
00:02:25



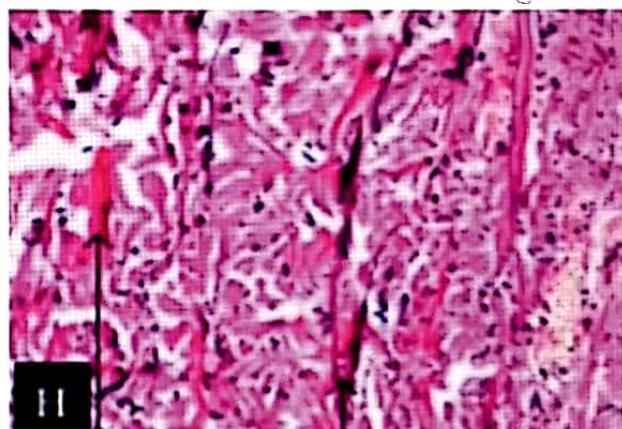
Identify the structures at the arrows.

- Long **wavy** fibers found in bundles (anastomose with each other)
- Appearance : white
- On Eosin and Haematoxylin : **light pink**
- On Masson's trichrome : blue in color

Active space



- On Van Gieson stain: pink



- With silver impregnation: Brown in color

#### Types :

Type 1 : Ligaments , fascia , tendon , aponeurosis , dermis ,  
fibrous cartilage

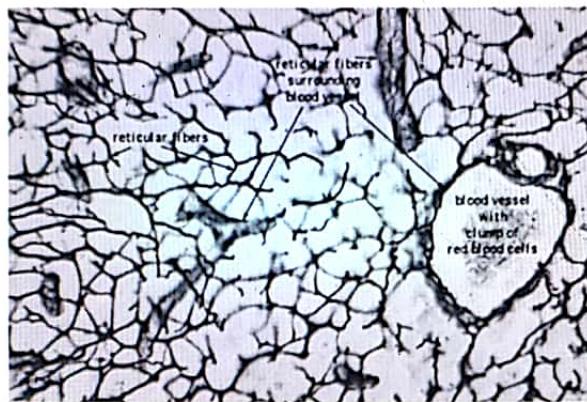
Type 2 : Hyaline and elastic cartilage

Type 3 : Reticular fibers – lymphoid organs (absent in thymus)

Type 4 : sheet like present in lens capsule and basement membrane

#### Reticular fibers : Type 3

- Short, not wavy, thin
- Branch → anastomose to form Reticulum [network]
- With silver impregnation : black color

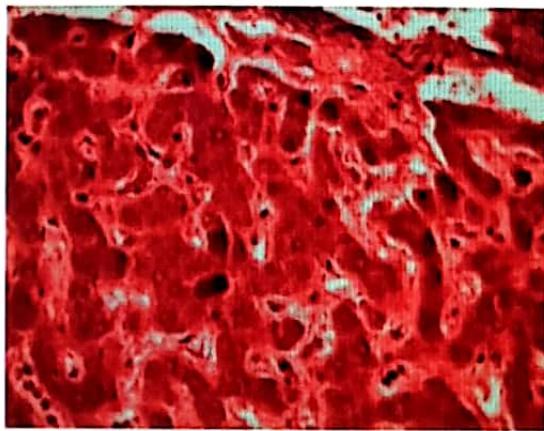


#### Elastic fibers :

- Not in bundles
- Single, thin and non-wavy
- Thick one in "Ligamentum flavum"
- Special stains :
  - Verhoeff stain :



- Orcein with aldehyde fusion :



## Cells in connective tissue

Two types :

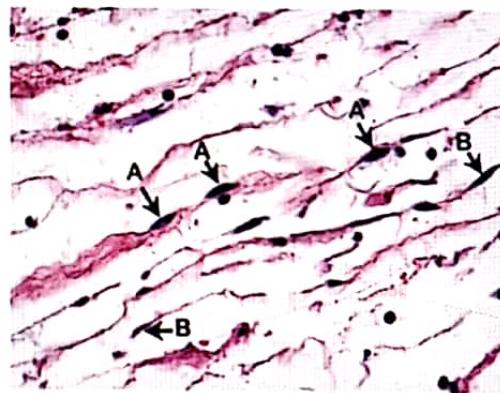
- make intrinsic component of CT (fibroblast, adipose tissue)
- immune system cells (lymphocyte, macrophage)

Fibroblast cells :



### The "Fabulous" Fibroblast

- Fibroblast: synthesizes the extracellular matrix and collagen, the structural framework (stroma) for animal tissues, and play a critical role in wound healing.
- They are the most common cells of connective tissue
- Spindle shaped with flat nucleus (fixed and immobile close to collagen fibre)



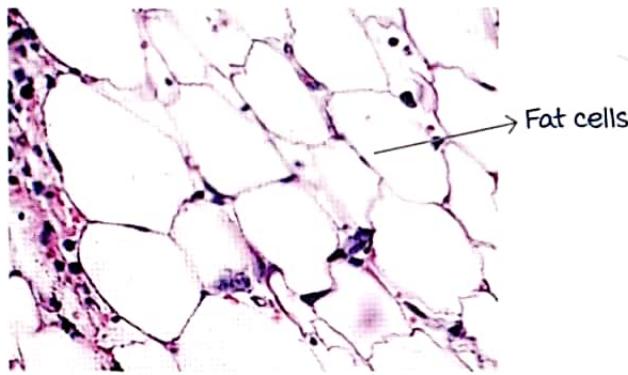
- Fibrocyte : inactive fibroblast

Active space

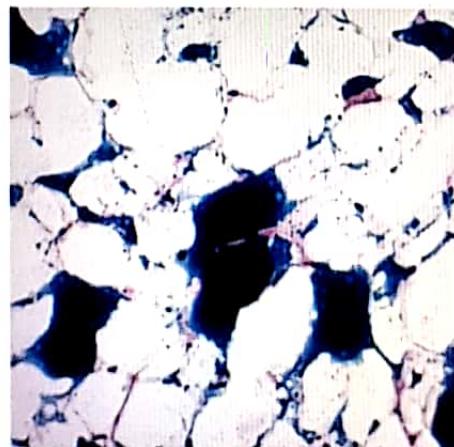
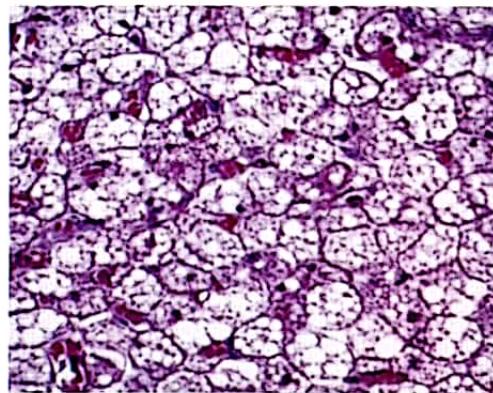


**Adipose tissue :**

- Aggregation of fat cells
- Stained with xylene and benzene which dissolve fat, so we see empty spaces
- Two types :
  - Yellow :
    - unilocular and peripherally placed tissue



- Brown : Found in newborn
  - multilocular and contain aggregate of small fat droplets



Active space

## Classification based on the arrangement of fibers

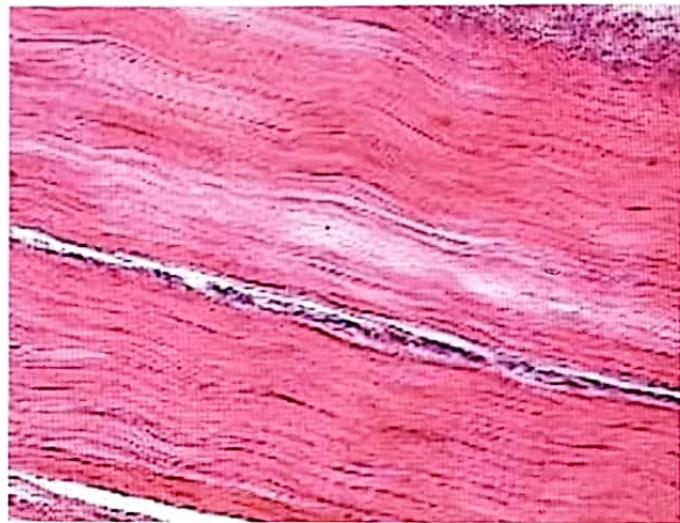
00:17:45

Dense regular CT : seen in

A : Aponeurosis

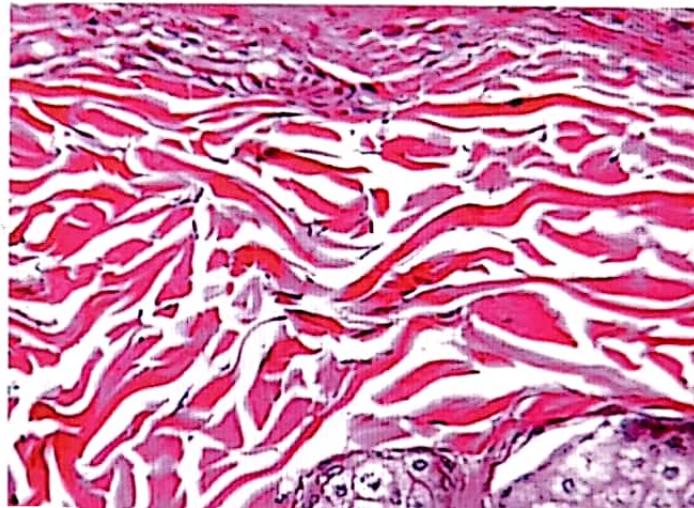
L : Ligaments

T : Tendons



Dense irregular CT : Seen in

Dermis of skin and Organ capsule (periosteum)

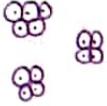
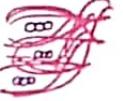


Active

# CARTILAGE

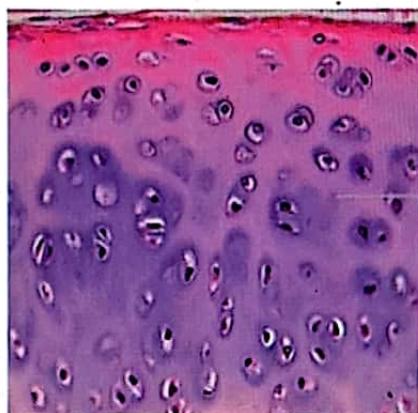
Contains :

- Cells [chondrocyte]
- matrix [ground substance + fibre (collagen + elastic)]

Hyaline	Elastic	white fibers
 <ul style="list-style-type: none"> <li>• cells in group</li> <li>• matrix: shiny and glossy</li> <li>• <math>\mu</math> (refractive index) of ground substance and the collagen</li> <li>Collagen type - a</li> <li>• Perichondrium present</li> <li>• E.g.: ACE-ER / REECA <ul style="list-style-type: none"> <li>• R- Respiratory cartilage</li> <li>• E-Embryonic cartilage</li> <li>• E-Epiphyseal cartilage</li> <li>• C-Costal cartilage</li> <li>• A-Articular cartilage</li> </ul> </li> </ul>	 <ul style="list-style-type: none"> <li>• cells in group</li> <li>• Elastic fibers</li> <li>• Collagen type - a</li> <li>• Perichondrium present</li> <li>E.g.: EEE <ul style="list-style-type: none"> <li>• Epiglottis</li> <li>• Eustachian tube</li> <li>• Ear tube</li> <li>• Ear lobule</li> <li>• Apex of Arytenoid</li> <li>• Corniculate</li> <li>• Cuneiform</li> </ul> </li> </ul>	 <ul style="list-style-type: none"> <li>• cells in Rows</li> <li>• Bundles of collagen - I</li> <li>• Perichondrium absent</li> <li>• E.g.: MAGI <ul style="list-style-type: none"> <li>• m - meniscus</li> <li>• A - Articular cartilage</li> <li>• G - Glenoid labrum</li> <li>• I - Intervertebral disc</li> </ul> </li> </ul>

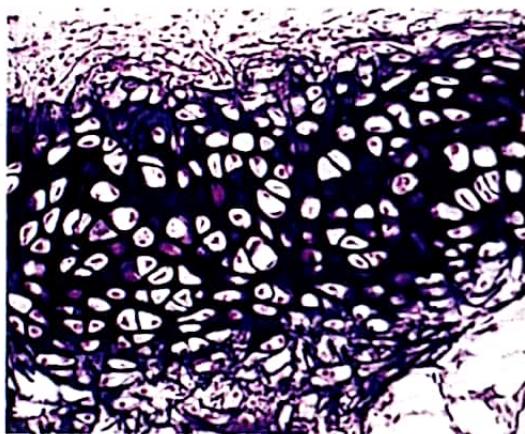
Active space

Hyaline cartilage :

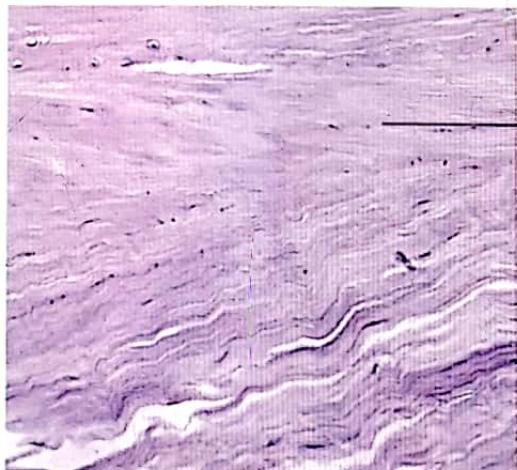


matrix

Elastic cartilage :



White fibrous cartilage :



Bundles of collagen

# HISTOLOGY OF MUSCLE

muscle is made up of myocytes

myocytes - elongated muscle fibres

It is covered by connective tissue - provides pathway for neurovascular structures

Skeletal muscle	Smooth muscle	Cardiac muscle
In skeletal system (Limb, trunk)	In hollow visceral organs	In the heart
Striations present	Striations absent	Striations present
Voluntary muscle	Involuntary muscle	Involuntary muscle
Somatic nerves	Autonomic nervous system	Autonomic nervous system

## Skeletal muscles

Long cylindrical fibres, parallel to each other

Each fibre varies in length and diameter.

Each fibre is a syncytium with 100s of nuclei

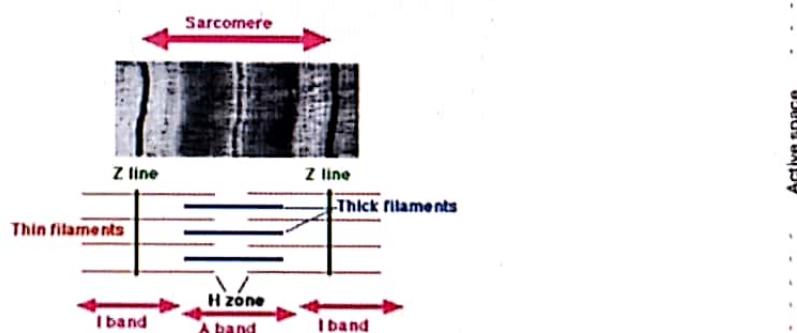
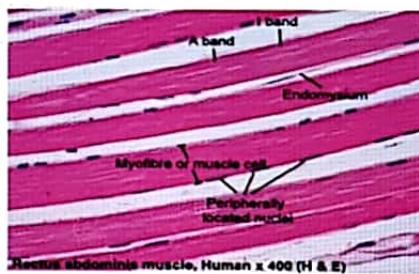
The nucleus is elongated and found in the periphery.

- Eosin & hematoxylin staining :

Striations - alternate dark(A) band and light(I) band.

Z band - dark line in the I band

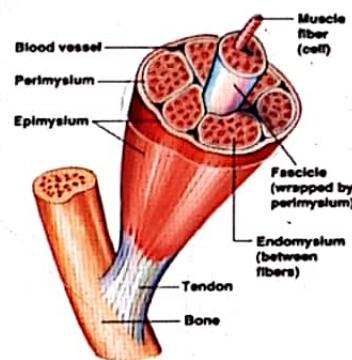
H band - light zone in the A band



**Sarcomere**: myocyte between two successive 'Z' band  
**Endomysium** - covering each muscle fibre

**Perimysium** - covering each fasciculus (group of muscle fibres)

**Epimysium** - covering muscle (group of fasciculus)



## Cardiac muscle

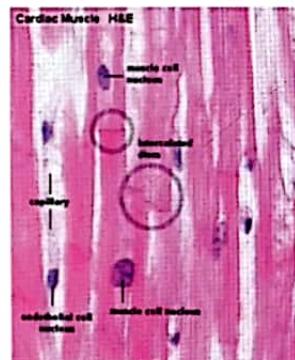
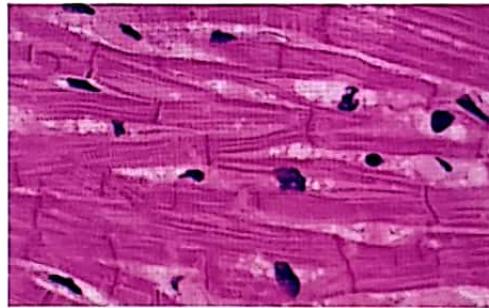
00:08:52

Not arranged in parallel manner

Fibres branch and anastomose with each other.

Don't act as syncytium.

Each myocyte has centrally placed spherical nucleus



- Eosin-hematoxylin staining :

Intercalated disc seen between myocytes

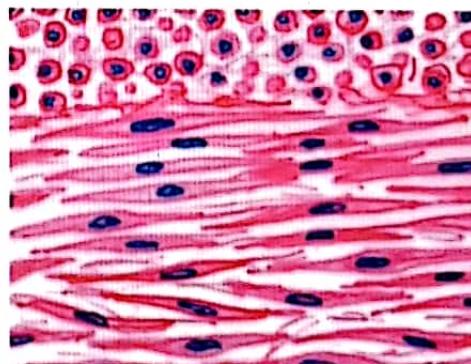
Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

## Smooth muscle

00:11:10

Plain muscle without striations.

Spindle shaped cells with oval shaped nucleus.



# NERVOUS SYSTEM

## Histology of the Neuron

00:00:03

The neuron is the structural and functional unit of the nervous system.

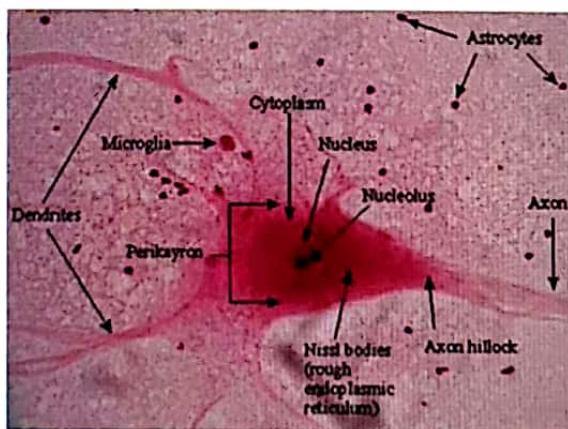
### Cell Body of the Neuron :

- The cell body has a cell membrane and cytoplasm along with organelles.
- It contains Nissl Granules which stain intensively with basic dye.
- There are numerous endoplasmic reticula, indicative of the high level of protein synthesis taking place.
- Neurofibrils : These are thread like structures permeating cytoplasm that contain microtubules and microfilaments.

Neurites are of 2 types :

Dendrites	Axons
Variable thickness	Uniform thickness
Carry impulses towards the cell body	Carry impulses away from the cell body
Short	Long
Nissl Granules present	Nissl Granules absent

Axon of Hillock : The Nissl free zone which extends into the body.



## Myelin Sheath formation

00:05:12

myelin sheath is formed by :

- Oligodendrocytes in the central nervous system
- Schwann cells in the peripheral nervous system.

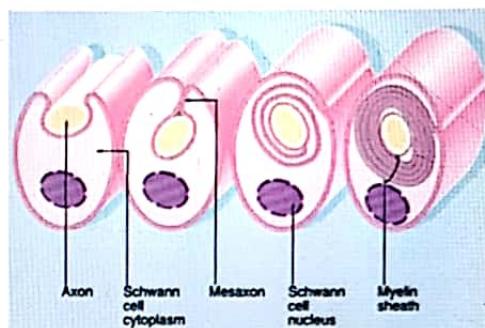
Active space

**Process of formation :**

The axon invaginates the Schwann cells and is suspended by the **mesaxon**.

The mesaxon elongates and winds around the axon.

Lipids are deposited and the myelin sheath is formed.

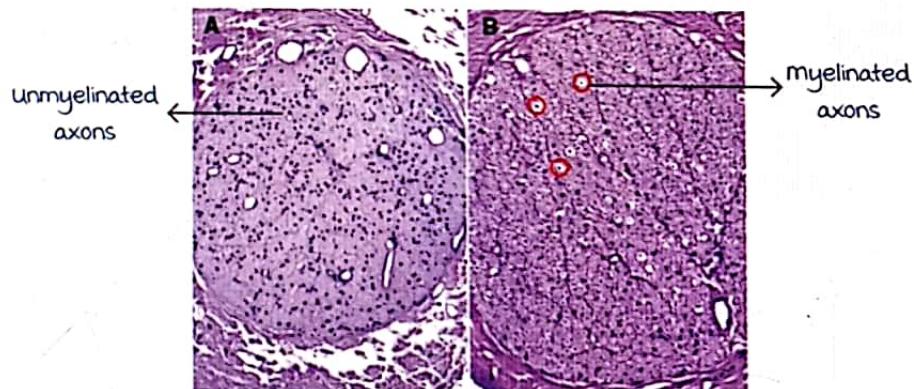


**Nodes of Ranvier :**

The axon is related to numerous Schwann cells.

Each Schwann cell contributes to the myelin sheath only for a short distance.

The gap between the myelin sheath of two such segments is known as **Node of Ranvier**.



## Histology of Cerebrum

00:09:36

**Types of cells in the Cerebrum :**

**Pyramidal cells**

- Triangular shape.
- Large dendrites arise from the apex of the pyramidal cell.
- The axon arises from the base and extends **throughout the thickness** of the cerebrum.

### Stellate cells

- Smaller than the pyramidal cells.
- multipolar cells.
- Stellate cells appear as granules under microscopy hence they are also known as Granular cells.

motor cortex : Contains more Pyramidal cells > granular cells

Sensory cortex : Contains more Granular cells > pyramidal cells.

### Layers of the Cerebrum

1. molecular Layer :
  - Contains Horizontal fibers.
  - Contains scattered supporting cells of Cajal.
2. External Granular Layer
  - Densely packed with granular cells.
3. External Pyramidal layer
  - Contains small and medium sized pyramidal cells.
4. Internal Granular Layer
  - Contains granular cells.
  - Contains the Outer band of Baillarger :
    - Comprises heavily myelinated horizontally running axons.
    - It is very dominant in the visual cortex thus the visual cortex is also known as Striate cortex.
5. Internal Pyramidal Layer
  - Contains large pyramidal cells.
  - Contains Inner band of Baillarger.
6. multiform layer
  - All types of cells are found in this layer.

# ENDOCRINE SYSTEM

## Pituitary Gland

00:00:05

Divided into **two parts** - 1. Adenohypophysis

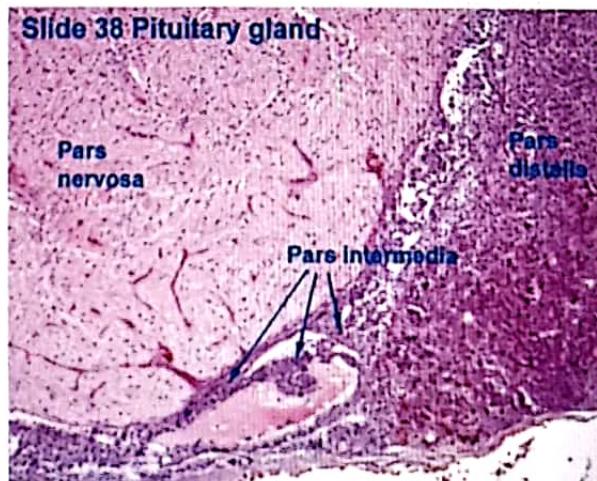
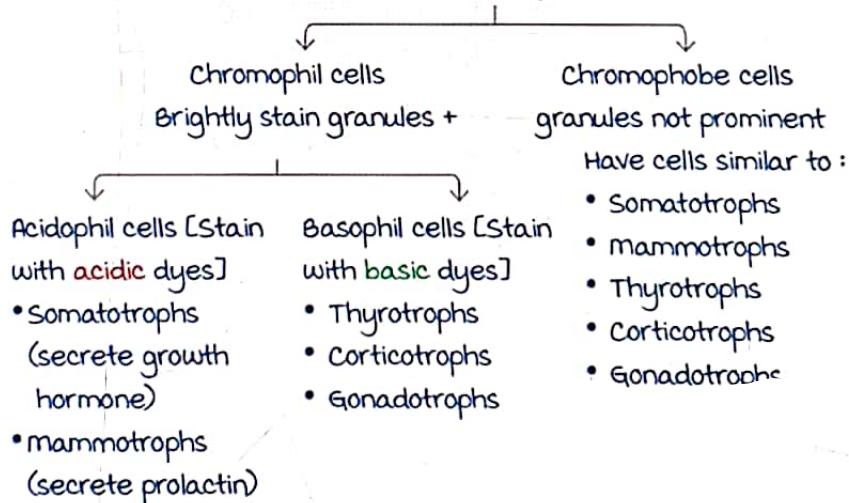
2. Neurohypophysis

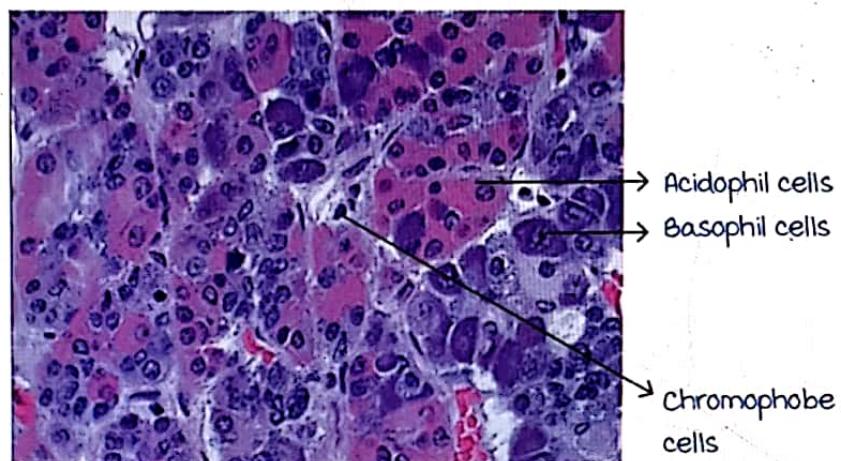
Adenohypophysis :

Cells arranged in form of chords and separated by sinusoid.

### I. Pars distalis (pars anterior)

- Various type of cells for secreting each hormones
- mainly two types of cells :





#### a. Pars intermedia:

- Poorly developed
- Remnants of Rathke's pouch : vesicles filled with colloid
- Secretes mSH - melanocyte stimulating hormone

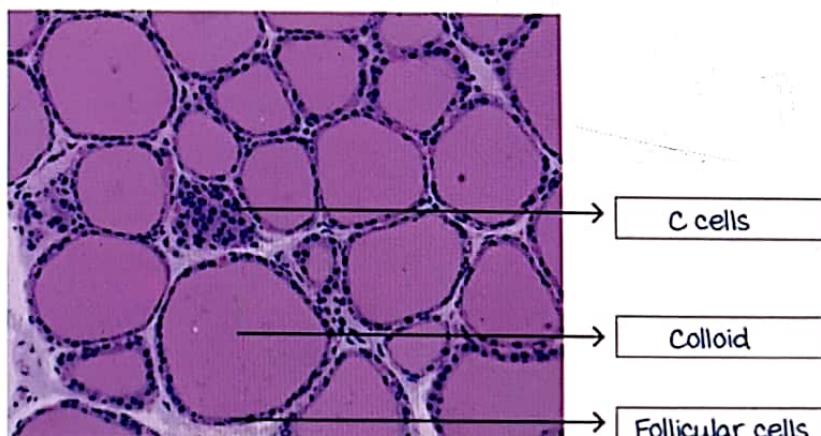
#### Neurohypophysis :

##### Pars nervosa :

- Unmyelinated axons coming [from the neurons in the hypothalamus (Nucleus supraoptic and Para ventricular) and secrete vasopressin and Oxytocin]
- Pituicytes** : supporting cells for the axons

## Thyroid Gland

00:09:22



Covered by capsule



Septum arise from the capsule



Divide gland into lobules (aggregation of follicles)

**Follicular cells :**

- Normal : cuboidal
- Highly active : squamous
- Less active : columnar

**em of follicular cells :**

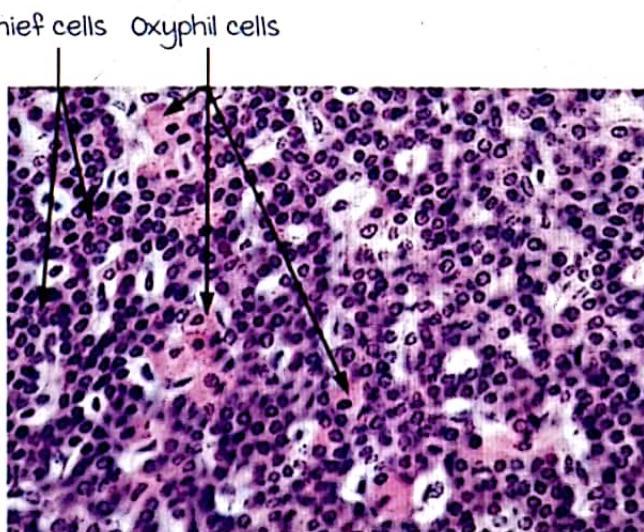
- Apical microvilli
- Numerous ER
- Supranuclear Golgi complex

**C-cells/Para-follicular cells :**

- Clear cell or light cell
- Polyhedral cells found between follicles
- Secrete thyrocalcitonin

**Parathyroid Gland**

00:14:00



- 4 in number (2 superior and 2 inferior)
- Covered by capsule
- Cells arranged in form of chords and separated by sinusoids

**Chief cells :**

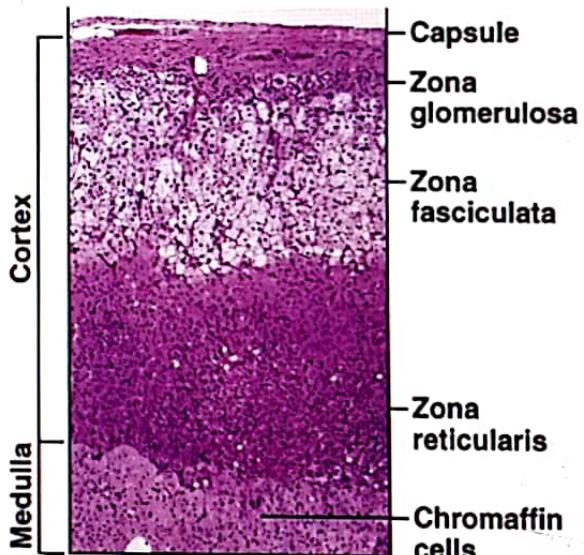
- Principal cell
- Smaller
- Numerous
- Secrete parathormone

**Oxyphil cells :**

- Eosinophilic cells
- Larger
- Few
- Function not known

**Adrenal Gland**

00:16:33

**Adrenal cortex :**

- Covered by capsule
- Cortex is 10 times the thickness of the medulla.

**Zona glomerulosa :**

- Outer 1/5th
- Inverted U shaped cells (umbrella shaped cells)
- Small, polyhedral cells with basophilic cytoplasm
- Secrete mineralocorticoid

### Zona reticularis:

Inner 1/5th

- cords - branch anastomose → Reticulum
- same as fasciculata (fewer lipids content but contain brown pigment)
- secrete some glucocorticoids and sex hormones

### Adrenal medulla:

- structurally, embryologically and functionally different from cortex cells
- cells postganglionic sympathetic neurons (secrete adrenaline and noradrenaline)
- **Chromaffin reaction:**

Fix cells of adrenal medulla

+

Solution containing chromium salts

↓

Cytoplasm - yellow granules

### APUD cells

00:23:45

- scattered endocrine cells.
- show Chromaffin reaction +
- take amine precursors
  - ↓
  - Process by decarboxylation
  - ↓
  - Form peptides - hormones

### Examples:

- Cells in Adenohypophysis
- Neurons in hypothalamus
- C-cells of thyroid
- Chief cells of parathyroid
- Adrenal medulla cells
- Glomus cells - in carotid body
- melanocyte cells
- Some cells in the pineal gland
- Renin producing cells in the kidney

## HISTOLOGY OF LYMPHATIC SYSTEM

Primary lymphoid organs -

Produce lymphocytes independent of antigenic stimulus.

Eg : Thymus , Bone marrow

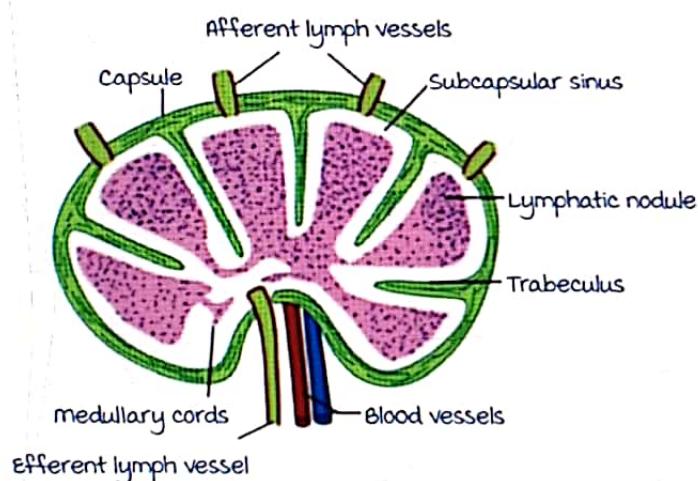
Secondary lymphoid organs -

Produce lymphocytes only in response to an antigenic stimulus

Eg : Spleen , Tonsil , Lymph node , MALT

### Lymph node

00:01:41



- Function : lymph is filtered before reaching blood stream  
bacteria, particulate matter filtered.
- Structure - Bean shaped
- Capsule - present
- Lymphocytes are arranged
  - as follicles in cortex - Lymphocytic nodule
  - as cords in medulla
- Numerous afferent lymphatics enter the convex surface
- Single efferent lymphatic vessel in the concave surface  
Lymph enters via the afferent vessels



From subcapsular sinus



Numerous cortical radial sinuses pass through lymph node

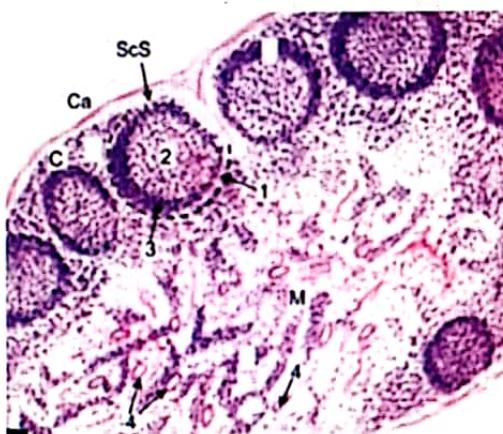


Active space

Reach medulla and form medullary sinus



Exit via efferent vessel



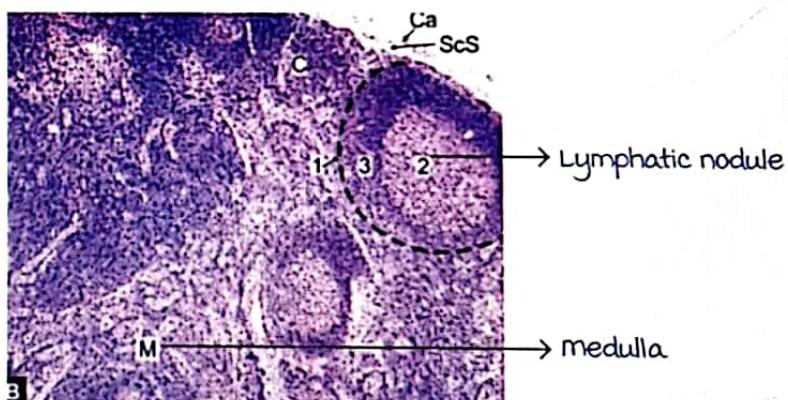
Ca - capsule

ScS - subcapsular sinus

m - medulla

In cortex, Lymphatic nodule : Pale germinal centre , thick at the periphery

In medulla, arranged as cords that anastomose with each other



## Spleen

00:09:02

Numerous trabecular septae from capsule enter the substance of spleen

Splenic artery



Enter trabeculae - Trabecular arteries



Arteriole enters inter-trabecular space

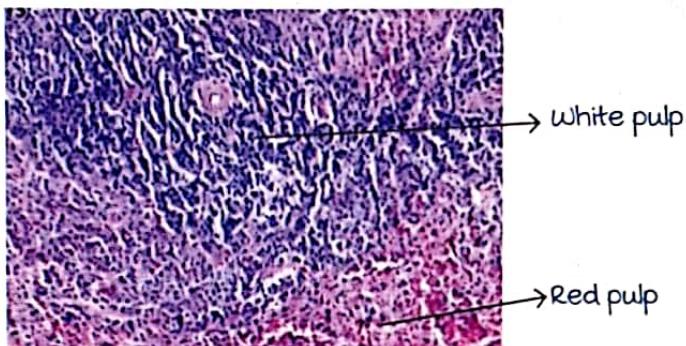
**white pulp :**

White pulp is lymphatic nodule and 'eccentrically placed arteriole'

Periarteriolar lymphatic sheath present.

### Red pulp:

Straight branches - penicular arteries - surrounded by ellipsoid  
Distal to ellipsoid, penicular artery dilate (called ampulla) and  
infiltrate splenic tissue

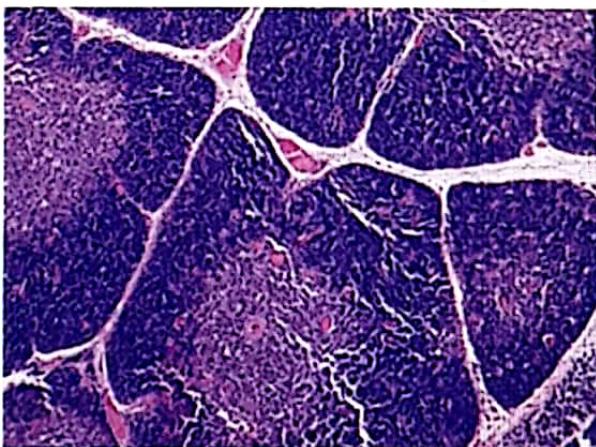


Red pulp made of sinusoids and splenic cords of bilroth.

Sinusoids have special endothelium - banana shaped endothelium -  
'Stave cells'

Splenic cords of bilroth contain reticular fibres, fibroblasts,  
macrophages.

### Thymus



Capsule present

Lymphocytes arranged as lobules

Each lobule contains cortex and medulla

Hassall's corpuscles present.

Cortex: numerous lymphocytes and few epithelial-reticular cells

medulla: few lymphocytes and more epithelial-reticular cells.

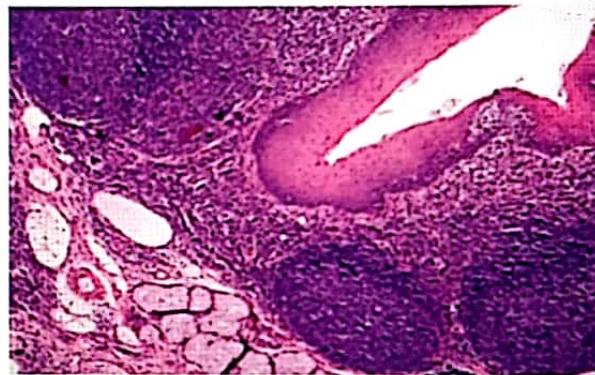
Active space

Hassall's corpuscles -  
Degenerated cells  
concentrically arranged eosinophilic mass  
Function- not known

## Tonsil

00:21:15

Only lymphoid organ with epithelial lining  
Stratified squamous non-keratinised epithelium.



Numerous crypts present on medial side.  
Lymphocytes arranged as lymphatic nodules.

### Note :

Lymphatic nodules (follicle) seen in

- Lymph node
- Spleen
- Tonsil

# GIT

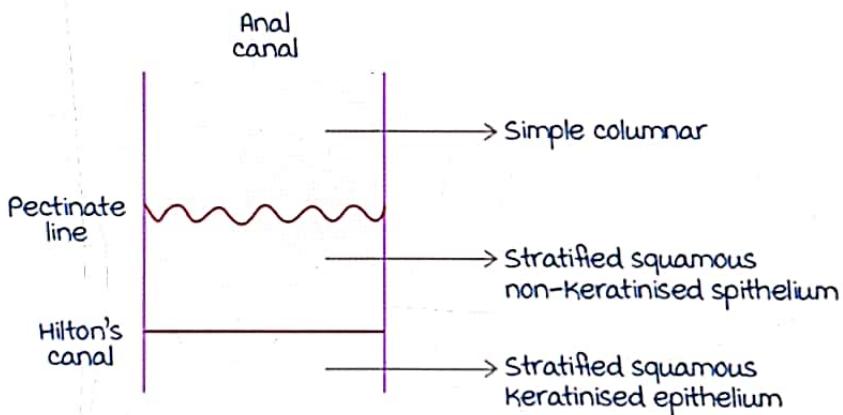
## Four layers

00:00:05

mucosa :

Epithelial :

- Up to esophagus (including tongue and tonsils) - stratified squamous non keratinized epithelium
- Stomach - simple columnar
- Small intestine - simple columnar with microvilli
- Large intestine - simple columnar
- Anal canal -



Lamina propria :

- Contains connective tissue, gastric glands and intestinal glands
- Ileum contains Peyer's patches
- muscularis interna : inner circular and outer longitudinal muscles

Submucosa :

- Strongest layer in the GIT
- Contains connective tissue
- Meissner's corpuscles present
- Contains Esophageal glands and Brunner's gland

muscularis externa :

- Inner circular outer longitudinal
- Auerbach Plexus
- In esophagus :
  - upper 1/3<sup>rd</sup> - skeletal muscles

Active space

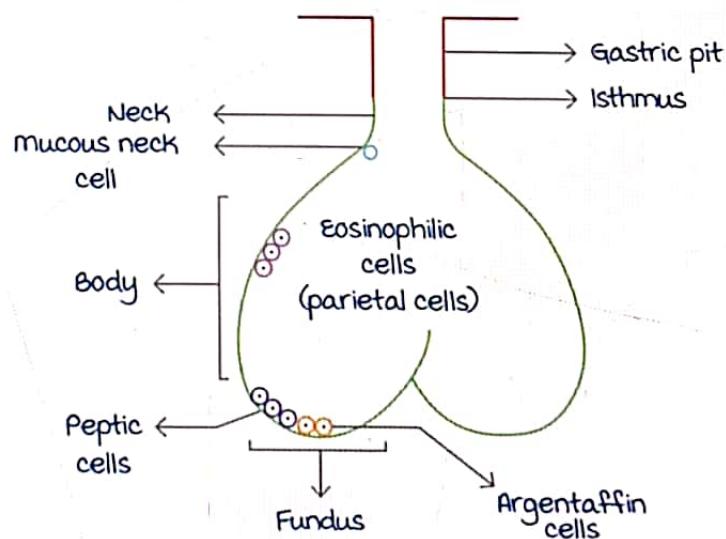
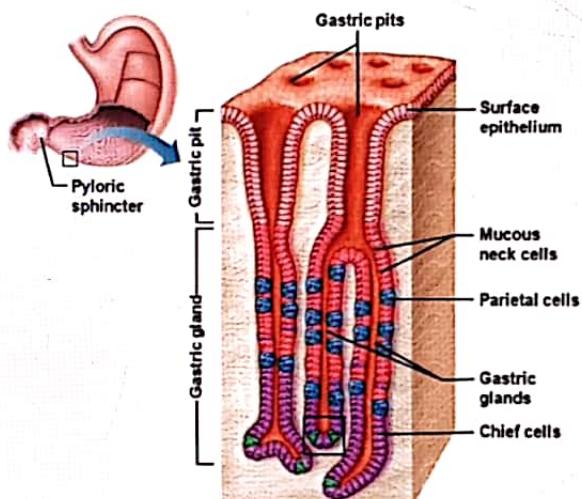
- middle  $1/3$ <sup>rd</sup> – skeletal + smooth muscles
- Lower  $1/3$ <sup>rd</sup> – smooth muscles

### Serosa/Adventitial layer :

- If covered by peritoneum then called as Serosal layer and if not then **Adventitial** layer

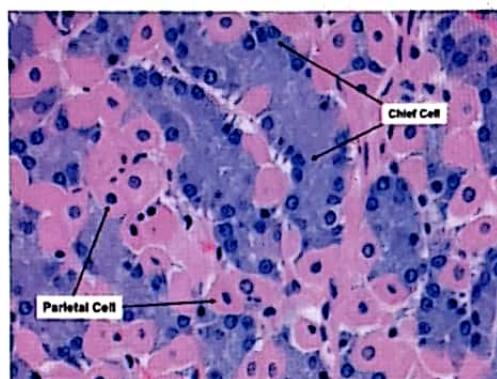
## Stomach

00:08:30

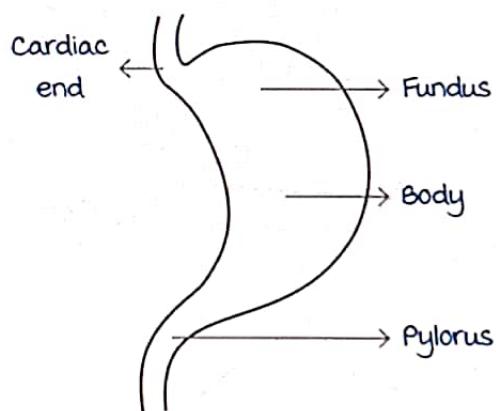


- Body of the gland :
  - Parietal cell/ Oxytotic cell :
    - Secrete HCl and intrinsic factor
- Fundus of the gland :
  - Peptic cells/Chief cells : secrete pepsinogen

- Argentaffin cells :
  - Have affinity for "silver salts"
  - Neuroendocrine cells - secrete gastrin



Glands :



1. Cardiac glands :
  - a. Gastric pit is shallow
  - b. mucous neck cells
2. Pyloric glands :
  - a. very deep
  - b. mucous neck cells + Argentaffin cells
3. Fundus glands of stomach :
  - a. All cells are present

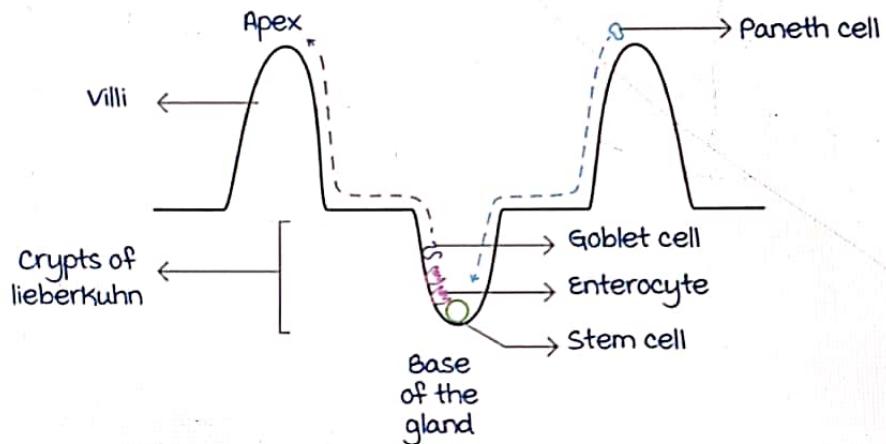
Active space

**Small intestine**

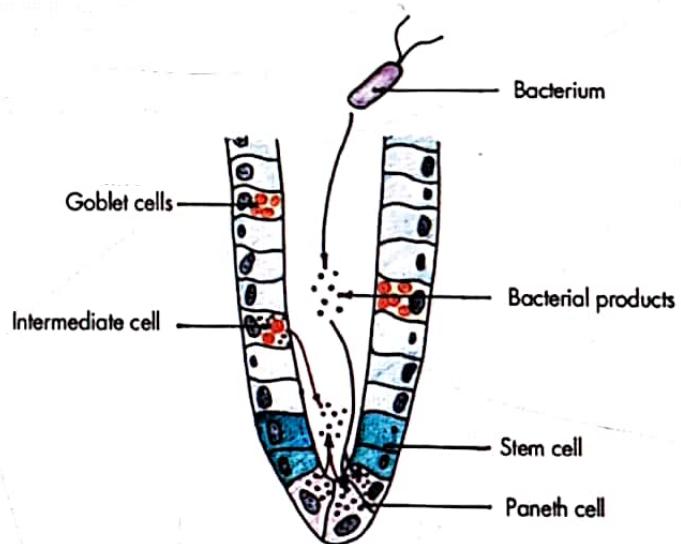
00:18:05

Will have villi having crypts of Lieberkuhn (small intestinal glands)

Cells :



- Paneth cells :

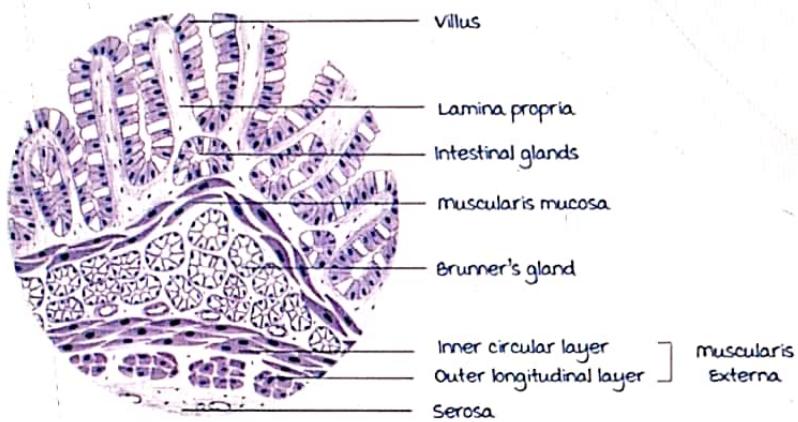


**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

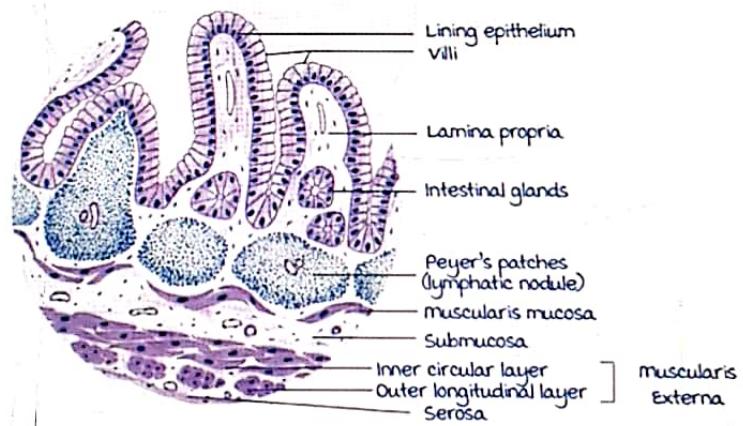
- migrate from the apex of the gland to base of the gland
- Apical eosinophilia - more lysosomal granules at apex
- Phagocytic in function
- M cells : antigen presenting cells

Slides :

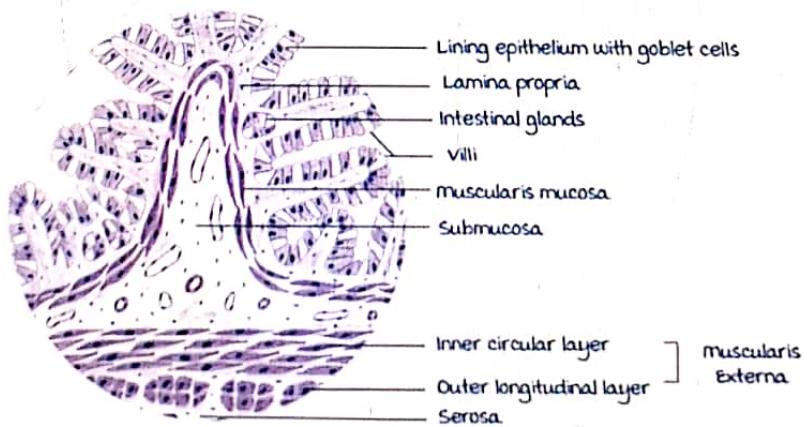
- Duodenum : features of GIT + villi + Brunner's gland (more in proximal area)



- Ileum : GIT + villi + Peyer's patches

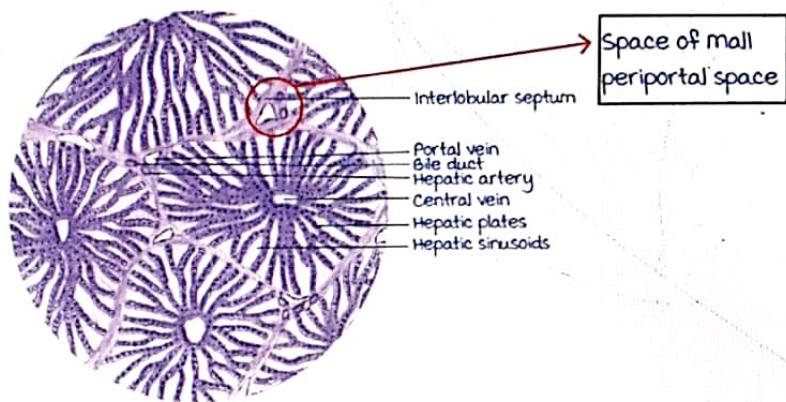


- Jejunum : only GIT + villi



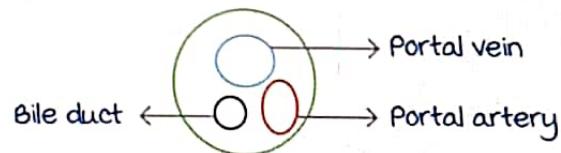
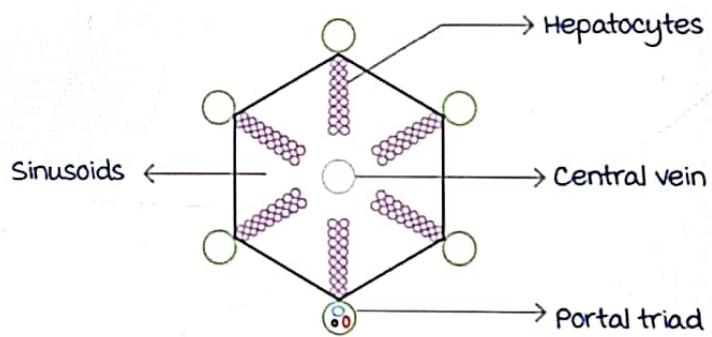
## Liver

00:25:35



## Hepatic lobule :

- Hexagon shape
- Contains anastomosing chords of hepatocytes



## • Blood Flow :

Blood from portal vein and hepatic artery



Sinusoids



Central vein



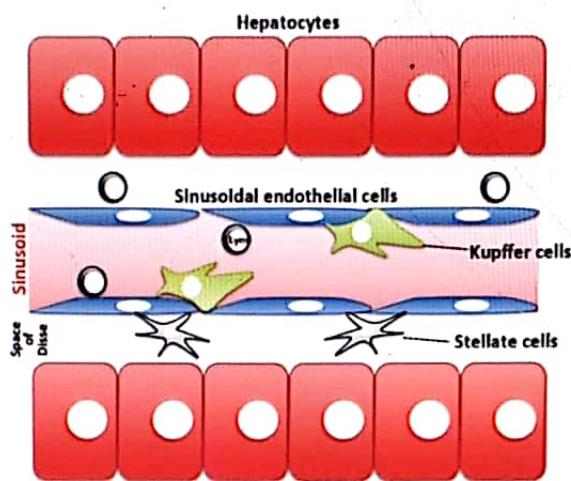
Hepatic venule



Hepatic vein

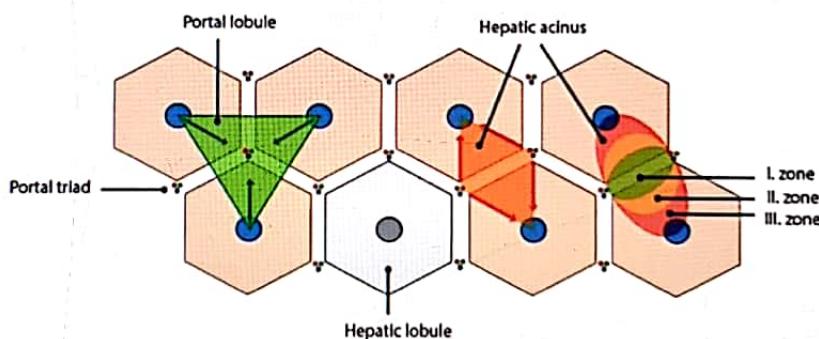


IVC

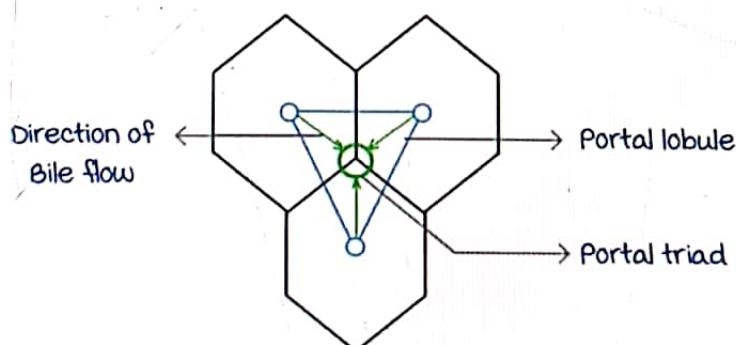


- Kupffer cells : present in sinusoid (mesodermal structure)
- Stellate cells : present in the space of Disse and have **Ho** cells (store Vit A)

#### Portal lobule and Hepatic acinus :



#### Portal lobule :



Active space

- is **triangular** in shape
- Central vein in the corner
- Portal triad structure in the center
- Signifies the direction of bile flow

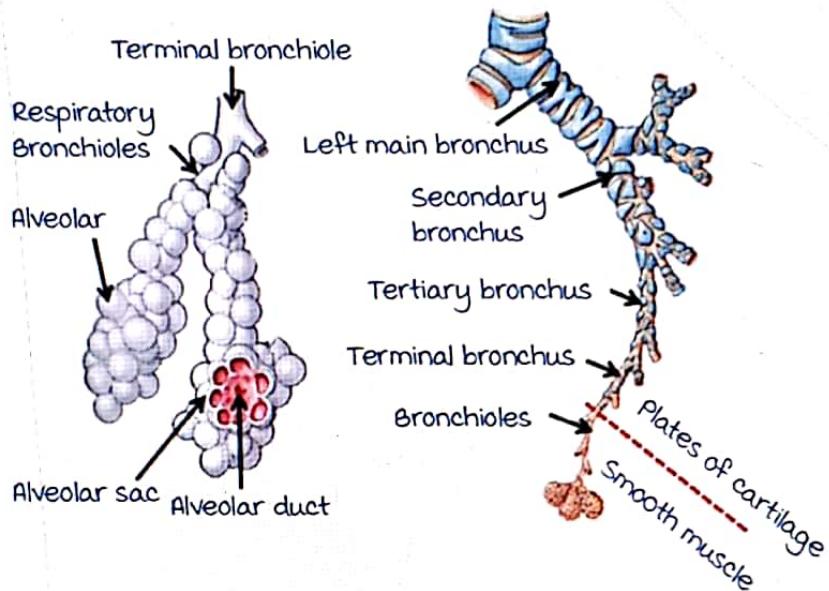
**Hepatic Acinus :**

- Is diamond shaped
- Area between the adjacent hepatocytes supplied by Portal vein and Hepatic artery
- Zone :
  - Zone 1 - highly vascular
  - Zone 2
  - Zone 3 - less vascular (prone to ischemic injuries)

Active space

# HISTOLOGY OF RESPIRATORY SYSTEM

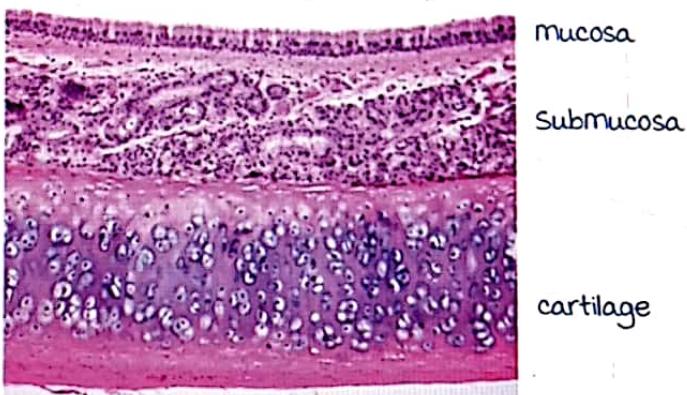
## Tracheobronchial tree



Trachea and bronchus have the **same** histological features

### Features of Trachea and bronchus

00:00:47



Layers:

mucosa (innermost)

Submucosa

Cartilage

**mucosa:**

Pseudo stratified ciliated columnar epithelium

Goblet cells **present**

Clara cells - surfactant (like type 2 pneumocytes)

Active space

Basal cells - mitotic nature  
 brush cells  
 Kulchitsky cells - Neuroendocrine cells

Submucosa:

Submucosal glands - present

Cartilage:

Hyaline cartilage present  
 Chondrocytes are in groups

Bronchioles -

Epithelium: simple columnar to ciliated columnar

Goblet cells absent

Submucosal glands absent

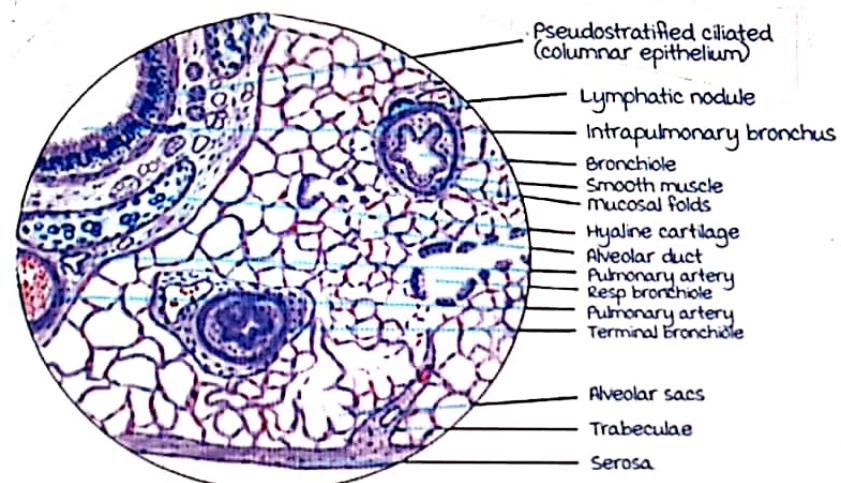
Cartilage replaced by smooth muscles

Respiratory and terminal bronchioles - simple cuboidal epithelium

Alveoli - simple squamous

Type I pneumocytes  
 (occupies 95%) Gaseous exchange Squamous cells

Type 2 pneumocytes  
 (occupies 5%) surfactant production Large round cuboidal cells



# OSTEOLOGY OF HEAD AND NECK

## Superior aspect of Base of Skull

00:00:12

The cribriform plate of ethmoid is pierced by numerous olfactory nerves.

Parts of sphenoid bone :

- Lesser wing of sphenoid.
- Body of sphenoid.
- Greater wing of sphenoid.

Structures passing through Anterior Ethmoidal foramen :

- Anterior ethmoidal nerve.
- Anterior ethmoidal artery.

Structures passing through Posterior Ethmoidal foramen :

- Posterior ethmoidal nerve.
- Posterior ethmoidal artery.

Optic canal :

Present in lesser wing of sphenoid.

Structures passing through optic canal :

- Optic nerve with meninges.
- Ophthalmic artery.

Structures passing through foramen Rotundum :

Only maxillary nerve.

Structures passing through foramen Ovale -

mnemonic : "MALE".

- mandibular nerve. (AIIMS 2017)
- Accessory middle meningeal artery.
- Lesser Petrosal nerve. (AIIMS 2015)
- Emissary veins (communicating veins between scalp and venous sinuses).

Foramina present  
in greater wing of  
sphenoid (AIIMS)

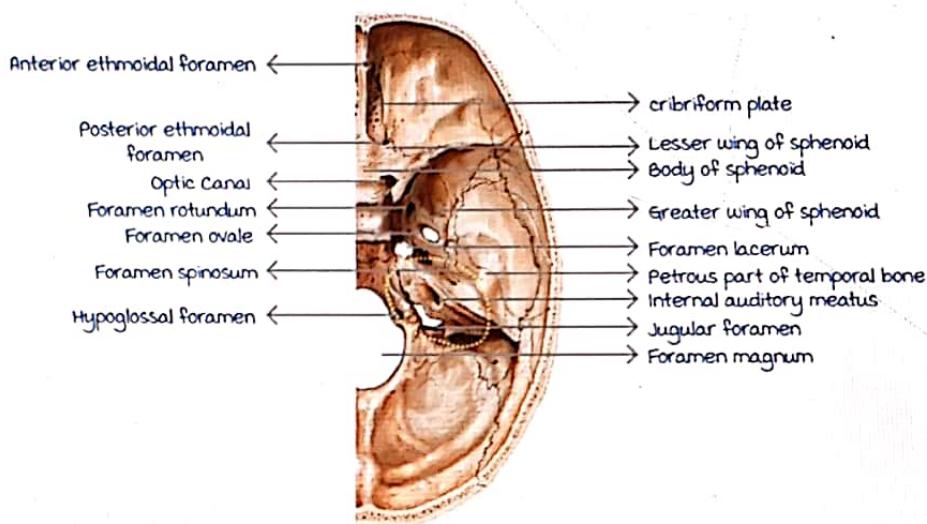
Structures passing through foramen Spinosum :

- middle meningeal artery.
- Posterior trunk of middle meningeal vein.
- Nervi spinosum (meningeal branch from mandibular nerve).

Active space

middle ear and inner ear are situated in the Petrous part of Temporal bone.

Internal auditory meatus is present on posterior surface of petrous temporal bone.



### Foramen Lacerum

00:07:05

misnomer since its lower part is closed by cartilage.

No structures pass vertically through foramen Lacerum.

Internal Carotid Artery (ICA) traverses the superior part of foramen Lacerum.

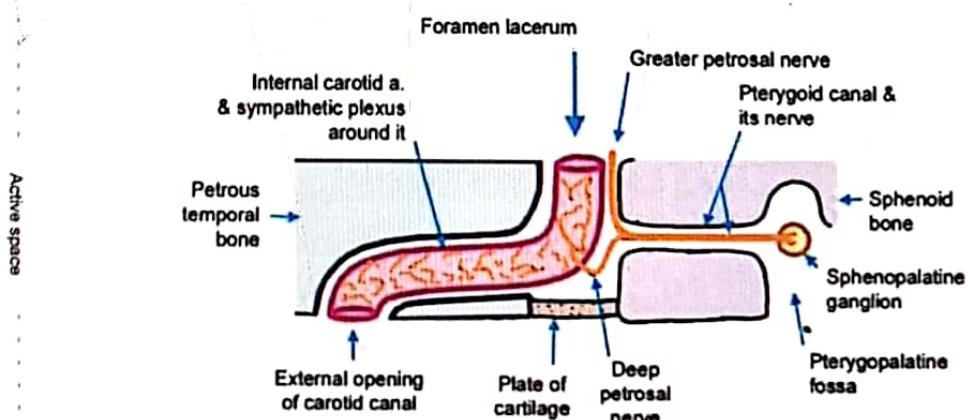
The ICA enters cranial cavity through Carotid canal.

Deep petrosal nerve forms sympathetic plexus around the ICA.

Deep Petrosal nerve joins with Greater Petrosal nerve to form Vidian nerve.

Vidian nerve passes through Pterygoid canal/ Vidian nerve canal.

Vidian nerve ends in Sphenopalatine ganglion/ Pterygopalatine ganglion.



## Internal auditory meatus and Jugular foramen

00:13:22

Internal Auditory meatus is present on the posterior surface of petrous temporal bone.

Structures passing through internal auditory meatus :

- VII Nerve (middle ear).
- VIII Nerve (inner ear).
- **Labyrinthine artery**, branch of Anterior Inferior Cerebellar Artery > Basilar artery (inner ear).

Jugular Foramen has 3 compartments :

1. Anterior compartment :

Contains Inferior Petrosal Sinus.

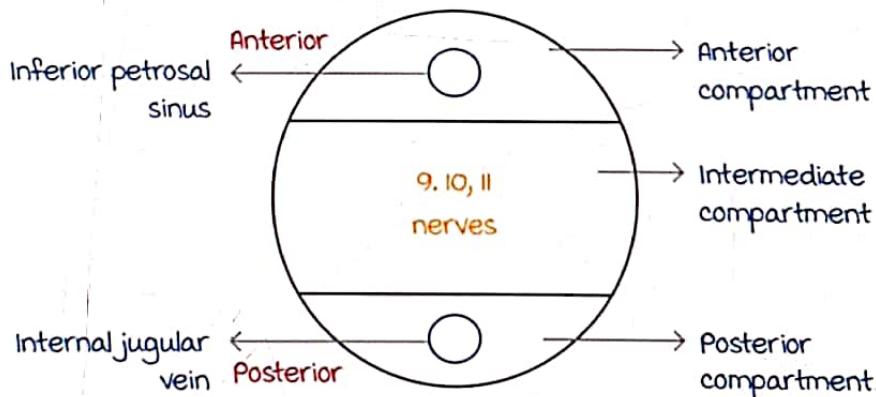
2. Intermediate compartment :

Contains 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup> cranial nerves.

3. Posterior compartment :

Contains Internal Jugular vein (Continuation of sigmoid sinus).

**Vernet Syndrome** : mass in Jugular foramen compresses the 9, 10, 11 nerves.



## Foramen magnum and Hypoglossal canal

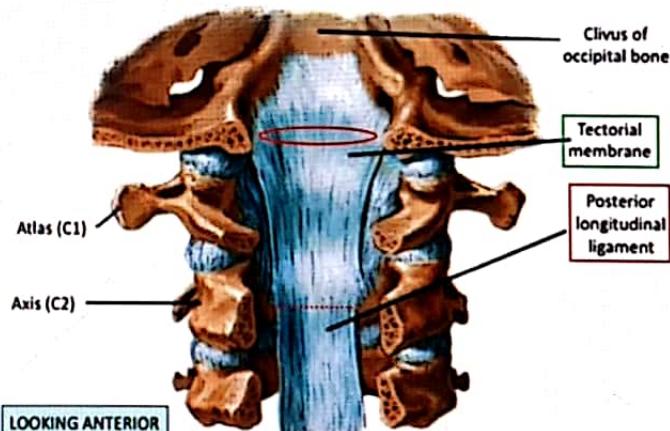
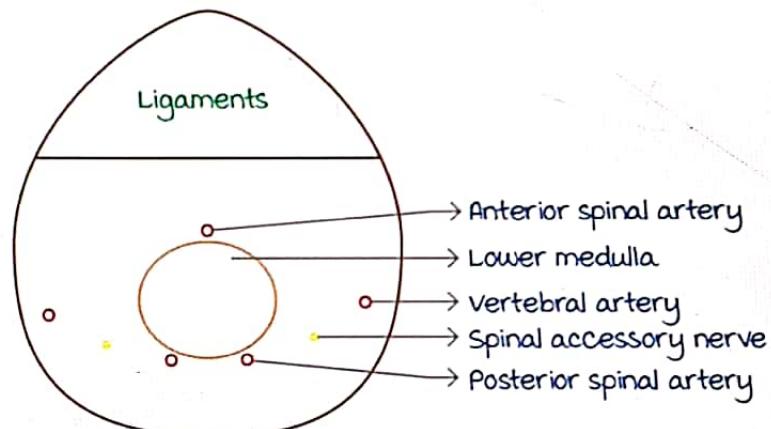
00:17:14

It has 2 compartments :

1. Anterior compartment : (contains ligaments).
  - Apical ligament of Dens.
  - upper band of cruciate ligament.
  - Tectorial membrane – continuation of Posterior longitudinal ligament from ca. (AIIMS 2015)
2. Posterior compartment : (contains neurovascular structures).
  - Anterior spinal artery

- Lower end of medulla
- Posterior spinal artery
- Fourth part of vertebral artery
- Spinal part of accessory nerve

Hypoglossal canal transmits Hypoglossal nerve.



### Anatomy of inferior aspect of base of skull

00:22:32

The following are seen in Norma Basalis view.

**Incisive canal** transmits :

- Nasopalatine nerve.
- Greater palatine vessels.

Greater Palatine foramen.

Lesser Palatine foramen.

Carotid canal.

Jugular foramen.

Foramen Lacerum.

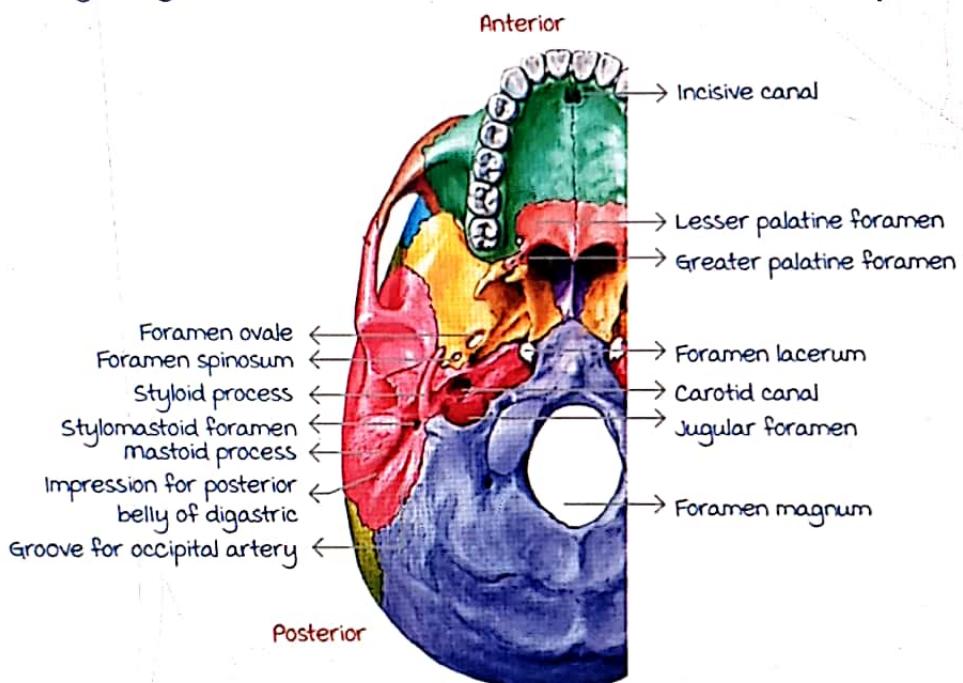
### Stygomastoid foramen:

It lies between the styloid process and mastoid process.

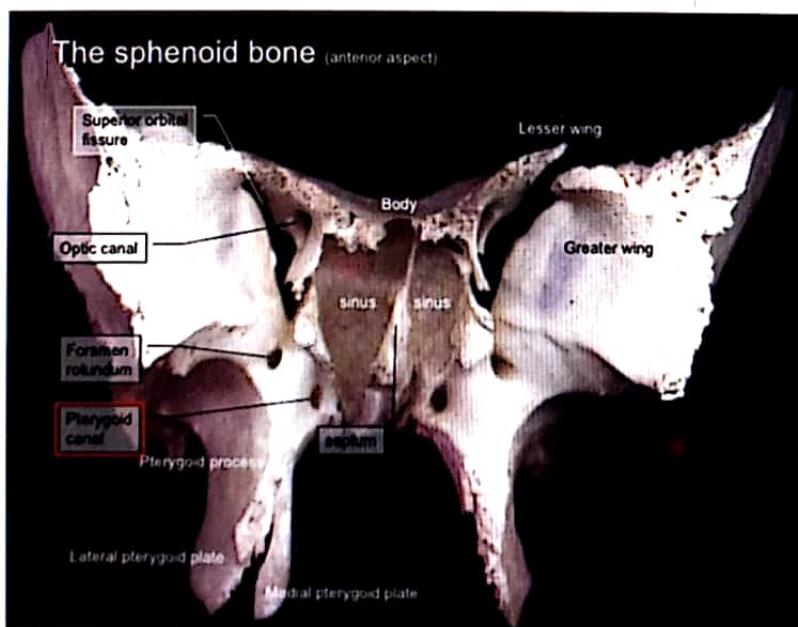
VII cranial nerve leaves cranial cavity through stygomastoid foramen.

Impression of Posterior belly of Digastric lies medial to mastoid process.

Groove for Occipital artery is seen medial to impression of posterior belly of digastric.



Pterygoid canal transmits Vidian nerve and is present in floor of Sphenoidal Sinus. (JIPMER)



## Anatomy of Mandible

00:28:05

Attachments on mandible :

Head : Lateral pterygoid muscle insertion.

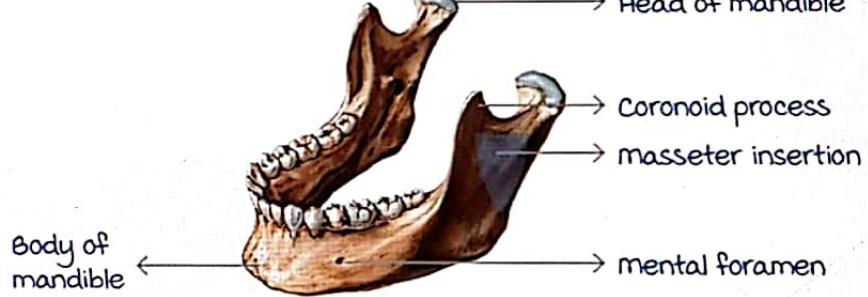
Coronoid process : Temporalis muscle.

Ramus - outer surface : masseter muscle insertion.

mental foramen

It is present on front side of body of mandible.

It transmits the **mental nerve** (continuation of inferior alveolar nerve).



mandibular foramen :

Present on medial surface of ramus of mandible.

Transmits Inferior Alveolar nerve and Inferior Alveolar vessels.

mylohyoid groove

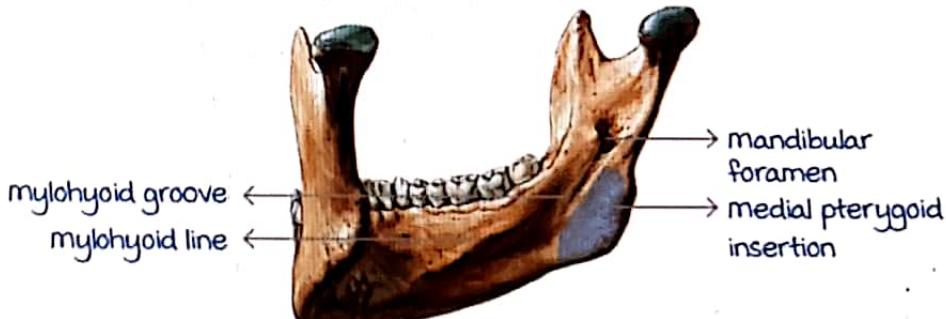
Transmits nerve to mylohyoid (branch of inferior alveolar nerve)

which supplies 2 muscles :

- mylohyoid muscle.
- Anterior belly of Digastric.

mylohyoid muscle takes origin from the **mylohyoid line**.

**medial pterygoid muscle** inserts on the posteroinferior aspect of medial surface of ramus of mandible, including the angle of mandible.



# SCALP AND FACE

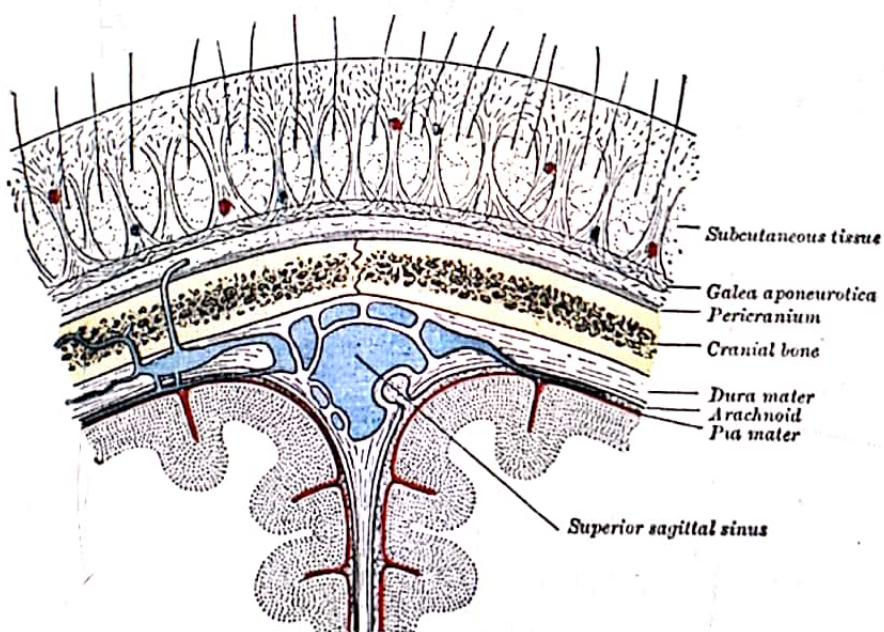
## Layers of scalp

00:00:30

- S : Skin - sebaceous glands, sweat glands
- C : Subcutaneous layer - highly vascular layer
- A : Aponeurosis layer (Galea aponeurotica)
- L : Loose areolar layer- contains Emissary veins (valveless veins)  
→ bidirectional flow of blood
- Dangerous area of scalp
- P : Pericranium

Tissue expander in scalp is placed between aponeurotic layer and periosteum.

Tissue expander in rest of the body is placed in avascular subcutaneous layer.



Implants in scalp are placed in subgaleal region - provides easy plane of cleavage and avascular.

Active space

## Face

00:09:59

Facial muscles are present subcutaneously : Panniculus carnosus derivative.

Other subcutaneous muscles : Platysma, Palmaris breviss, Dartos, Corrugator cutis ani.

motor supply of facial muscles - **Facial nerve**

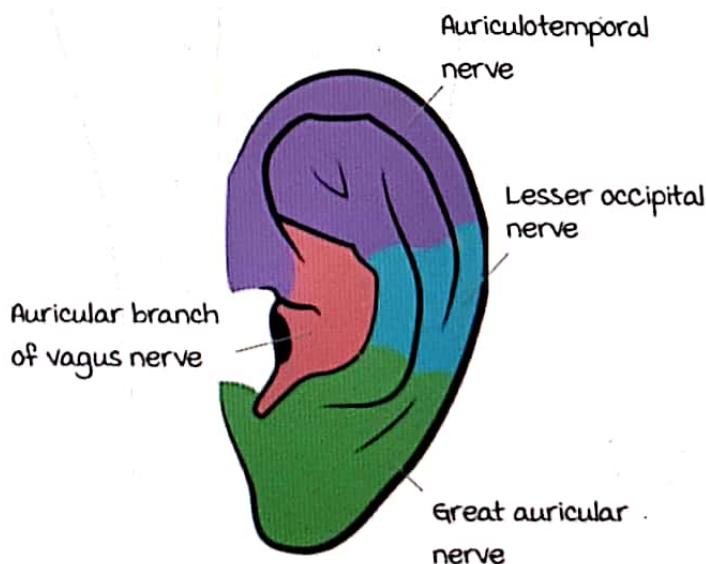
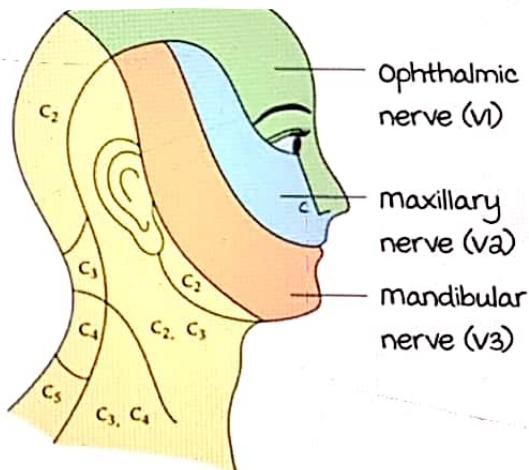
- Sensory supply of face :
- Ophthalmic nerve : forehead, upper eyelid, tip of nose.
  - maxillary nerve - upper lip, lower eyelid, side of nose.
  - mandibular nerve - lower lip, chin, cheek, adjoining areas of auricle and temple (Auriculotemporal nerve)

Skin over angle of mandible : **Great Auricular Nerve**

- branch from cervical plexus
- supplies major part of auricle

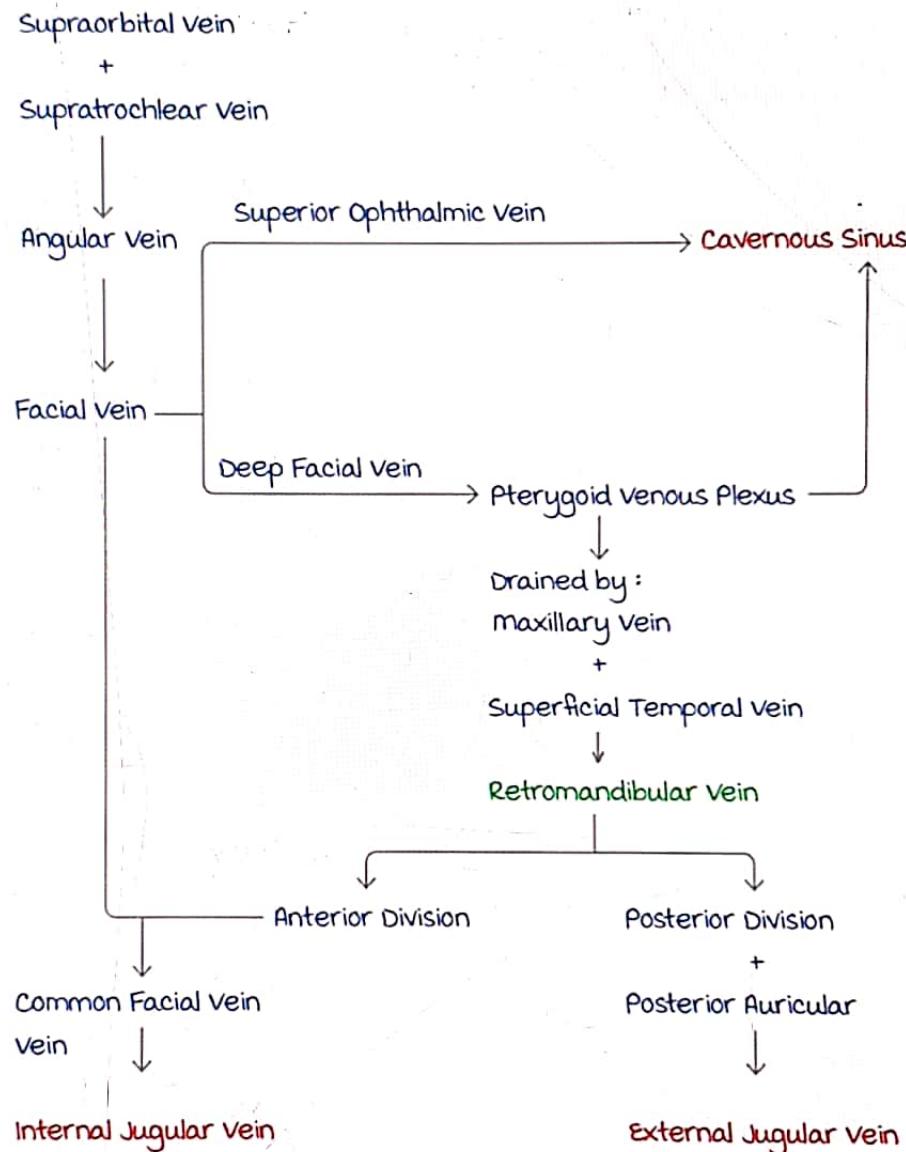
Lesser occipital nerve : posterior and superior part of auricle

External acoustic meatus : Auricular branch of vagus



**Venous drainage of face**

00:20:46

**Dangerous area of face**

Area between Nose and upper lip.

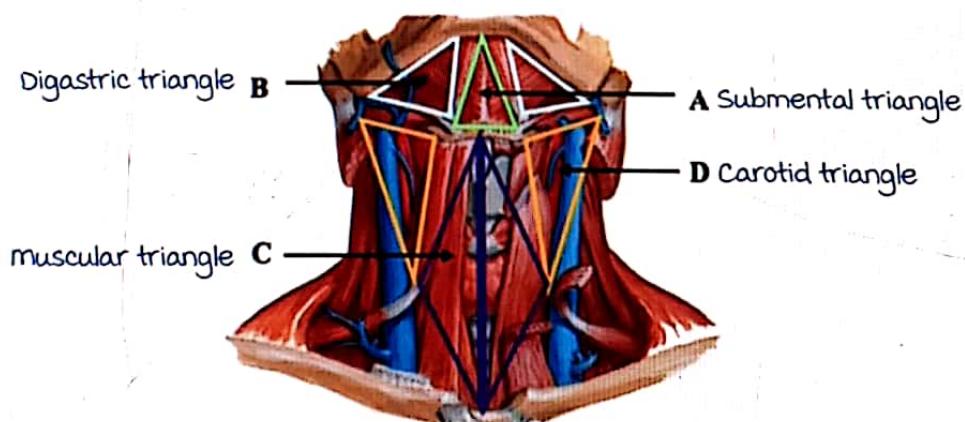
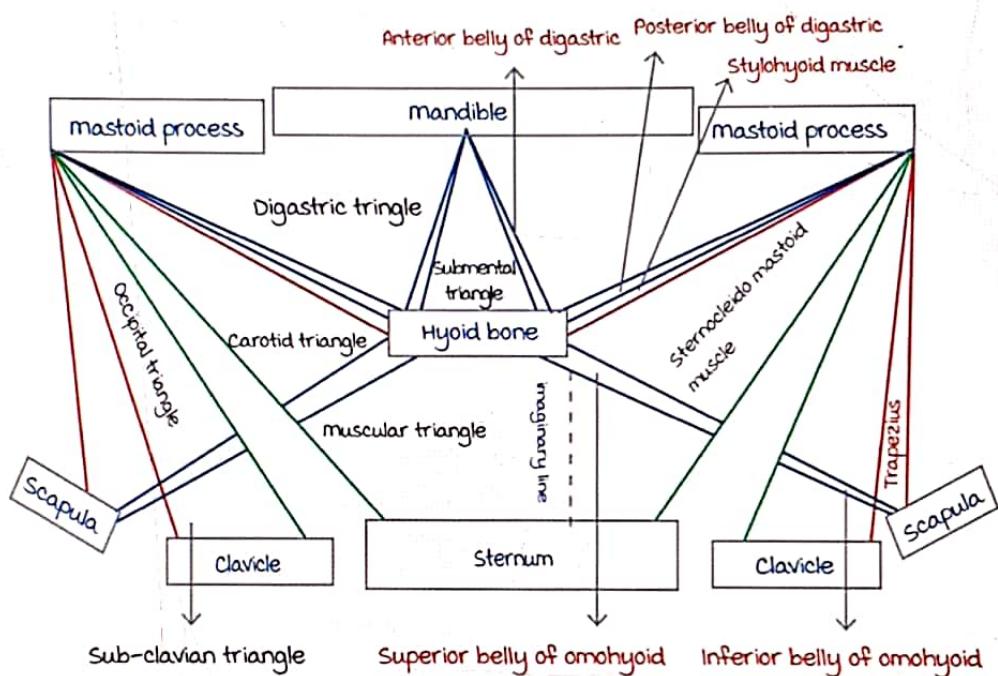
This area is drained by Facial vein → Cavernous sinus.

Infection in this area: Directly spreads to cavernous sinus.

# TRIANGLES OF THE NECK

## Boundaries of neck

00:00:05



## Boundaries of triangles neck

### Submental triangle :

- Apex – mandible bone.
- Base – hyoid bone.
- Either side – anterior belly of digastric muscle.
- Content – submental nodes.

Active space

### muscular triangle :

- Above and behind - superior belly of omohyoid muscle.
- Below and behind - sternocleidomastoid muscle.
- Base - imaginary line (from hyoid to sternum).
- Content - infrahyoid muscles.

### Digastric triangle :

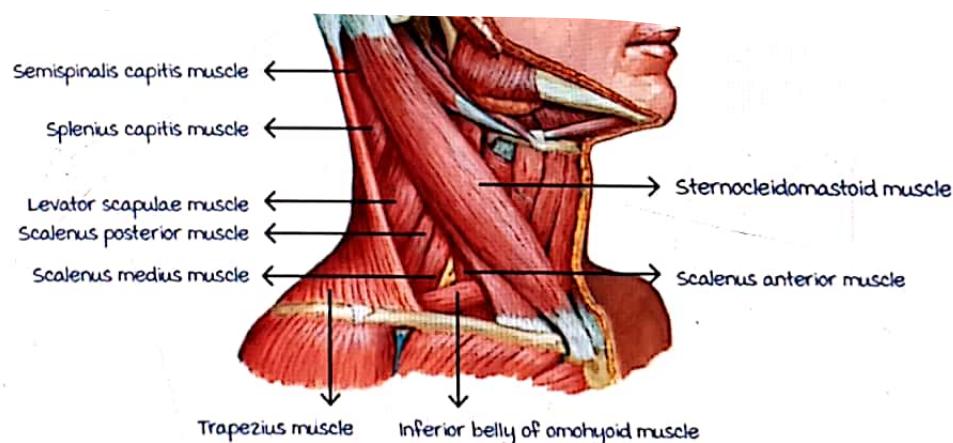
- Above - mandible and mastoid process.
- Below and in front - anterior belly of digastric muscle.
- Below and behind - posterior belly of digastric and stylohyoid muscles.

### Carotid triangle :

- Behind - anterior border of sternocleidomastoid muscle.
- Infront and above - posterior belly of digastric and stylohyoid muscles.
- Infront and below - superior belly of omohyoid muscle.

## Floor and roof of posterior triangle

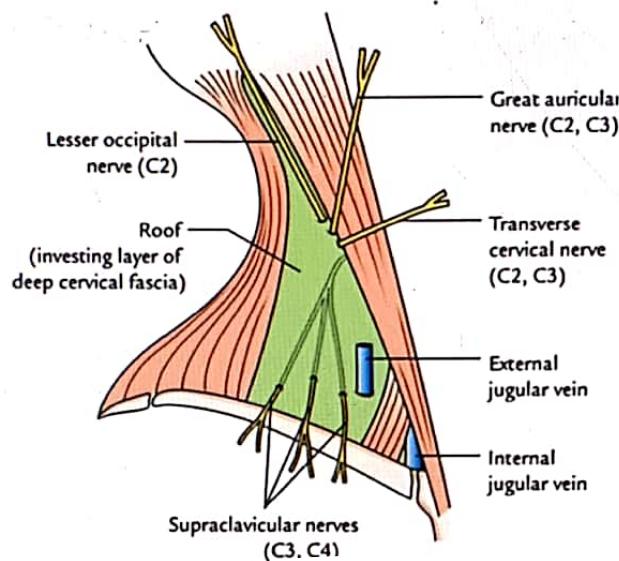
00:13:46



### Floor is formed by 6 muscles :

- Semispinalis capitis muscle.
- Splenius capitis muscle.
- Levator scapulae muscle.
- Scalenus posterior muscle.
- Scalenus medius muscle.
- Scalenus anterior muscle.

All these muscles are covered by prevertebral fascia.



**Roof of posterior triangle is formed by :**

- Skin.
- Superficial fascia.
- Deep fascia.
- Investing layer of deep cervical fascia.
- External jugular vein.
- Branches of cervical plexus (great auricular nerve, lesser occipital nerve, supra clavicular nerve and transverse cervical nerve).

### Contents of posterior triangle

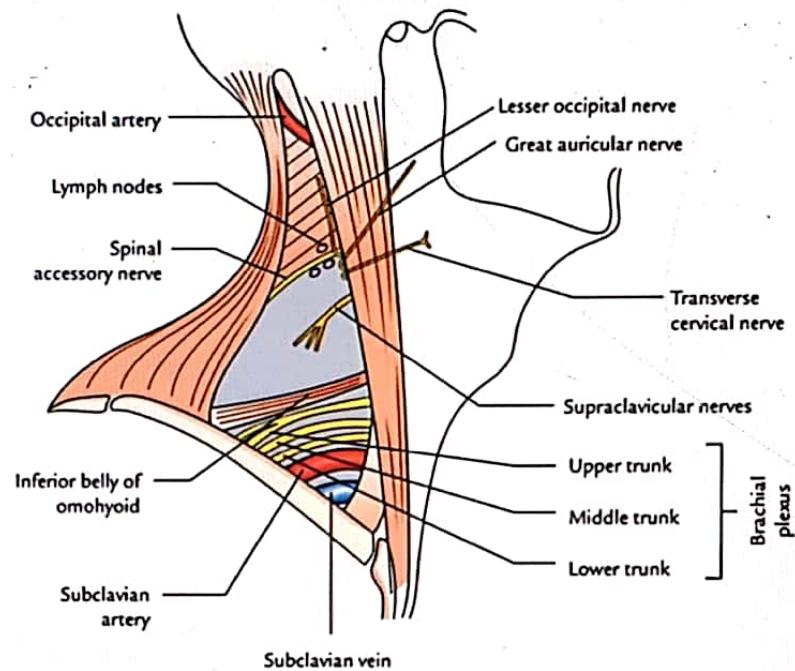
00:19:51

**Contents of occipital triangle :**

- Spinal part of accessory nerve (supplies SCM and trapezius muscle).
- Cutaneous branch of cervical plexus.
- Roots of brachial plexus.
- Occipital artery.
- Transverse cervical artery.

**Contents of subclavian triangle:**

- Subclavian vein.
- Subclavian artery (3rd part).
- Dorsal scapular artery.
- Suprascapular artery.
- Trunk of brachial plexus.

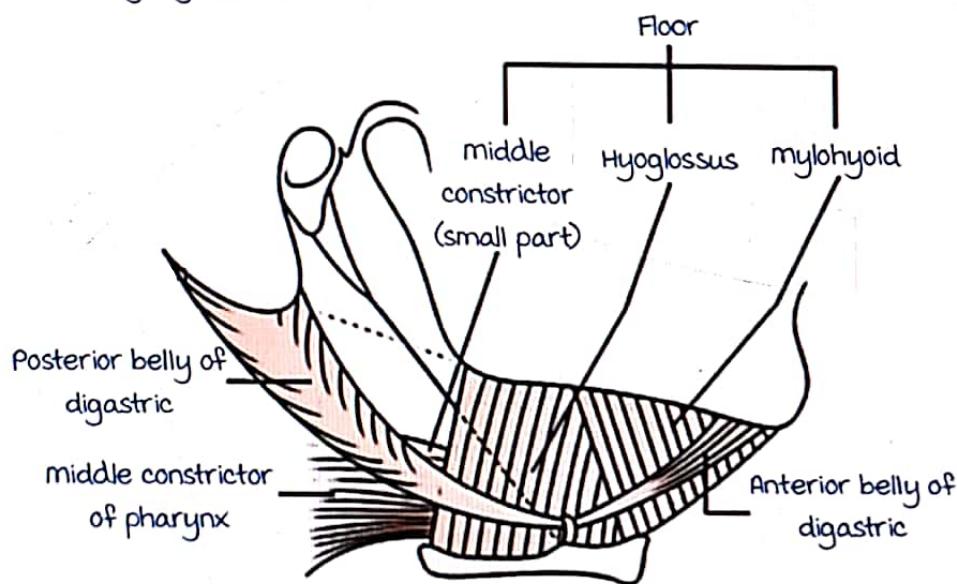


### Floor muscle of anterior triangle

00:25:24

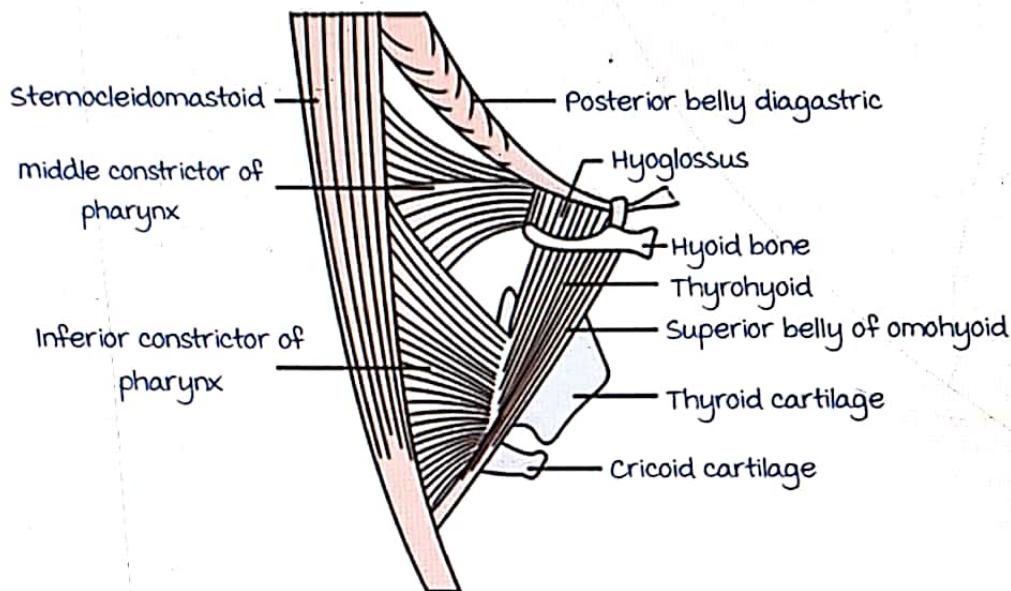
#### Digastric triangle :

- middle constrictor muscle.
- Hyoglossus muscle.
- mylohyoid muscle.



#### Carotid triangle :

- Thyrohyoid muscle.
- Inferior constrictor muscle.
- middle constrictor muscle.
- Hyoglossus muscle.

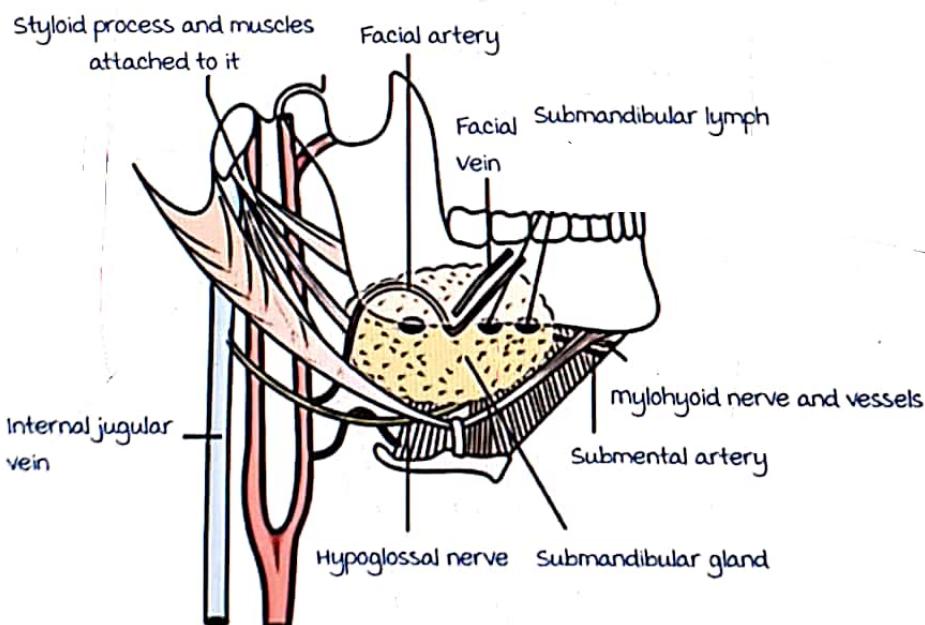


### Contents of anterior triangle

00:29:27

#### Contents of digastric triangle:

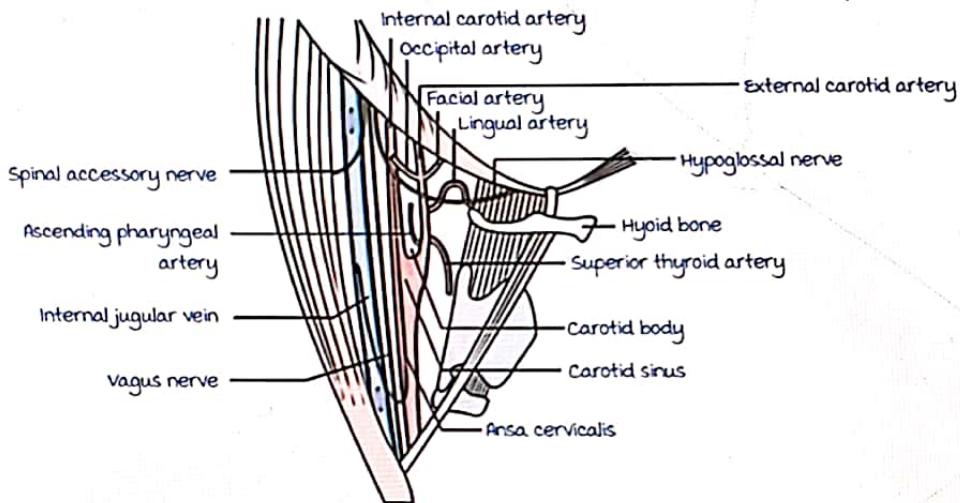
- Submandibular gland
- Facial artery and vein.
- Hypoglossal nerve.
- Nerve to mylohyoid
- Apex of parotid gland



#### Contents of carotid triangle :

- Common carotid artery.
- Internal jugular vein.

- Vagus nerve.
- Ansa cervicalis.
- Hypoglossal nerve.
- Cervical sympathetic chain (present posterior to carotid sheath)



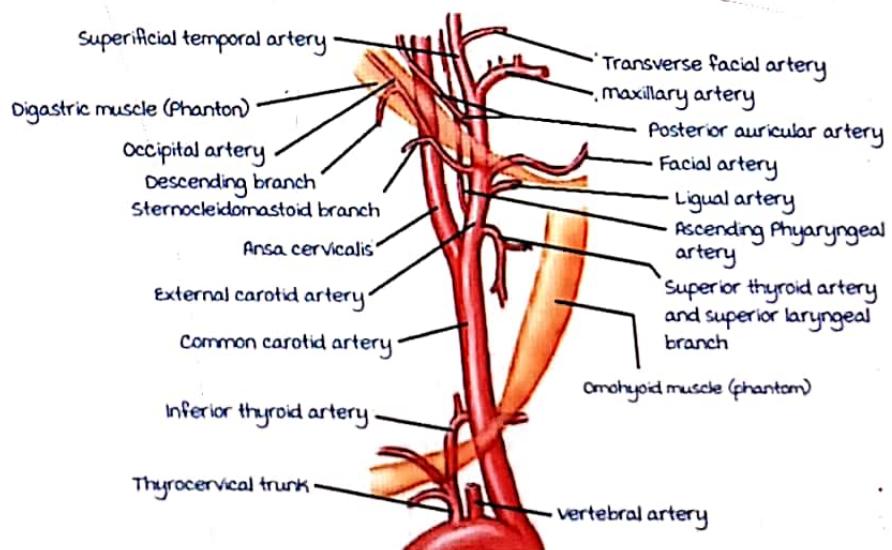
**Note :**

- Hypoglossal nerve is a content of both, carotid and digastric triangles.
- Common carotid artery bifurcates into internal and external carotid artery at the upper border of lamina thyroid/C3-C4 level.  
*(may2019 Allms)*

Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

### Branches of external carotid artery

00:37:30



Anterior side :

- Superior thyroid artery (1st branch)
- Lingual artery.
- Facial artery.

medial side :

- Ascending pharyngeal artery.

Posterior side :

- Occipital artery.
- Posterior auricular artery.

Terminal branches :

- maxillary artery.
- Superficial temporal artery.

vessels in carotid triangle :

- Common carotid artery.
- Internal carotid artery.
- External carotid artery.
- Superior thyroid artery.
- Lingual artery.
- Facial artery.
- Ascending pharyngeal artery.
- Occipital artery.

## Carotid sinus and carotid body

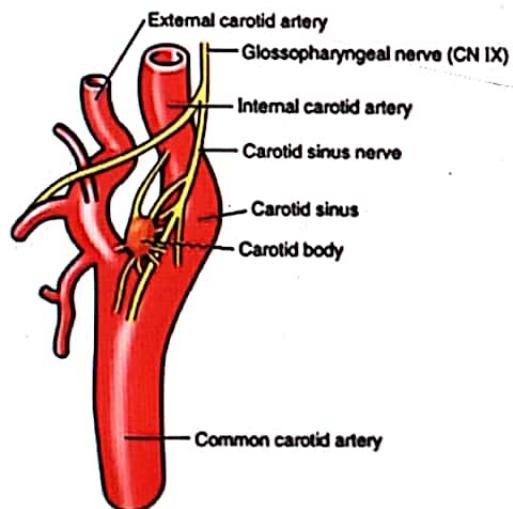
00:42:42

Carotid sinus :

Fusiform dilation over the internal carotid artery.  
Acts as baroreceptor (monitors pressure).

Carotid body :

Yellow pigmented structure at the bifurcation of common carotid artery.  
Acts as chemoreceptor.



Active space

Carotid body and carotid sinus

derive nerve supply from carotid sinus branch of 9th nerve, 10th nerve, and superior cervical ganglion.

## Suboccipital triangle

00:45:19

### Boundary:

Above and medial - rectus capitis posterior major muscle.

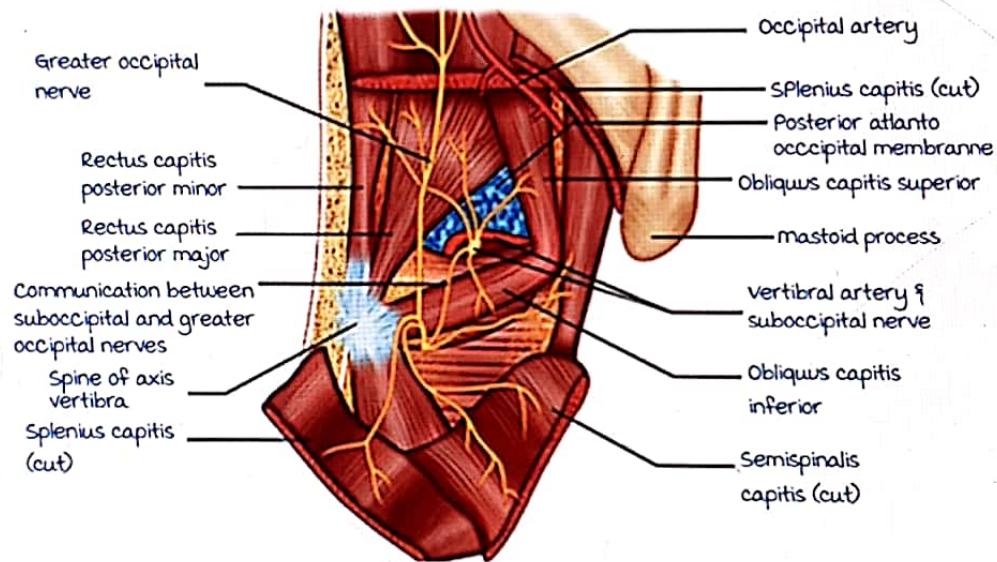
Above and lateral - oblique capitis superior muscle.

Below and lateral - oblique capitis inferior muscle.

Roof - formed by greater occipital nerve.

Floor - formed by atlanto - occipital membrane.

Contents - 3rd part of vertebral artery and suboccipital nerve.



# NEUROVASCULAR STRUCTURES OF THE NECK

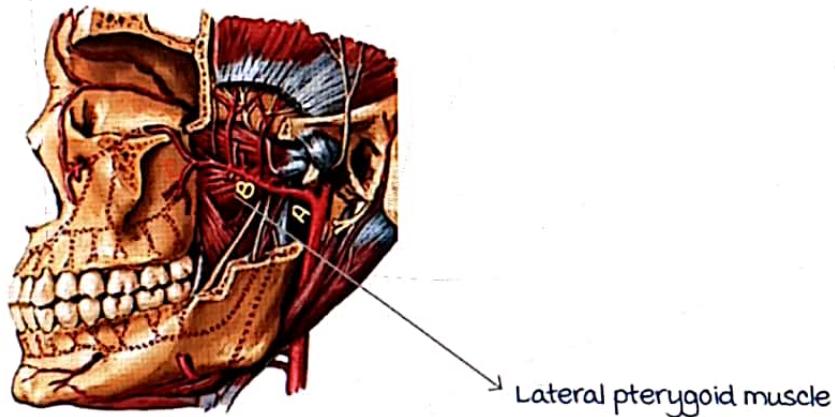
## Maxillary artery

00:01:14

It is a content of infratemporal fossa.

The lateral pterygoid muscle divides the artery into three parts:

- mandibular part - from the origin up to lateral pterygoid muscle
- Pterygoid part - present over lateral pterygoid muscle
- Pterygopalatine part - present in Pterygopalatine fossa



Branches of maxillary artery - first part

1. middle meningeal artery

Encircled by auriculotemporal nerve.

Passes through the foramen spinosum.

2. Accessory meningeal artery

Enters the cranial cavity through foramen ovale.

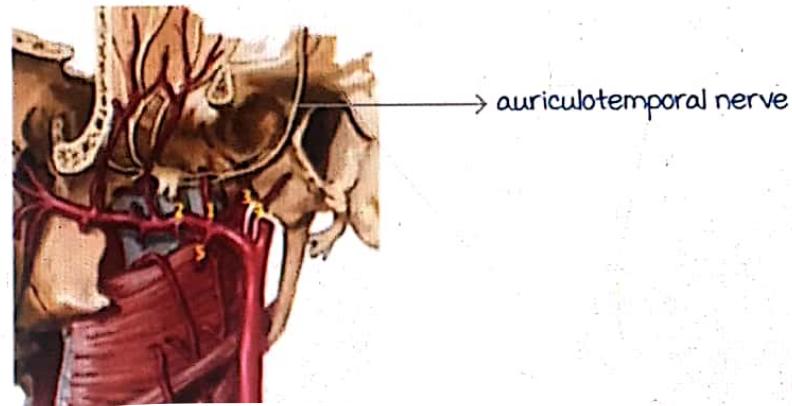
3. Anterior tympanic branch

4. Deep auricular branch

5. Inferior alveolar artery

Passes through mandibular foramen and supplies lower jaw.

Active space



### Branches of maxillary artery - second & third part

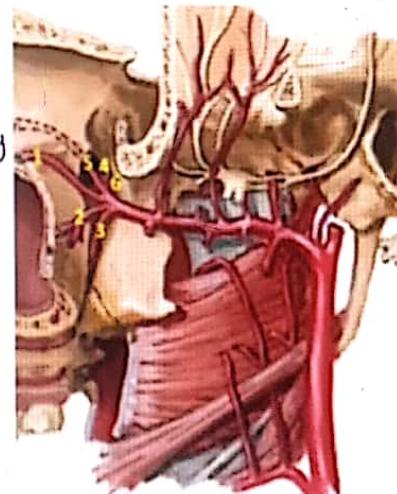
00:05:47

The second part gives **muscular branches**—supplies muscles of mastication.

1. Deep temporal artery
2. Masseteric branch
3. Pterygoid branch
4. Buccal branch

#### Third part branches:

1. Infraorbital artery
2. Posterior superior alveolar artery
3. Greater palatine artery
4. Pharyngeal artery
5. Sphenopalatine artery—  
posterior lateral nasal branch  
Posterior septal branch
6. Artery of pterygoid canal



### Cervical plexus

00:08:24

It is formed by C1, C2, C3, C4.

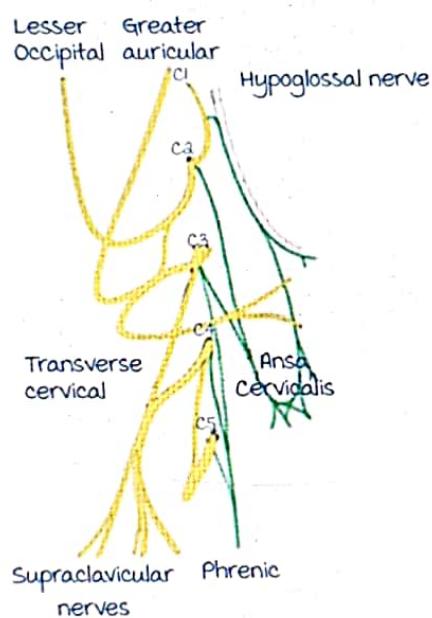
It gives **two branches**—cutaneous  
muscular

### Cutaneous branches

They form the roof and content of the posterior triangle of the neck.

There are four branches:

1. Greater auricular nerve
2. Lesser occipital nerve
3. Transverse cervical nerve
4. Supraclavicular nerve



Clinical correlation:

Hansen's disease [2018 NEET]

The nerves to be checked for peripheral nerve thickening in leprosy:

- Greater auricular nerve
- Transverse cervical nerve
- Supraclavicular nerve
- Supraorbital nerve
- Supratrochlear nerve



Active space

muscular branches

There are two branches - Ansa cervicalis  
Phrenic nerve

Ansa cervicalis

It is formed by C1, C2, C3

The C1 fibres join with hypoglossal nerve and supplies



Geniohyoid muscle [supra hyoid]

Thyrohyoid muscle [infra hyoid]

The branch from C1 - called descendens hypoglossi

or superior root of Ansa



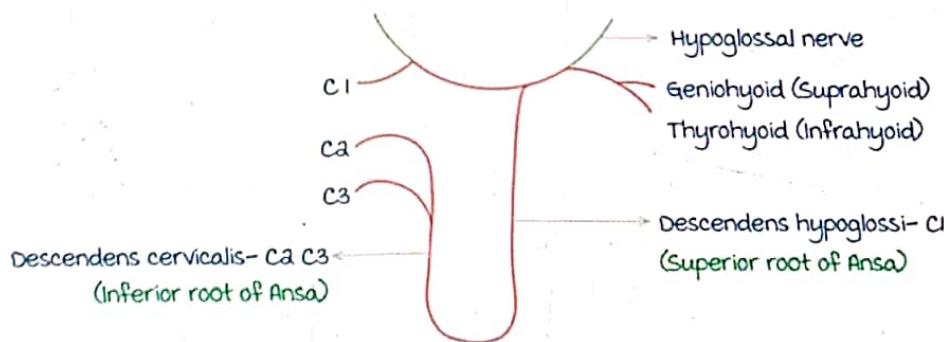
Root value C1

The C2, C3 join together form - descendens cervicalis/inferior

root of Ansa



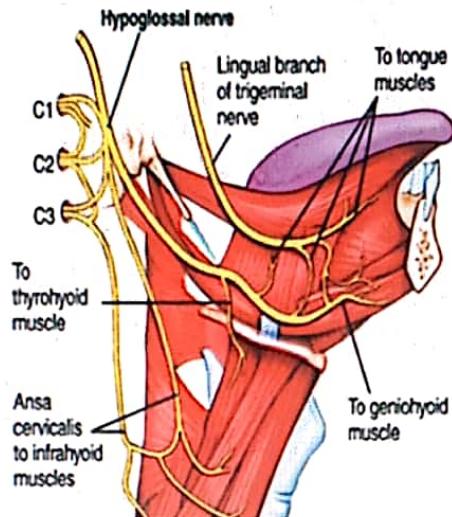
Root value C2, C3



Ansa cervicalis supplies :

All the infra hyoid muscles/strap muscle/ribbon muscle.

Except thyrohyoid-supplied by C1 fibres through hypoglossal nerve.



## Phrenic nerve

00:16:41

Root value C3, C4, C5

The majority of fibres are from C4

C4 is also the dermatome of the tip of the shoulder.

### Function

It is the mixed nerve - carries both sensory and motor fibres.

It passes anterior to the scalenus anterior.

It enters thorax - by passing between the subclavian in front and subclavian artery behind.

It passes in front of the hilum of the lungs.

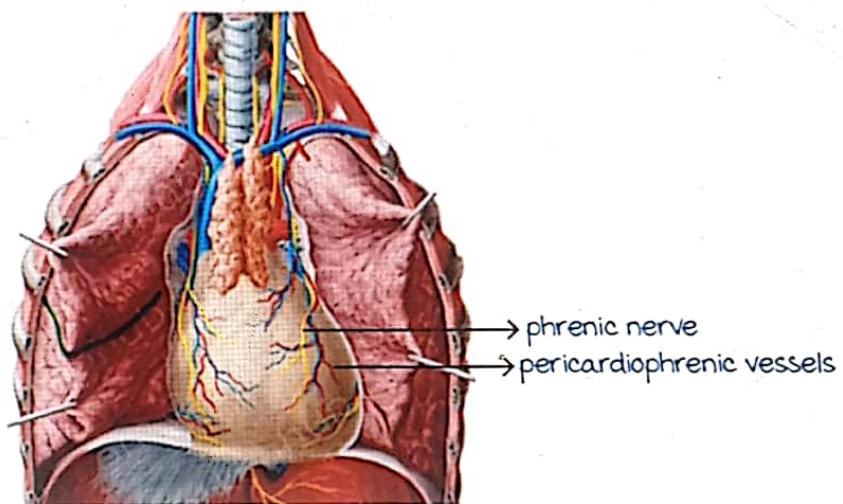
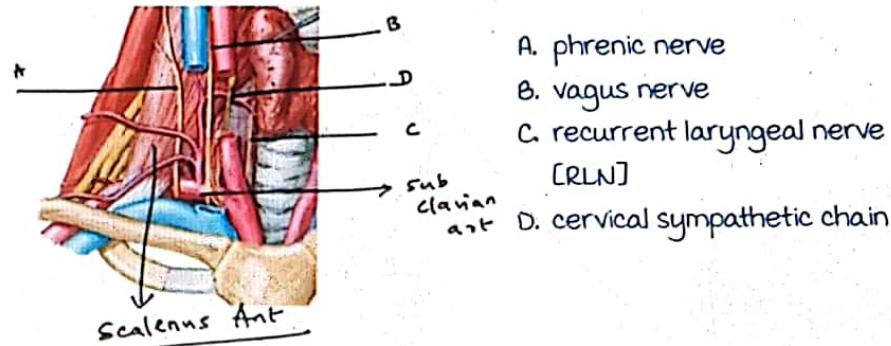
It is accompanied by pericardiophrenic vessels.

Right phrenic nerve is shorter in length than left phrenic nerve



Because of the liver which raises the dome of diaphragm.

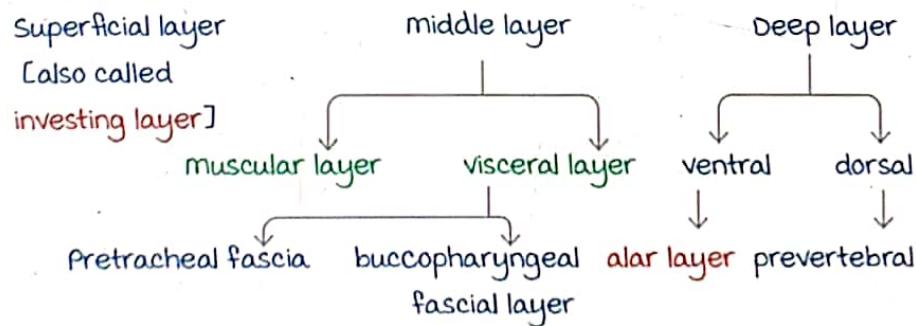
Active space



### Deep cervical fascia

00:24:44

It is made up of three layers

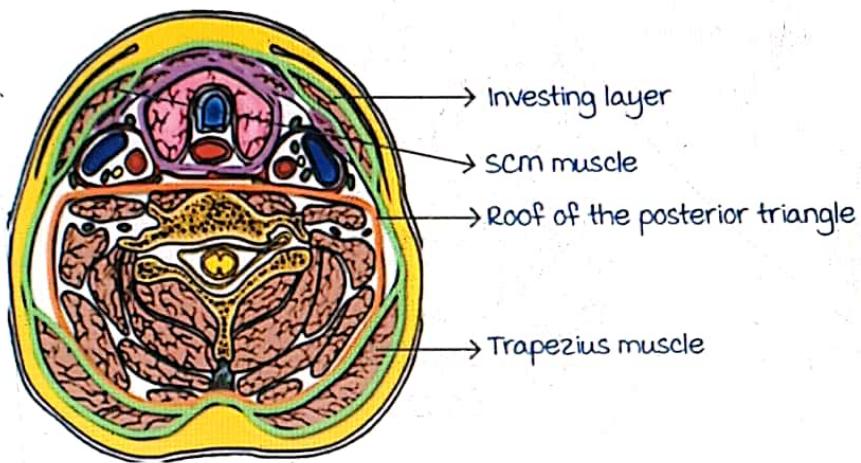


superficial layer/investing layer

It encloses two muscles - trapezius and sternocleidomastoid (SCM) muscles.

It forms the roof of the posterior triangle.

It provides false capsules for parotid and submandibular glands.



It encloses two spaces :

1. Supraclavicular space

Space above the clavicle.

**Contents** - external jugular vein

Supraclavicular nerve

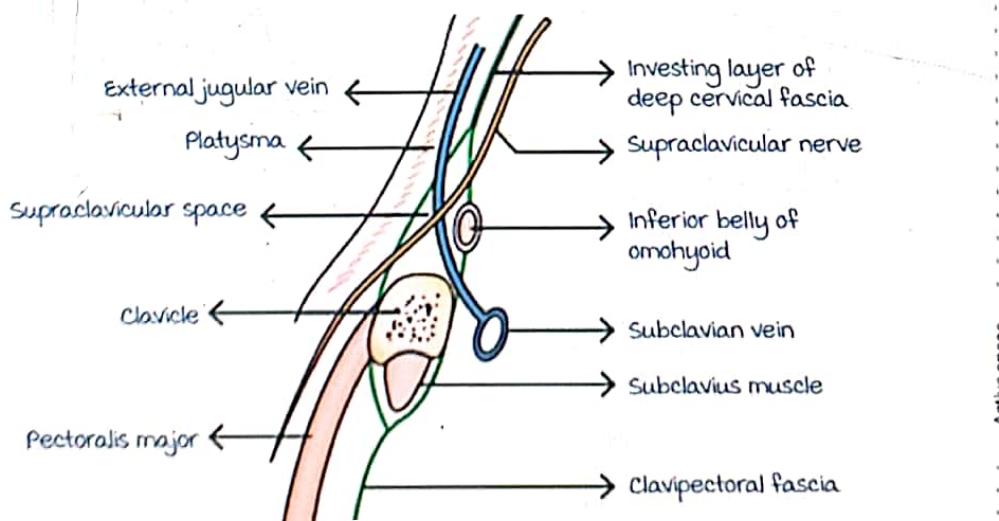
2. Suprasternal space

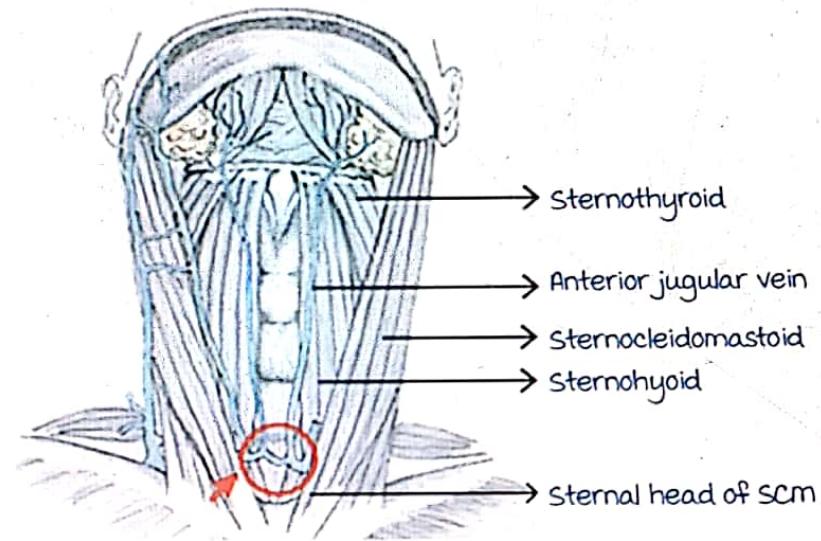
Space above the sternum

**Contents** - jugular venous arch

Sternal head of SCM

Inter clavicular ligament





### Deep cervical fascia - middle layer

00:31:15

Two layers- muscular and visceral.

The **muscular layer**- invest the intrathyroidal muscles.

**visceral layer** - pretracheal fascia

Splitting and enclosing the thyroid gland.

Posterior to the thyroid gland, the fascia thickens

↓  
Forms **ligament of berry**

↓  
which connects thyroid gland to cricoid cartilage.

The thyroid gland and thyroid swellings move with deglutition

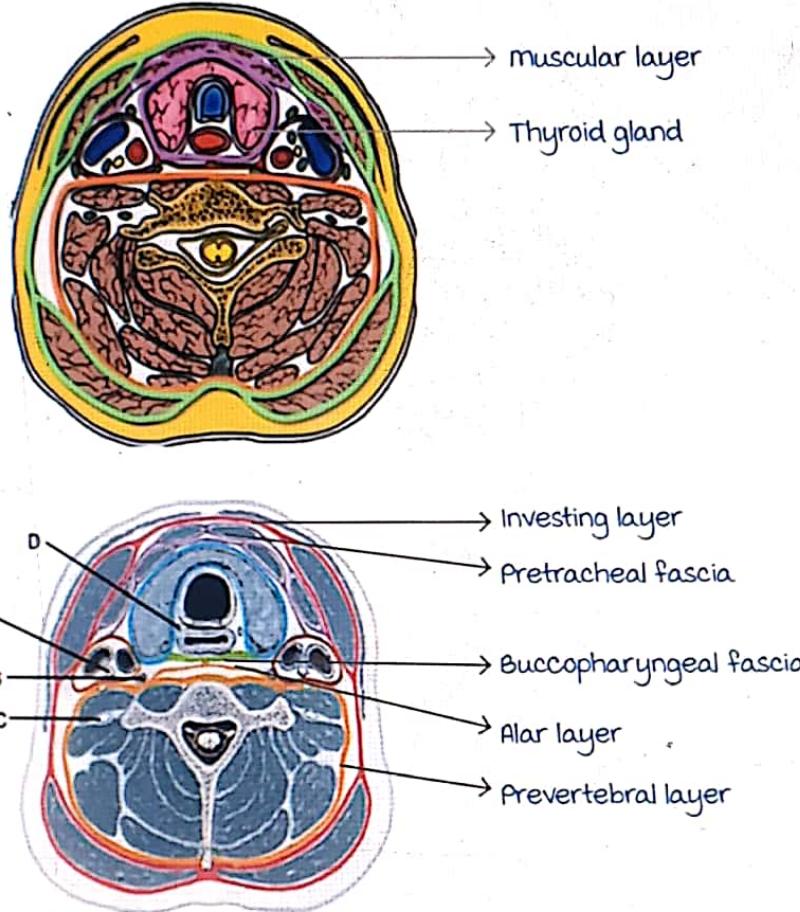
↓  
Because of the ligament of berry.

**mc site of damage of RLN during thyroid surgery- berry ligament**

**Visceral layer** - Buccopharyngeal fascia

It covers the outer surface of the constrictor muscles.

It also covers the buccinator muscle.



### Deep cervical fascia - Deep layer

Ventral layer - alar.

Alar fascia fuse with buccopharyngeal fascia at the level of C7 [C6 TO T4].

Dorsal layer - Prevertebral layer

It encloses the vertebral muscles.

It forms the floor of the posterior triangle of the neck.

It contributes to axillary sheath [fascia over brachial plexus & axillary artery].

### Carotid sheath

00:38:43

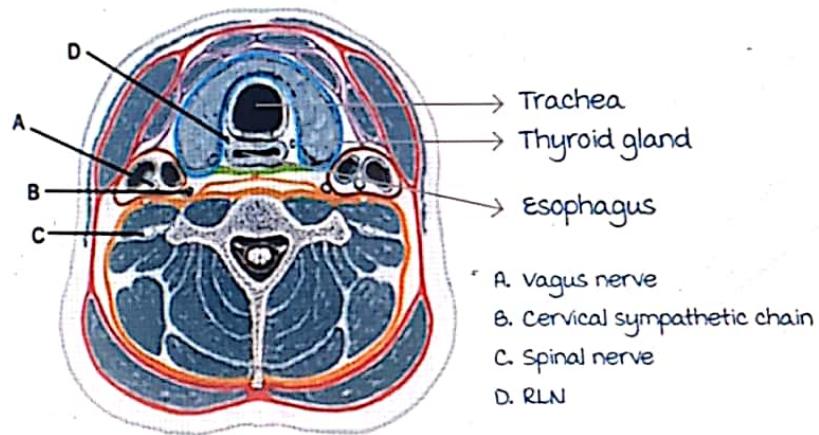
All the layers of deep cervical fascia contribute to the carotid sheath.

### The contents of carotid sheath [aoao Allms]

Infra hyoid	supra hyoid
Common carotid artery	internal carotid artery
Internal jugular vein	internal jugular vein
vagus nerve	9th, 10th, 11th, 12th cranial nerves

Cervical sympathetic chain is located **posterior** to the sheath.

Ansa cervicalis is located **anterior** to the sheath.



### Danger area of the neck

00:43:40

There are three constrictor muscles covered by buccopharyngeal fascia:

1. Superior constrictor
2. middle constrictor
3. Inferior constrictor

In **front** of the vertebra, there is prevertebral layer.

The space between the prevertebral layer and the vertebra -

prevertebral space



Pott's abscess is formed.

Alar fascia joins with buccopharyngeal fascia.

The space between buccopharyngeal fascia and alar fascia - **retropharyngeal space**.

The space between alar fascia and prevertebral layer - danger area of the neck.

It extends from the base skull to mediastinum.

Therefore, infection can spread easily to the brain and heart.

**Boundaries of danger area of the neck:**

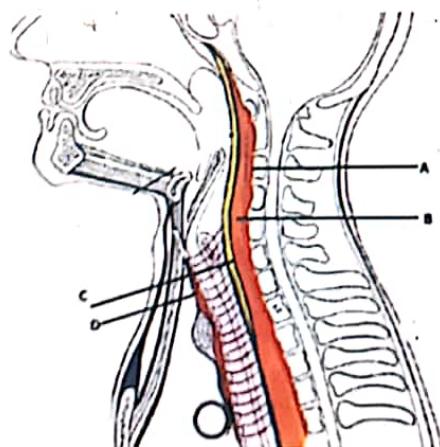
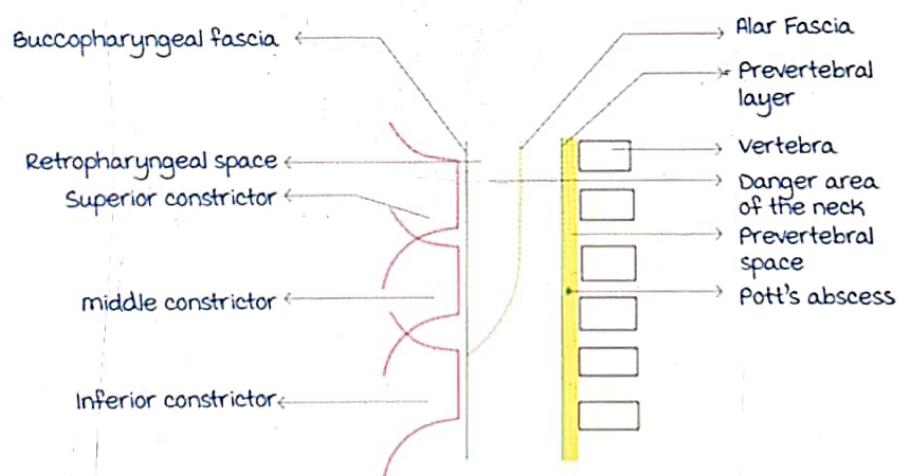
Anteriorly - alar fascia

Posteriorly - prevertebral layer

**Boundaries of retro pharyngeal space:**

Anteriorly - buccopharyngeal fascia

Posteriorly - alar fascia



- A. Prevertebral space
- B. Danger area of neck
- C. Retropharyngeal space
- D. Pretracheal space

Active space

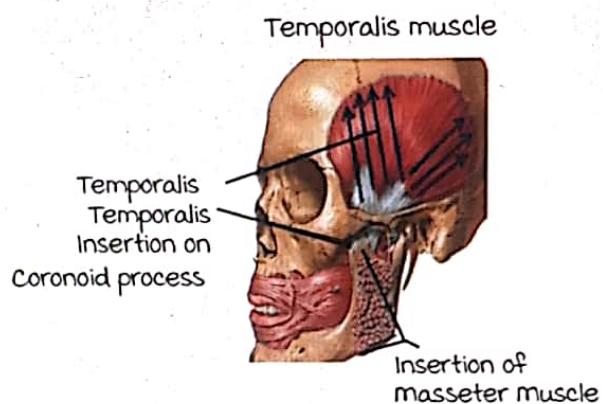
# MUSCLES OF MASTICATION

## Temporalis and Masseter Muscles

00:01:06

muscles of mastication :

1. Temporalis
2. masseter
3. medial Pterygoid
4. Lateral Pterygoid



**Temporalis muscle :**

Origin : **Temporalis fossa** and **temporalis fascia**.

Insertion : **Coronoid process** of **mandible**.

Action : **Elevation** > **Retraction**. (Allms 2018)

- **Elevation** of **mandible**.
- **Retraction** of **mandible**  
(By **posterior fibers**).

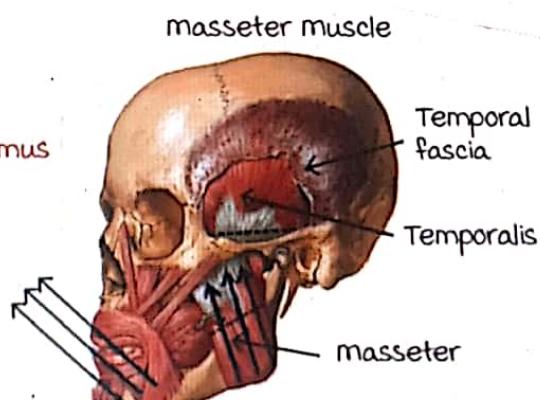
**masseter muscle :**

Origin : **zygomatic arch**.

Insertion : **Outer surface of ramus** of **mandible**.

Action : **Elevation** > **Protrusion**.

- **Elevation** of **mandible**.
- **Protrusion** of **mandible**  
(Due to **oblique fibers** on the **anterior side**).



## Lateral Pterygoid Muscle

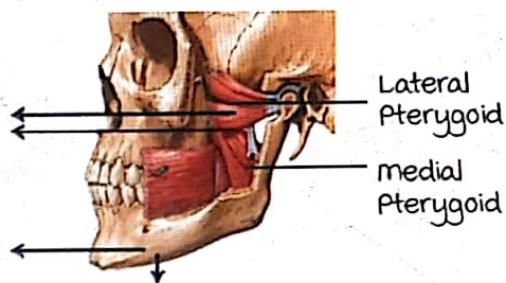
00:06:37

Origin :

- Infratemporal area and infratemporal crest of sphenoid bone.
- Lateral surface of lateral pterygoid plate.

Insertion :

- Head of mandible.
- Neck of mandible.
- Capsule of Temporomandibular Joint.



Action :

- Protrusion of mandible (Horizontal fibers).
- Depression of mandible (By means of gravity).

Lateral Pterygoid is the **only** muscle for depression of the mandible.

There are 3 muscles are responsible for elevation of the mandible:

1. masseter
2. Temporalis
3. medial pterygoid

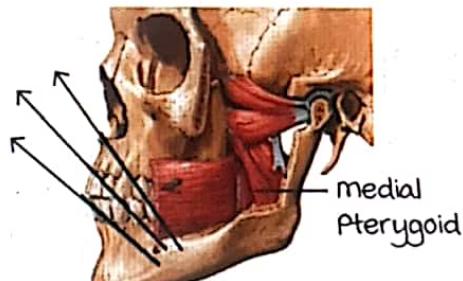
## Medial Pterygoid Muscle :

Origin :

- maxilla tuberosity.
- medial surface of lateral

Pterygoid plate.

(medial pterygoid plate does not give origin to pterygoid muscles.)



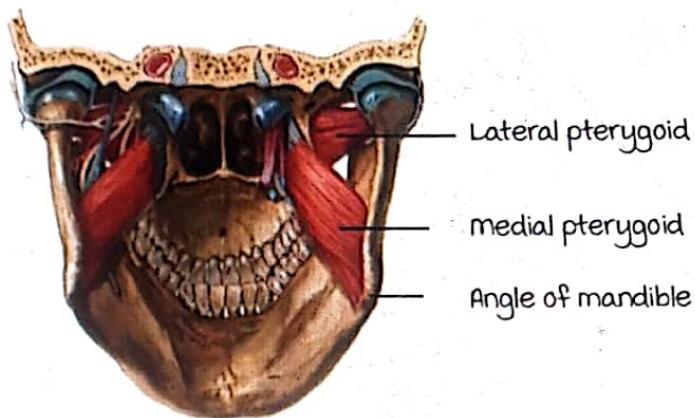
Insertion :

- Posteroinferior aspect of ramus of mandible.
- Angle of mandible.

Action : (Elevation > Protrusion)

- Elevation of mandible.
- Protrusion of mandible. (By oblique fibers anteriorly).

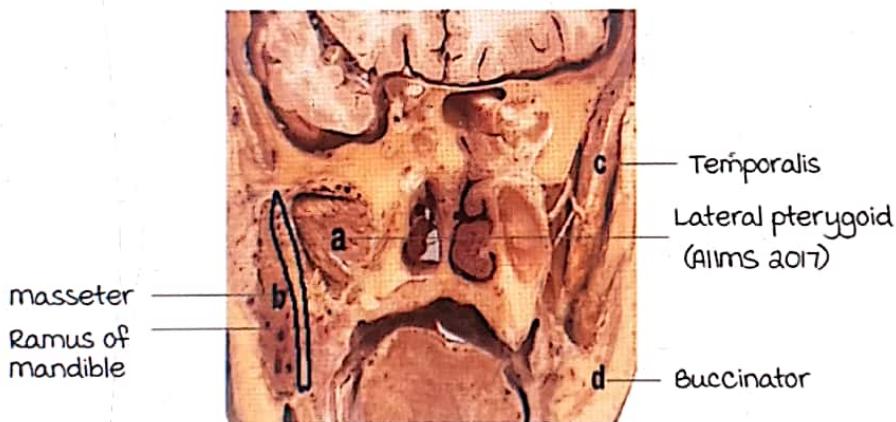
Protrusion is done by Lateral pterygoid > medial pterygoid and masseter.



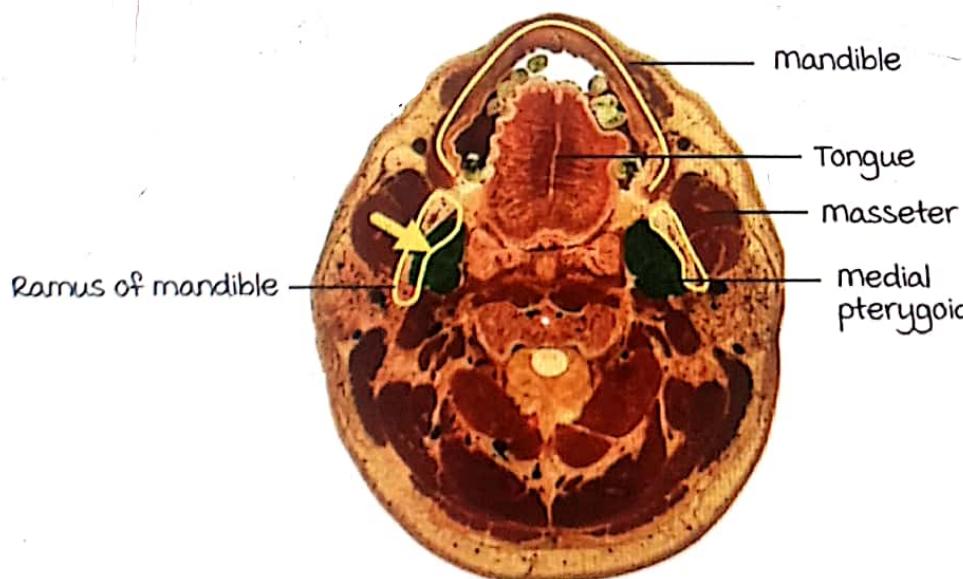
### Images of Muscles of Mastication :

00:16:52

Coronal section of skull :



Cut section at the level of tongue:



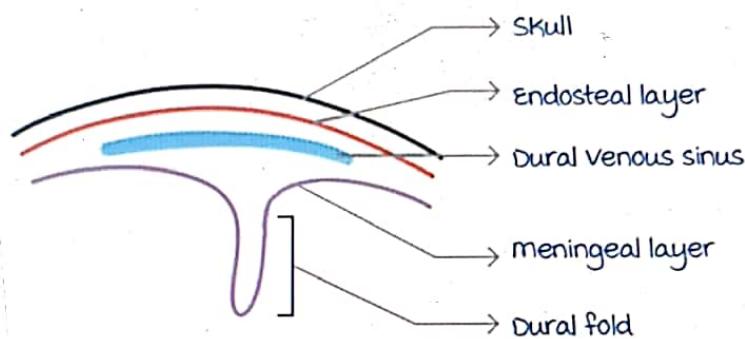
Active space

# DURAL VENOUS SINUSES

## Dural Fold

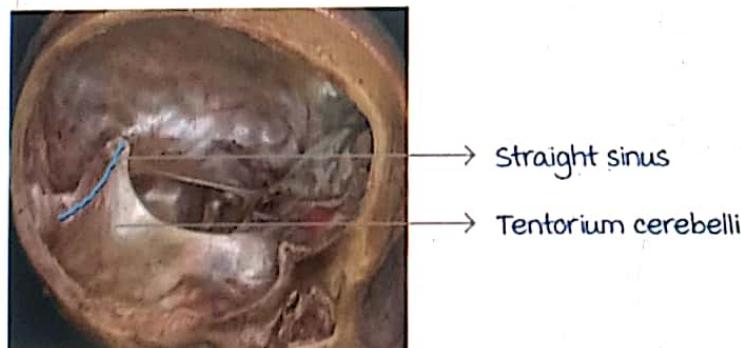
00:00:19

- Cranial dura is **double** layer and the spinal dura is **single** layer



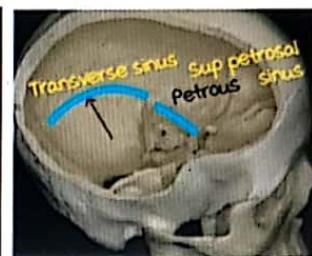
- Dural venous sinus [DVS]: space between two layers of the dura filled with venous blood.
- Two DVS present in the meningeal layer of the dura:
  - Straight sinus
  - Inferior sagittal sinus
- There are **four** dural folds.

### I. Tentorium cerebelli:



Active space

- Present between cerebrum and cerebellum
- 3** sinus present in tentorium cerebelli:
  - Straight sinus
  - Transverse sinus
  - Superior petrosal sinus

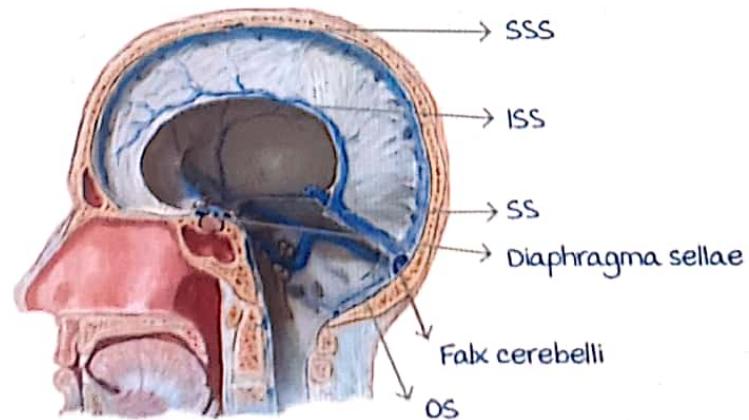


2. Falx Cerebri:



- Present between two cerebral hemispheres
- Sinuses present are :
  - i) Superior sagittal sinus [SSS]
  - ii) Inferior sagittal sinus [ISS]
  - iii) Straight sinus [SS]

3. Falx cerebelli:



- Present between two hemispheres of cerebellum
- Contains occipital sinus [OS]

#### 4. Diaphragma sella :

- Forms the roof over **sella turcica** (contains pituitary gland)

## Dural Venous Sinuses

00:08:27

Unpaired DVS :

S : Superior sagittal sinus

I : Inferior sagittal sinus

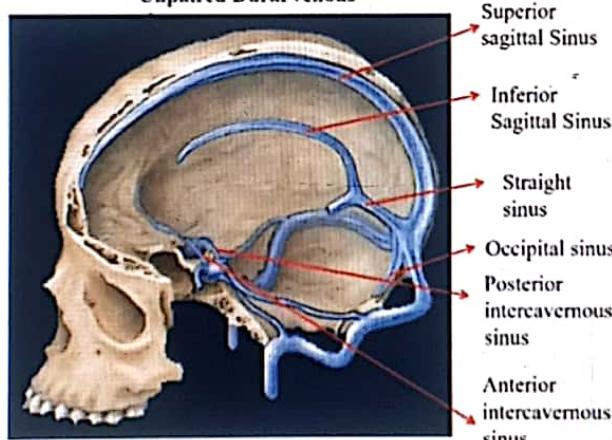
S : Straight sinus

B : Basilar venous plexus

P : Posterior and anterior intercavernous sinus

O : Occipital sinus

Unpaired Dural venous



Paired DVS :

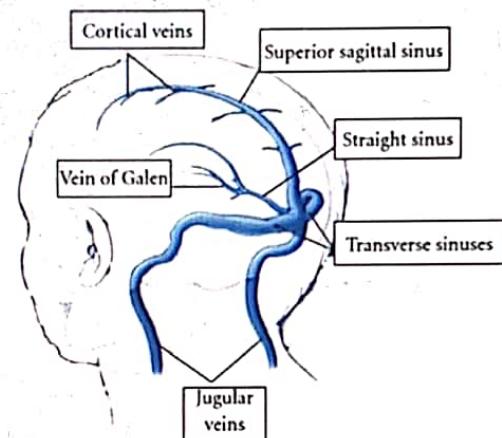
- 1) Cavernous
- 2) Transverse
- 3) Sigmoid
- 4) Superior petrosal
- 5) Inferior petrosal
- 6) Sphenoiparietal sinus
- 7) Petro squamous sinus
- 8) middle meningeal vein

Course :

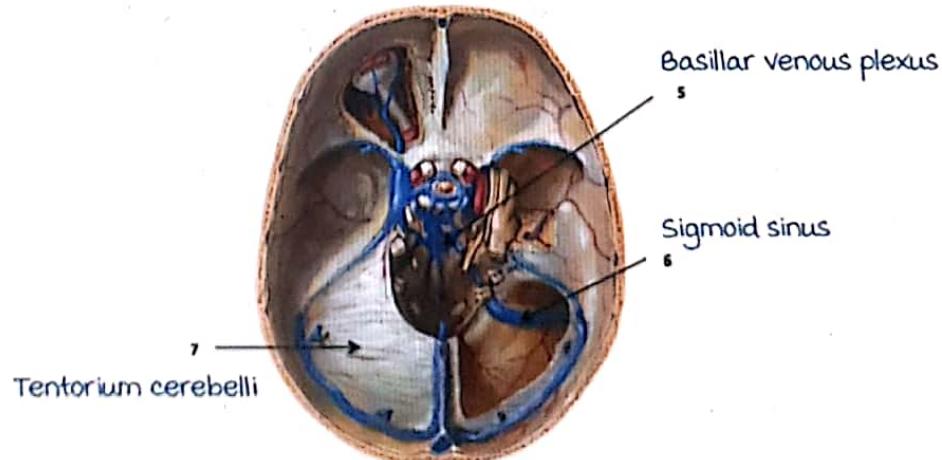
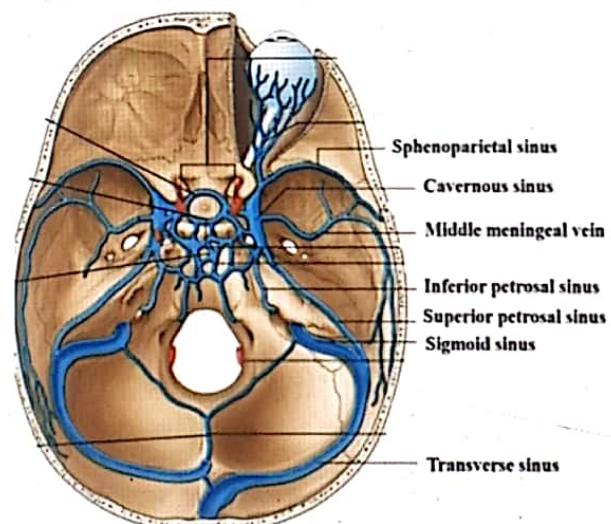
- SSS → Right transverse sinus
- ISS → Straight sinus + Galen's vein → Left Transverse sinus

- Transverse sinus:
  - ↓
  - Sigmoid sinus → internal jugular vein
- Lateral sinus: Transverse sinus + sigmoid sinus

Unpaired DVS image:



Paired DVS image:

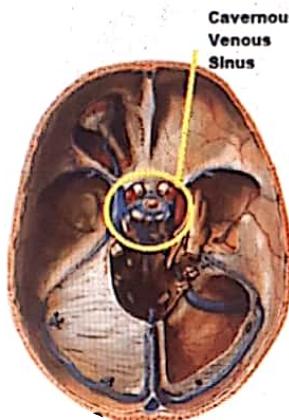


- 1- Straight sinus
- 2- Transverse sinus
- 3- Superior Petrosal sinus

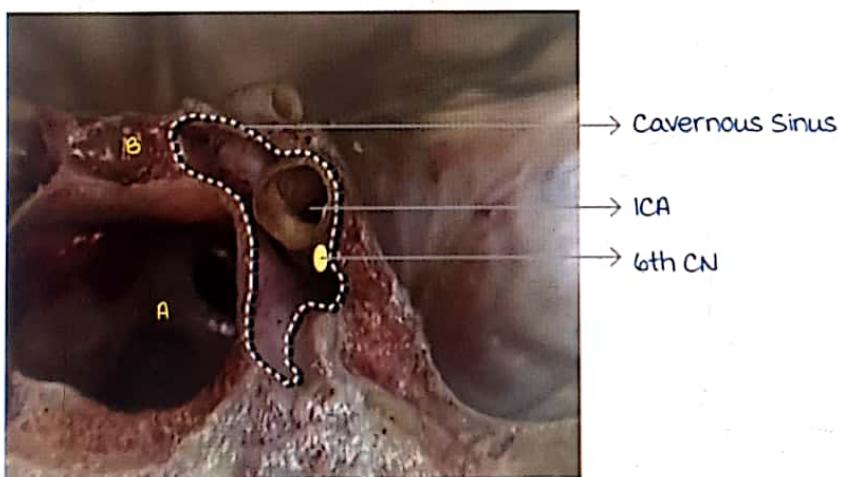
## Cavernous Venous Sinus

00:14:30

- Located on either side of **Body of sphenoid**.

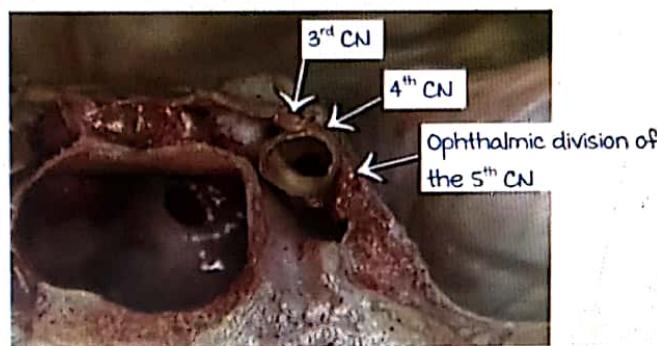


Related structure

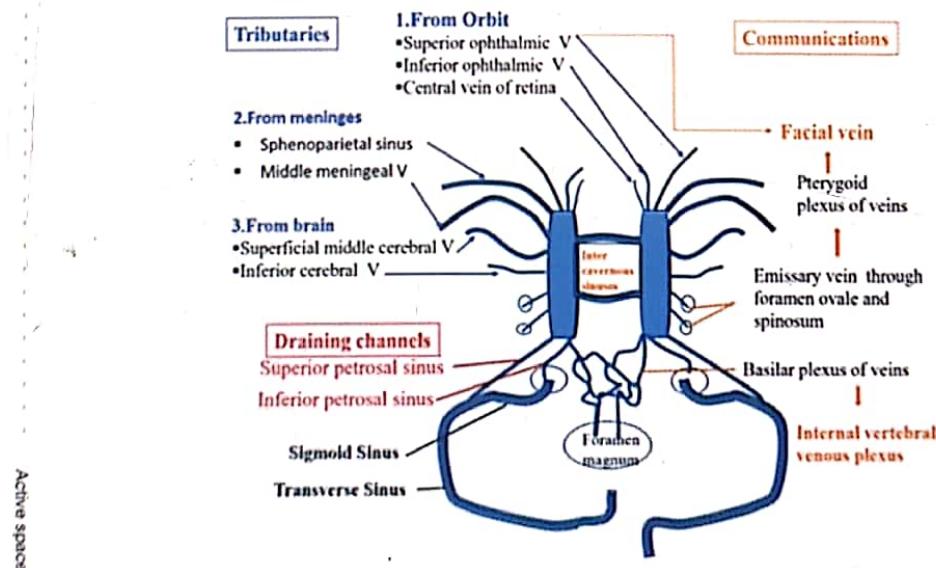
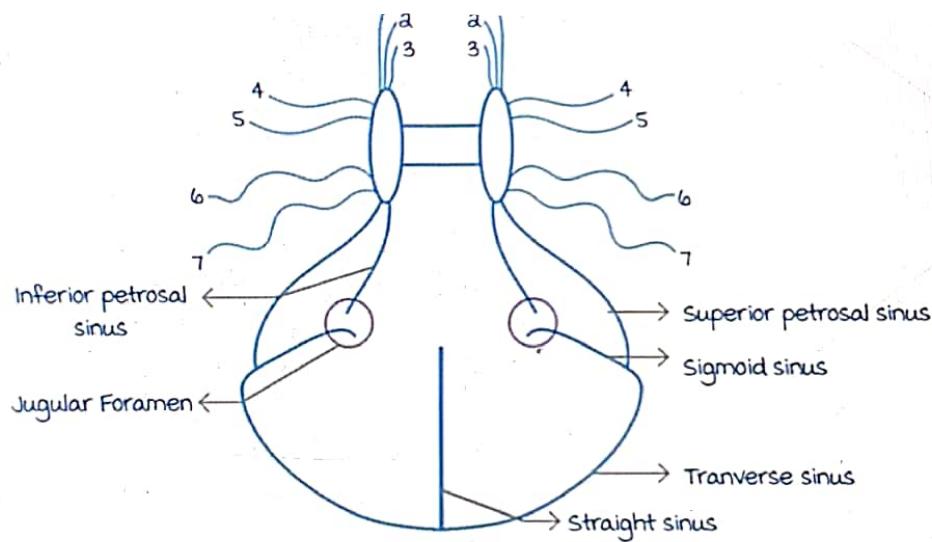


- 1) medial relations :
  - A. Sphenoid sinus
  - B. Pituitary gland
- 2) Structures Pass through :
  - a. ICA
  - b. 6<sup>th</sup> CN
- 3) Lateral wall :
  - a. 3<sup>rd</sup> CN
  - b. 4<sup>th</sup> CN
  - c. Ophthalmic division of the 5<sup>th</sup> CN

Active space

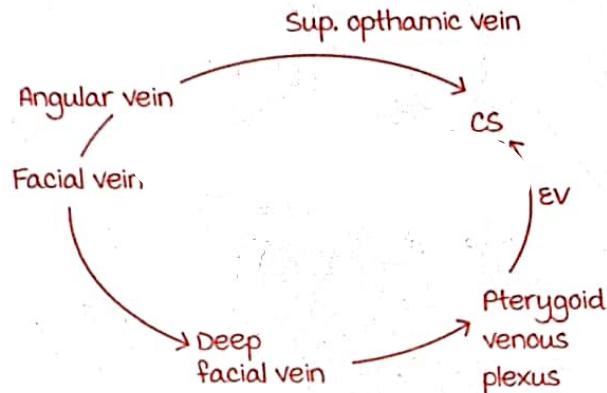


Tributaries and Communicating channels :

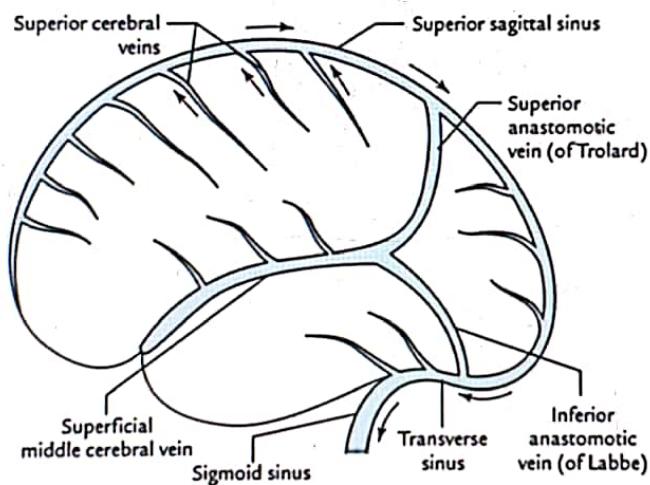


Draining Channel/communicating channel :

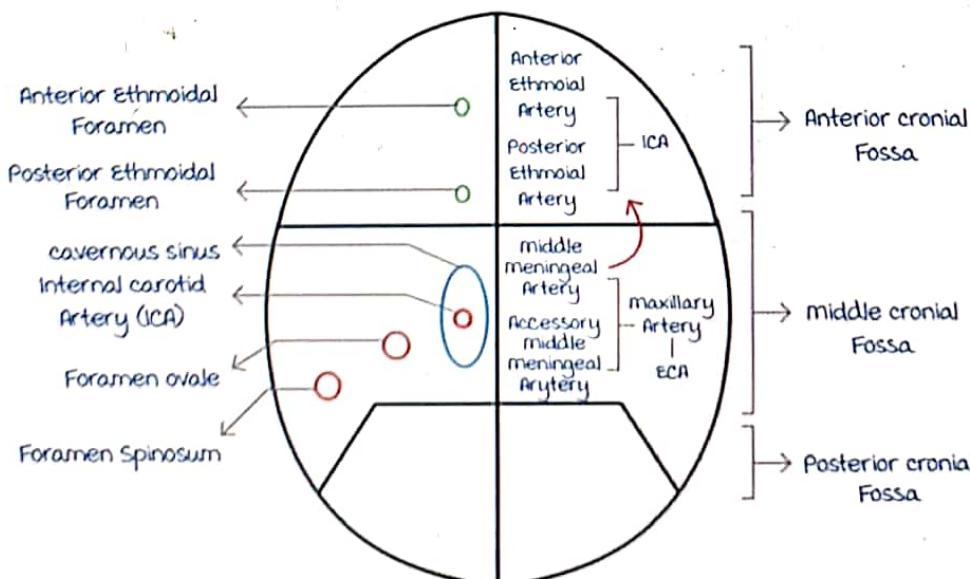
- CS → Transverse (via Superior petrosal sinus)
- CS → IJV (via inferior petrosal sinus)
- CS [Right side] → CS [Left side] via Anterior and posterior

**Intercavernous sinus**

- CS communicate with facial vein most commonly through Superior ophthalmic vein [SOV]
- Only structure acting both as tributary and communicating channel : SOV

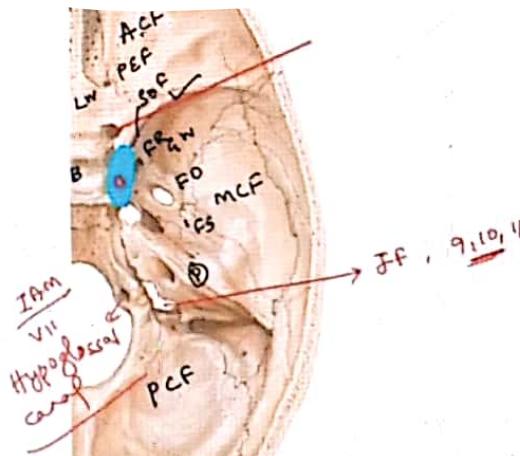
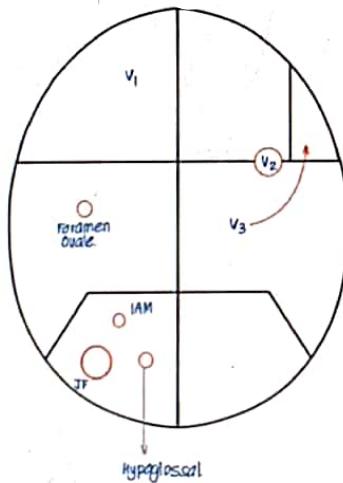
**Blood supply and nerve supply of dura**

00:30:00



**Blood Supply:**

- Anterior cranial fossa:
  - Anterior ethmoidal artery (branch of ICA)
  - Posterior ethmoidal artery (branch of ICA)
  - middle meningeal artery (branch of ECA)
- middle cranial fossa : (both ECA and ICA)
  - middle meningeal artery (branch of maxillary artery branch of ECA)
  - Accessory middle meningeal artery (branch of maxillary artery branch of ECA)
- Ascending pharyngeal artery gives meningeal artery which supplies middle and posterior cranial fossa
- Posterior cranial fossa:
  - vertebral artery +meningeal branch from occipital artery



**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

**Nerve Supply:**

- Anterior cranial fossa: ophthalmic division of trigeminal + maxillary nerve + mandibular nerve
- middle cranial fossa: maxillary nerve + mandibular nerve
- Posterior cranial fossa: Facial nerve + 9 th, 10 th and 12 th CN + C2, C3, C4

Unlike Ophthalmic division of the Trigeminal nerve, the maxillary division of the Trigeminal nerve does not run through the lateral wall of the cavernous sinus.

## TRIGEMINAL NERVE AND PARASYMPATHETIC GANGLION

### Trigeminal nerve

00:00:02

Roots :

Sensory (large).

motor (small).

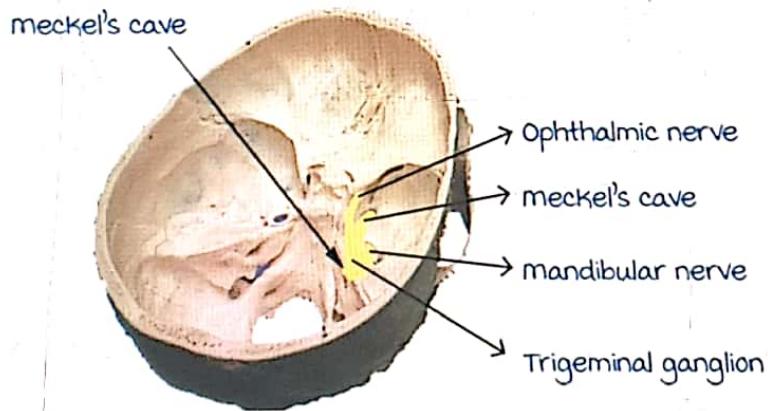
Trigeminal ganglia :

Sensory root expansion.

Location - meckel's cave.

Divided into - ophthalmic, maxillary and mandibular subdivisions.

mandibular subdivision joins the motor root of trigeminal nerve and forms the trunk.



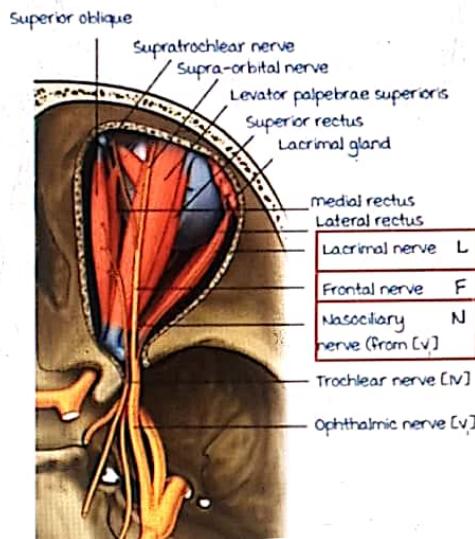
Ophthalmic nerve :

Passes through lateral wall of cavernous sinus and gives off three branches -

1. Lacrimal nerve.
2. Frontal nerve.
3. Nasociliary nerve.

Lacrimal and frontal nerve passes through superolateral compartment of superior orbital fissure.

Nasociliary nerve passes through common tendinous ring.



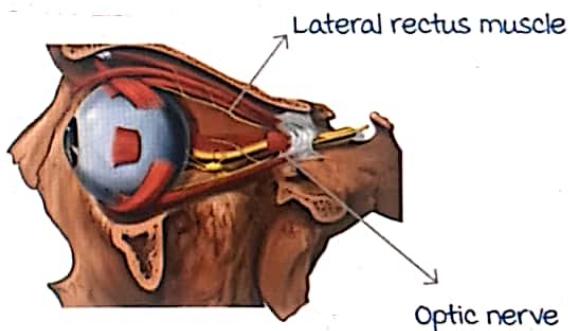
### Ciliary ganglion

00:09:17

Parasympathetic ganglion of the eyeball.

Location – present between lateral rectus muscle and optic nerve.

Branches – 8 to 11 short ciliary nerves.



Parasympathetic pathway:

Roots:

- Parasympathetic root.
- Sympathetic root.
- Sensory root.

Arises from Edinger-Westphal nucleus



IIIrd nerve



Nerve to inferior oblique muscle



ciliary ganglion



Via short ciliary nerves supplies ciliaris muscle and sphincter pupillae muscle

Parasympathetic root:

Also known as motor root.

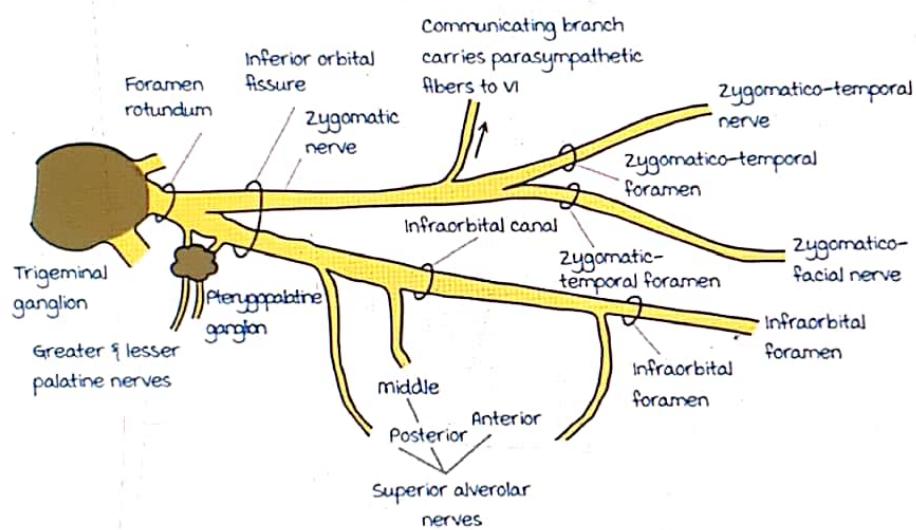
Sympathetic root pathway:

Derived from plexus over internal carotid artery

↓  
 Ciliary ganglion  
 ↓  
 via short ciliary nerves supplies dilator pupillae muscle

## Maxillary nerve

00:19:15



Pathway:

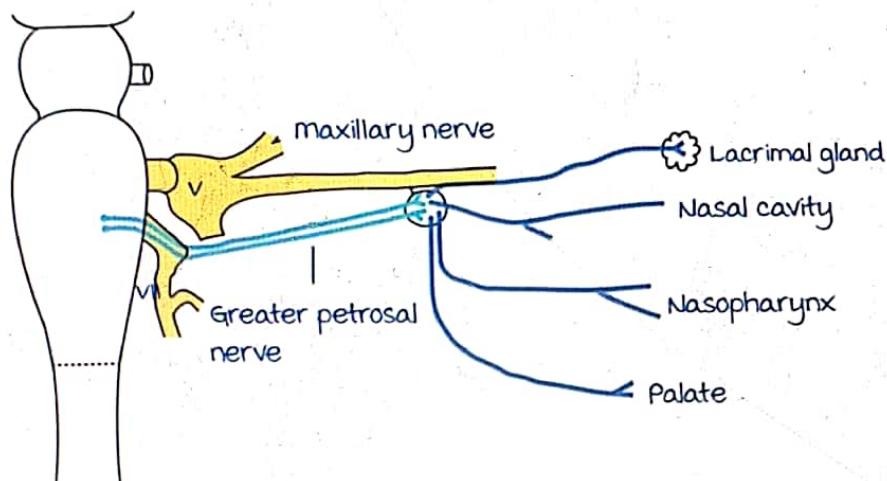
Arises from trigeminal ganglion

↓  
 Through foramen rotundum, enters pterygopalatine fossa.  
 (suspends pterygopalatine ganglion)

↓  
 Through infraorbital fissure, enters floor of orbit and passes through  
 infra-orbital canal

↓  
 Through infra-orbital foramen it enters the face, giving three  
 branches:

1. Palpebrae branch
2. Nasal branch.
3. Labial branch.



### Branches of maxillary nerve

00:25:15

meningeal nerve – supplies anterior and middle cranial fossa.

Posterior superior alveolar nerve – supplies upper jaw (molar).

Zygomatic nerve – divided into zy.temporal and zy.facial nerves.

Infra orbital nerve – gives middle superior alveolar nerve (supplies upper jaw-premolar) and anterior superior alveolar nerve (supplies upper jaw- incisor and canine).

maxillary sinus – supplied by posterior superior alveolar nerve + middle superior alveolar nerve + anterior superior alveolar nerve.

### Pterygopalatine ganglion

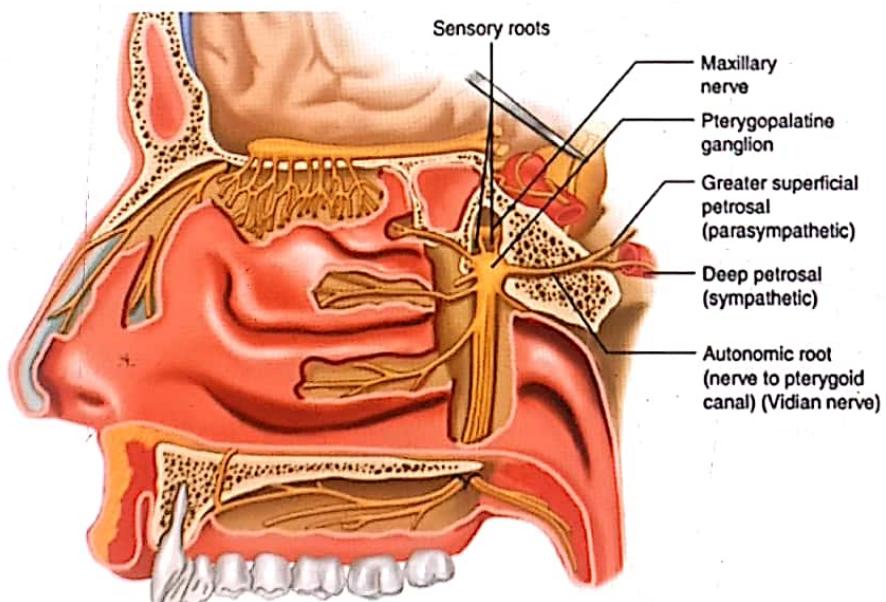
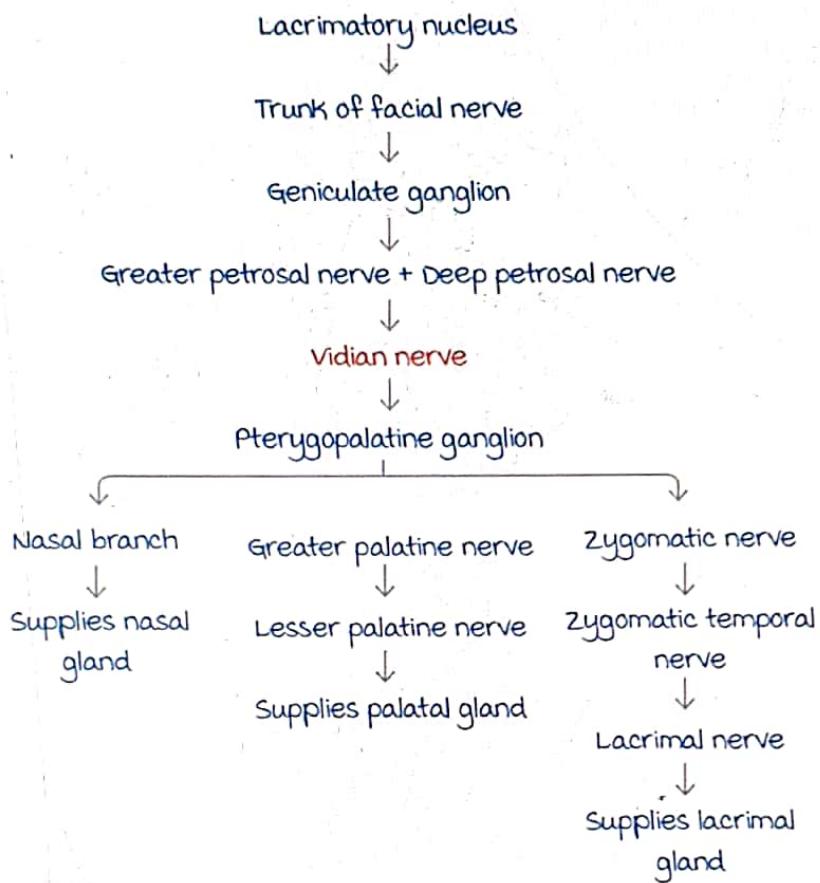
00:29:49

Topographically connected to maxillary nerve.

Functionally connected to facial nerve.

Glands supplied – lacrimal gland, nasal gland and palatal gland.

Parasympathetic pathway :



Active space

## Mandibular nerve

00:33:56

- It's a sensory root of trigeminal ganglion.

motor root (trigeminal ganglion) + mandibular nerve

↓  
Joins and passes through foramen ovale

↓  
Forms trunk of mandibular nerve

- Trunk gives attachment to otic ganglion.
- Trunk gives direct branch to medial pterygoid muscle.
- Nerve to medial pterygoid passes through otic ganglion and without any relay supplies tensor palatini muscle and tensor tympani muscle.

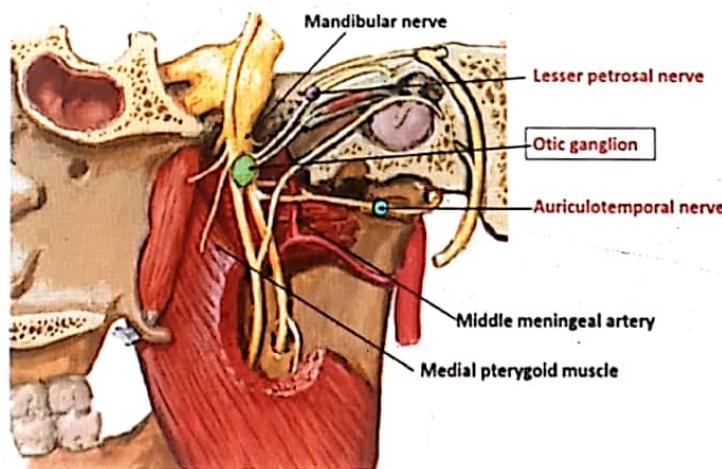
Relations of otic ganglion :

medially - tensor veli palatini muscle.

Laterally - trunk of mandibular nerve.

Above - foramen ovale.

Below - middle meningeal artery.



## Divisions of mandibular nerve

Anterior division :

3 muscular branches - Deep temporal branch.  
masseteric nerve.

Pterygoid branch.

1 sensory branch - Buccal nerve (pierces buccinator muscle and supplies skin over cheek)

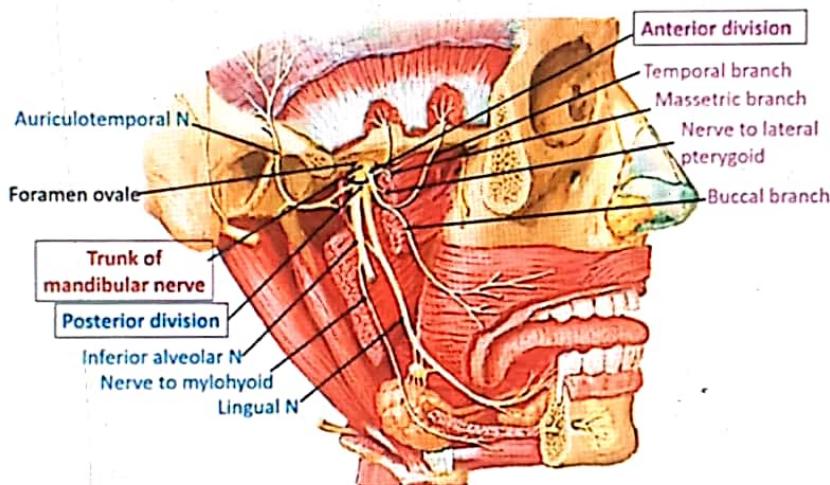
Posterior division :

3 branches -

Auriculotemporal nerve (sensory).

Lingual nerve (sensory).

Inferior alveolar nerve (mixed).



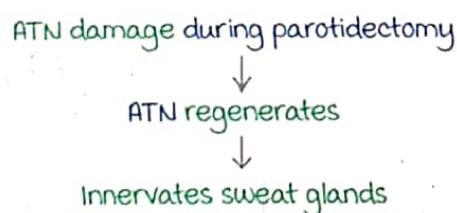
## Frey syndrome (2019 NEET)

00:43:16

Gustatory sweating.

Occurs due to damage of auriculotemporal nerve (ATN).

Commonly seen during parotidectomy.



## Submandibular ganglion

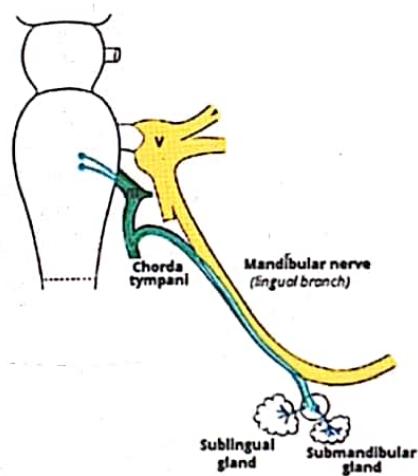
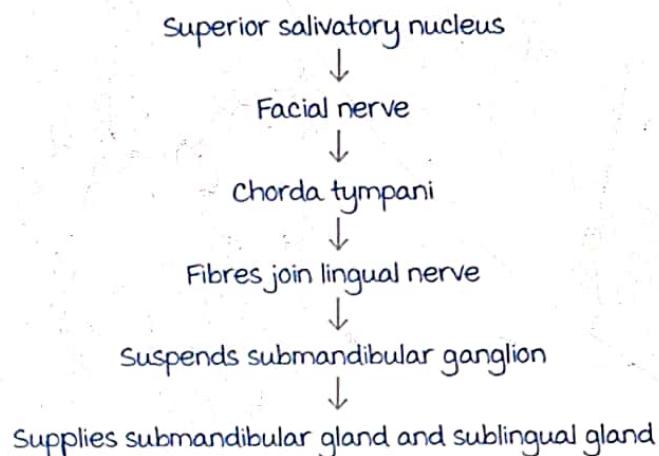
00:45:55

Topographically connected to lingual nerve.

Functionally connected to facial nerve.

Glands supplied - submandibular gland and sublingual gland.

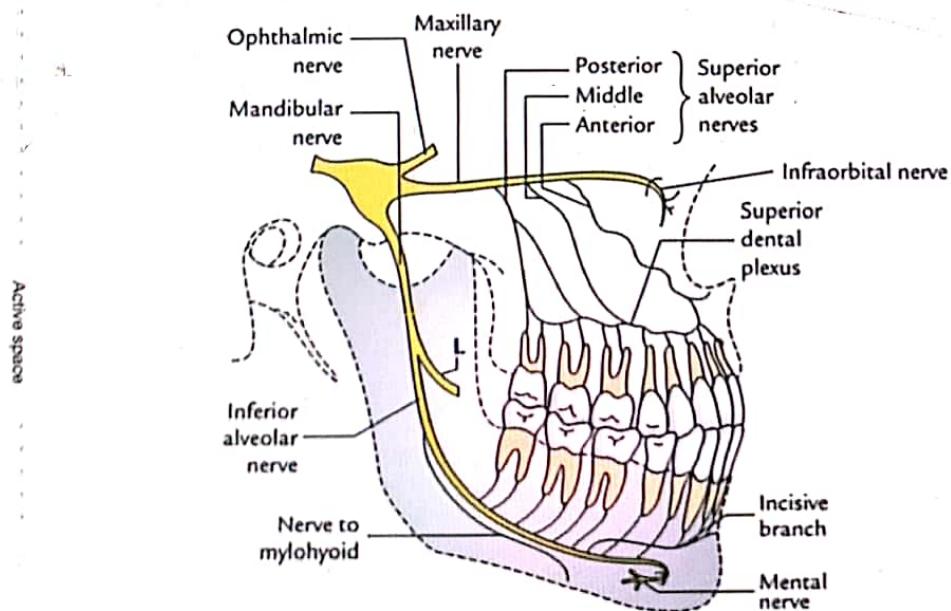
Parasympathetic pathway:



### Inferior alveolar nerve

00:47:46

Passes through mandibular foramen and gives sensory supply to entire lower jaw.



Nerve to mylohyoid :

- Branch of inferior alveolar nerve (given off before passing through mandibular foramen).
- Supplies - anterior belly of digastric and mylohyoid muscle.

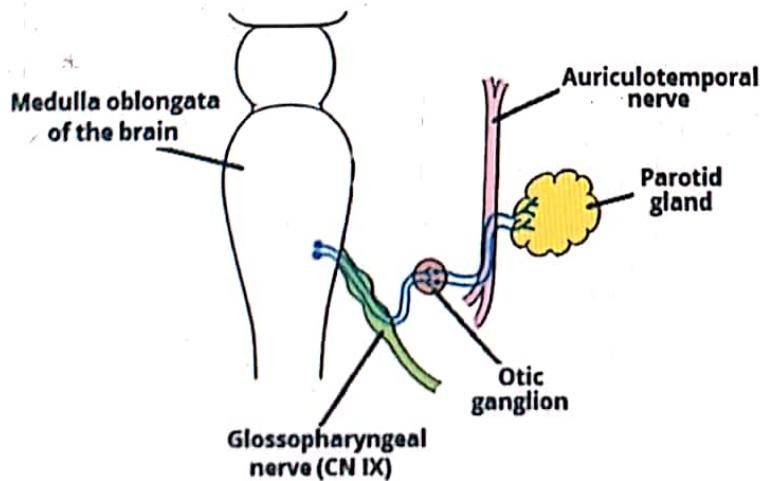
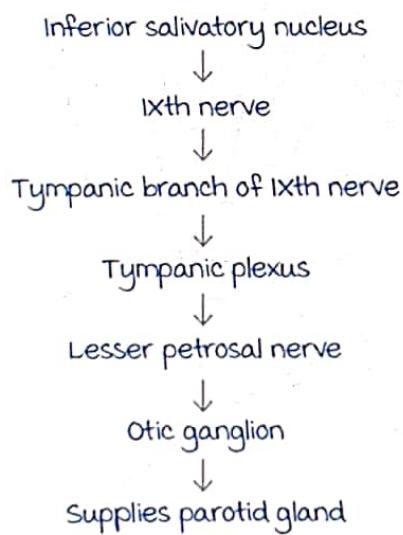
### Otic ganglion

Topographically connected to mandibular nerve.

Functionally connected to glossopharyngeal nerve.

Glands supplied - parotid gland

Parasympathetic pathway :



## GLANDS IN THE HEAD AND NECK

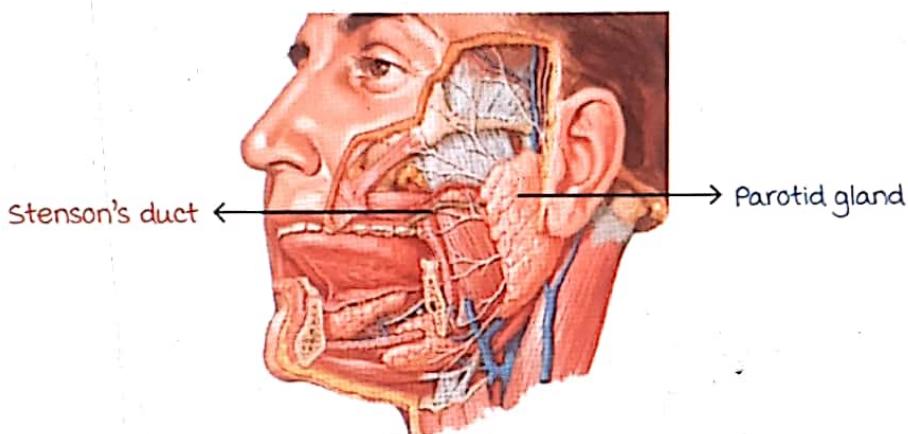
### Parotid gland

00:00:05

It's an **exocrine salivary gland**.

Derived from **ectoderm**.

Developed by **6<sup>th</sup> week**.

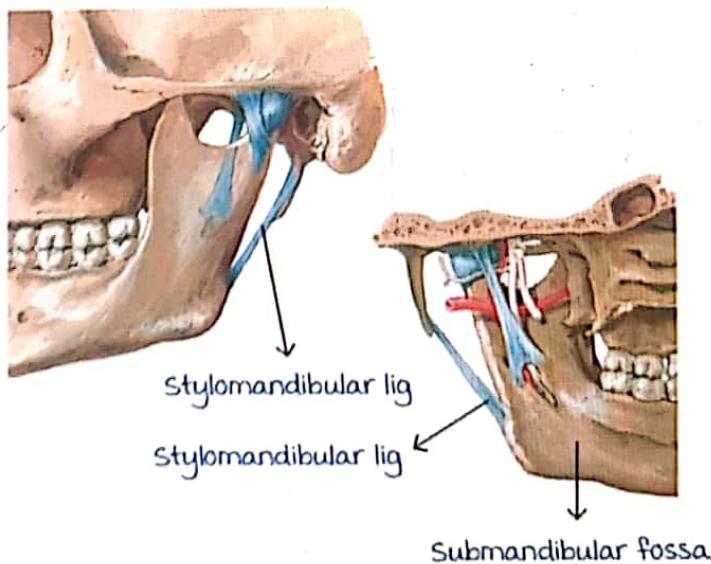


Capsules of parotid gland:

True capsule – condensation of fibrous stroma.

False capsule – derived from investing layer of deep cervical fascia.

False capsule thickens to form **stylomandibular ligament** (divides the floor of mouth into parotid and submandibular fossa).



Active space

## Surfaces of parotid gland

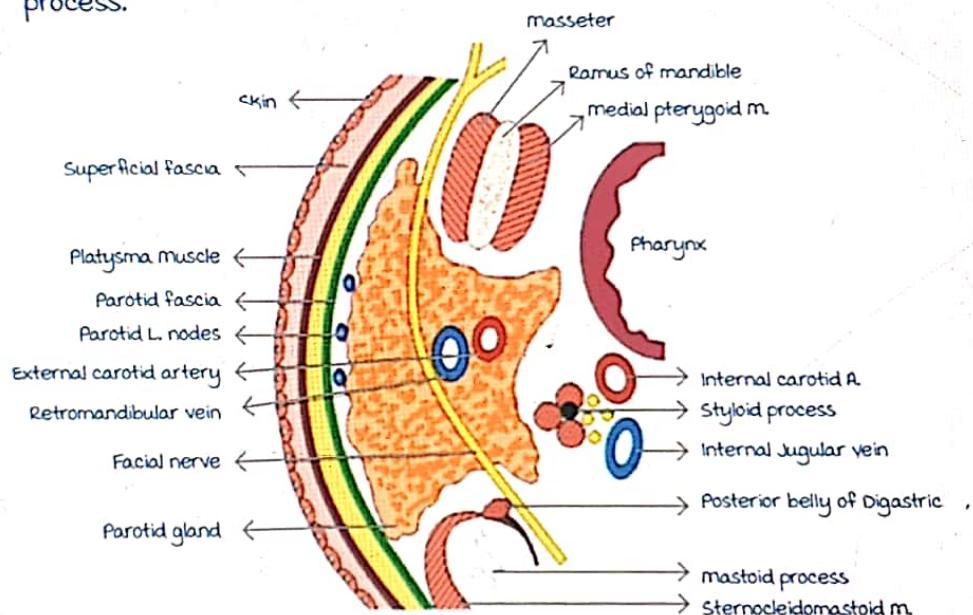
00:04:19

Parotid has 3 surfaces:

Lateral surface - related to parotid nodes.

Anteromedial surface - grooved by ramus of mandible and 2 muscles (masseter and medial pterygoid).

Posteromedial surface - related to mastoid process and styloid process.



## Stenson's duct

00:08:28

Stenson's duct or duct of parotid.

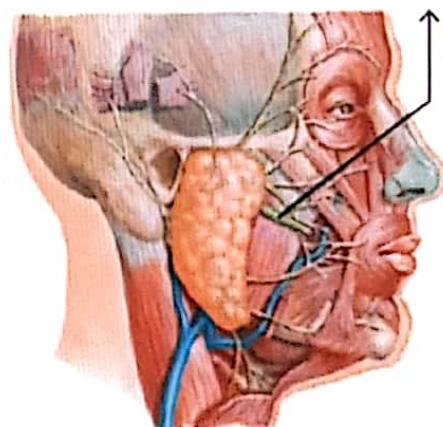
Course - Originates from the anterior border of parotid gland

Pierces buccinator muscle

Structures piercing buccinator muscle:

- Stenson's duct.
- Buccal branch of mandibular nerve.
- Molar mucus gland.

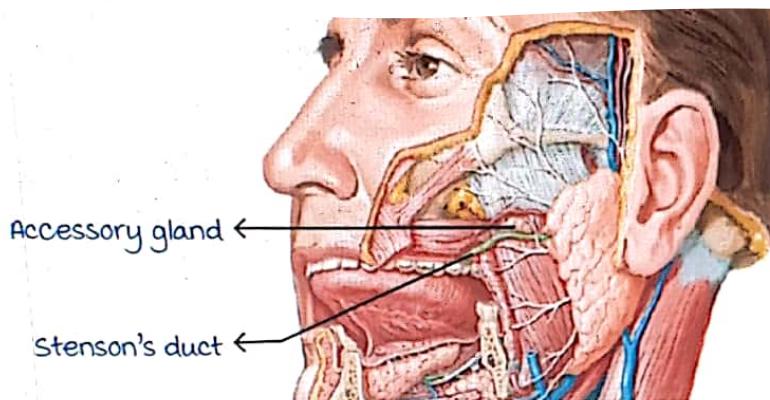
Opens into upper jaw (and molar)



Accessory gland:

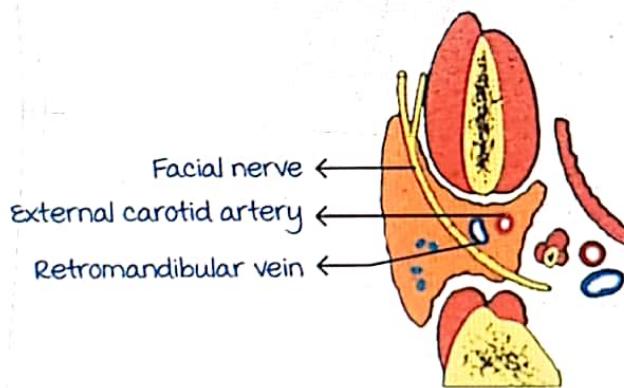
Small facial process at the anterior border of parotid gland.

Location – between zygomatic arch and Stenson's duct.



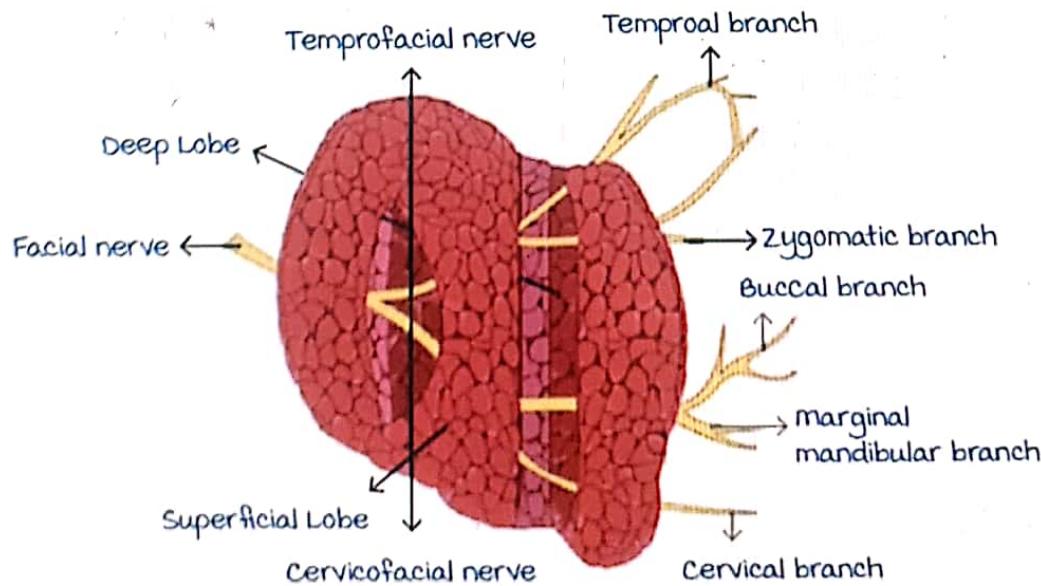
### Structures passing through parotid gland

00:12:01



Facial nerve and parotid gland:

Facial nerve passes between deep and superficial lobes of parotid gland.



Active space

**Retromandibular vein:**

Formed by maxillary vein + superficial temporal vein.

Divides into anterior and posterior division.

Anterior division + facial vein → common facial vein.

Posterior division + posterior auricular vein → external jugular vein

**Nerve supply of parotid**

00:16:21

**Sympathetic nerve supply :**

- Responsible for thick mucus secretion.
- Sympathetic plexus is derived from plexus over middle meningeal artery.

**Parasympathetic nerve supply :**

- Responsible for watery secretion.
- Fibres originate from inferior salivatory nucleus.

**Parasympathetic pathway :**

inferior salivatory nucleus



9th cranial nerve



Tympanic branch of glossopharyngeal nerve



Tympanic plexus



Lesser petrosal nerve



Otic ganglion



Parotid gland

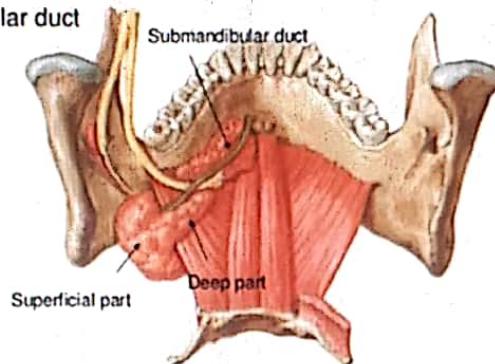
## Submandibular salivary gland

00:18:56

1. Superficial part

2. Deep part

3. Submandibular duct



Deep part - present on the lateral surface of hyoglossus muscle.

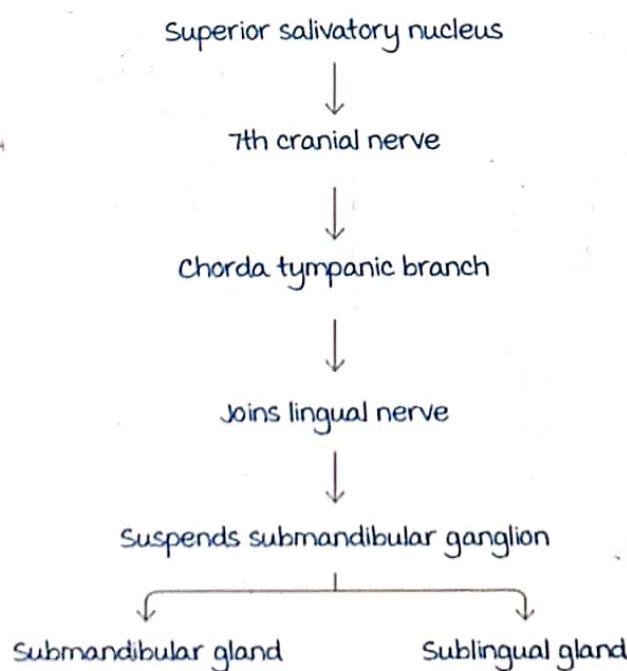
Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

Nerve supply:

Sympathetic plexus - derived from the plexus over the facial artery.

Sympathetic plexus carries post ganglionic fibres from superior cervical ganglion.

Parasympathetic fibres -



## Thyroid gland

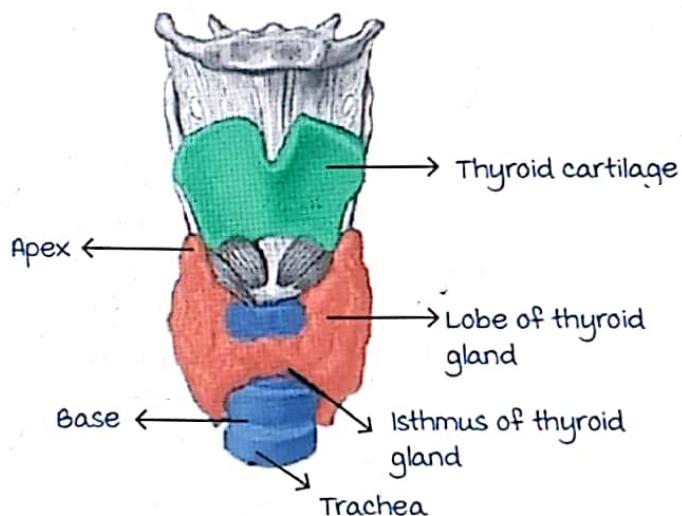
00:21:56

Endocrine gland.

Parts - 2 lateral lobes and isthmus (connecting lobes).

- True capsule - condensation of fibrous stroma.
- False capsule - derived from pre-tracheal layer of deep cervical fascia.

**Ligament of Berry** - posteriorly pre-tracheal fascia thickens to form ligament of Berry (connects thyroid gland to cricoid cartilage).



Relations of parts of thyroid gland

• Apex :

Reaches upto oblique line of thyroid cartilage.

Related to superior thyroid artery and external laryngeal nerve.

• Base :

Related to 4th-5th tracheal rings.

Related to inferior thyroid artery and recurrent laryngeal nerve.

**Note :** from surgical point of view, ligation of superior thyroid artery and inferior thyroid artery should be close to the gland in order to preserve the blood supply to the parathyroid gland.

• Isthmus :

upper border is related to pyramidal lobe and superior thyroid artery.  
inferior border is related to inferior thyroid vein + arteria thyroid ima

## Parathyroid gland

00:29:43

Total 4 in numbers (2 superior and 2 inferior).

- Superior parathyroid glands – derived from 4th endodermal pouch and constant (in position).
- Inferior thyroid glands – derived from 3rd endodermal pouch and are variable (in position).

Blood supply – derived from inferior thyroid artery (superior branch).

## Structures affected during tracheostomy

00:35:00

Isthmus.

Inferior thyroid vein.

Arteria thyroidema.

} midline structures

Active space

# ORBIT AND EXTRAOCULAR MUSCLES

Orbit: **Bony socket containing eyeball and extra ocular structures.**

## Boundaries of orbit

00:00:32

Roof is formed by

- Frontal bone
- Lesser wing of sphenoid bone  
(Optic canal is present in the lesser wing of sphenoid bone)

medial wall (thinnest wall of orbit) formed by

mnemonic - **uSMLE**

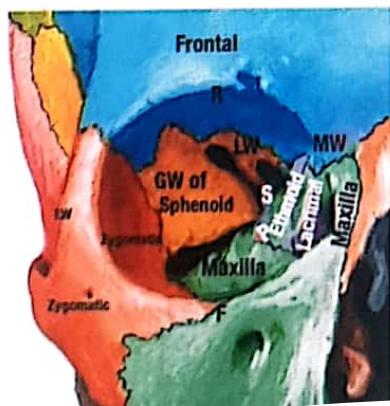
- Sphenoid bone
- maxilla bone
- Lacrimal bone
- Ethmoid bone

Floor (commonest site for fracture) formed by

- maxilla bone
- Zygomatic bone
- Palatine bone

Lateral wall formed by

- Greater wing of sphenoid bone
- Zygomatic bone



R - Roof

MW - medial wall

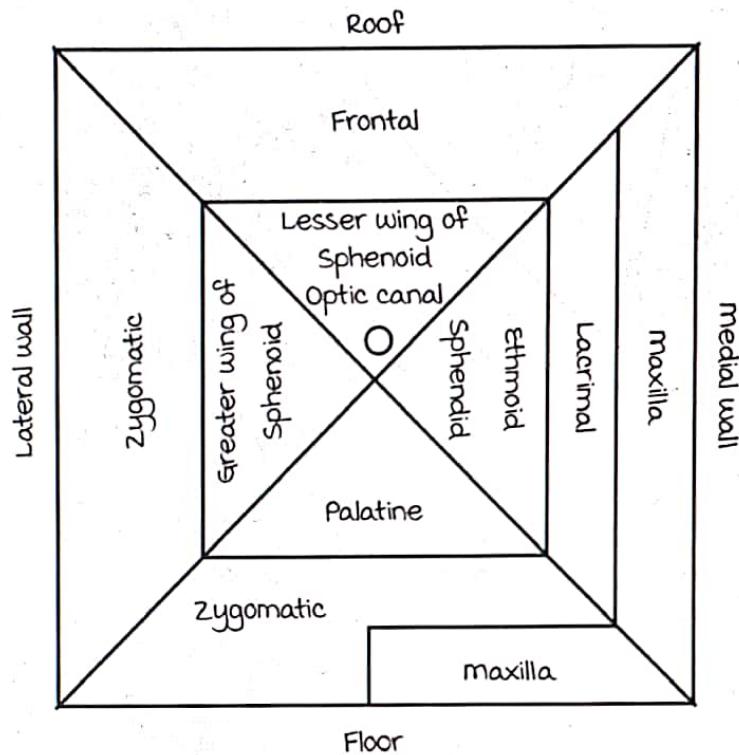
F - Floor

LW - Lateral wall

S - sphenoid

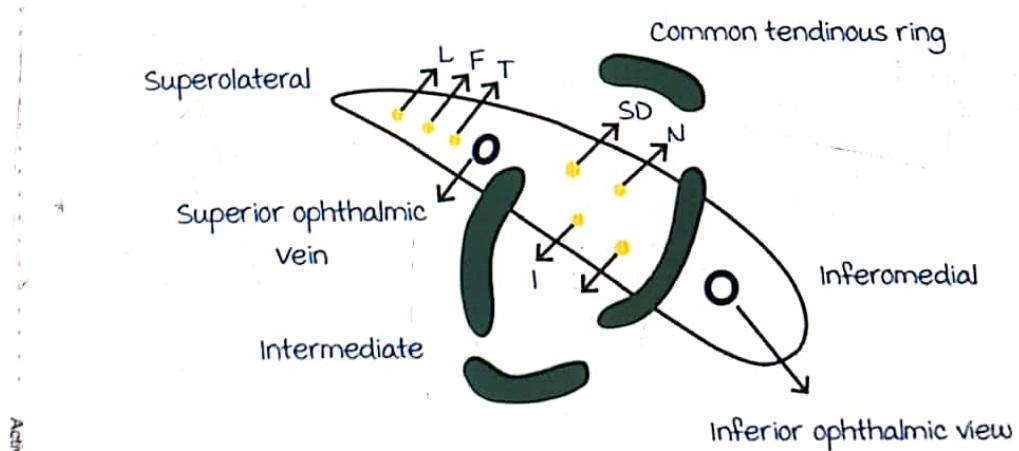
P - palatine bone

Active space



Superior orbital fissure (SOF) is at the junction of roof and lateral wall.

Inferior orbital fissure (IOF) is at the junction of floor and lateral wall.



## Superior orbital fissure

00:05:20

Divided into 3 compartments by common tendinous ring

Structures passing through:

Superolateral compartment

Mnemonic: LFT

- Lacrimal nerve
- Frontal nerve
- Trochlear nerve
- Superior ophthalmic vein

Intermediate compartment

- Superior division of Oculomotor nerve
- Nasociliary nerve
- Inferior division of oculomotor nerve
- Abducent nerve

Inferomedial compartment

- Inferior ophthalmic vein

Inferior orbital fissure:

Mnemonic - ZIME

Zygomatic nerve

Infra orbital nerve (continuation of maxillary nerve)

Maxillary nerve

Emissary veins - connecting inferior ophthalmic vein to pterygoid plexus.

Structures passing through optic canal:

- Optic nerve with meninges
- Ophthalmic artery

## Extra ocular muscles

00:11:50

4 recti muscles (straight)

- Superior rectus
- Inferior rectus
- medial rectus
- Lateral rectus

Origin of recti muscles: common tendinous ring

2 oblique muscles

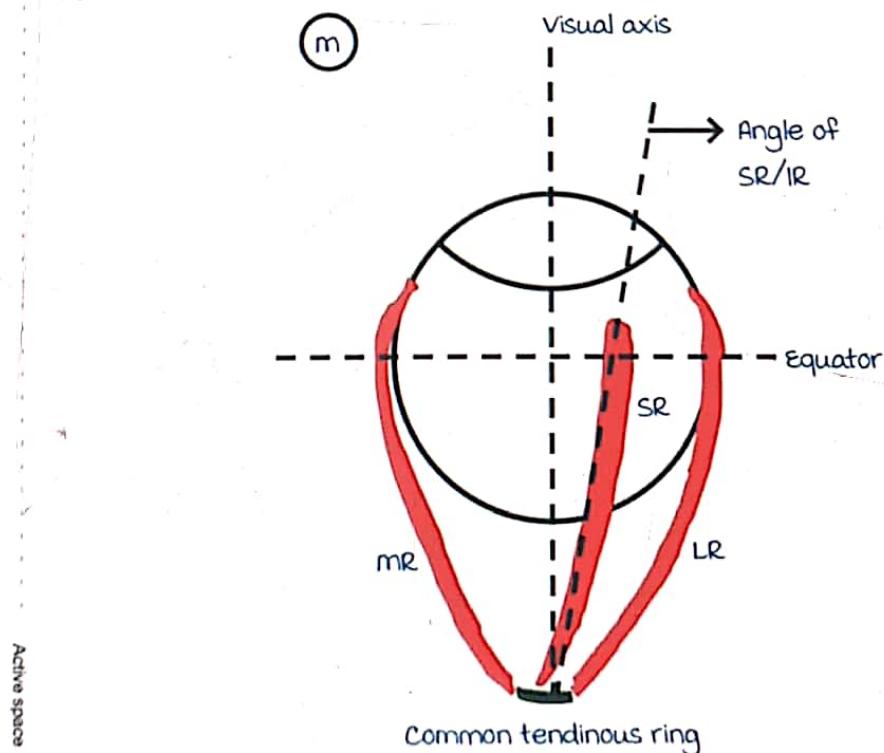
- Superior oblique (arises from sphenoid, superomedial to optic canal)
- Inferior oblique (only muscle to have origin from floor)

Levator palpebrae superioris (LPS)

Action of extra ocular muscles

medial Rectus – Adduction

Lateral Rectus – Abduction



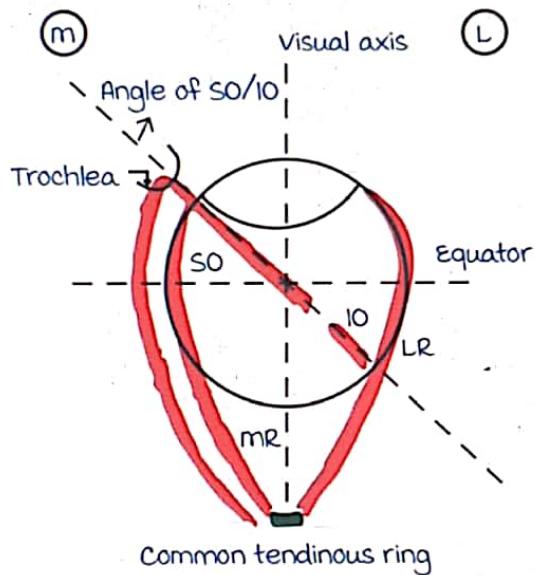
All the rectus muscles are inserted in front of the equator of the eyeball.

Angle of superior rectus & inferior rectus lies to the lateral visual axis.

Action of Superior rectus	Action of inferior rectus
elevation of adducted eye	Depression of adducted eye
Abduction	Abduction
Intorsion	Extorsion

## Oblique muscles

00:18:25



The oblique muscles are attached behind the equator of the eyeball  
 Angle of superior oblique & inferior oblique lies medial to visual axis

Action of Superior oblique	Action of inferior oblique
Depression of adducted eye	Elevation of adducted eye
Abduction	Abduction
Intorsion	Extorsion

Nerve supply of muscles :

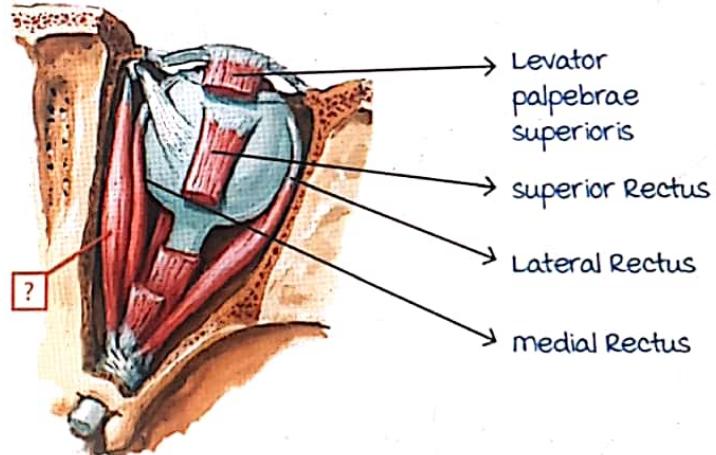
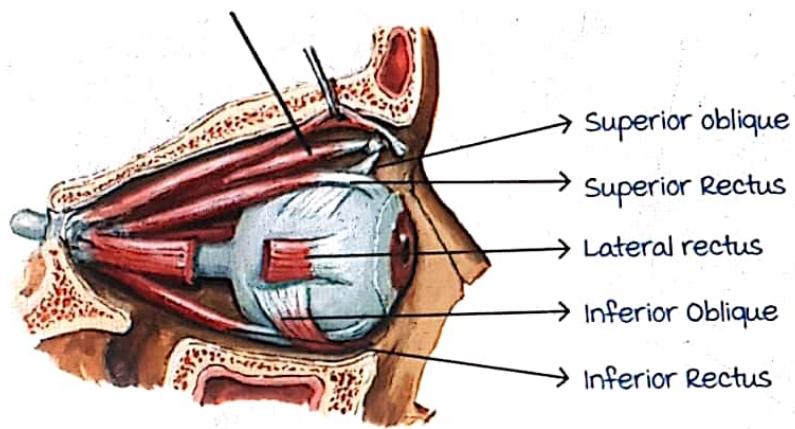
SO4 - Superior oblique - 4<sup>th</sup> cranial nerve (Trochlear)

LR6 - Lateral rectus - 6<sup>th</sup> cranial Nerve (Abducens)

3<sup>rd</sup> nerve supplies all other muscles

- Elevation of abducted eye - Superior Rectus
- Elevation of adducted eye - Inferior oblique
- Depression of abducted eye - Inferior Rectus

- Depression of adducted eye - Superior Oblique



# ORBIT AND EXTRAOCULAR MUSCLES

Orbit: bony socket containing eyeball and extra ocular structures.

## Boundaries of orbit

00:00:32

Roof is formed by

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- Lesser wing of sphenoid bone  
(Optic canal is present in the lesser wing of sphenoid bone)

medial wall (thinnest wall of orbit) formed by

mnemonic - USMLE

- Sphenoid bone
- maxilla bone
- Lacrimal bone
- Ethmoid bone

Floor (commonest site for fracture) formed by

- maxilla bone
- Zygomatic bone
- Palatine bone

Lateral wall formed by

- Greater wing of sphenoid bone
- Zygomatic bone



R - Roof

mw - medial wall

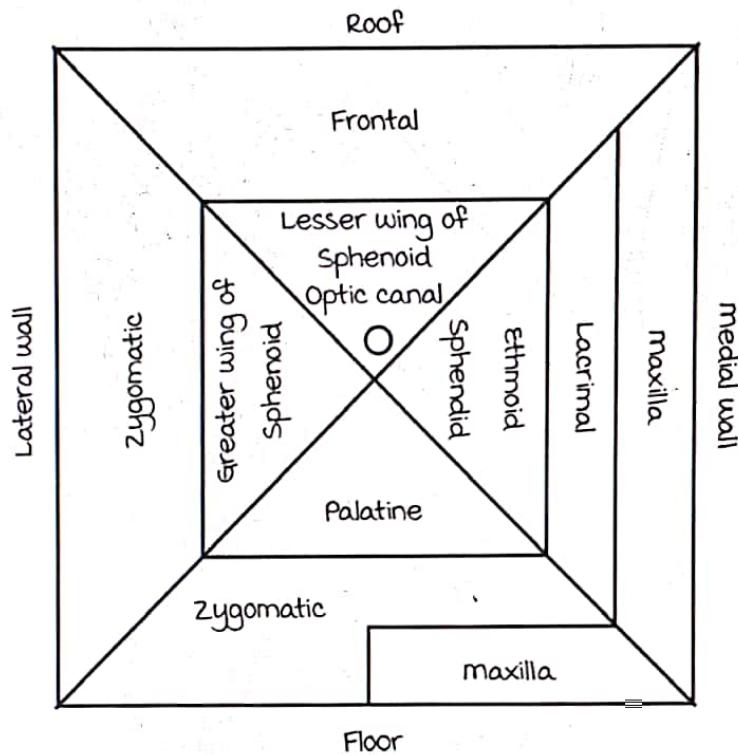
F - Floor

LW - Lateral wall

S - sphenoid

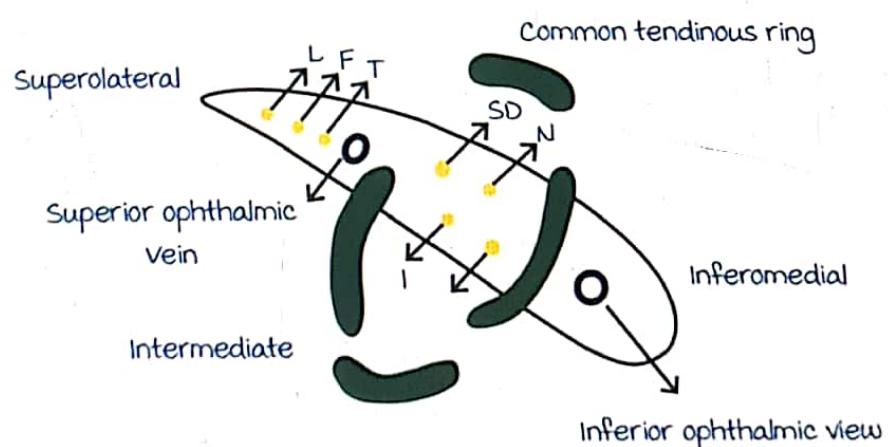
P - palatine bone

Active space



Superior orbital fissure (SOF) is at the junction of roof and lateral wall.

Inferior orbital fissure (IOF) is at the junction of floor and lateral wall.



## Superior orbital fissure

00:05:20

Divided into 3 compartments by common tendinous ring

Structures passing through:

Superolateral compartment

Mnemonic: LFT

- Lacrimal nerve
- Frontal nerve
- Trochlear nerve
- Superior ophthalmic vein

Intermediate compartment

- Superior division of Oculomotor nerve
- Nasociliary nerve
- Inferior division of oculomotor nerve
- Abducent nerve

Inferomedial compartment

- Inferior ophthalmic vein

Inferior orbital fissure:

Mnemonic: ZIME

Zygomatic nerve

Infra orbital nerve (continuation of maxillary nerve)

Maxillary nerve

Emissary veins - connecting inferior ophthalmic vein to pterygoid plexus.

Structures passing through optic canal:

- Optic nerve with meninges
- Ophthalmic artery

## Extra ocular muscles

00:11:50

4 recti muscles (straight)

- Superior rectus
- Inferior rectus
- medial rectus
- Lateral rectus

Origin of recti muscles: common tendinous ring

2 oblique muscles

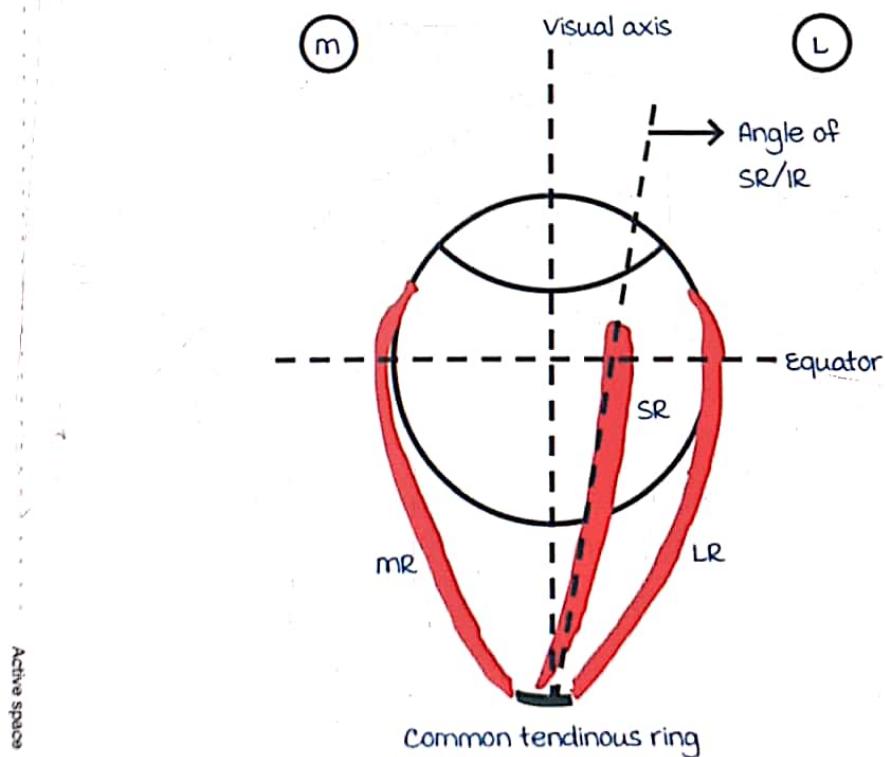
- Superior oblique (arises from sphenoid, superomedial to optic canal)
- Inferior oblique (only muscle to have origin from floor)

Levator palpebrae superioris (LPS)

Action of extra ocular muscles

medial Rectus – Adduction

Lateral Rectus – Abduction



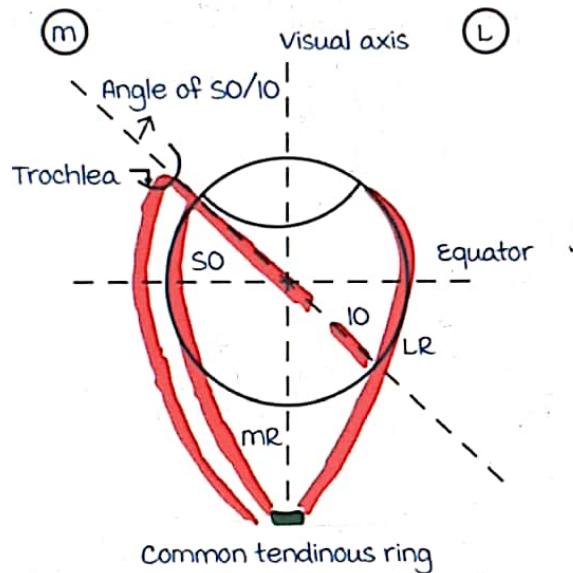
All the rectus muscles are inserted in front of the equator of the eyeball.

Angle of superior rectus & inferior rectus lies to the lateral visual axis.

Action of Superior rectus	Action of inferior rectus
elevation of adducted eye	Depression of adducted eye
Abduction	Abduction
Intorsion	Extorsion

## Oblique muscles

00:18:25



The oblique muscles are attached behind the equator of the eyeball  
 Angle of superior oblique & inferior oblique lies **medial to visual axis**

Action of Superior oblique	Action of inferior oblique
Depression of adducted eye	Elevation of adducted eye
Abduction	Abduction
Intorsion	Extorsion

Nerve supply of muscles :

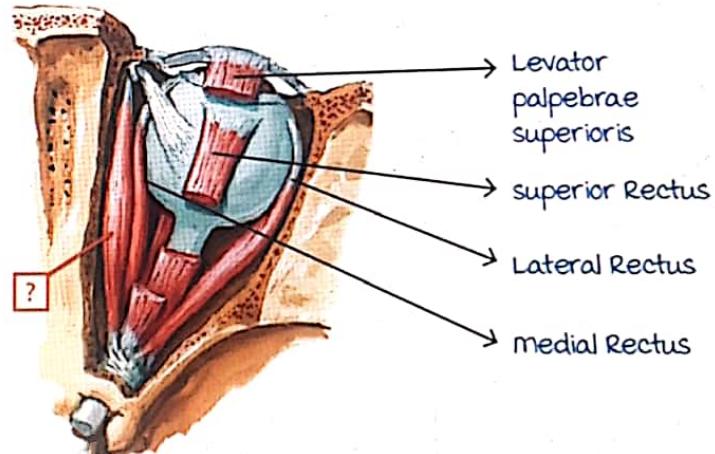
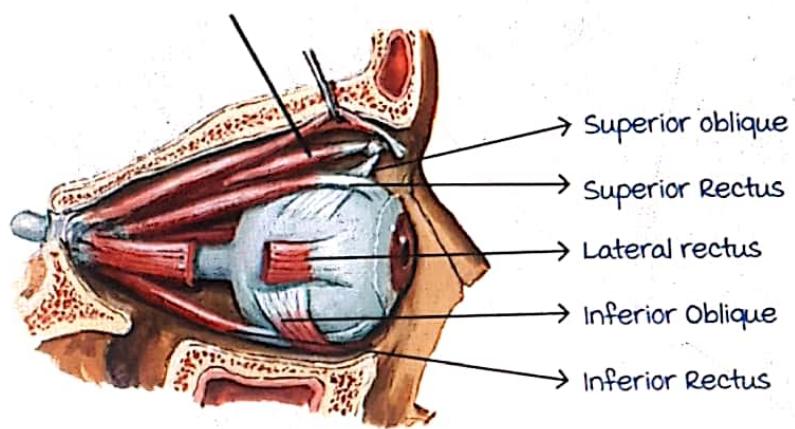
SO4 - Superior oblique - 4<sup>th</sup> cranial nerve (Trochlear)

LR6 - Lateral rectus - 6<sup>th</sup> cranial Nerve (Abducens)

3<sup>rd</sup> nerve supplies all other muscles

- Elevation of abducted eye - Superior Rectus
- Elevation of adducted eye - Inferior oblique
- Depression of abducted eye - Inferior Rectus

- Depression of adducted eye - Superior Oblique



# CRANIAL NERVES III, IV AND VI

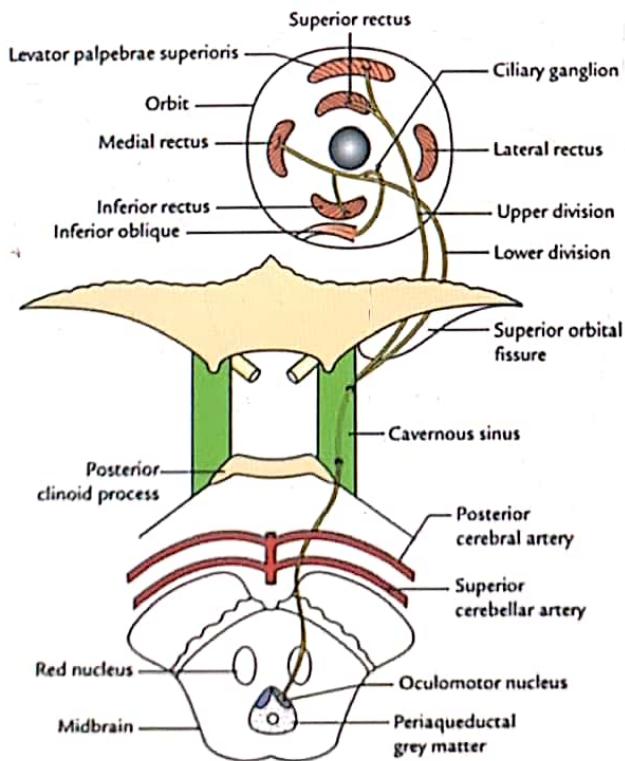
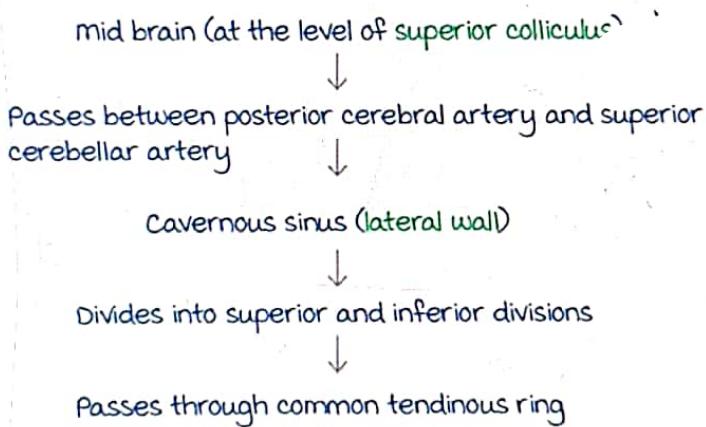
## III<sup>rd</sup> cranial nerve/Oculomotor nerve

00:00:03

Has 2 functional columns :

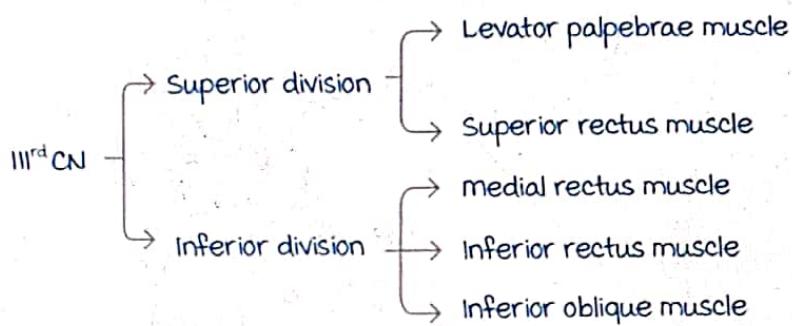
- General somatic efferent column – supplies extraocular muscles.
- General visceral efferent column (parasympathetic column) – supplies ciliaris muscle and sphincter pupillae muscle.

Course :



Active space

Structures supplied:



Note:

1. Fibres supplying superior rectus muscle crosses to opposite side and innervates contralateral muscles.
2. In case of nuclear injury, both the superior rectus muscles are affected.

#### Features of III cranial nerve/Oculomotor nerve injury

00:06:50

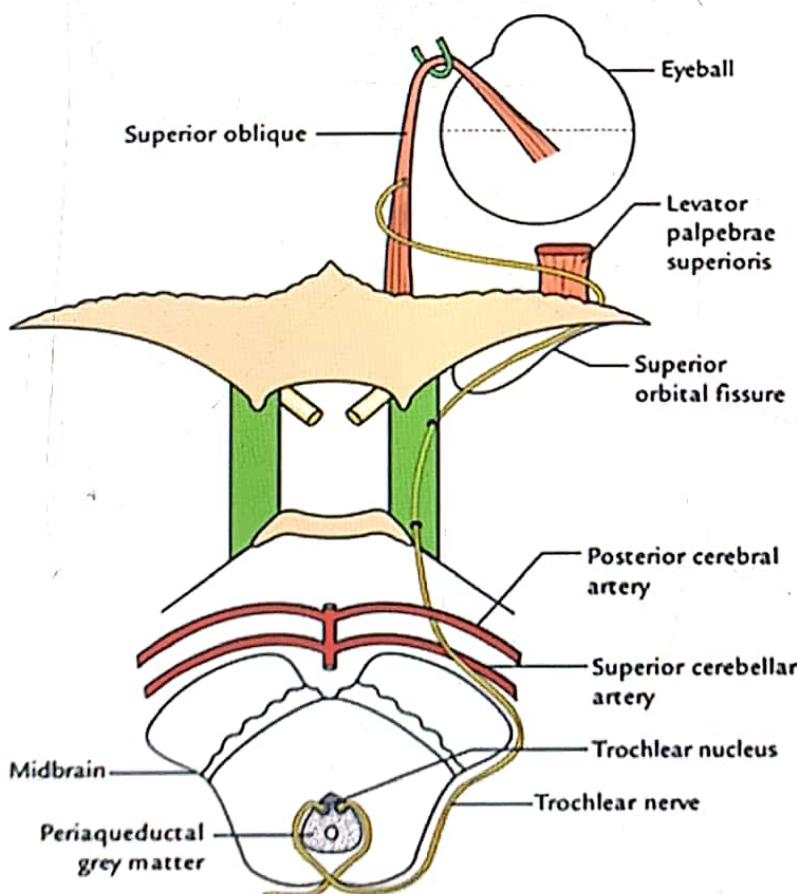
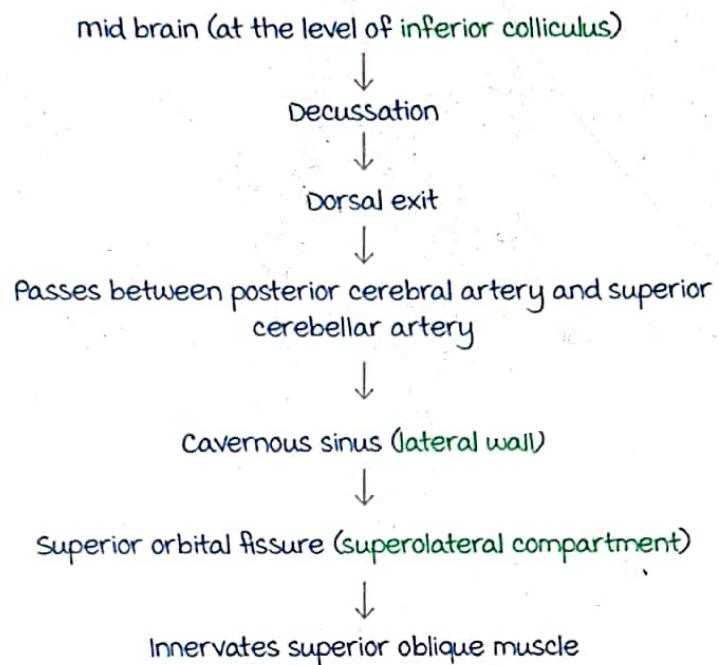
- Ptosis.
- Dilated pupils.
- Downward and outward gaze.
- Loss of accommodation reflex.
- Loss of light reflex.

#### IV cranial nerve/ Trochlear nerve

00:14:25

- Smallest and slender nerve.
- Only nerve with dorsal exit.
- Only nerve that decussates internally.
- Longest intracranial course.

Course:



## Features of IV nerve injury

00:18:04

The 4<sup>th</sup> nerve supplies the Superior Oblique muscle.

Both Superior Oblique muscles are intorsion muscles.

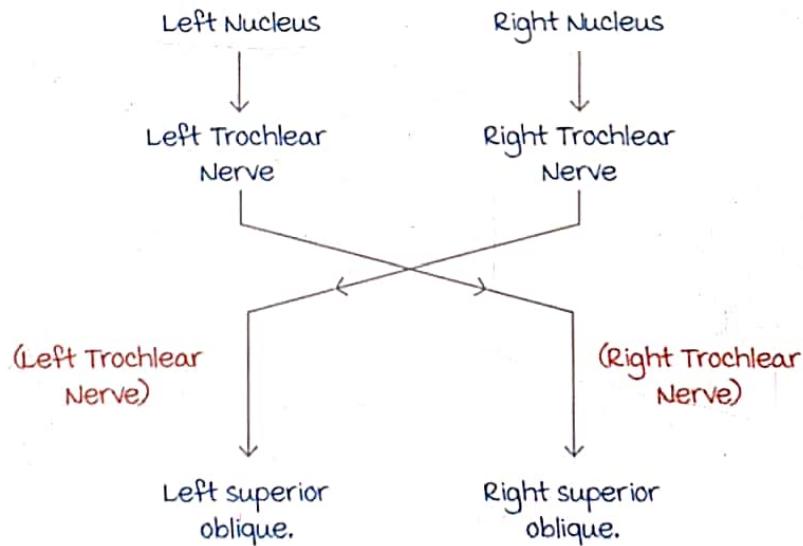
The Trochlear nerve injury leads to unopposed action of extorsion

The Head tilt will be to the opposite side to compensate for extorsion

Eg) In case of Right 4<sup>th</sup> nerve injury, the head tilt will be towards left side

The 4<sup>th</sup> nerve undergoes internal decussation:

- The Right Trochlear nerve, innervating the left Superior Oblique is called left Superior nerve as a misnomer.
- The Left Trochlear nerve, innervating the Right Superior Oblique is called Right Superior nerve as a misnomer.

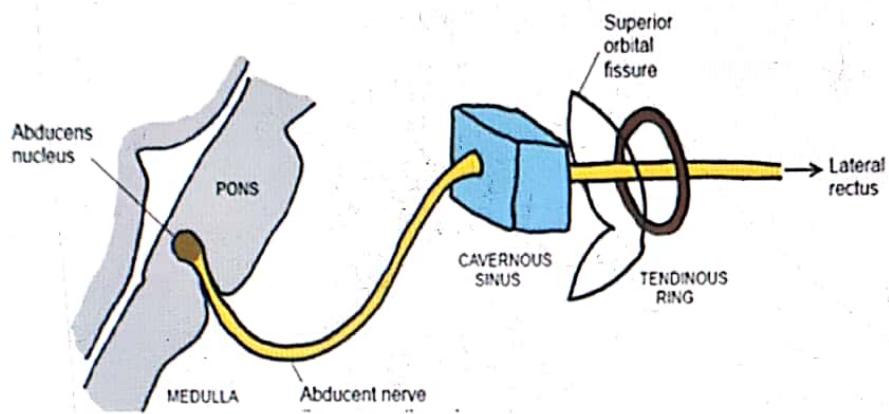


## VI cranial nerve/ Abducent nerve

00:23:42

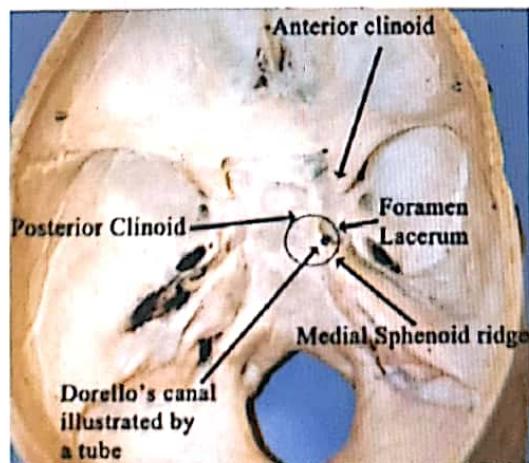
VIth nerve is the **most commonly affected** in increased intracranial tension.

Longest intradural course.



Course :

- Pons (lower level)
- ↓
- Exits brain stem at ponto-medullary junction
- ↓
- Pierces dura matter (Dorello's canal)
- ↓
- Passes through the cavernous sinus
- ↓
- Superior orbital fissure (common tendinous ring)
- ↓
- Innervates lateral rectus muscle



Active space

# NOSE

## Nasal septum/medial wall

00:00:25

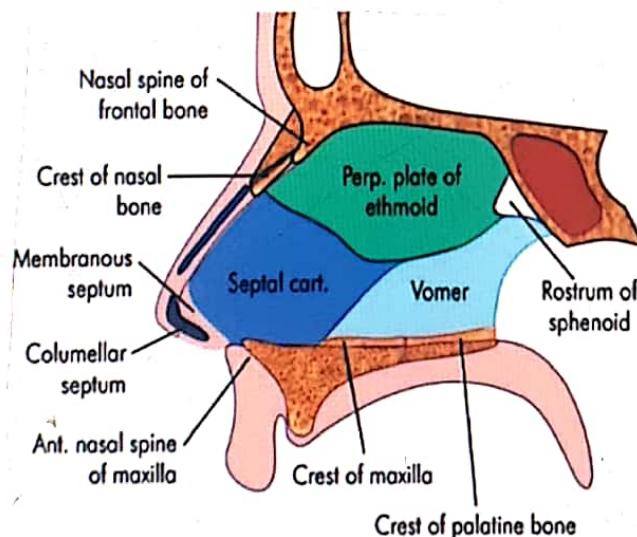
It is formed by **two bones and one cartilage**:

1. Vomer bone
2. Perpendicular plate of ethmoid
3. Septal cartilage or quadrilateral cartilage

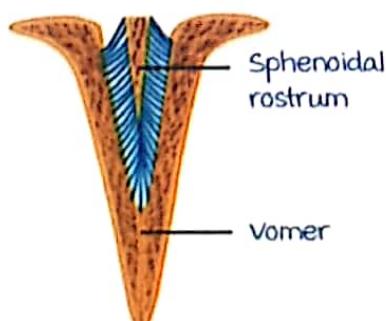
**minor structures of the nasal septum:**

- Crest of nasal bone
- Nasal spine of the frontal bone
- Rostrum of sphenoid
- Crest of maxilla
- Crest of palatine bone

The **Schindylesis joint** or **ridge and groove suture** is present between the sphenoidal rostrum and vomer bone.



Schindylesis  
(ridge and groove)



## Little's area/ Kiesselbach area

00:03:10

It is a **highly vascular area** in the anteroinferior aspect of the nasal septum

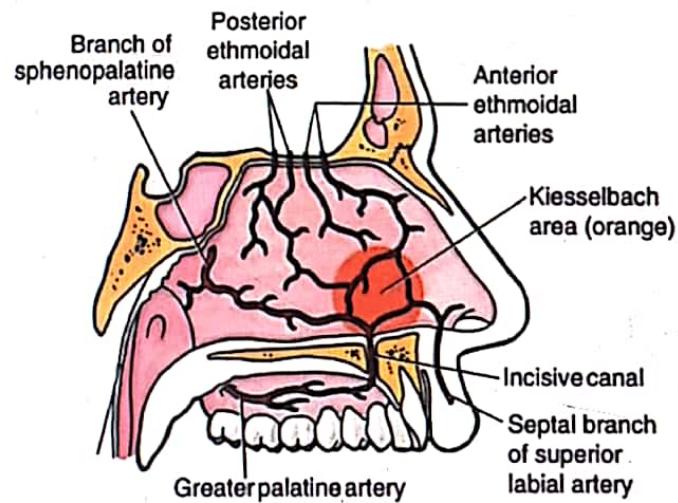
↓  
Due to the presence of **Kiesselbach plexus**.

The arteries involved in Kiesselbach plexus are :

1. Anterior ethmoidal artery - branch of ophthalmic artery - branch of internal carotid artery [ICA]
2. Sphenopalatine artery - branch of maxillary artery - branch of external carotid artery [ECA]
3. Greater palatine artery - branch of maxillary - branch of ECA
4. Superior labial artery - branch of facial artery - branch of ECA  
Gives **septal branches**.

Note : [2017, 2019 AIIMS]

All the arteries involved in the Kiesselbach plexus are branches of **ECA**.  
Except anterior ethmoidal artery, branch of **ICA**.



## Lateral wall of nasal septum

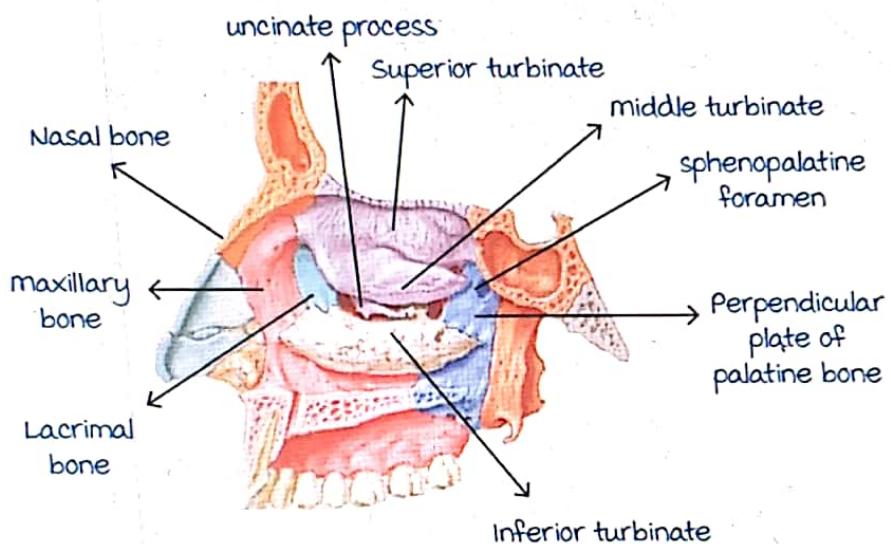
00:09:02

It is formed by prominent elevations called **turbinates**.

There are **three turbinates** - superior → part of ethmoid bone  
middle  
Inferior - separate bone

Other bones forming lateral wall :

- Lacrimal bone
- maxillary bone
- Nasal bone
- Perpendicular plate of palatine bone



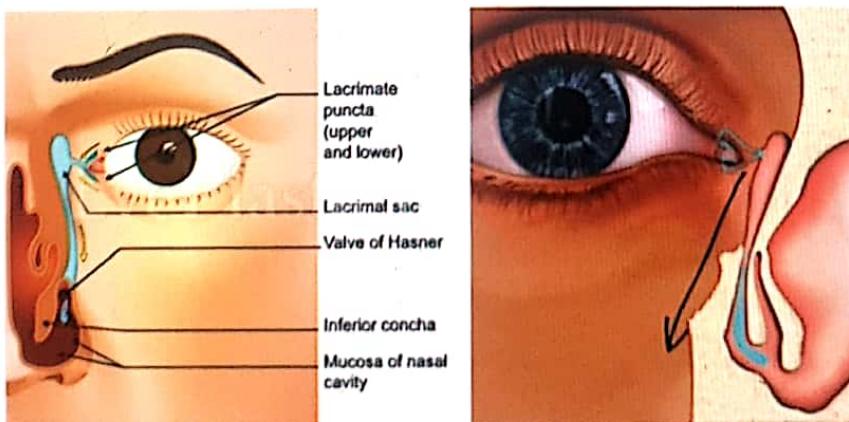
### Nasal meatus

Three meatus - Inferior meatus  
middle meatus  
Superior meatus

Structures opening into Inferior meatus :

Nasolacrimal duct - provided with valve of Hasner.

Direction - downwards, backwards, laterally.



Active space

Structures opening into middle meatus:

middle ethmoidal sinus opens into **Bulla Hiatus semilunaris**

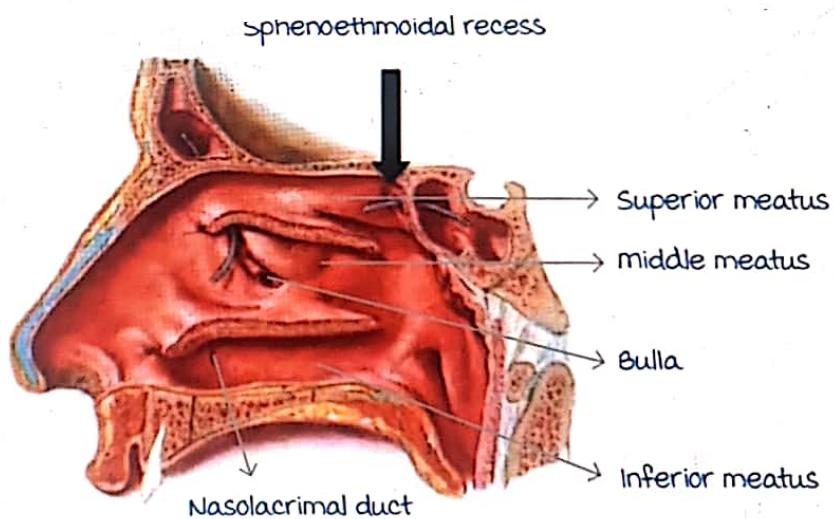
**maxillary sinus** - opens into infundibulum [3dimensional area] via  
hiatus semilunaris  
Infundibulum > hiatus semilunaris.

Anterior ethmoidal sinus and **frontal sinus** opens also into infundibulum.

Posterior ethmoidal sinus

Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

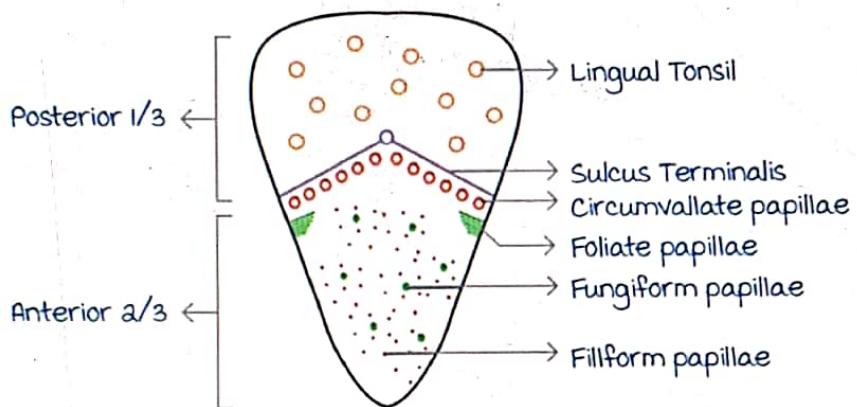
Sphenoethmoidal recess receives **sphenoidal sinus**.



# TONGUE

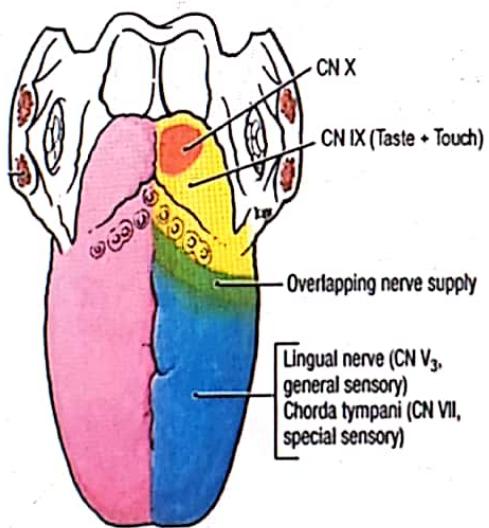
## External features

00:00:06



## Nerve Supply

00:03:15



Anterior 2/3rd : derived from 1<sup>st</sup> arch

- General sensation : Lingual nerve
- Taste sensation : Chorda tympani nerve

Posterior 1/3rd : derived from 3<sup>rd</sup> arch

CN 9 : Taste and touch

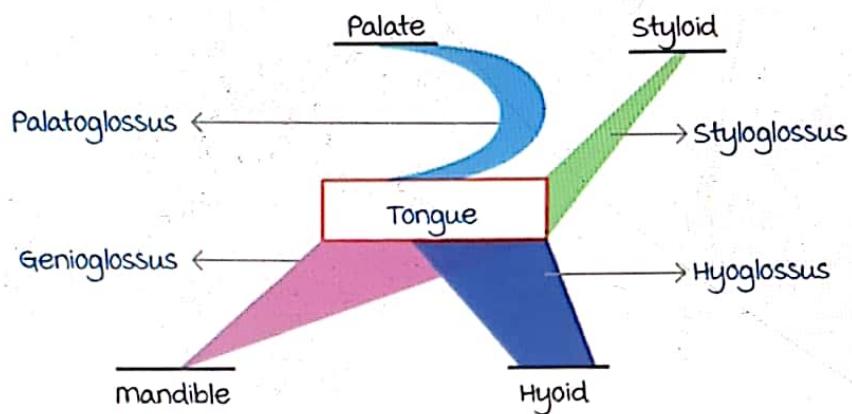
Posterior most : derived from 4<sup>th</sup> arch

- CN 10

Circumvallate papillae : CN 9

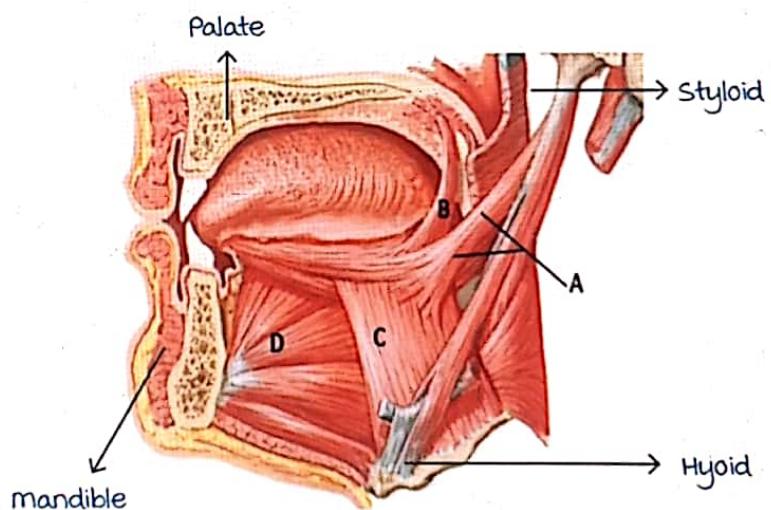
## Muscles

00:05:28



- Only one muscle for tongue protrusion: Genioglossus (Safety muscle of tongue)

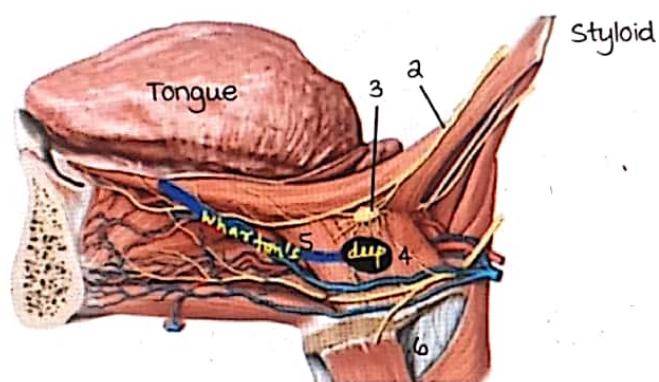
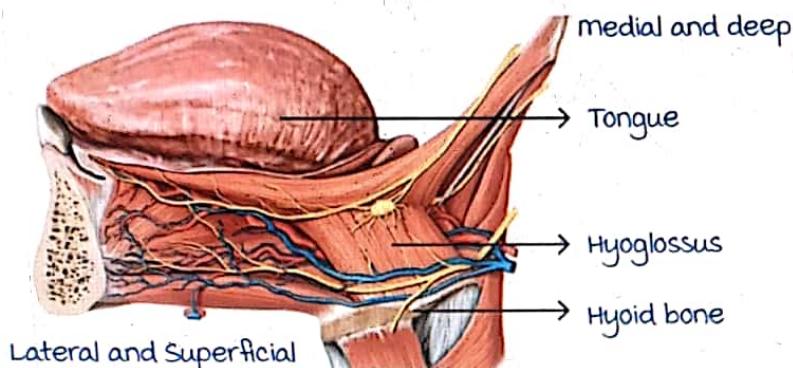
Sagittal section:



- Styloglossus
- Palatoglossus
- Hyoglossus
- Genioglossus

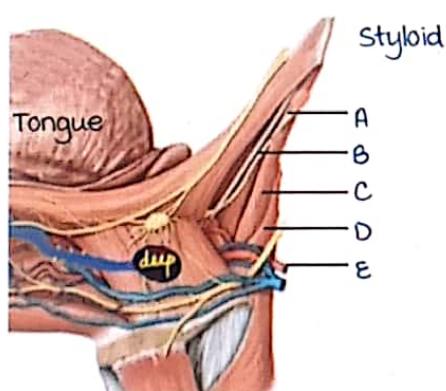
- All tongue muscles supplied by: Hypoglossal nerve except Palatoglossus (Pharyngeal plexus)
- Hypoglossal nerve injury → Genioglossus palsy → deviation of tongue on the same side

Relation of the Hyoglossus muscle :



Lateral :

1. Styloglossus
2. Lingual
3. Submandibular gland
4. Deep part of submandibular gland
5. Wharton's duct
6. CN 12



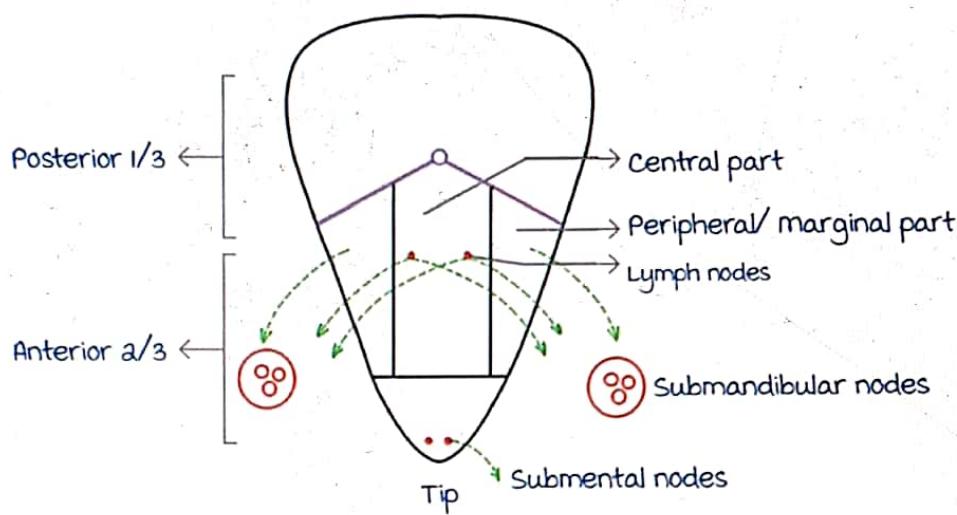
medial :

- A. Stylohyoid ligament
- B. CN 9
- C. Stylopharyngeus muscle
- D. middle constrictor muscle
- E. Lingual artery

Active space

## Lymphatic drainage

00:18:08



- Lymph from marginal group will be draining to **ipsilateral** submandibular nodes
- Lymph from central group will be draining to **bilateral** submandibular nodes

Principle node of tongue : Jugulo omohyoid node.

# LARYNX

## Anatomy of the Larynx

The larynx is a **cartilage tube**.

It consists of paired and unpaired cartilages.

There are **3 Unpaired Cartilages**:

1. Thyroid cartilage:

- Hyaline cartilage.

2. Cricoid cartilage:

- Hyaline cartilage.
- Posteriorly it forms cricoid lamina.
- It is the only cartilage which forms a **complete ring** (AIIMS)

3. Epiglottis:

- Elastic cartilage.

There are **3 Paired Cartilages**: (3>4)

1. Arytenoid cartilage

- Hyaline cartilage except the **apex** which is **Elastic cartilage**.

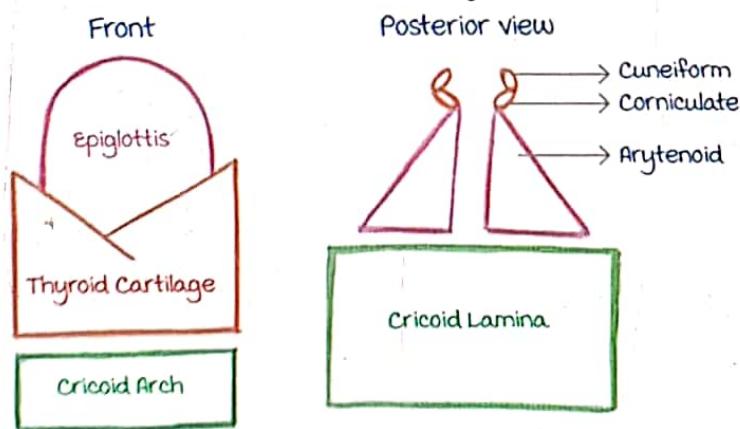
2. Corniculate cartilage

- **Elastic cartilage**.

3. Cuneiform cartilage

- **Elastic cartilage**.

4. Tritiate cartilage is an **elastic cartilage** in the **thyrohyoid membrane**.



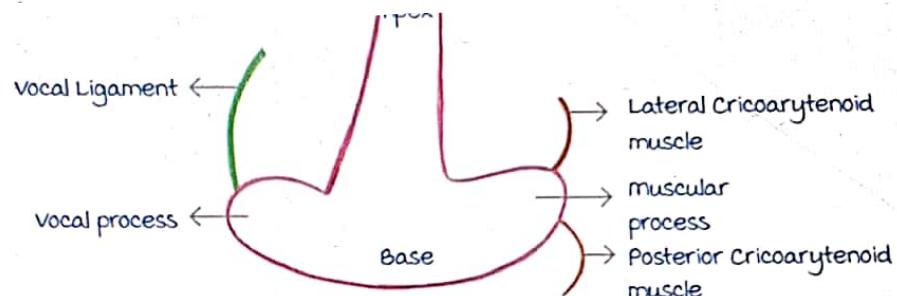
## Arytenoid Cartilage

The arytenoid cartilage is made up of **hyaline cartilage** except for the **apex** which is **elastic cartilage**.

Parts of Arytenoid Cartilage:

- **Apex**: Only part of arytenoid cartilage which is **elastic**.

- **Base** : It rests over the Cricoid Lamina.
- **muscular process** : Gives attachment to the following muscles :
  - Front side : Lateral Cricoarytenoid muscle.
  - Back side : Posterior Cricoarytenoid muscle.
- **vocal process** : Gives attachment to vocal ligament.



### Coronal section of the Larynx

00:06:44

**Vestibular ligament** : This is the thickening of the lower part of quadrangular membrane.

**Vocal ligament** : This is the thickening of upper part of cricovocal membrane.

**Rima Vestibuli** : The space between the vestibular folds.

**Rima Glottidis** : The space between the vocal folds.

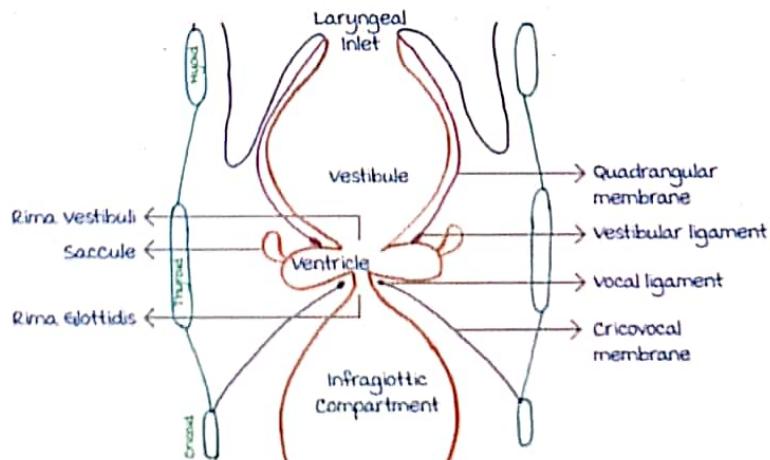
**Vestibule** : Present between laryngeal inlet and vestibular ligament.

**Ventriole** : Present between vestibular ligament and vocal ligament.

**Infraglottic compartment** : Present below the vocal ligament.

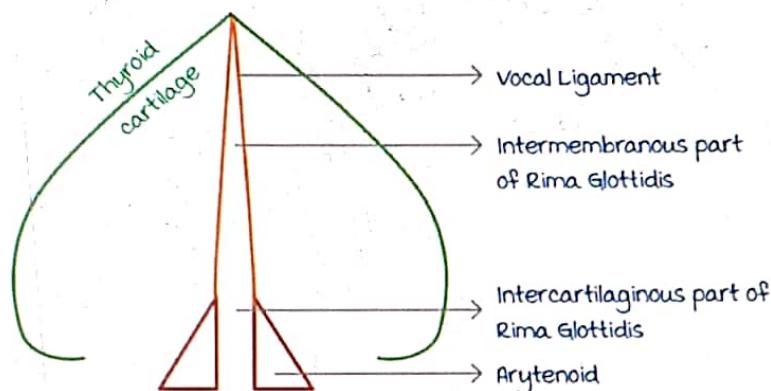
**Saccule (Oil can of the Larynx)** :

- This is a small extension on the ventricle which has numerous mucous glands.
- Function : Lubrication of vocal cords. (The larynx is lined by non-keratinized stratified squamous epithelium).



### Parts of Rima Glottidis :

- **Intermembranous part** : present between vocal ligaments.
- **Intercartilaginous part** : present between the arytenoid cartilages.



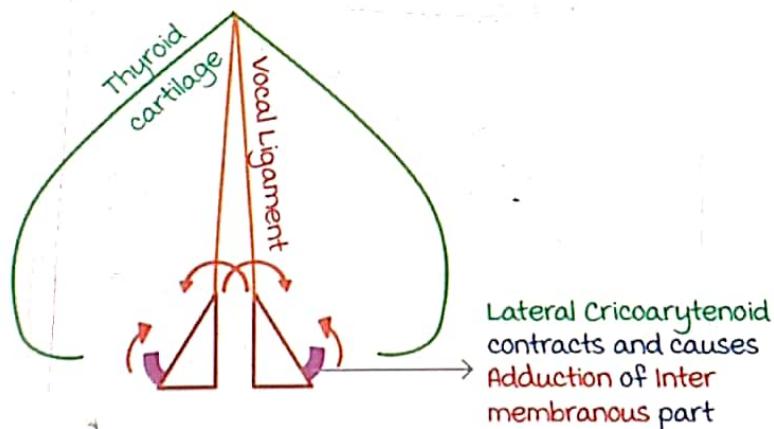
### Muscles Adducting and Abducting the Vocal Cord:

00:16:00

#### Lateral cricoarytenoid muscle :

Lateral cricoarytenoid muscle extends from cricoid cartilage to arytenoid.

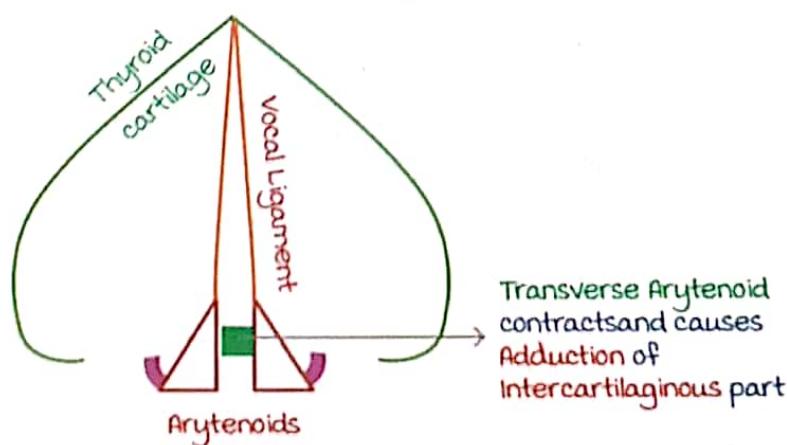
Action : **Adduction of Intermembranous part of Rima Glottidis.**



#### Interarytenoid/ Transverse arytenoid muscle :

Transverse arytenoid extends between both arytenoids.

Action : **Adduction of Intercartilaginous part of Rima Glottidis.**



Active space

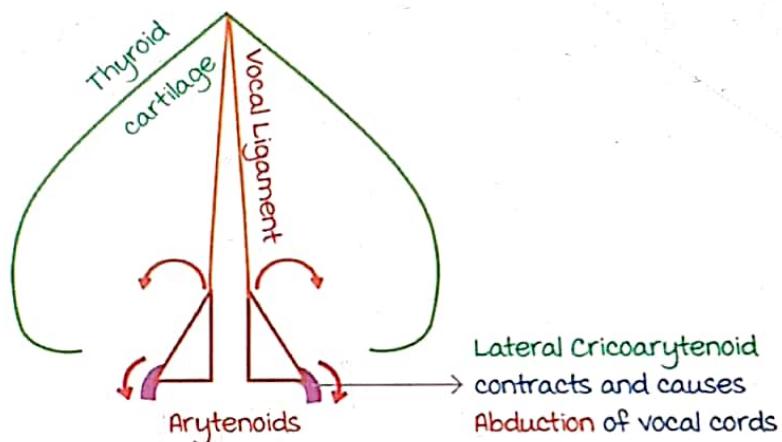
### Posterior Cricoarytenoid muscle :

The muscle extends from cricoid cartilage to muscular process of arytenoid cartilage.

Action : Abduction of vocal cords.

It is the **only muscle for abduction of vocal cords**.

It is known as the **Safety muscle of the Larynx** as it allows air to enter the trachea during abduction.



### Tensors and Relaxers of the Vocal Cord

00:22:50

#### Cricothyroid muscle : Tensor

Cricothyroid muscle contracts and  
Cricoid Arch moves up



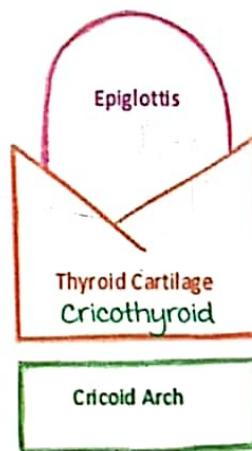
This causes the cricoid Lamina to  
move down



Thus the arytenoids resting over the  
cricoid lamina also move down



This results in lengthening of vocal ligament  
hence the **Cricothyroid** muscle acts as a **Tensor**.



#### Thyroarytenoid muscle : Relaxer

Thyroarytenoid muscle extends from thyroid cartilage to arytenoid cartilage.

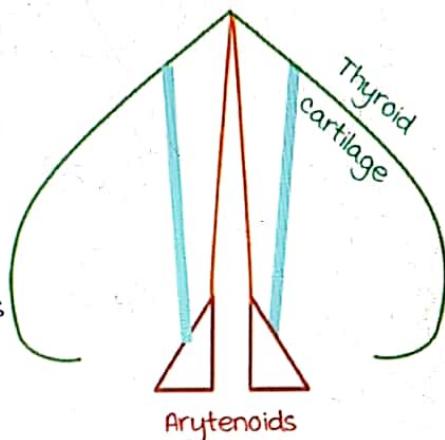
Thyroarytenoid muscle contracts



Decrease in distance between thyroid cartilage and the arytenoid cartilage.

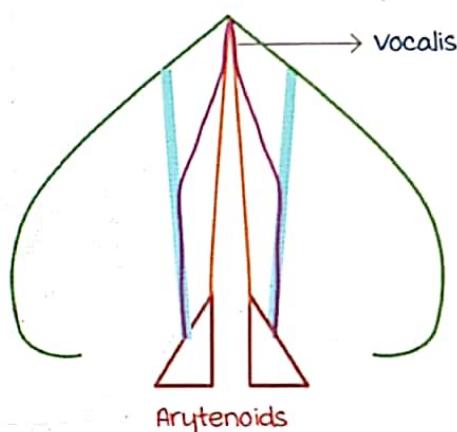


Thus length of vocal cord decreases hence the Thyroarytenoid muscle acts as a **Relaxer**



Vocalis muscle : Tensor + Relaxer

- vocalis muscle is the detached part of Thyroarytenoid muscle.
- It merges with vocal ligament at anterior 1/3<sup>rd</sup>.
- Action : **Tensor** at anterior 1/3<sup>rd</sup> and **relaxer** at posterior 2/3<sup>rd</sup> of vocal ligament.



## Muscles acting on laryngeal Inlet

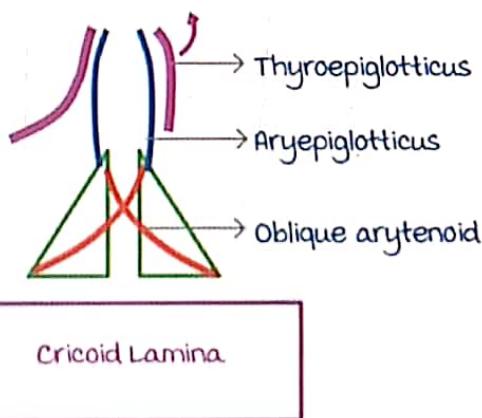
00:30:06

### Aryepiglotticus muscle

- Aryepiglotticus muscle is the continuation of Oblique Arytenoid muscle which extends from base of arytenoid cartilage to the opposite apex
- **Closes** the laryngeal inlet.

### Thyroepiglotticus muscle :

- Extent : From thyroid cartilage to the epiglottis.
- Pulls aryepiglottic fold laterally, thus **opens** laryngeal inlet.
- mnemonic : OT : Open for Thyroepiglotticus.



Nerve Supply of Larynx:

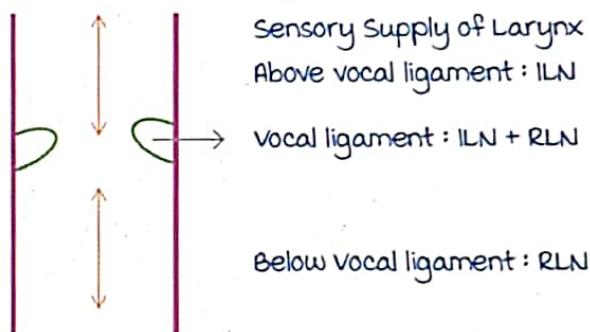
00:33:09

All muscles of larynx except cricothyroid are supplied by : Recurrent laryngeal nerve (RLN).

Cricothyroid muscle : Supplied by External laryngeal nerve (ELN).

Superior laryngeal nerve divides into :

- Internal Laryngeal nerve (ILN) :
    - Provide sensory supply to laryngeal mucosa above the vocal cord.
  - External laryngeal nerve : Provides motor supply to cricothyroid muscle.
- ELN accompanies superior thyroid artery.



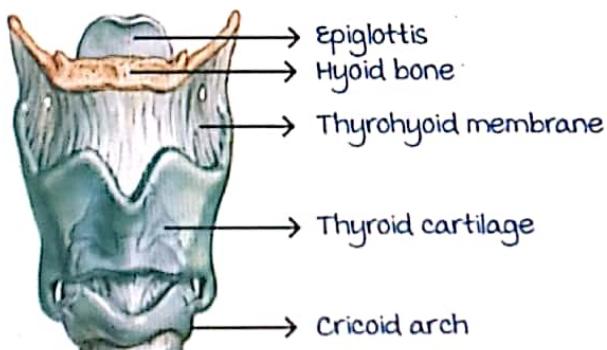
Recurrent Laryngeal Nerve is a mixed nerve :

- Sensory : Larynx below vocal cord.
- motor : All muscles of vocal cord except cricothyroid.
- vocal cords are supplied by both ILN + RLN.
- Galen's Anastomosis : Between ILN and RLN.

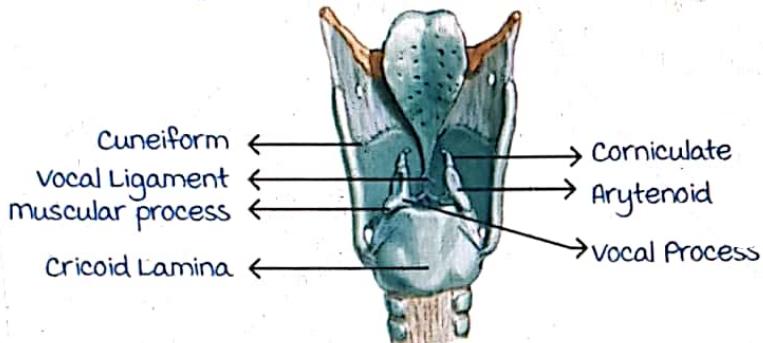
Images of Larynx

00:36:26

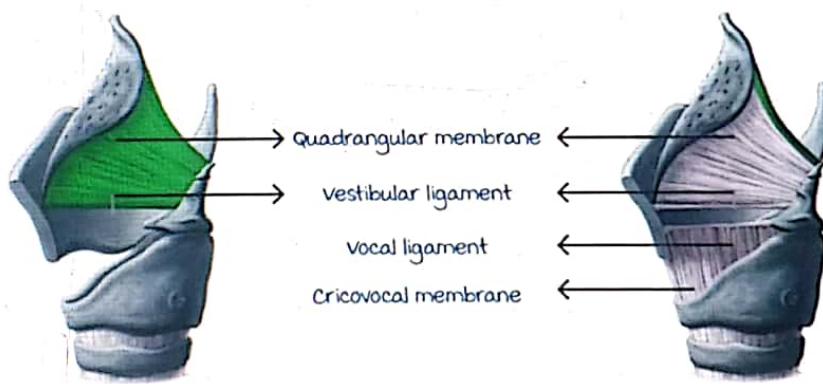
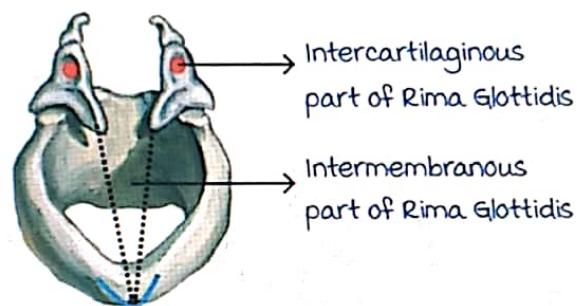
Anterior view of Larynx :



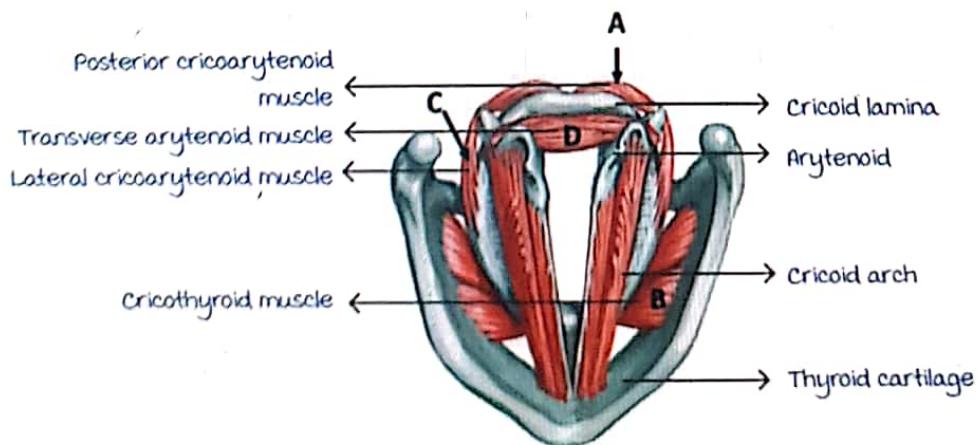
Posterior view of Larynx :



Parts of Rima Glottidis :



muscles of the Larynx (Allms 2016) :

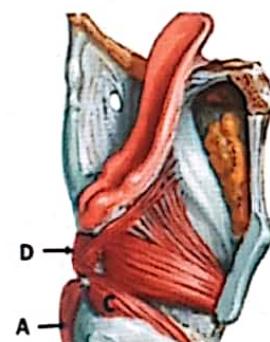
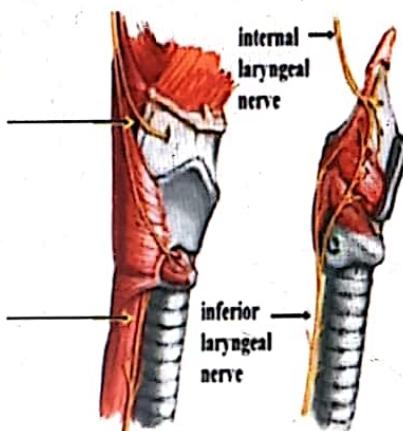


Active space

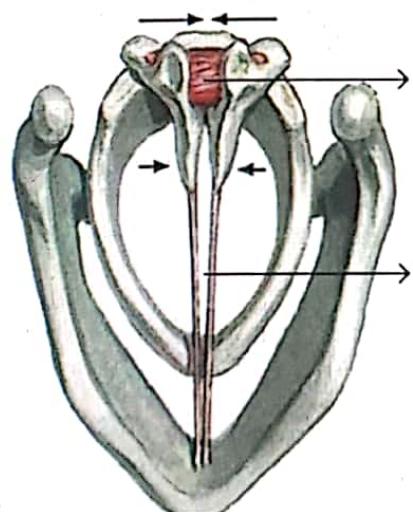
## Nerve supply of larynx

Internal Laryngeal Nerve

Inferior Laryngeal Nerve



## Adduction of Larynx:



Transverse arytenoid muscle brings about adduction of intercartilaginous part of Rima Glottidis.

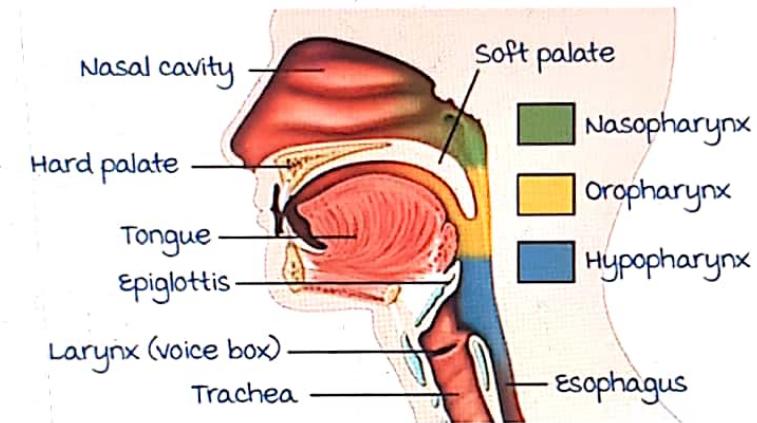
Lateral cricoarytenoid muscle brings about adduction of intermembranous part of Rima Glottidis.

# PHARYNX

**Extent** — Base of skull to lower border of cricoid cartilage

**Subdivisions :**

- Nasopharynx
- Oropharynx
- Laryngopharynx



## Nasopharynx

00:01:09

**Anterior wall** : Deficient

Has an opening — **Choana**, that connects nasopharynx with the nasal cavity.

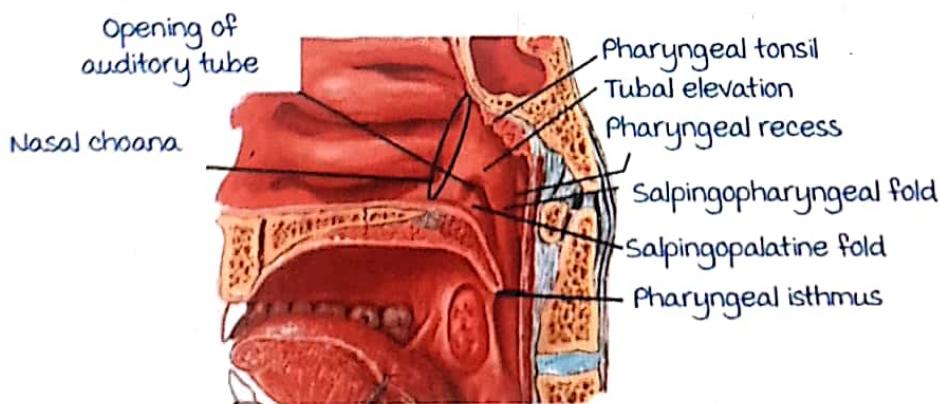
**Posterior wall** : Sphenoid

Occipital

C1 vertebra

**Floor** : Soft palate

Pharyngeal isthmus (space between soft palate & posterior pharyngeal wall)



Active space

**Passavant's ridge:**

Upper fibres of palatopharyngeus

+

Upper fibres of superior constrictor



(palatopharyngeus > superior constrictor)

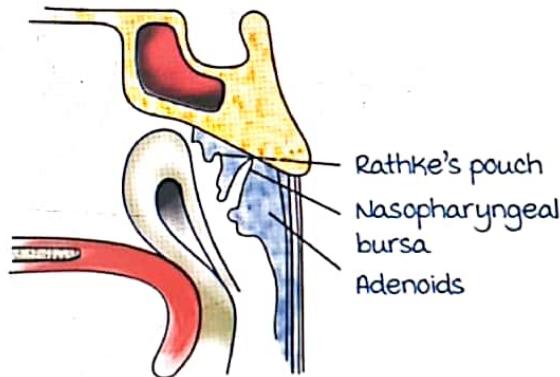
"U" shaped ridge in the posterior pharyngeal wall called the Passavant's ridge

During swallowing, pharyngeal isthmus is closed by

- Elevation of soft palate
- Forward pulling of passavant's ridge

**Features of nasopharynx**

00:06:30

**Roof / Posterior wall**

- Lymphocytic aggregation called as **adenoid** / nasopharyngeal tonsil.
- **Nasopharyngeal bursa** — mucus diverticulum extending into adenoid
- **Rathke's pouch** — above the nasopharyngeal bursa giving rise to **adenohypophysis** or anterior pituitary

**Lateral wall**

- Opening of auditory tube — 1.25 cm behind inferior turbinate
- Tubal elevation is present above and behind it.

**Fossa of Rosenmüller** : Pharyngeal recess behind the tubal elevation.

**Salpingopalatine fold** & **Salpingopharyngeal fold** are 2 elevations extending downwards

## Oropharynx

00:10:56

Anterior wall — communicates with oral cavity

Posterior wall — C2 C3 vertebrae

Roof — soft palate

Floor — Posterior 1/3<sup>rd</sup> of tongue

Lateral wall — Tonsillar fossa

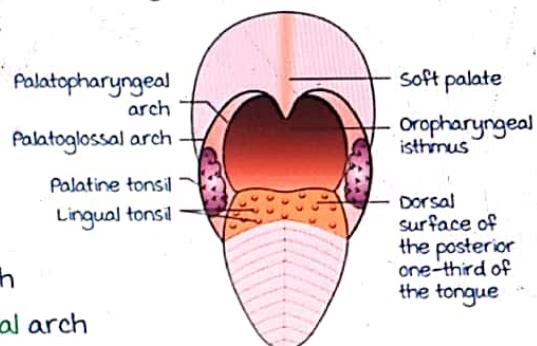
**Boundaries of Tonsillar fossa:**

Anterior pillar — palatoglossal arch

Posterior pillar — palatopharyngeal arch

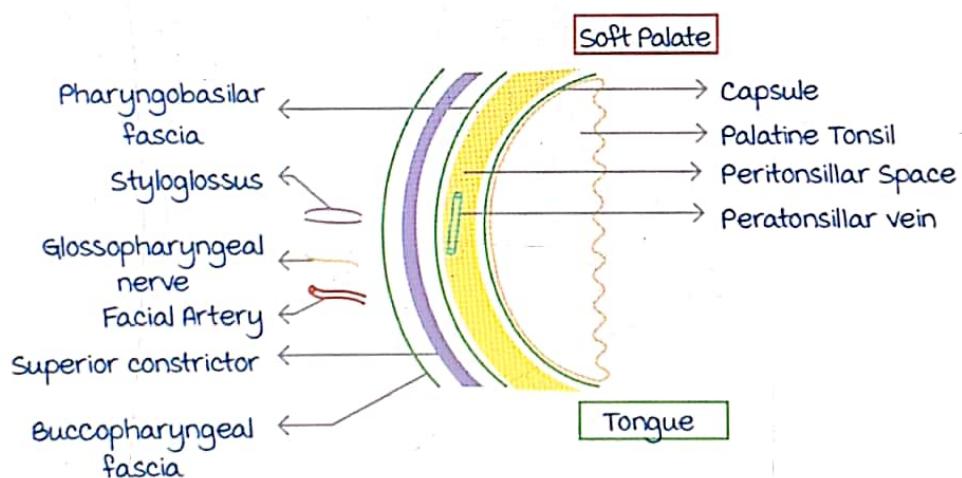
Above — Soft palate

Below — Posterior 1/3<sup>rd</sup> of tongue



## Relations of tonsil

00:13:28



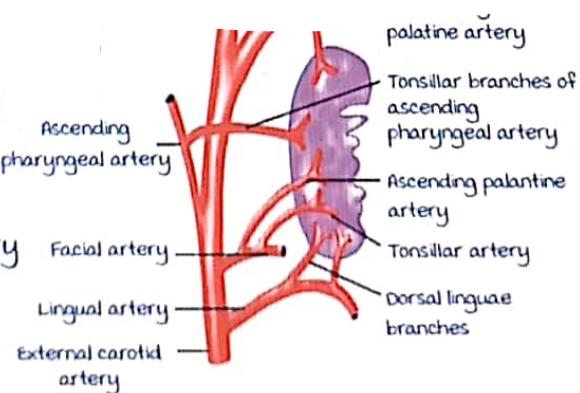
Common infections : Peritonsillar space infection — 'Quinsy'

Source of haemorrhage in tonsillectomy

procedure : Paratonsillar vein

Blood supply of tonsil :

- Facial artery — principal artery of tonsil
- Lingual artery
- Ascending palatine artery
- Ascending pharyngeal artery
- maxillary artery



Lymphatics of palatine tonsil — Jugulodigastric node Principal node

## Laryngopharynx

00:20:23

Situated behind laryngeal inlet & posterior wall of larynx

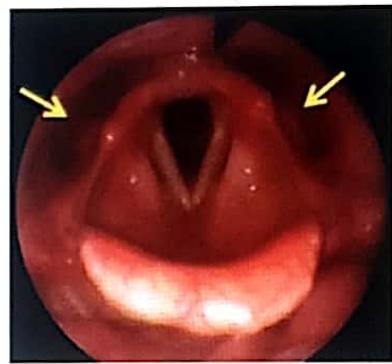
Extent — upper border of epiglottis to lower border of cricoid

Communicates anteriorly with laryngeal cavity through laryngeal inlet.

Depression in the lateral wall of hypopharynx is pyriform fossa.

### Pyriform fossa

- Boundaries :
  - medially — Aryepiglottis fold
  - Laterally — mucous covering the lamina of thyroid cartilage.
- Also called as fish bone area or Smuggler's pouch
- Sensory supply — Internal laryngeal nerve > superior laryngeal nerve



Pyriform fossa  
(2020 June Allims)

## Coverings of pharynx

00:24:42

From inside to outside

- mucosa
  - Submucosa
- Pharyngobasilar fascia is thickening of submucosa.  
median fibrous raphe is the thickening of pharyngobasilar fascia.
- Constrictors are inserted into median raphe.
- muscular layer :
    - Inner longitudinal muscles
    - Outer circular muscles
  - Buccopharyngeal fascia

## Constrictors of pharynx

00:27:51

- Superior constrictor
- middle constrictor
- Inferior constrictor

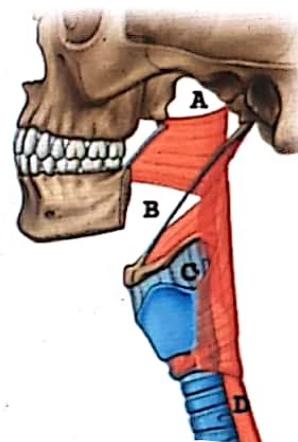
## Structures passing between constrictors

### A. Sinus of Morgagni :

- Auditory tube
- Levator palatini muscle
- Ascending palatine artery
- Palatine branch of ascending pharyngeal artery
- Tensor palatini (last choice)

### B. Between superior and middle constrictor :

- Stylohyoid ligament
- 9th cranial nerve (Glossopharyngeal)
- Stylopharyngeus muscle  
(2019 JIPMER)



### C. Between middle and inferior constrictor :

- Internal laryngeal nerve
- Superior laryngeal vessels

### D. Below inferior constrictor :

- Recurrent laryngeal nerve
- Inferior laryngeal vessels

## Longitudinal muscles of pharynx

00:35:04



A. Salpingopharyngeus muscle

B. Palatopharyngeus muscle

C. Stylopharyngeus muscle

## Nerve supply of larynx

- Sensory + motor supply — **Pharyngeal Plexus**
- All muscles supplied by pharyngeal plexus except stylopharyngeus.
- Stylopharyngeus supplied by IX nerve (glossopharyngeal)

Active space

## Killian's dehiscence

00:36:42

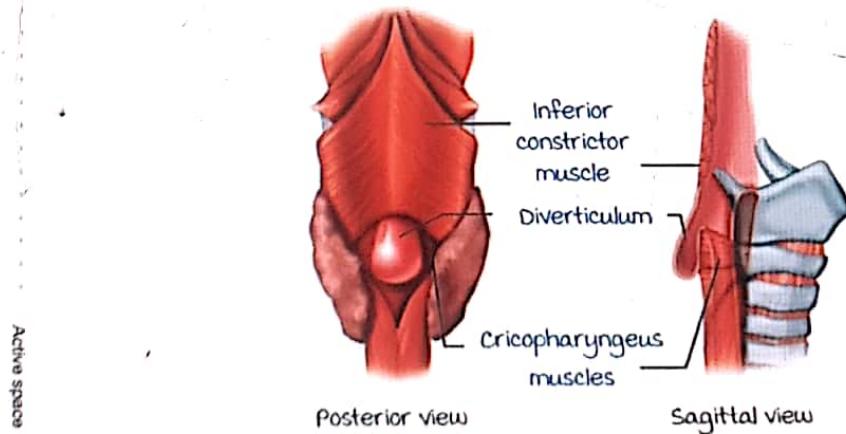
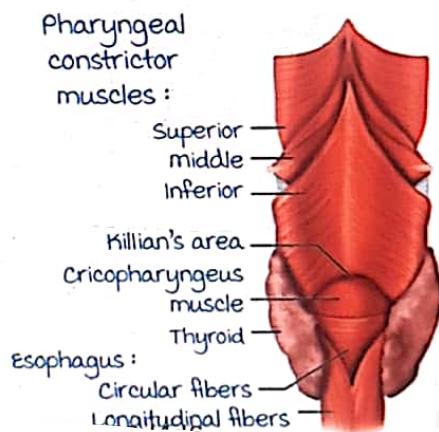
### Inferior constrictor

- Thyropharyngeus (TP)
- Cricopharyngeus (CP)

**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

The **triangular space** between TP and CP is Killian's area.  
muscular incoordination – mucous diverticulum called **Zenker's diverticulum**.

### Zenker's Diverticulum Anatomy



# LYMPHATIC AND VENOUS DRAINAGE OF HEAD AND NECK

## Lymph Nodes in the Head and Neck and Waldeyer's Ring

00:00:05

The lymph nodes in the head and neck are broadly divided into :

- Peripheral nodes.
- Deep cervical nodes.

Peripheral Nodes :

Outer Circle :

- Situated at the junction of head and neck.
- Has the following Lymph Nodes :
  - Submental nodes
  - Submandibular nodes
  - Pre-auricular nodes
  - Post-auricular nodes
  - Occipital nodes

Inner Circle :

- Situated deep to investing layer of Deep Cervical fascia.
- Waldeyer's ring lies deep to the inner circle.
- Inner circle has the following groups of lymph nodes :
  - Prelaryngeal nodes.
  - Pretracheal nodes.
  - Retropharyngeal nodes

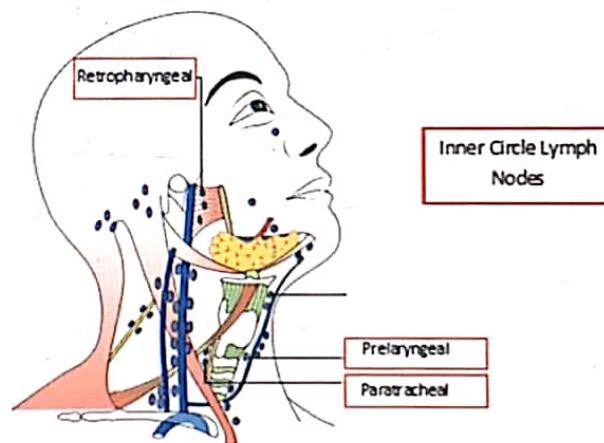
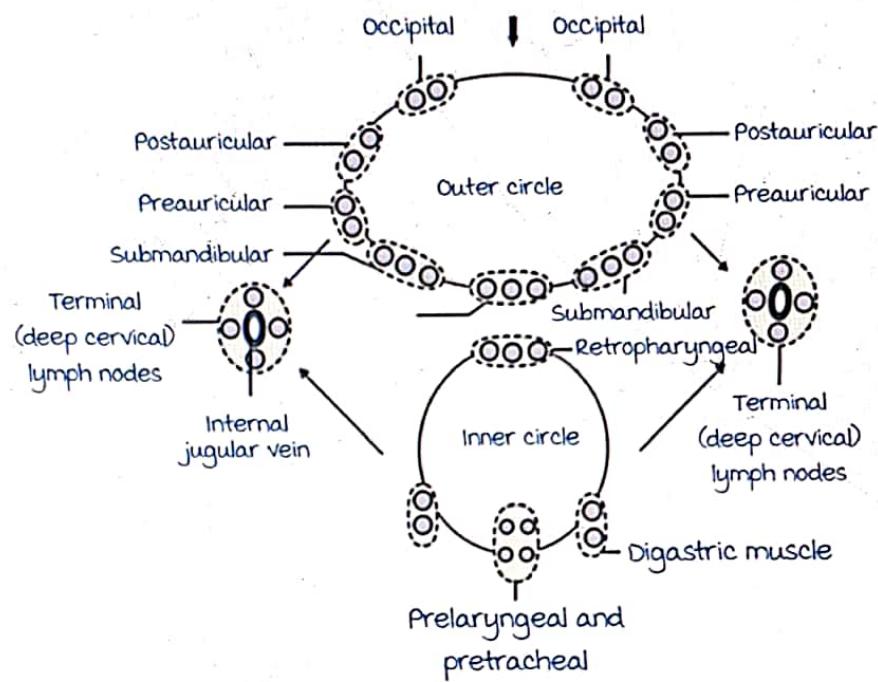
Deep Cervical nodes :

Deep cervical nodes are the final area of drainage.

It includes the following groups of lymph nodes :

- Jugulodigastric nodes
- Jugulo-omohyoid nodes.

Active space



Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

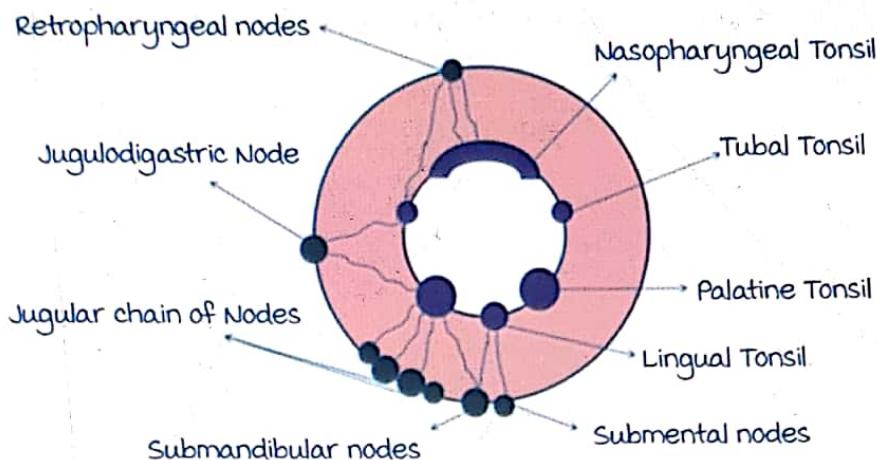
### Waldeyer's Ring:

Waldeyer's ring is situated deep to inner circle of lymph nodes.

It is a submucosal lymphatic aggregation surrounding the oral and nasal passage.

Waldeyer's ring constitutes of:

- Anterior : Lingual tonsil.
- Anterolateral : Palatine tonsils.
- Posterolateral : Tubal tonsil
- Posterior : Nasopharyngeal tonsil (Adenoids).



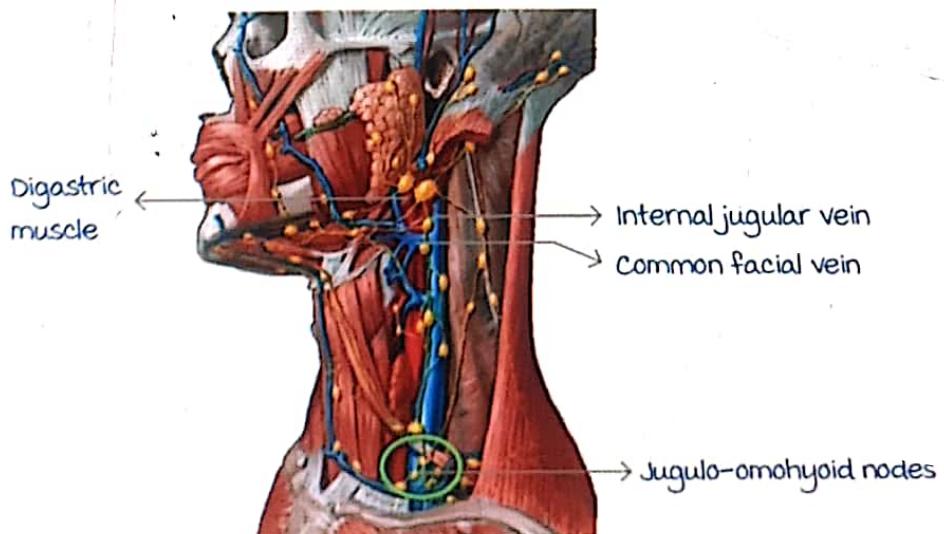
### Deep Cervical Nodes

#### Jugulodigastric nodes

- Jugulodigastric nodes are the principal nodes for the tonsils.
- Location: In the triangular interval between:
  - Internal Jugular Vein
  - Common Facial vein
  - Digastric muscle

#### Jugulo-omohyoid nodes

- Jugulo-omohyoid nodes are the principal nodes for tongue.
- Location: Related to Intermediate tendon of Omohyoid muscle.



## Levels of Lymph Nodes

00:08:17

There are 7 levels of lymph nodes of the head and neck.

Level Ia : Submental nodes.

Level Ib : Submandibular nodes.

Level II : upper Jugular nodes (Behind upper part of Sternocleidomastoid).

Level III : mid Jugular nodes (Behind middle part of Sternocleidomastoid).

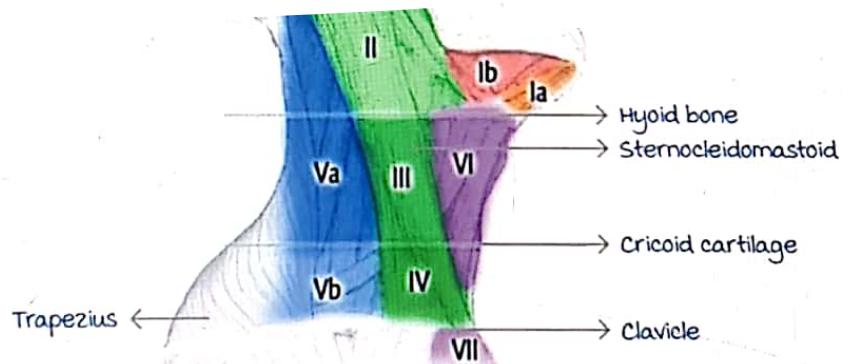
Level IV : Lower Jugular nodes (Below lower part of Sternocleidomastoid).

Level V : Posterior triangle of neck lymph nodes (between Sternocleidomastoid and Trapezius).

Level VI : Nodes present between hyoid bone and clavicle (Allims 2018).

Level VII : mediastinal nodes.

**Applied :** The levels of lymph nodes can be used to assess the spread of cancers and to formulate treatment plans.



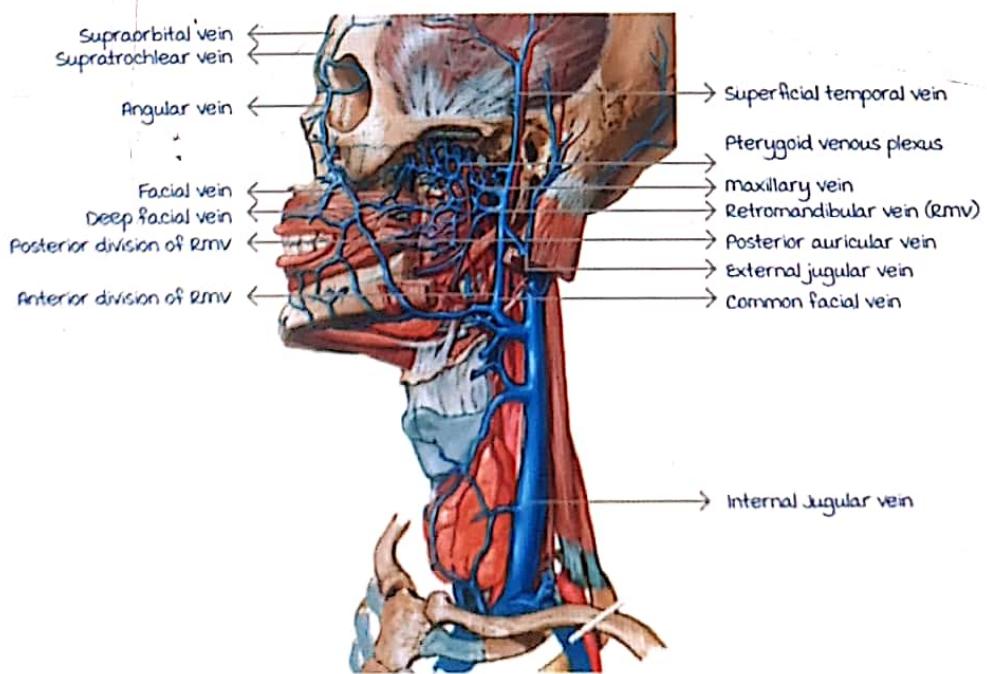
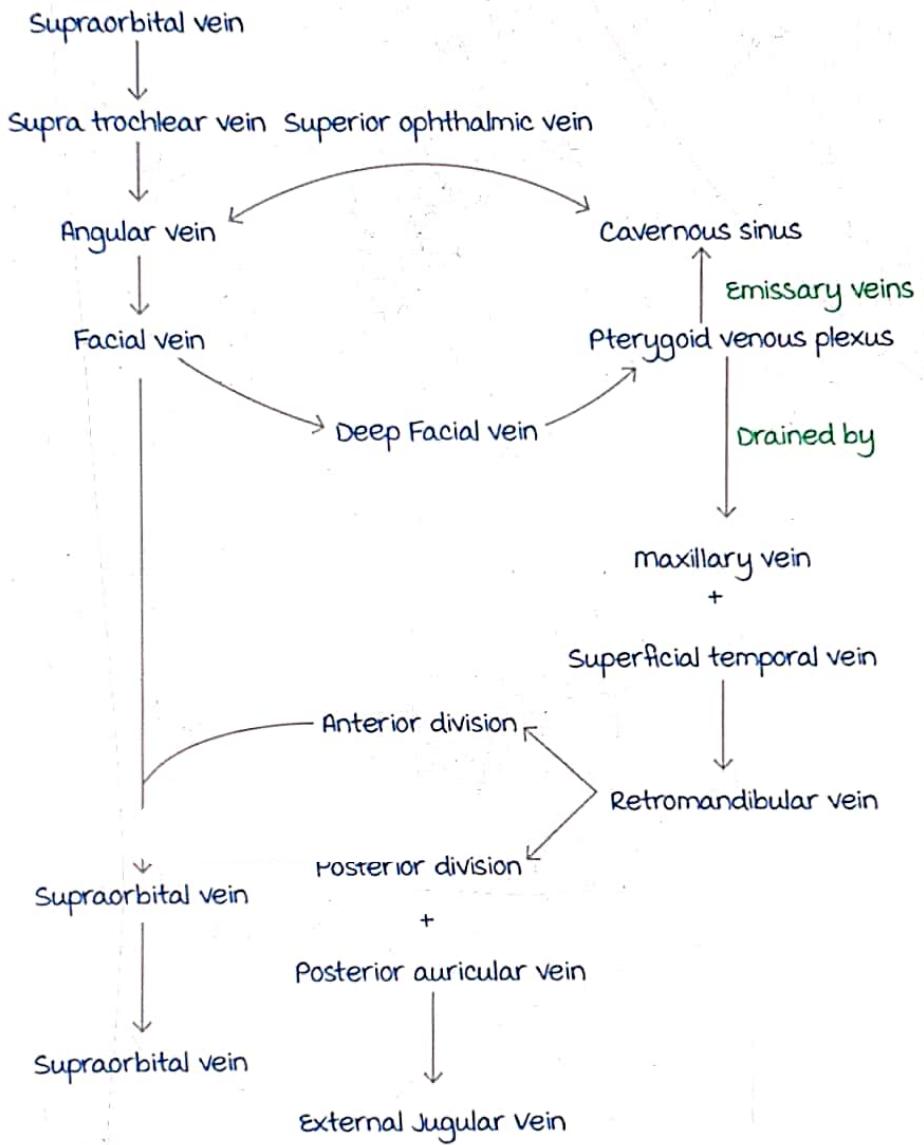
## Venous drainage of the Head and Neck

00:11:28

Superior ophthalmic vein acts both as a tributary and communicating channel between Cavernous sinus and Angular vein.

The facial vein communicates with the cavernous sinus via 2 routes :

1. Superior ophthalmic vein : m/c communicating channel.
2. Deep facial route.



Active space

## Internal Jugular Vein

00:18:04

Transverse sinus continues as sigmoid sinus.

Sigmoid sinus passes through jugular foramen and continues as Internal Jugular Vein (IJV).

Tributaries of IJV :

- The first tributary of IJV is Inferior Petrosal Sinus and not a vein.
- Pharyngeal vein.
- Common facial vein
- Lingual vein
- Superior thyroid vein
- middle thyroid vein

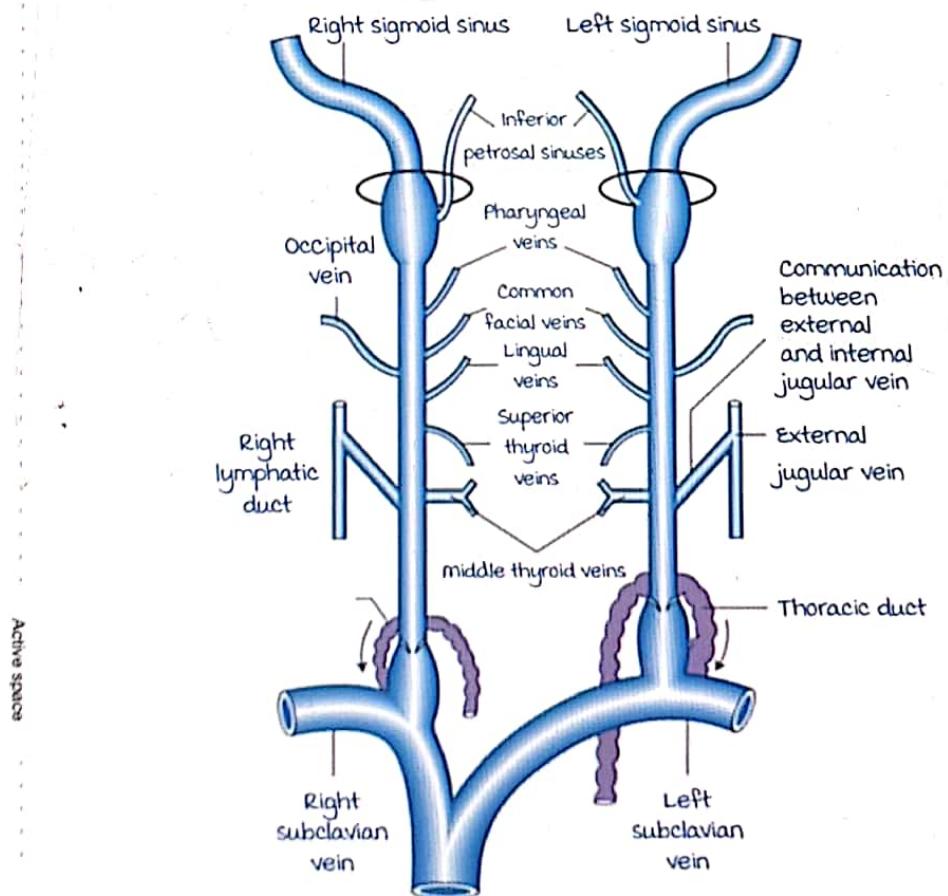
Inferior petrosal sinus connects cavernous sinus and IJV.

Inferior thyroid vein drains into brachiocephalic vein and is not a tributary of IJV.

Thoracic duct drains into angle between left subclavian and left IJV.

IJV joins subclavian vein and forms Brachiocephalic vein.

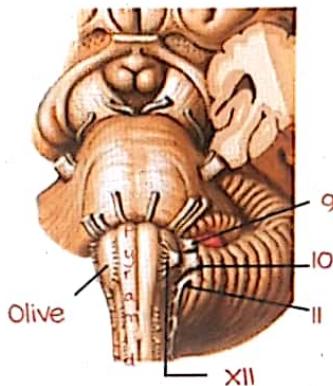
Both brachiocephalic veins join together and form Superior vena cava.



## CRANIAL NERVES IX, X, XI, XII

The 9th, 10th, 11th cranial nerves emerge lateral to olive.

The 12th cranial nerve emerges in between the pyramid and olive.



### Glossopharyngeal nerve/9th nerve

00:00:58

The functional components are :

1. SVE [special visceral efferent] - supplies third arch muscle  
↓  
**stylopharyngeus muscle**
  2. GVE [general visceral efferent] - secretions from parotid gland
  3. SVA [special visceral afferent]
  4. GVA [general visceral afferent]
  5. GSA [general somatic afferent] - proprioceptive fibres from  
**stylopharyngeus muscle.**
3. SVA [special visceral afferent]      4. GVA [general visceral afferent] } carries general sensation + taste sensation  
From posterior 1/3rd of the tongue

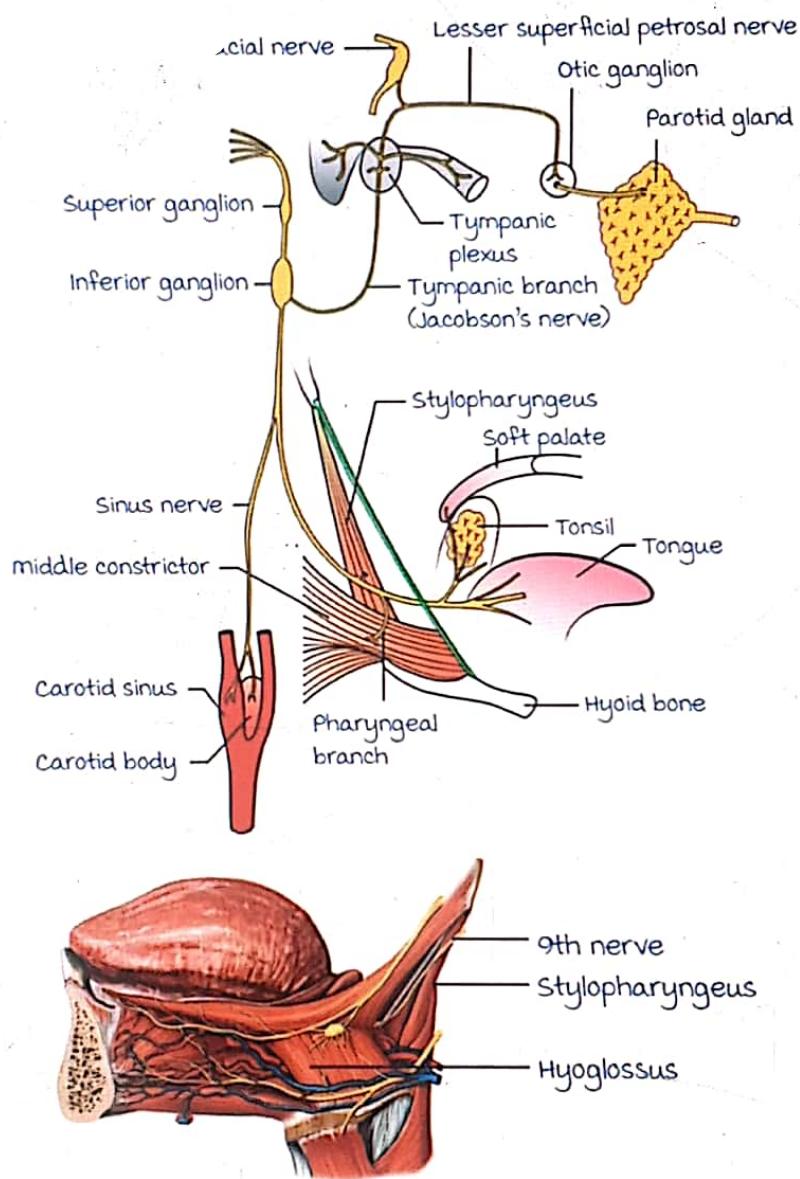
The course of 9th nerve :

- It emerges lateral to olive
- ↓
- It leaves the cranial cavity through jugular foramen
- ↓
- Contains 2 **ganglia** - superior and inferior [cell bodies of sensory neurons]
- ↓
- It crosses internal carotid artery and reaches
- ↓
- Posterior border of stylopharyngeus and supplies the muscle
- ↓
- It passes **between** the superior and middle constrictors along with Stylopharyngeus muscle

Active space

Related to medial side of hyoglossus

Reach posterior 1/3rd of tongue and gives general & taste sensation.



### Branches of the 9th nerve

00:07:27

1. meningeal branch - posterior cranial fossa.
2. Tympanic branch/ Jacobson's nerve - contributes to tympanic plexus.
3. Sinus branch - carotid sinus & body.
4. muscular branches - to stylopharyngeus muscle.
5. Pharyngeal branch - contributes to pharyngeal plexus.
6. General and taste sensation fibres - to posterior 1/3rd of tongue.

### Tympanic plexus

It is formed by :

1. Tympanic branch of 9th cranial nerve.
2. Carotid tympanic nerve.

Course of Tympanic plexus :



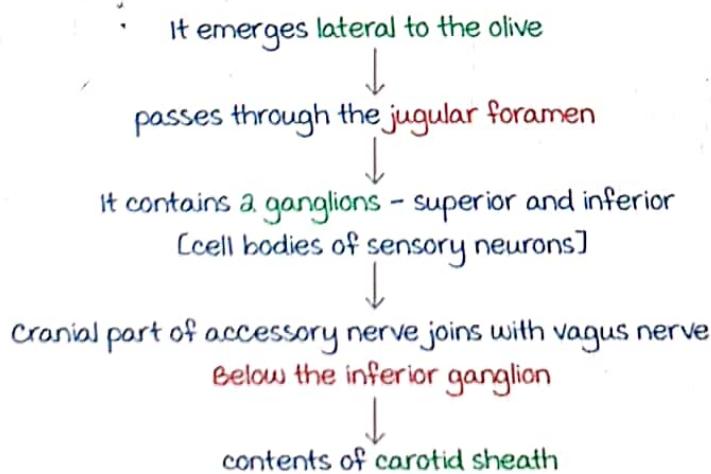
### Vagus nerve/10th nerve

00:10:20

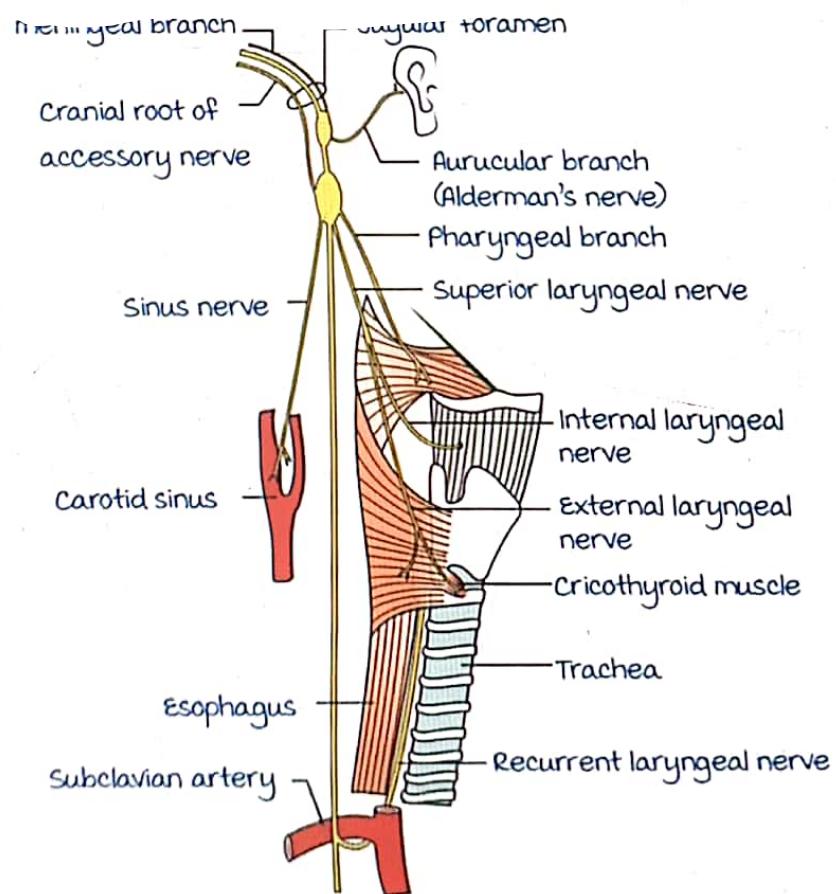
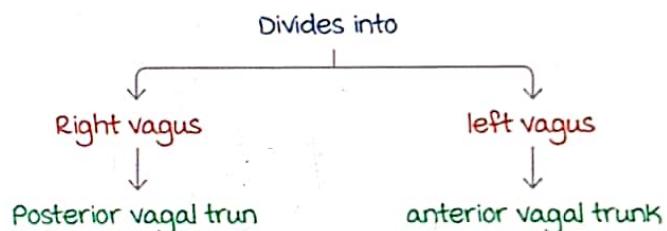
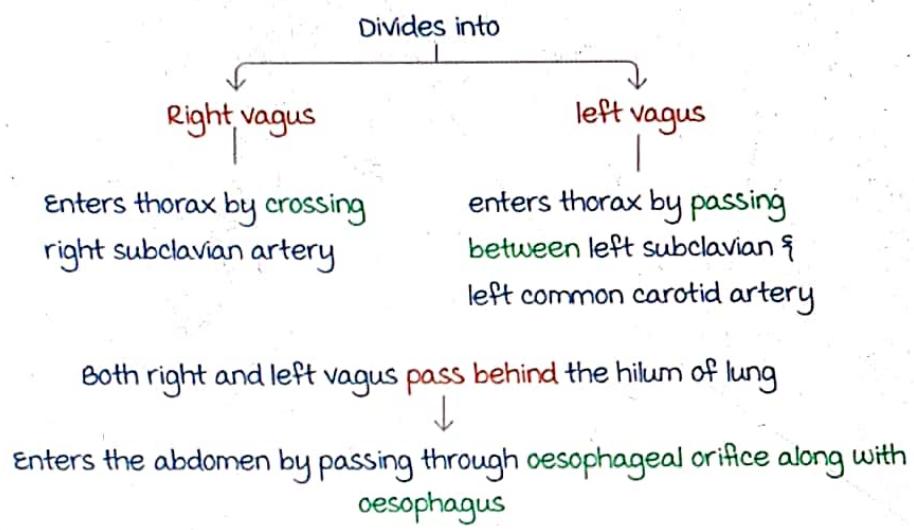
The functional components are :

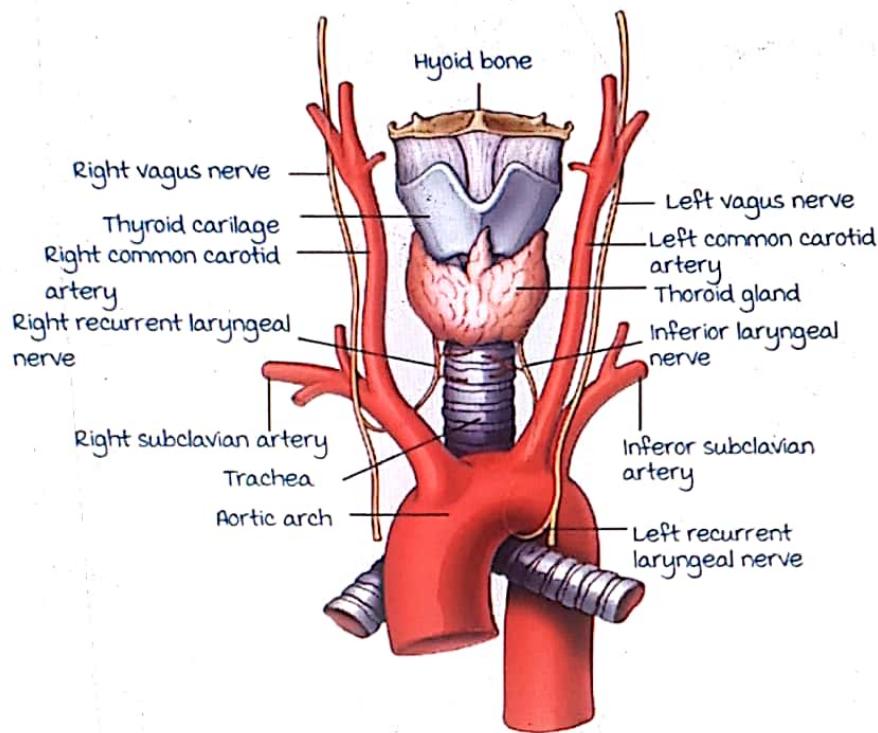
1. SVE - supplies muscles of palate, pharynx, larynx
2. GVE
3. GVA } carries general and taste sensation from
4. SVA } posterior most part of tongue.
5. GSA - carries general sensation

The course of 10th nerve :



Active space



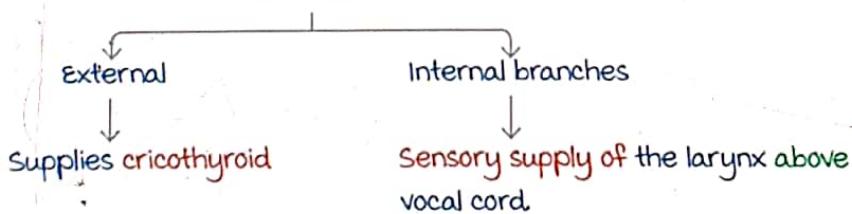


### Branches of the 10th nerve

00:16:13

1. meningeal branch
2. Pharyngeal branch - contributes to pharyngeal plexus
3. Auricular branch / Alderman's branch
4. Sinus branch - carotid sinus & body
5. Superior laryngeal nerve

Divided into



#### 6. Recurrent laryngeal nerve :

Right RLN wind around the right SCA  
Left RLN wind around arch of aorta

↓  
It enters the tracheoesophageal groove.

Function - it is a mixed nerve.

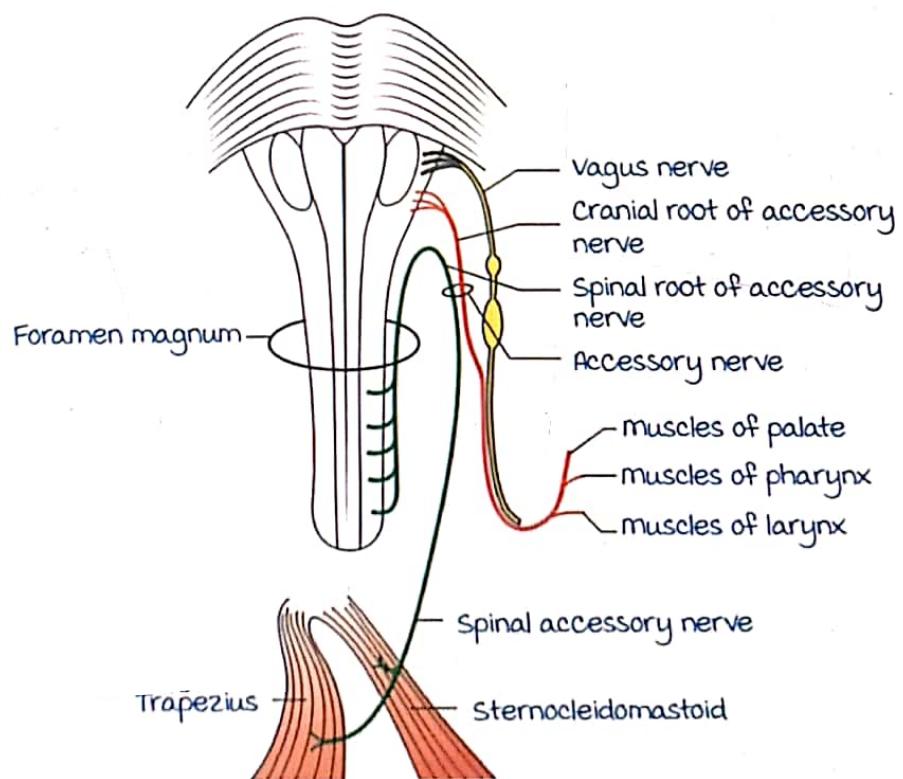
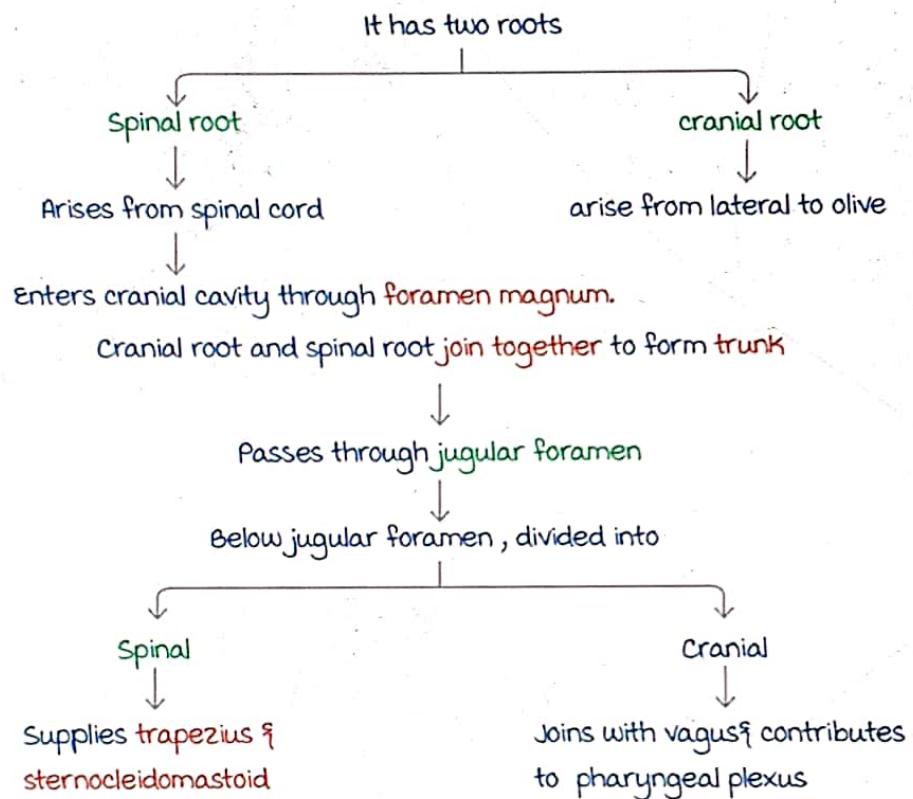
motor to all larynx muscle except cricothyroid

Sensory supply to larynx below the vocal cord

7. Superior and inferior cardiac branches- supplies heart.
8. Superior and inferior cervical cardiac branches - contributes to cardiac plexus.

Accessory nerve/11th nerve

00:20:51



Hypoglossal nerve/12th nerve

00:25:21

It emerges between pyramid and olive

↓  
It leaves cranial cavity through **hypoglossal canal**

↓  
It is a content of **carotid sheath**

↓  
Crosses internal and external artery, loop of lingual artery

↓  
Reach the **posterior border of hyoglossus muscle**

↓  
Passes on the **lateral surface of hyoglossus**

↓  
**Reaches tongue and supplies the tongue muscles.**

**Branches :**

1. meningeal branch
2. Fibres from C1 through 12th nerve supplies **geniohyoid**  
**Thyrohyoid**
3. Supplies all the tongue muscle except **palatoglossus**

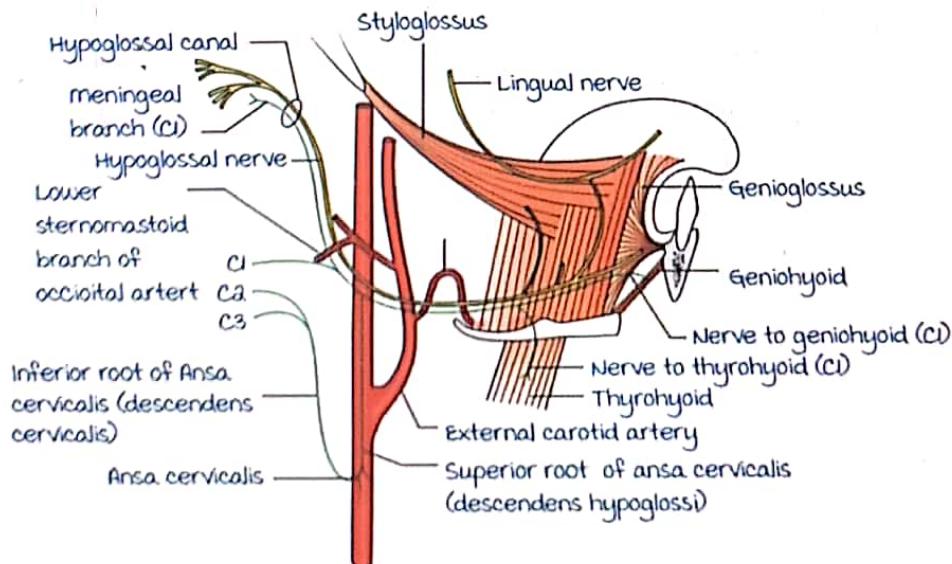
**Features of 12th nerve injury :**

**Ipsilateral tongue atrophy**

**Deviation of the tongue towards the same side/ipsilateral side of lesion.**

The geniohyoid and thyrohyoid muscles are also paralysed.

The larynx deviates to the **normal side**.



Active space

# NEUROANATOMY BASICS

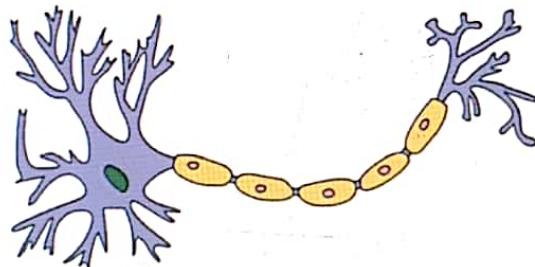
## Neuron

00:00:30

Parts of neuron:

- Cell body
- Axon

nucleus	ganglion
Aggregation of cell bodies in central nervous system (CNS)	Aggregation of cell bodies in peripheral nervous system (PNS)
Derived from neuroectoderm	Derived from neural crest cells



The nucleus is also called grey matter.

The axons are also called white matter/fasciculus/lemniscus.

The collection of axons in CNS is called the tract.

The collection of axons in PNS is called the nerve.

## Glial cells

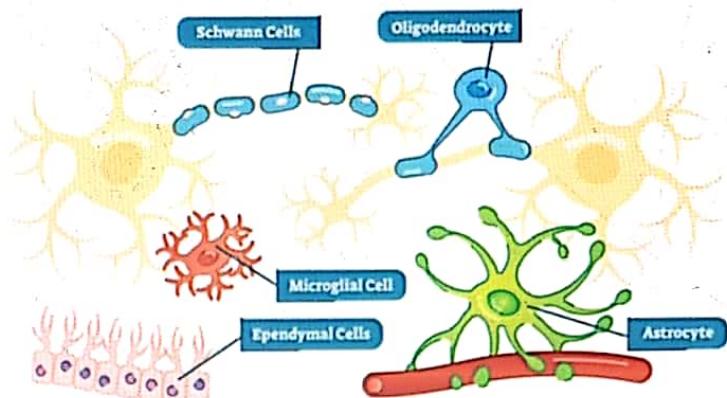
00:03:45

They are the supporting cells.

cells	Function	Derived from
Astrocytes	Blood brain barrier	neuroectoderm
microglial cells	Phagocytic cells	mesodermal derivative
Oligodendrocytes	myelin sheath formation in CNS (NMHANS 2019)	neuroectoderm
Schwann cells	myelin sheath formation in PNS	Neural Crest cells
Ependymal cells	Lining of ventricles	neuroectoderm

Active space

## Glial Cells



Active space

# CSF AND VENTRICLES

## Cerebrospinal fluid (CSF)

00:00:03

Clear, colourless fluid.

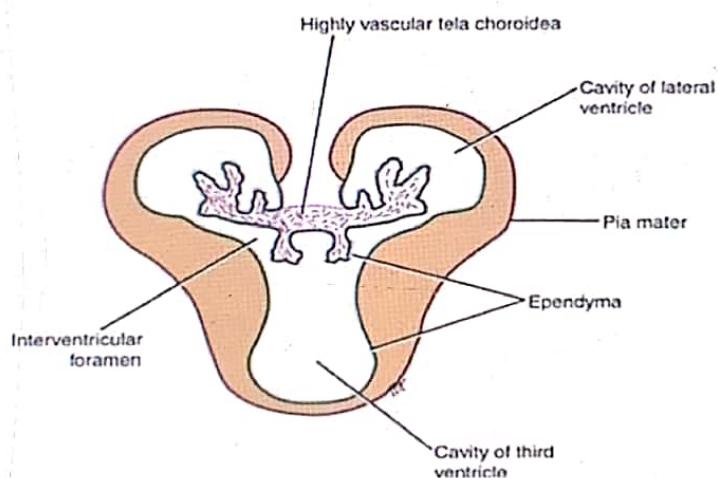
Not an **ultrafiltrate** of blood.

Secreted actively by choroid plexus (majorly).

Minor contributors of CSF secretion

- Ependymal cells lining ventricle.
- Brain substance, through perivascular space.

Schematic diagram of a coronal section of the third and lateral ventricles at the site of the interventricular foramina showing the structure of the tela choroidea and its relationship with the ependyma and pia mater



Tela choroidea – ependyma enclosing the tuft of capillaries.

Choroid plexus – aggregation of tela choroidea.

Choroid plexus of lateral ventricle and 3rd ventricle is derived from –

- Anterior choroidal artery (branch of internal carotid artery).
- Posterior choroidal artery (branch of posterior cerebral artery).

Choroid plexus of 4th ventricle is derived from –

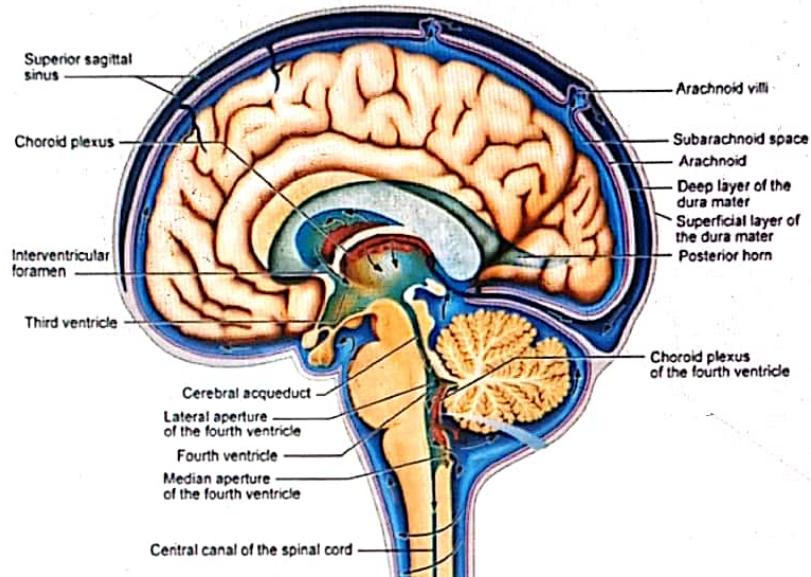
- PICA (posterior inferior cerebellar artery).
- AICA (anterior inferior cerebellar artery)
- **PICA > AICA.**

CSF production rate (as per GRAYS) – 600 to 700 ml/day.

CSF production rate (as per GUYTON) – 500 to 600 ml/day.

(500-600ml/day > 600-700ml/day)

Active space



## CSF circulation

00:05:12

Produced in - choroid plexus of lateral ventricles

↓ Foramen of monro

III<sup>rd</sup> ventricle

↓ Cerebral aqueduct of Sylvius

IV<sup>th</sup> ventricle

(minimal amount)

Central canal spinal cord

(major amount)

Subarachnoid space

IV<sup>th</sup> ventricle to subarachnoid space

(1 median aperture)

Foramen of magendie

Cisterna magna

(2 lateral apertures)

Foramen of Luschka

Cerebellopontine cistern

via arachnoid villi

Drains into dural venous sinus (majorly into superior sagittal sinus)

## Meningeal spaces

00:11:03

Bridging veins - drains the cerebral veins into dural venous sinus.

Epidural space - space between skull and endosteal layer; contains middle meningeal artery.

Sub dural space – space between arachnoid membrane and pia mater; contains bridging veins.

Dural venous sinus – space between layers of dura mater; contains venous blood.

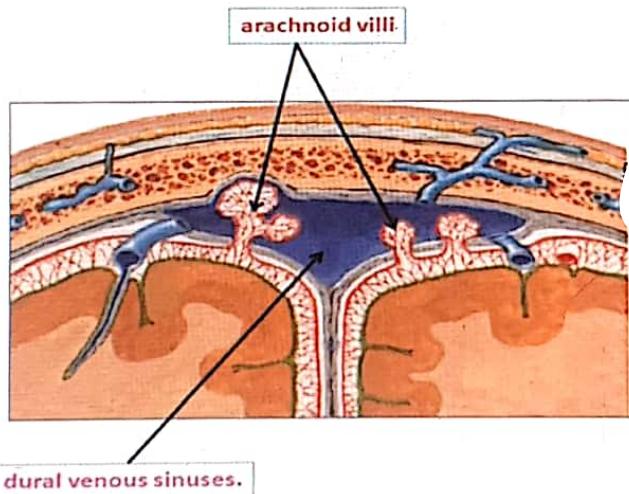
Lucid interval → Epidural haemorrhage > Subdural haemorrhage

## Arachnoid villi

00:08:26

Arachnoid villi –

- major site for absorption of CSF.
- Prevents entry of venous blood into subarachnoid space, acting as a valve.
- Hypertrophied arachnoid villi are known as arachnoid granulations or, pacchionian bodies.

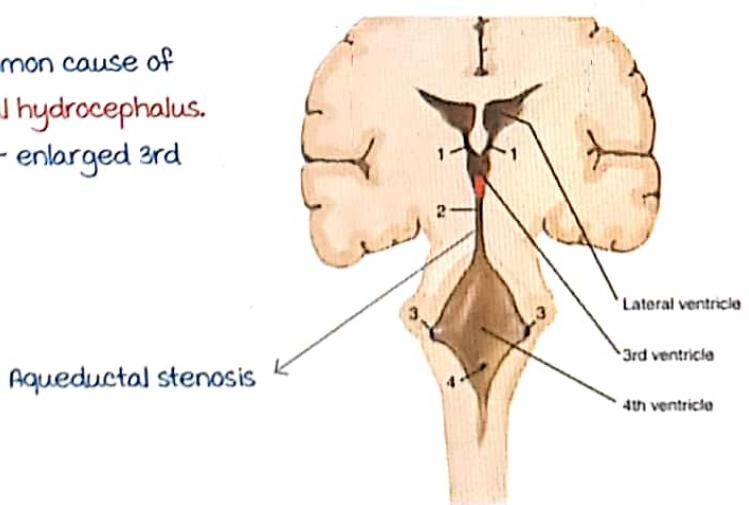


## Congenital aqueductal stenosis :

00:22:43

most common cause of congenital hydrocephalus.

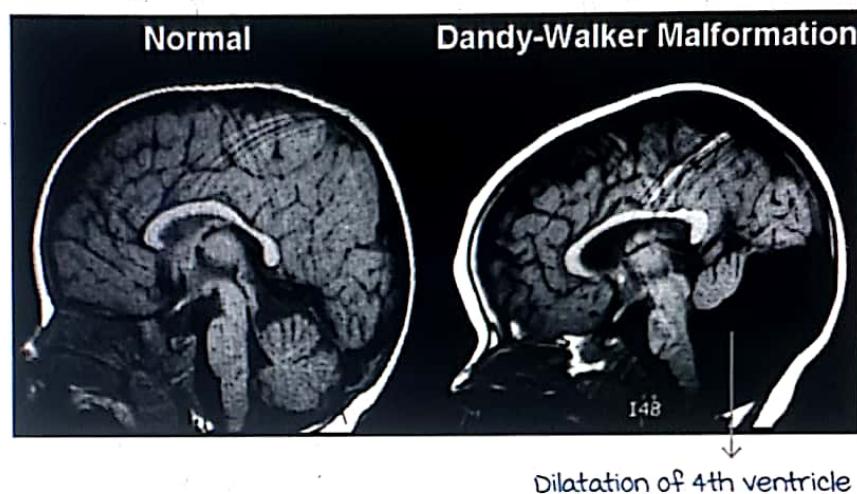
Feature – enlarged 3rd ventricle.



Atresia of foramen of Magendie and foramen of Luschka.

Seen in Dandy - Walker syndrome.

Cause - cyst in posterior cranial fossa.



Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

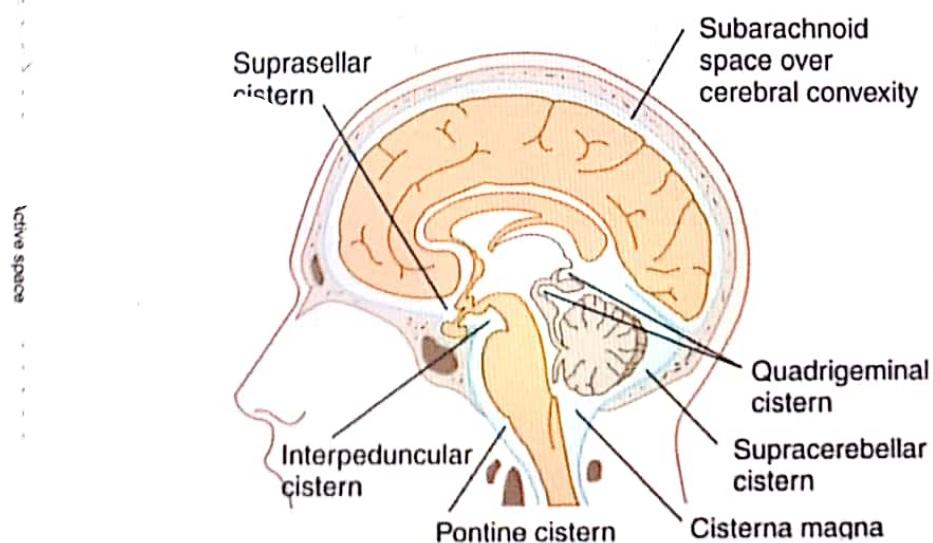
## Cistern

00:25:21

Cistern is an enlarged subarachnoid space.

Types

- Interpeduncular cistern.
- Cisterna magna.
- Quadrigeminal cistern.
- Pontine cistern.
- Sylvian cistern.



Interpeduncular cistern:

Site - base of brain.

Content - circle of Willis.

Cisterna magna:

Also known as cerebello-medullary cistern.

Site - between cerebellum and medulla.

Content - vertebral artery, PICA, 9thCN, 10thCN, 11thCN and 12thCN.

Quadrigeinal cistern:

Also known as ambient cistern.

Site - between splenium of corpus callosum and cerebellum.

Content - great cerebral vein of Galen.

Pontine cistern:

Site - ventral surface of pons.

Content - basilar artery.



Sylvian cistern:

Site - over lateral sulcus.

Content - middle cerebral artery, superficial and deep middle cerebral vein.

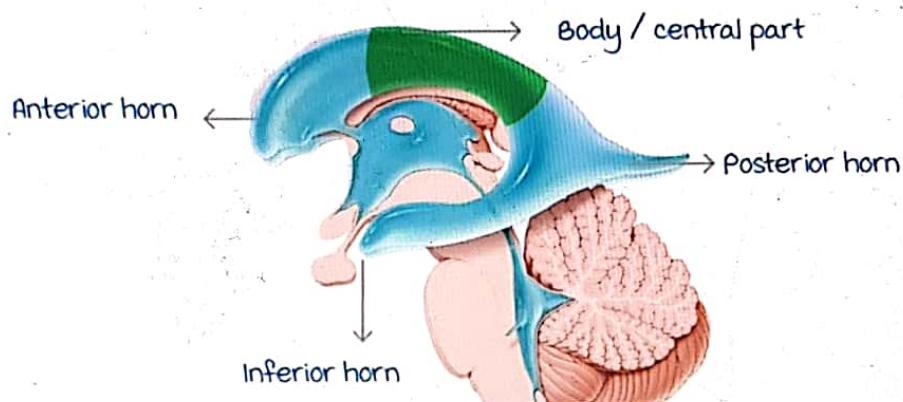
## Lateral ventricle

00:30:53

It's a cavity present inside the cerebrum.

Parts	Site
Body / central part	Parietal lobe
Anterior horn	Frontal lobe
Posterior horn	Occipital lobe
Inferior horn	Temporal lobe

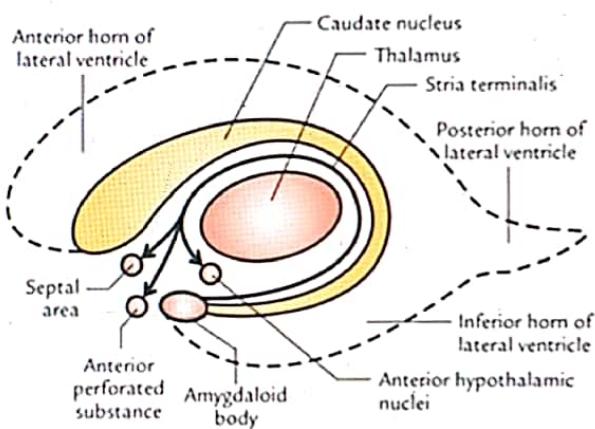
Active space



**Relation of caudate nucleus:**

Head of caudate nucleus – floor of anterior horn.

Tail of caudate nucleus – roof of inferior horn.



### Relations of lateral ventricle

00:34:58



**Relation of anterior horn:**

Anterior wall – genu and rostrum of corpus callosum.

Roof – body of corpus callosum.

medial wall – septum pellucidum.

Floor – caudate nucleus.

Relation of body/central part:

Roof - body of corpus callosum.

Floor - fornix of thalamus and caudate nucleus.

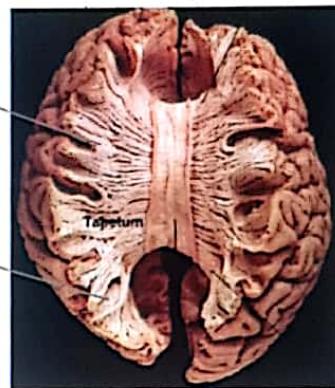
medial wall - septum pellucidum.

Relation of posterior horn:

Roof and lateral wall - **tapetum** ←

fibre (fibres from body and splenium of corpus callosum).

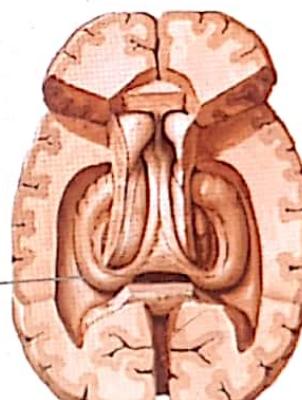
medial wall - **forceps major** and, anterior part of **calcarine sulcus**.



Relation of inferior horn:

Roof - tail of caudate nucleus.

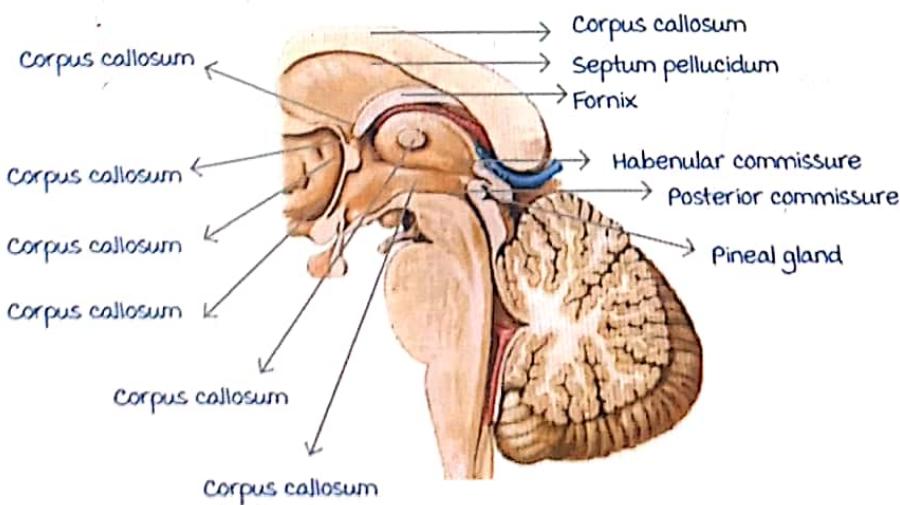
Floor - hippocampus. ←



### III ventricle

00:44:57

It's a cavity of diencephalon.



Lateral wall :

Thalamus and hypothalamus.

Anterior wall :

Anterior columns of fornix.

Anterior commissure (1<sup>st</sup> commissure to develop).

Lamina terminalis (circumventricular organ, has no blood brain barrier).

Posterior wall :

Pineal gland (circumventricular organ, has no blood brain barrier).

Habenular commissure.

Posterior commissure.

Floor :

Optic chiasma.

Infundibulum.

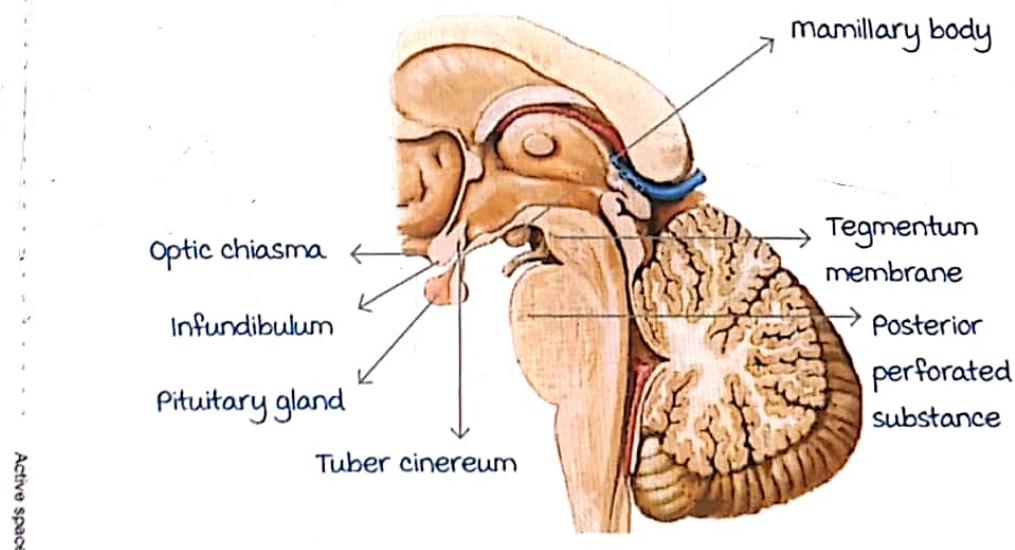
Pituitary gland.

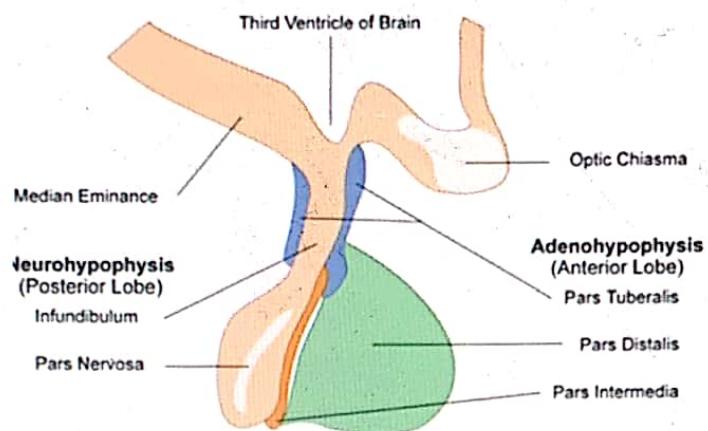
Tuber cinereum.

mamillary body.

Posterior perforated substance.

Tegmentum membrane.





NOTE : Fornix contains association fibres (A), commissural fibres (C), and projection fibres(P).

A>C>P

(June 2020 AIIMS)

A > C > P

## Circumventricular organs

00:55:10

- Lamina terminalis.
- Pineal gland.
- median eminence.
- Pars nervosa (pituitary).
- Area postrema (in the floor of IV<sup>th</sup> ventricle).

Has no blood brain barrier.

## IV ventricle

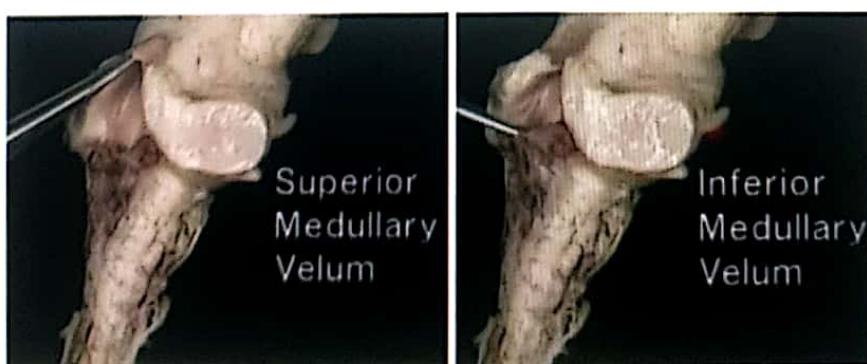
01:00:54

It's a cavity between cerebellum, pons and medulla.

Roof:

Superior medullary velum (above).

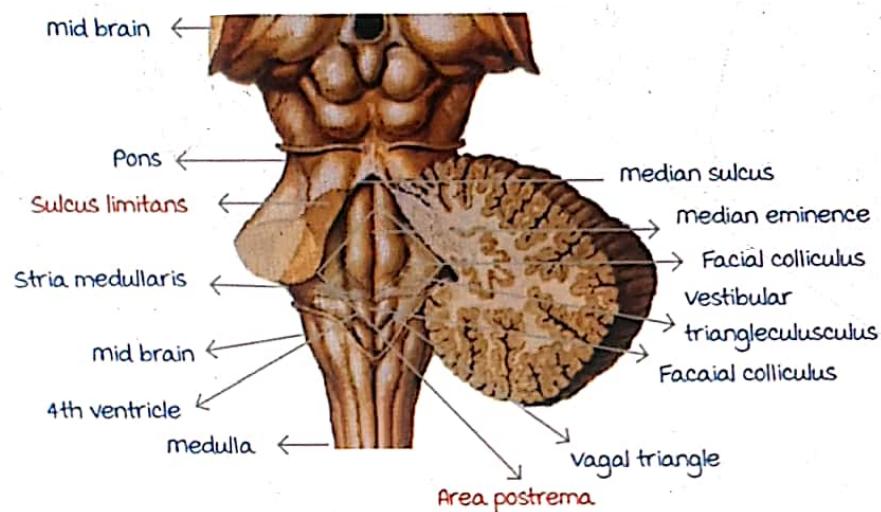
Inferior medullary velum (below).



Floor

Lower part of pons.

Upper part of medulla.

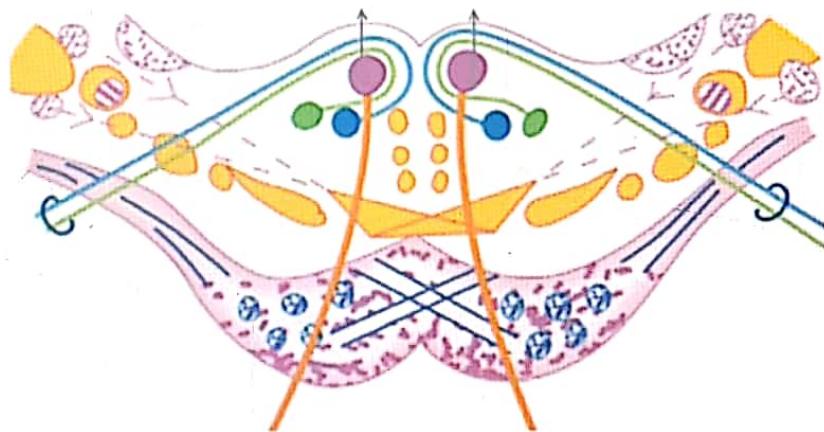
**Facial colliculus**

01:11:11

Structures affected in damage to facial colliculus

VII<sup>th</sup> nerve > VI<sup>th</sup> nerve (2016 AIIMS)

Facial colliculus    Abducent nucleus



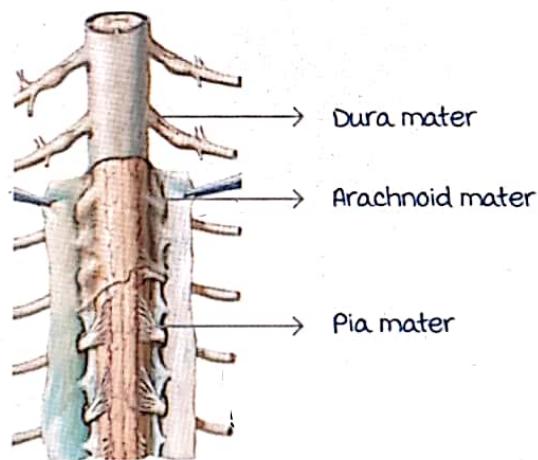
Active space

# SPINAL CORD

## Introduction

00:00:06

Spinal cord is covered by pia mater, arachnoid mater and dura mater (single layer).



The spinal cord extends from the Cl to L1 in adults.

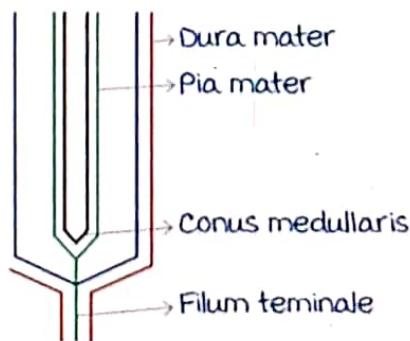
At the lower border of L1, the spinal cord forms a triangular part called the **conus medullaris**.

The **pia mater** at the L1 forms a modification called the **filum terminale**

↓  
It continues upto coccyx

The arachnoid membrane ends at the lower border of S2.

The dura mater converges at the level of L1 and continues upto coccyx.



Active space

Spinal cord in adults ends at	Lower border of L1 (2018 NEET)
Spinal cord in children ends at	Lower border of L3
Pia mater ends at	Coccyx
Arachnoid membrane ends at	Lower border of S2
Dura mater converges at	S2
Dura mater ends at	coccyx
Lumbar puncture is done at	L3-L4

### Modifications of pia mater

00:04:43

1. Filum terminale

2. Ligamentum denticulatum

Denticulatum = tooth like projections.

It is present between ventral root and dorsal root.

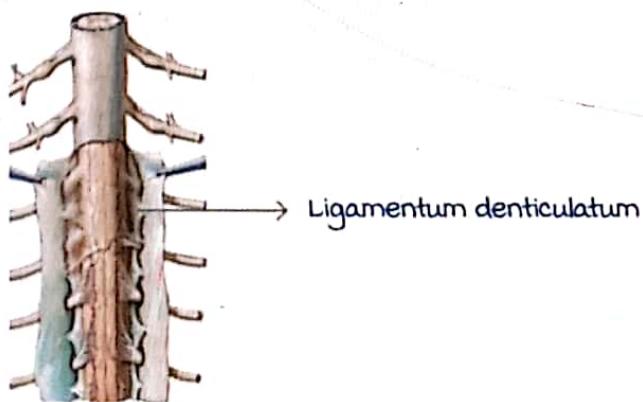
It is two in number one on each side.

On each side there are 21 projections.

It connects the pia mater to the dura.

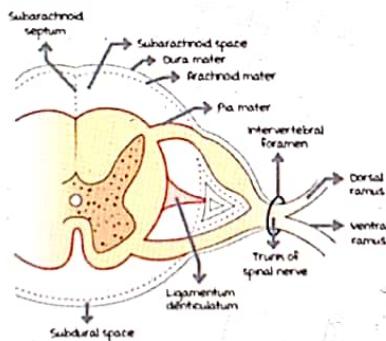
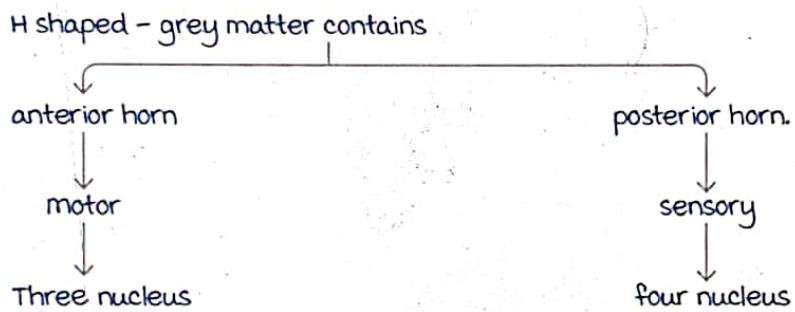
The last projection is located at T12-L1.

It is an important landmark for spinal surgeries.



Cut section of spinal cord

00:07:01

**Anterior horn nucleus :****Lateral**- innervates limb muscles.**Central**- phrenic nerve located in C1,C2,C3.

Spinal accessory nerve C1 to C5.

**medial**- innervates axial muscles.**posterior horn nucleus :****substantia gelatinosa**- it continues above as spinal nucleus of trigeminal nerve.

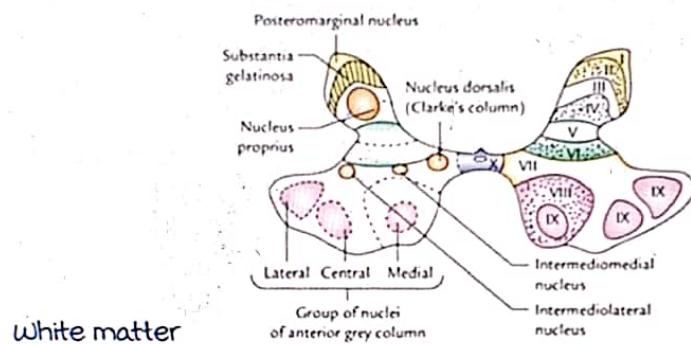
It is the nucleus for spinothalamic tract.

**Nucleus proprius**- visceral afferent.**Nucleus dorsalis or Clarke's column**- nucleus for spinocerebellar tract.**Intermediate horn**

It is present in certain regions and has two nucleus :

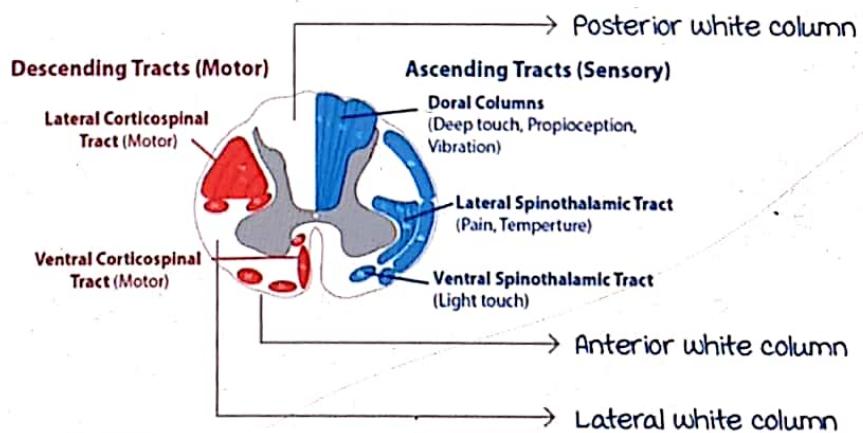
1. **Intermediomedial nucleus**- parasympathetic function (S2 TO S4)
- a. **Intermediolateral nucleus**- sympathetic function (T1 TO L2)

Active space



There are three columns :

1. Anterior white column
2. Lateral white column
3. Posterior white column



### Descending tracts

00:13:33

From the cortex to spinal cord- corticospinal tract.

From the cortex to cranial nerve nuclei- corticonuclear tract.

These two tracts are called the pyramidal tract.

It is an important voluntary motor pathway :

UMN (Upper motor neuron- Located in cortex)

↓  
LMN (lower motor neuron- located in cranial nerve motor nucleus & anterior horn of spinal cord)

↓  
Pass via cranial nerve/spinal nerve.

Active space

Innervates the skeletal muscles.



The LMN always over acts.

UMN lesion	LMN lesion
Spastic paralysis	Flaccid paralysis
Increased tone	Decreased tone
Increased reflex	Decreased reflex
Babinski sign positive	Babinski sign negative

## UMN and LMN lesion of facial nerve

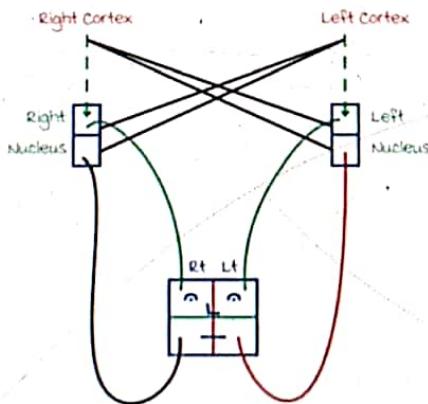
00:18:53

UMN lesion :

The contralateral lower half of the face is affected.

LNM lesion :

The ipsilateral entire half of the face is affected.



## Extrapyramidal tracts

00:24:56

There are three tracts :

### 1. Rubrospinal tract

Facilitates- flexor muscles

Inhibits- extensor muscles

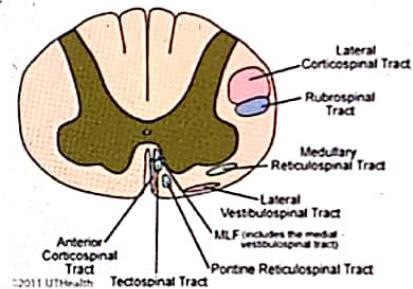
### 2. Vestibulo spinal tract (opposite to rubrospinal tract)

Facilitates- extensor muscles

Inhibits- flexor muscles

## 3. Tectospinal tract

Reflex movement of head & neck and eyeball movements in response to external stimuli.

Ascending tract-Spinothalamic tract

00:26:51

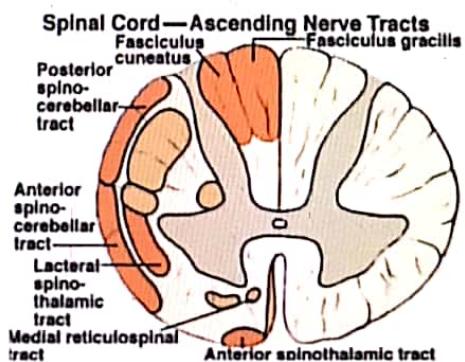
It is a sensory tract.

The pain and temperature are carried by the lateral spinothalamic tract.

Crude touch and pressure are carried by anterior spinothalamic tract.

Fine touch, vibration, two-point discrimination, stereognosis, and conscious proprioception are carried by dorsal column.

Unconscious proprioception is carried by the spinocerebellar tract.



## Spinothalamic tract

1st order neurons located in dorsal root ganglion (DRG)

↓  
2nd order neuron located in substantia gelatinosa

The fibres from 2nd order cross to the opposite side and ascend in the lateral white column and anterior white column and they end in thalamus.

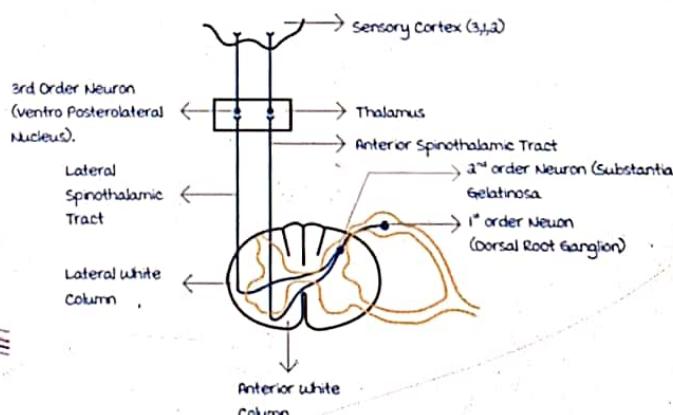
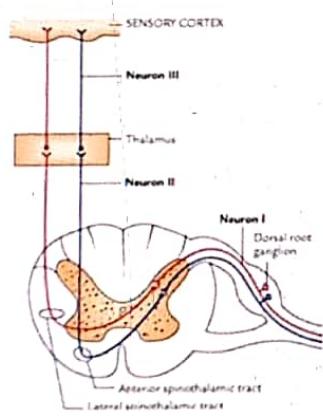
3rd order neurons located in VPL (ventroposterolateral nucleus)

3rd order neuron fibres are given to sensory cortex (area 3,1,2)

Clinical correlation:

Lesion of STT in spinal cord and brainstem:

Contralateral loss of pain, temperature, crude touch and pressure.



### Ascending tract- Dorsal column tract

00:34:49

1st order neuron located in dorsal root ganglion

Goes to posterior column and ascends to medulla

In medulla, Gracile and cuneate nucleus are present, and 2nd order neurons arise

Their fibres cross to opposite side called internal arcuate fibres

Medial lemniscus arises and ends in thalamus in VPL nucleus

From VPL, 3rd order arises and fibres project to sensory cortex

Clinical correlation:

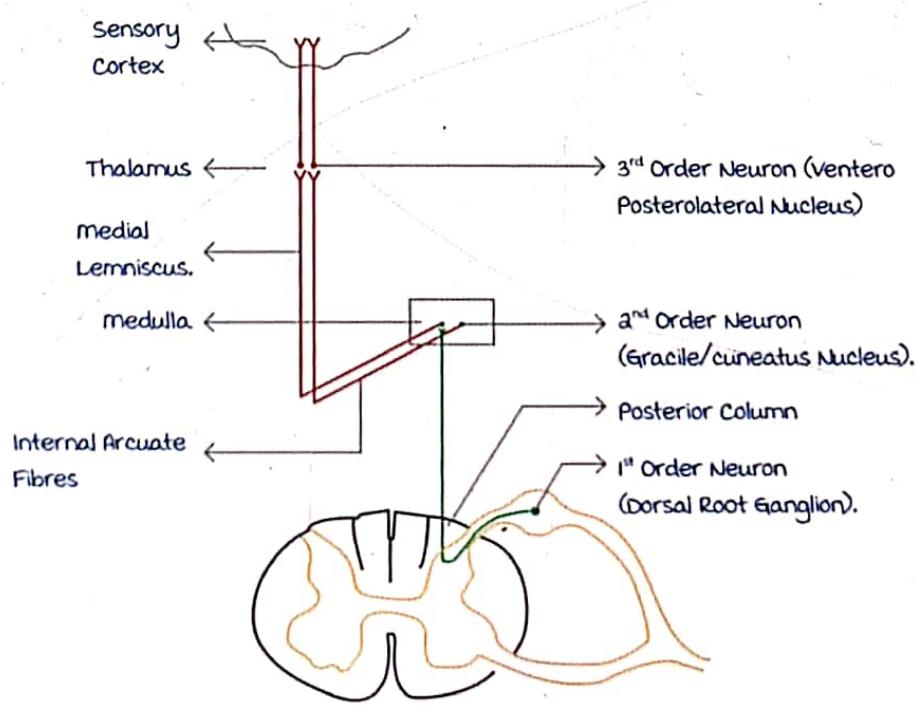
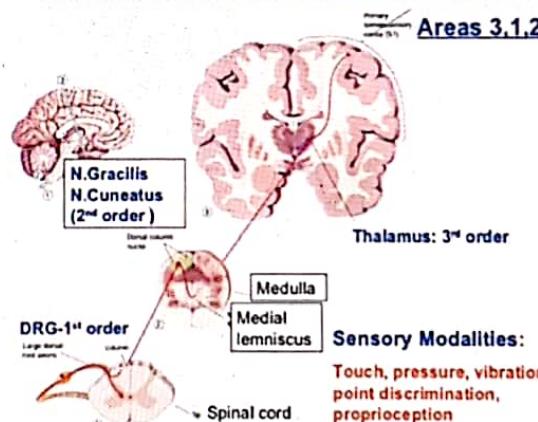
The lesion of dorsal column tract in the spinal cord

Ipsilateral loss of vibration/stereognosis, fine touch, two-point discrimination, conscious proprioception.

The lesion of dorsal column in the brain stem (aa NEET)

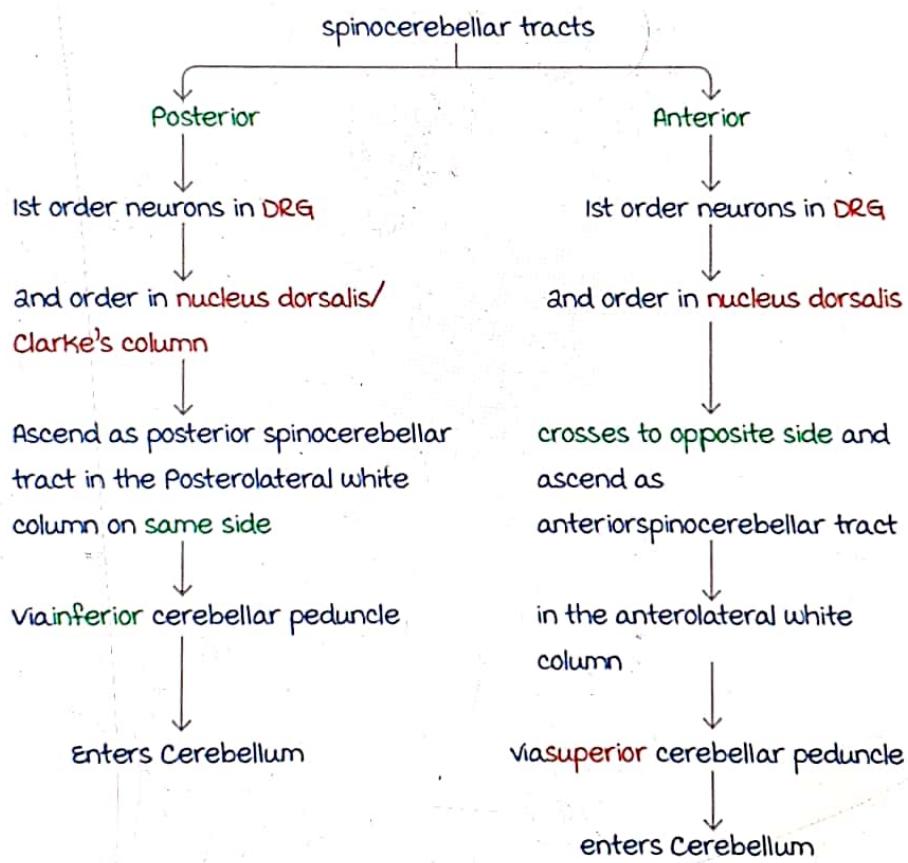
Contralateral loss of fine touch, vibration, two-point discrimination, stereognosis, conscious proprioception.

### Dorsal Column Medial lemniscal Pathway

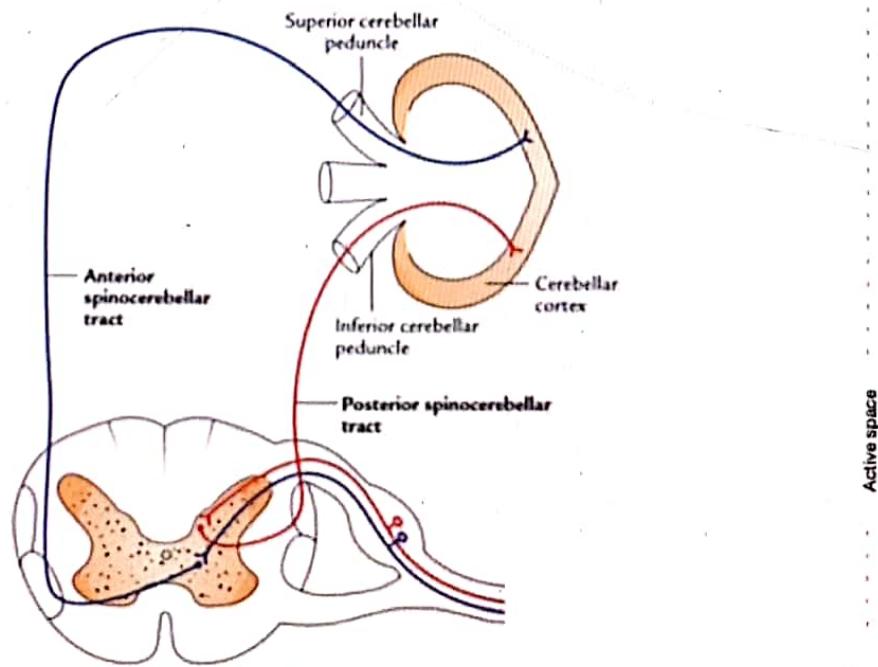


## Ascending tract-Spinocerebellar tract

00:39:37



Note : All ascending tracts decussate except the **posterior spinocerebellar tract**.

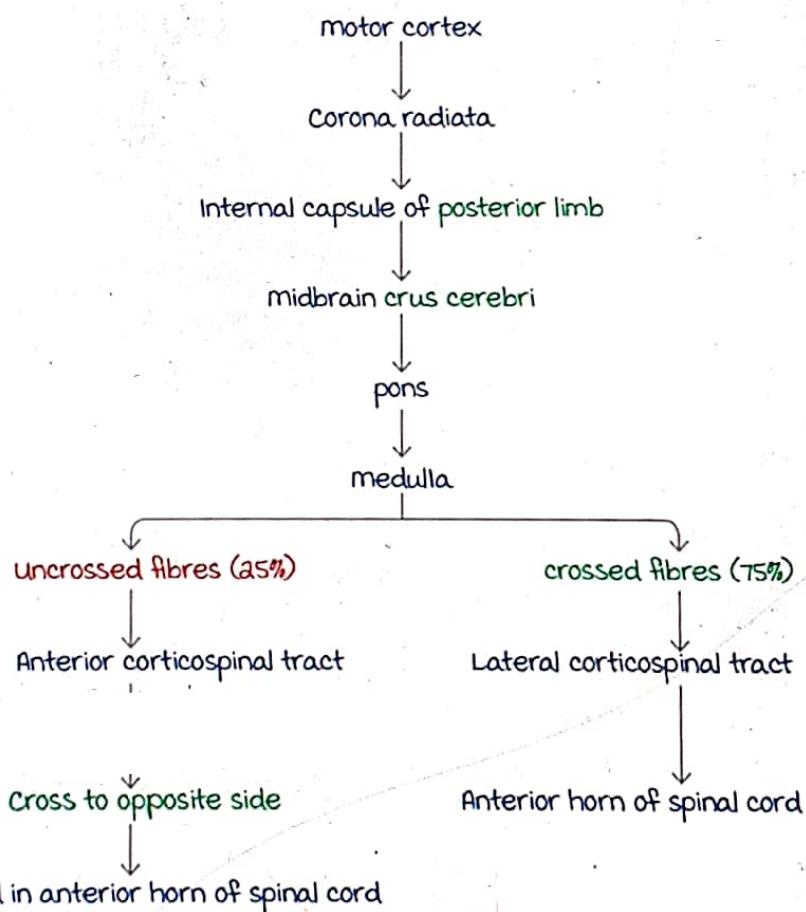


Active space

## Descending tracts

00:42:37

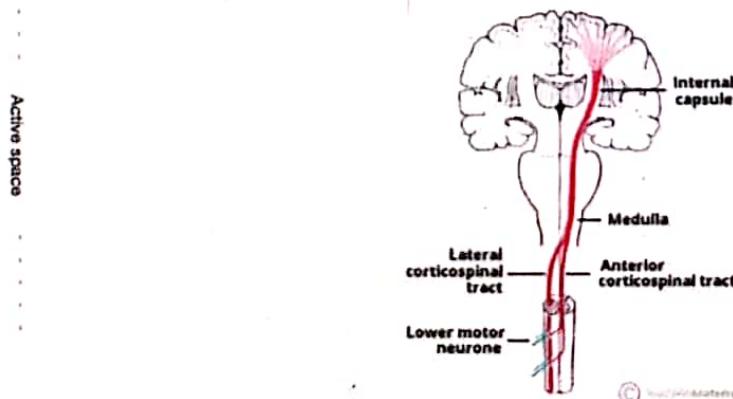
## Corticospinal tract



## Clinical correlation:

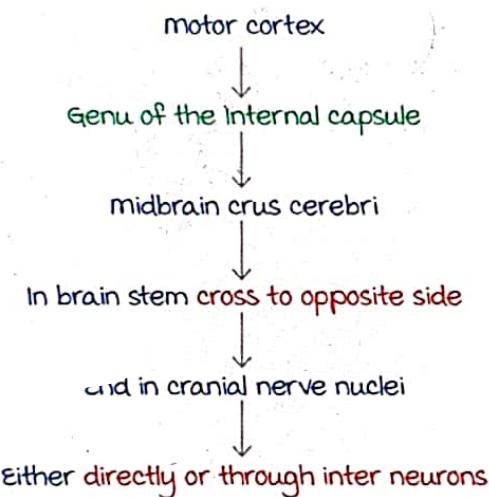
The lesion of corticospinal tract in the brain stem- **Contralateral hemiplegia**.

The lesion of corticospinal tract in the spinal cord- **Ipsilateral hemiplegia**.



## Corticuclear tract

00:47:38



Clinical correlation :

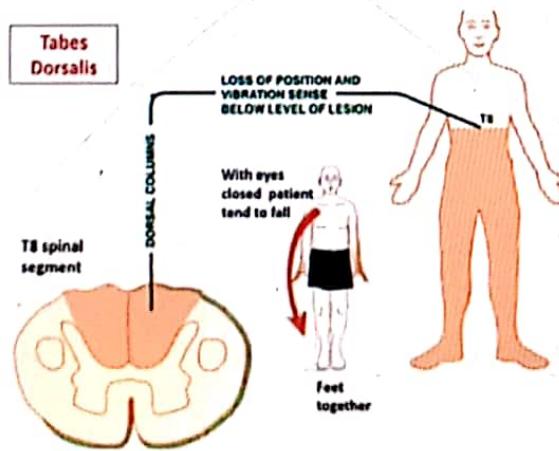
Tabes dorsalis :

It is seen in syphilis.

The dorsal column is affected, which causes loss of position sense.

The position sense is maintained with visual input.

Romberg's sign - the patient loses position and tends to fall with the eyes closed.



Brown Sequard syndrome

Hemisection of the spinal cord is affected.

c/F

Active space

## 1. spinothalamic tract affected

Contralateral loss of pain, temperature, pressure, crude touch below the level of lesion.

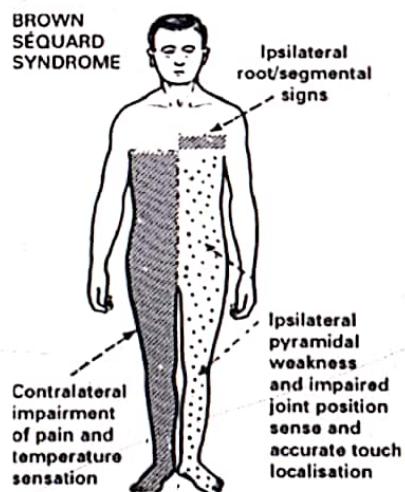
## 2. Dorsal column affected

Ipsilateral loss of vibration, two-point discrimination, stereognosis below the level of lesion.

## 3. Corticospinal tract affected

Ipsilateral hemiplegia.

## 4. At the level of lesion total loss of all the sensation.

Blood supply of the spinal cord

00:55:43

spinal cord is supplied by

Long arteries

i. Anterior spinal artery  
(branch of vertebral artery)

## a. Posterior spinal artery

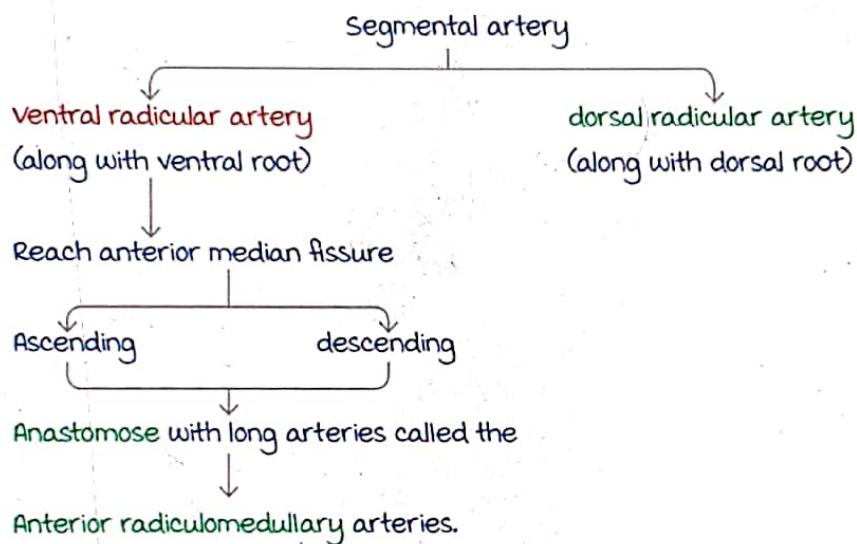
(branch of vertebral or  
posteroinferior cerebellar artery)

segmental arteries

vertebral artery  
Deep cervical artery  
Intercostal arteries  
Lumbar arteries

The segmental arteries anastomose with long arteries to form pial plexus.

Branches of segmental artery



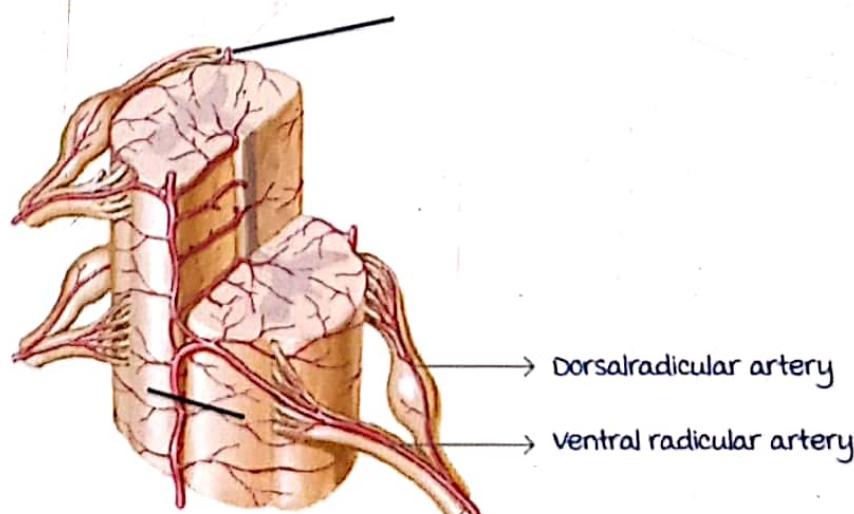
Anterior 2/3rd of the spinal cord- anterior spinal artery

Posterior 1/3rd of the spinal cord- posterior spinal artery

Artery of Adamkiewicz :

Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

- it is the largest anterior radiculomedullary artery.
- It is the major supply to the lower 2/3rd of the spinal cord.
- It is usually arising from the left side.
- The sources are lower intercostal, subcostal, lumbar arteries.

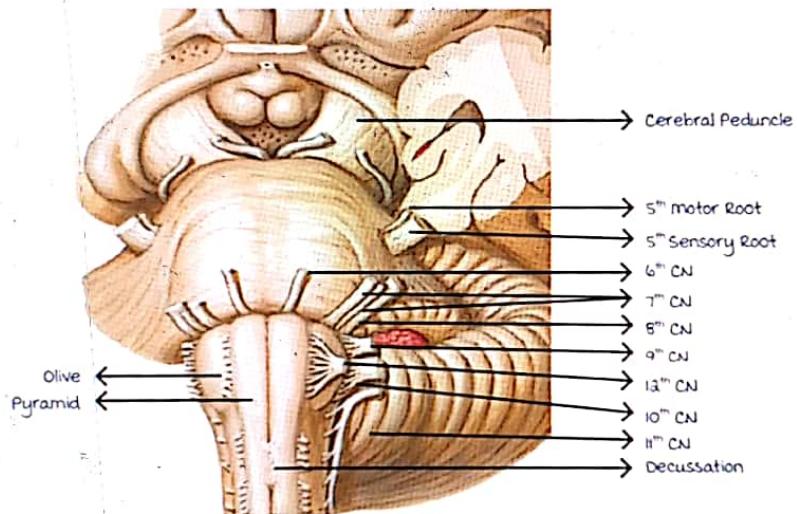


Active space

# BRAIN STEM

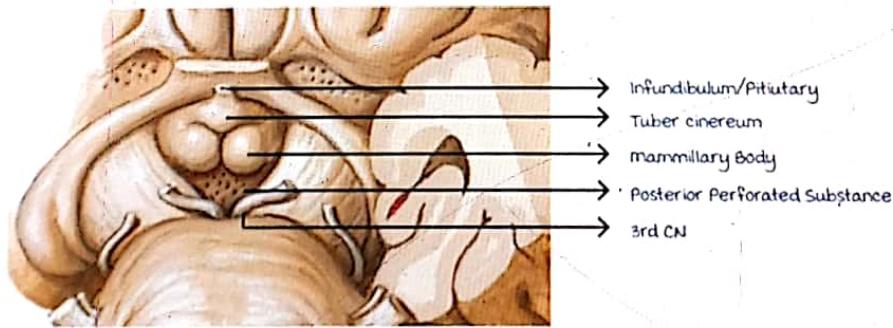
## Ventral View of Brainstem

00:00:02



**Three Parts :**

1. midbrain :



a) Cerebral Peduncles :

b) Interpeduncular Fossa :

- Contents same as that of the floor of the third ventricle (except Optic Chiasma and Tegmentum of midbrain) + 3rd Cranial Nerve
- Floor of Third Ventricle :
  1. Optic Chiasma
  2. Infundibulum
  3. Pituitary
  4. Tuber cinereum
  5. mammillary Body
  6. Posterior perforated substance
  7. Tegmentum of midbrain

Active space

## 2. Pons:

- Bridge between midbrain and medulla.
- 5th Cranial Nerve: Sensory root (Large) + motor root

## 3. medulla:

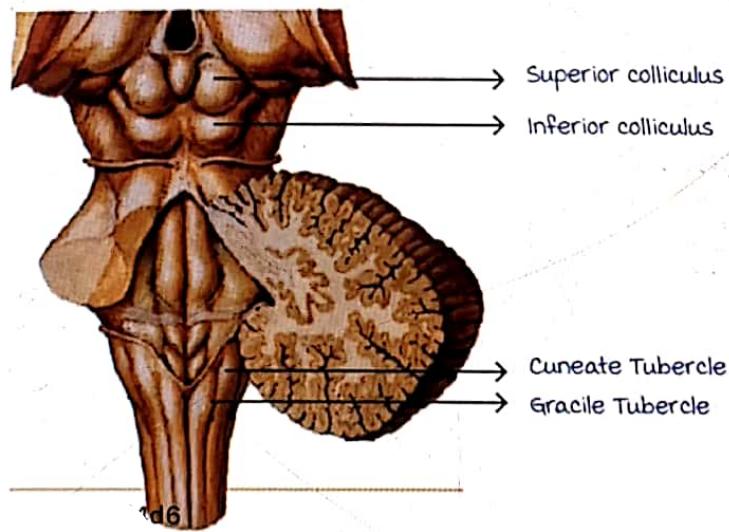
a. Pyramid(medial side) : Damage to these parts causes contralateral hemiplegia.

b. Olive(lateral side) : Inferior Olivary Nucleus lies under the olive.

- Nerve between Olive and Pyramid- 12<sup>th</sup> Cranial Nerve
- Nerve lateral to olive- 9<sup>th</sup>, 10<sup>th</sup> and 11<sup>th</sup> Cranial Nerve
- Nerve at Ponto-medullary Junction- 6<sup>th</sup> Cranial Nerve
- Nerve at Ponto-Olivary junction- 7<sup>th</sup> Cranial Nerve

Dorsal View of Brainstem

00:00:02



## Three Parts :

i. midbrain : called as Tectum in dorsal part

## a. Superior Colliculus :

- S - Superior Colliculus
- L - Lateral Geniculate Body
- O - Optic Pathway

## b. Inferior Colliculus :

- I - Inferior Colliculus
- m - medial Geniculate Body
- A - Auditory Pathway

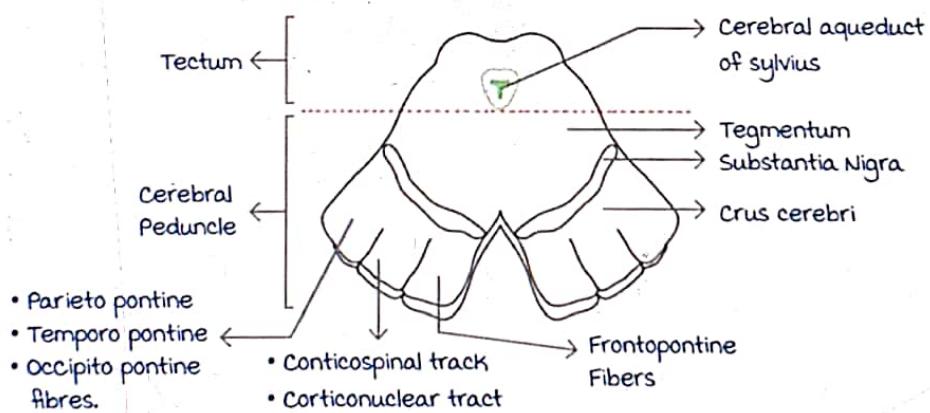
**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

- Corpora Quadrigemina - 4 swellings in midbrain

2. Pons :
  3. medulla : contains nucleus involved in dorsal column / medial lemniscus pathway
    - a. Gracile Tuber : contains nucleus gracilis
    - b. Cuneate Tuber : contains nucleus cuneatus
- Only nerve seen in the posterior view of the brainstem - 4<sup>th</sup> Cranial Nerve (Trochlear Nerve)

## Section of Midbrain

00:11:57



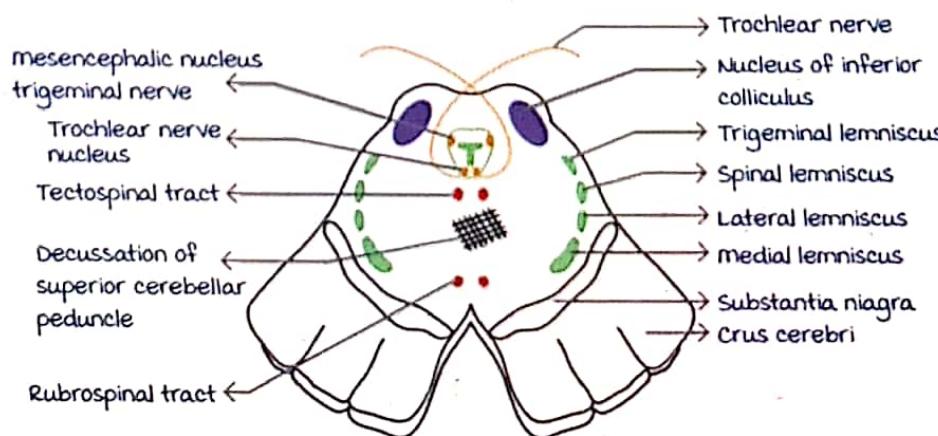
Two Parts :

1. Tectum :

2. Cerebral Peduncle :

- Tegmentum
- Substantia nigra
- Crux Cerebri : gives passage to
  - a. Frontopontine Fibers
  - b. Corticospinal and Corticonuclear Tract
  - c. Parietopontine, Temporopontine and Occipitopontine Fibers

Section of midbrain at the level of Inferior Colliculus :



Two Parts :

1. Tectum :

Gray matter with small cerebral aqueduct of sylvius

Trochlear Nucleus

mesencephalic nucleus of Trigeminal nerve

2. Cerebral Peduncle :

- Tegmentum : contains

a. Decussation of superior cerebellar peduncle

b. Rubrospinal and Tectospinal tract

c. Four Lemniscus :

medial

Trigeminal

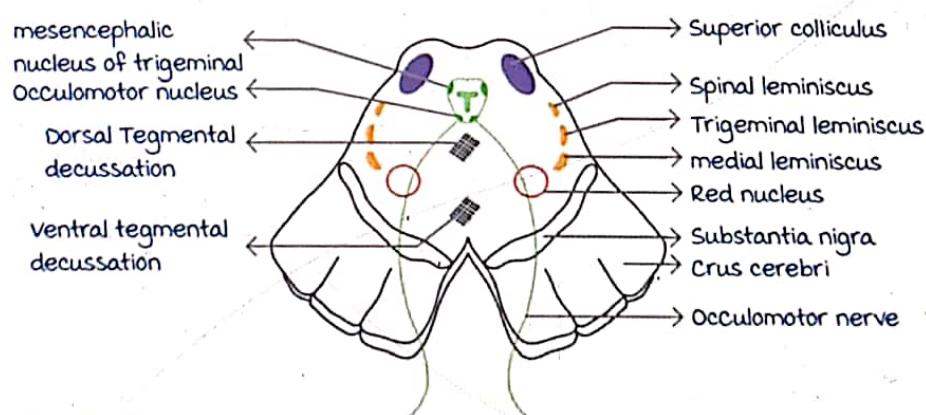
Spinal

Lateral

- Substantia Nigra

- Crux Cerebri :

Section of midbrain at the level of Superior Colliculus :



Two Parts :

1. Tectum :

Gray matter

Occulomotor nucleus

mesencephalic nucleus of Trigeminal

2. Cerebral Peduncle :

- Tegmentum : contains

a. Red Nucleus

b. Ventral Tegmental Decussation : due to Rubrospinal tract

c. Dorsal Tegmental Decussation : due to Tectospinal tract

d. Three Lemniscus :

medial

Trigeminal

Spinal

- Substantia Nigra
- Crux Cerebri
- Lateral Lemniscus ends at the level of Inferior Colliculus.

## Rule of Four

00:24:27

Essential to find the location of the lesion.

4 Cranial Nerves in medulla : 9,10,11,12	midline (medially Located) Cranial Nerves : 3,4,6,12
4 Cranial Nerves in Pons : 5,6,7,8	Laterally Located Cranial Nerves : 5,7,9,11
2 Cranial Nerves in midbrain : 3,4	
4m - medial <ul style="list-style-type: none"> <li>motor nucleus - 3,4,6,12</li> <li>motor system - pyramid</li> <li>medial Longitudinal Fasciculus</li> <li>medial Lemniscus</li> </ul>	4S - Side - Lateral <ul style="list-style-type: none"> <li>Spinothalamic Tract</li> <li>Spinocerebellar Tract</li> <li>Sympathetic System</li> <li>Sensory Nucleus of Trigeminal</li> </ul>

Clues :

- 3<sup>rd</sup> Cranial Nerve : ptosis, pupils dilated, eyeball is down and out.
- 4<sup>th</sup> Cranial Nerve : diplopia while looking down.
- 5<sup>th</sup> Cranial Nerve : Ipsilateral sensory loss in face. (Localize the lesion to the lateral side and not the pons)
- 6<sup>th</sup> Cranial Nerve : lateral gaze palsy
- 7<sup>th</sup> Cranial Nerve : ipsilateral spasm of facial muscles
- 8<sup>th</sup> Cranial Nerve : loss of hearing (vestibulocochlear nucleus in pons and medulla)
- 9<sup>th</sup>, 10th and 11th Cranial Nerve [Nucleus Ambiguous] : difficulty in swallowing.
- 10<sup>th</sup> Cranial Nerve : hoarseness of voice
- 12<sup>th</sup> Cranial Nerve : ipsilateral deviation of tongue

Case : Right sided deviation of tongue. Identify.

11th cranial nerve : lesion is in the medulla, medial side and on the right side (Right medial medullary Syndrome)

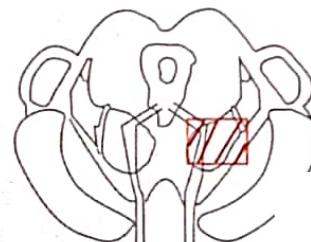
Other Clues :

- motor pathway (pyramid) : contralateral hemiplegia
- medial Lemniscus : contralateral loss of vibration/stereognosis
- medial Longitudinal Fasciculus[mLF] : intranuclear opthalmoplegia [INO]
- Spinothalamic tract : contralateral pain, temperature, crude touch and pressure
- Spinocerebellar tract : ipsilateral ataxia

- Sympathetic system : Horner's syndrome
- Sensory nucleus[5th CN] : ipsilateral sensory loss of face

### Benedikt Syndrome

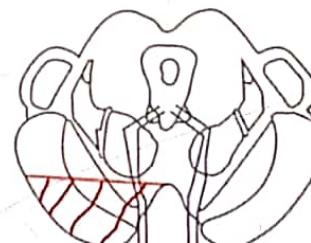
00:37:13



- CN3, medial lemniscus, red nucleus
- Oculomotor palsy
- Contralateral loss proprioception/vibration
- Involuntary movements
  - Tremor
  - Ataxia

### Weber's Syndrome

00:37:57



- CN3, corticospinal tract, corticobulbar tract
- Oculomotor nerve palsy
- Contralateral hemiparesis
- Pseudobulbar palsy
  - UMN cranial nerve motor weakness
  - Exaggerated gag reflex
  - Tongue spastic (**no** wasting)
  - Spastic dysarthria

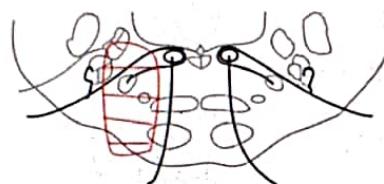
W - Weber syndrome

H - Hemiplegia

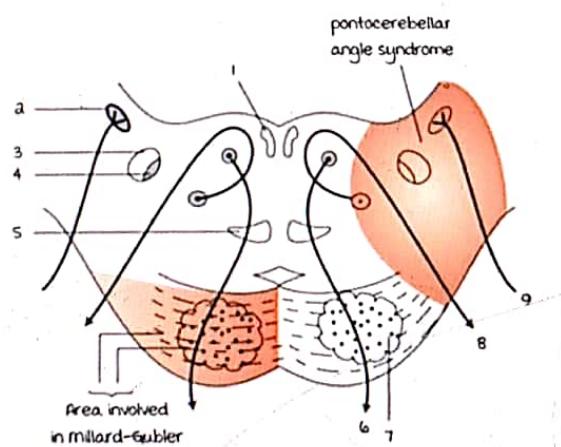
O - Oculomotor

## Medial Pontine Syndromes

00:39:29



- Corticospinal tract, CN 6, CN 7
- Contralateral hemiparesis
- CN 6 palsy
- Facial weakness /droop affected side
- Lateral gaze structures : MLF, CN nucleus
- Gaze palsies
- Can't look to affected side
- Damage to either PPRF or nucleus CN VI

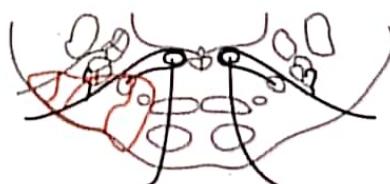


Abducent alternating Hemiplegia

## Lateral Pontine Syndromes

00:40:31

- Vestibular nuclei : nystagmus, vertigo, N/V
- Spinothalamic tract : ipsilateral face pain/temp
- Sympathetic tract : Horner's syndrome
- Facial nucleus :
  - Ipsilateral facial droop
  - Loss corneal reflex
- Cochlear nuclei
  - Deafness



AICA stroke

- Pneumonic : F AICA L

## Lateral medullary syndrome (Wallenberg's Syndrome) 00:40:55

- vestibular nuclei: Nystagmus, vertigo, N/V
- Sympathetic tract: Horner's syndrome
- Spinothalamic tract: Contralateral pain/temp
- Spinal V nucleus: ipsilateral face pain/ temp
- Nucleus ambiguus (IX, X)
  - Hoarseness, dysphagia

PICA Stroke

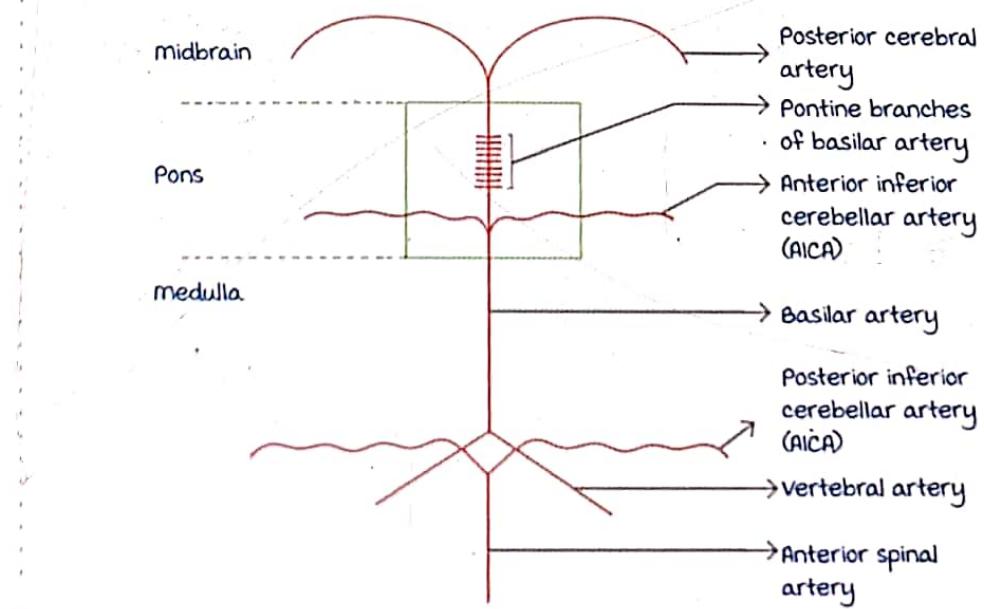
How to differentiate between lateral pontine syndrome and lateral medullary syndrome:



Pikachu (Pokemon species):

Pneumonic: In lateral medullary syndrome PICA is involved - can't chew (dysphagia)

Arteries involved in syndromes:

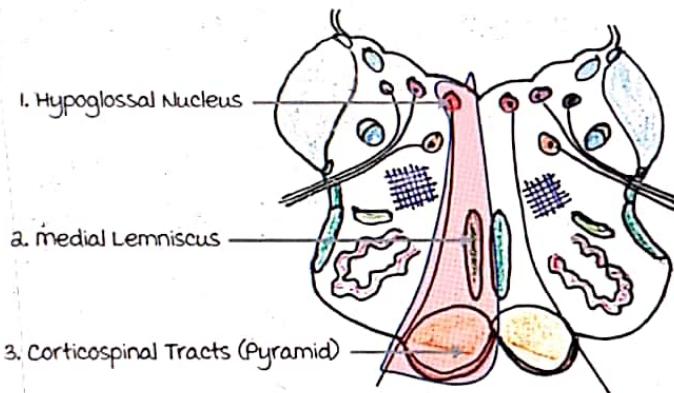


- medial medullary Syndrome : Anterior Spinal Artery
- Lateral medullary Syndrome : **Vertebral** > PICA
- Lateral Pontine Syndrome : AICA
- medial Pontine Syndrome : Pontine branch of the Basillar artery
- midbrain Syndrome : Posterior cerebral artery

## Medial Medullary Syndrome

00:46:04

main Structures Involved in medial medullary Syndrome



1. Tongue deviation on same side.
2. Contralateral loss of vibration/stereognosis
3. Contralateral hemiplegia

## Cases

00:46:55

### Case 1

- A 75 - year - old man presents for evaluation of weakness. He reports that two hours ago he suddenly was unable to move his left arm or leg. He denies any difficulty with speech. On examination, he is able to move all facial muscles normally. There is no ophthalmoplegia. On tongue protrusion, the tongue is deviated to the right. He is unable to detect lower or upper extremity vibration on the left.

Ans : Right medial medullary Syndrome

### Case 2

- Right sided weakness
- Left eye down/out, dilated

Ans : Left medial midbrain Lesion

### Case 3

- unable to do left hand finger to nose test
- Loss of pain and temperature to left face
- Left eyelid droop, small pupil
- Loss of pain/temp right arm and leg
- Hoarse voice
- Loss of gag reflex left throat
- Palate raised on right side

Ans : Left Lateral medullary Syndrome

## Case 4

- Right deafness / tinnitus
- Loss right finger to nose
- Right facial numbness
- No corneal reflex
- Right facial spasms

Ans : Right Lateral Pons

Case Question : 68 yr. old male presents in the emergency room with nystagmus and dizziness. Examination reveals a loss of pain and temperature sensation over the right side of face and left side of the body. Patient also exhibits ataxia and intentional tremors on both limbs. In addition he is having hoarseness of voice. Which of the following artery is blocked in this condition?

- A. Right posterior inferior cerebellar artery
- B. Left posterior inferior cerebellar artery
- C. Right anterior inferior cerebellar artery
- D. Basillar artery

Ans : Right posterior inferior cerebellar artery

# BASAL GANGLIA

## Introduction

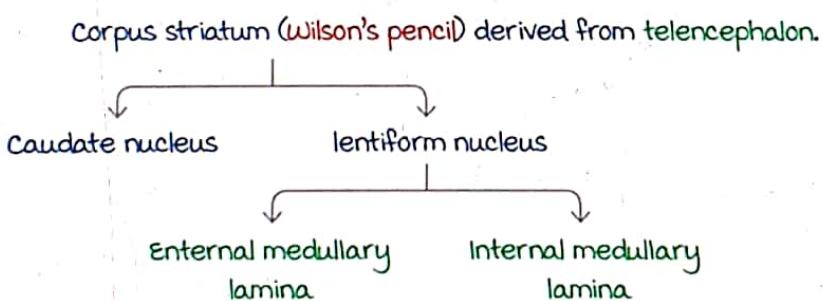
00:00:03

Basal ganglia is the nuclei present in the cerebrum.  
 Function – planning and progression of movements.

### Components

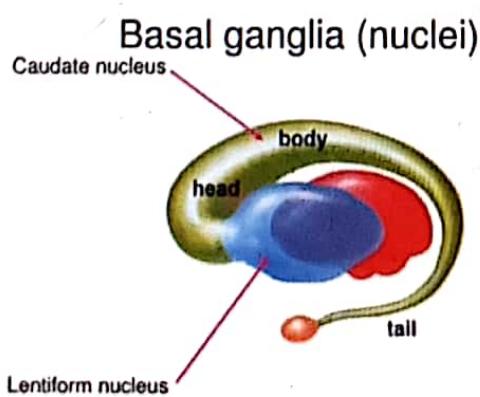
1. Structural component.
2. Functional component.

#### Structural component :



#### Functional component :

- Sustantia nigra (derived from mesencephalon).
- Subthalamus (derived from diencephalon).
- Red nucleus (derived from mesencephalon).



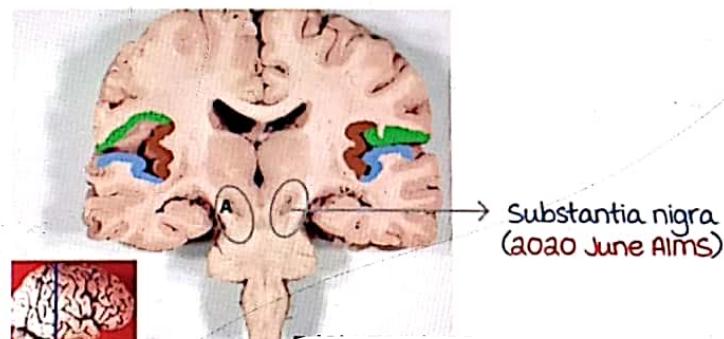
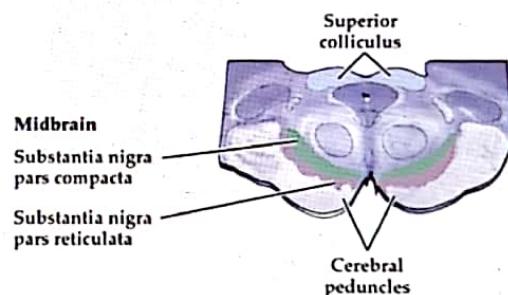
Caudate nucleus + lentiform nucleus → Neostriatum.  
 Globus pallidus → Paleostriatum/pallidum.

Tail of caudate nucleus – roof of inferior horn of lateral ventricle.  
 Head and body of caudate nucleus – floor and central part of anterior horn of lateral ventricle.

### Parts of substantia nigra

00:06:34

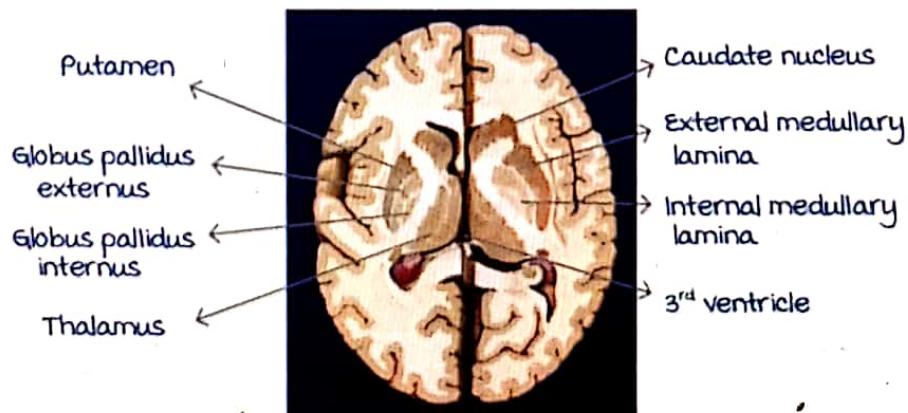
Pars reticulata – homologous to globus pallidus internus.

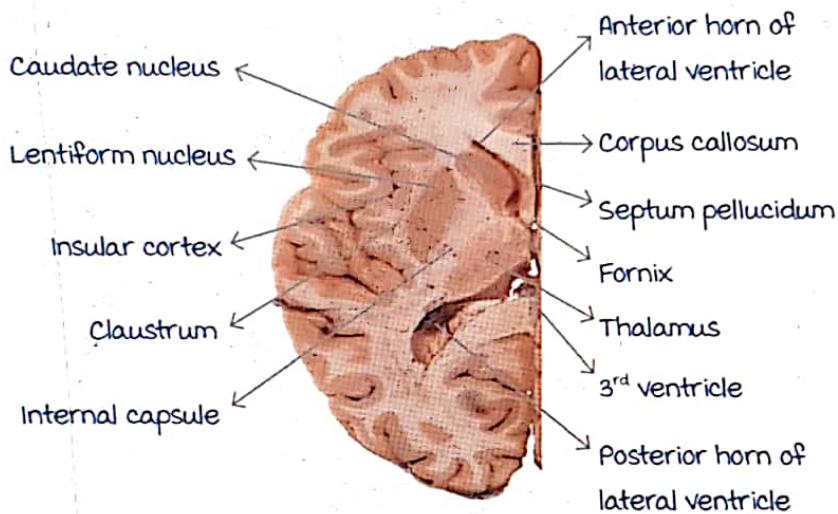


Relations of internal capsule :  
 medially – caudate nucleus and thalamus.  
 Laterally – lentiform nucleus.

### Insula

00:10:38





**Insula :**

Site - floor of lateral sulcus.

Function - planning of the articulating movements of speech.

**Claustrum :**

Function - unknown.

## Pathways of basal ganglia

00:15:10

Direct pathway - stimulates the movements.

Indirect pathway - inhibits the movements.

Neurotransmitters involved :

Glutamate - Excitatory neurotransmitter.

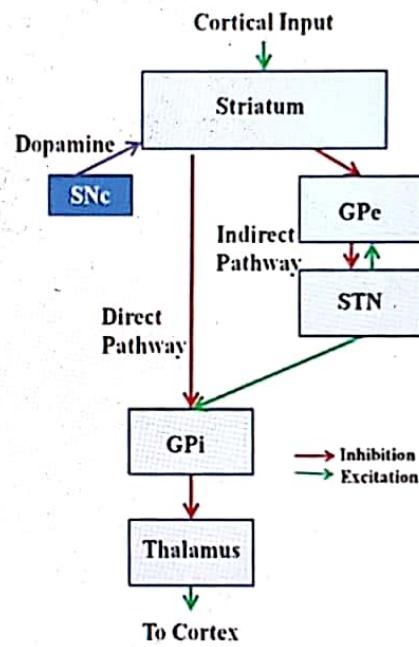
- Secreted by cerebrum, subthalamus, thalamus.

GABA - Inhibitory neurotransmitter.

- Secreted by corpus striatum (caudate nucleus, putamen, globus pallidus).

Dopamine - Secreted by substantia nigra.

Acetylcholine - Secreted by putamen.



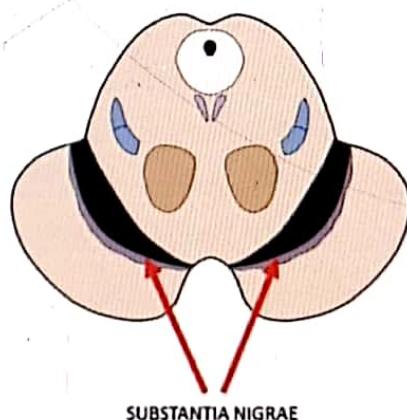
### Niagro-striatal pathway

00:25:16

Acts on 2 receptors :

D1 receptor - acts on direct pathway (stimulates movements).

D2 receptor - acts on indirect pathway (inhibits movements).



Lesion in substantia nigra → Parkinson's disease (paralysis agitans).

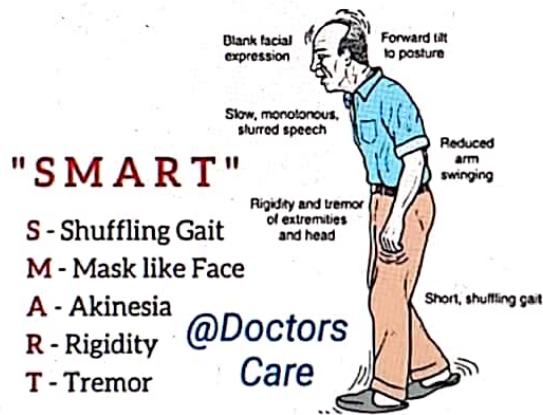
Cardinal features of Parkinson's disease :

- Resting tremor.
- Rigidity.
- Hypokinesia.

Treatment of Parkinson's disease :

- Dopamine analogues.
- Anticholinergics.

## DISEASE PARKINSONS



Lesions of Basal Ganglia :

- Globus pallidus -
  - Athetosis - spontaneous writhing movements of the hand, arm, neck, and face.
- Putamen -
  - Chorea - involuntary flicking movements of the hands, face, and shoulders.
- Substantia nigra -
  - Parkinson's disease - rigidity, tremor and akinesia.
  - Loss of dopaminergic input from substantia nigra to the caudate and putamen.

Hemiballismus - Lesion in the subthalamus leads to sudden flailing movements of an entire limb.

### Wilson's disease

00:31:18

Active space

It is a copper metabolism disorder.

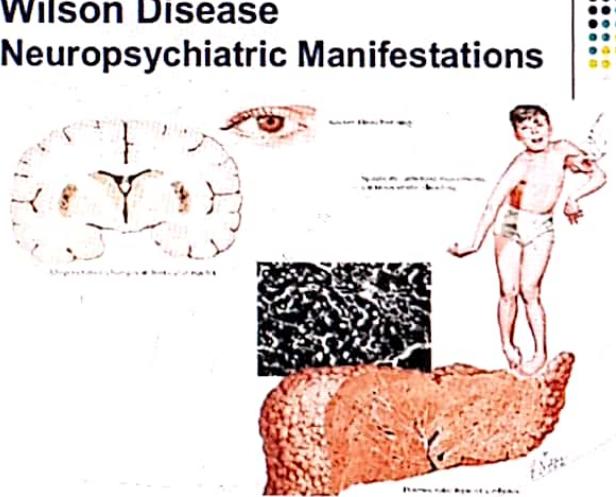
Copper is deposited in the lentiform nucleus and liver.

Manifestations :

- Wing beat tremors.
- Cirrhosis.
- KF rings (ocular manifestation).



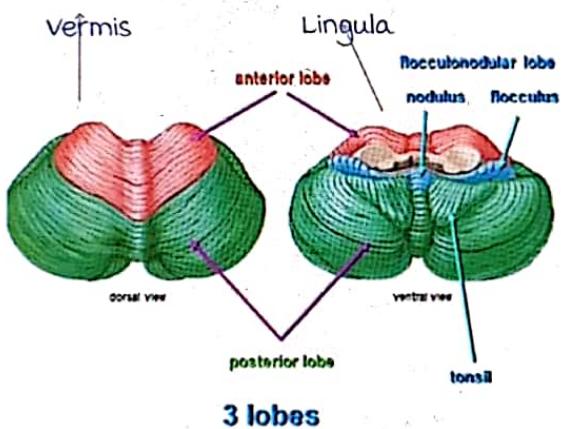
## Wilson Disease Neuropsychiatric Manifestations



# CEREBELLUM

Divisions of cerebellum (based on function)

00:00:02



Archicerebellum / vestibulocerebellum :

Includes : flocculonodular lobe + lingula of vermis.

Function : balance and equilibrium regulation.

Lesion : ataxia, nystagmus, loss of balance.

Paleocerebellum / spinocerebellum :

Includes : anterior lobe + uvula + pyramid.

Function : regulation of tone.

Lesion : hypotonia.

Neocerebellum / cerebrocerebellum :

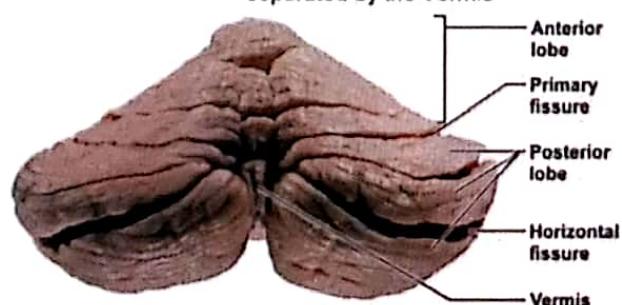
Includes : posterior lobe + remaining parts of vermis.

Function : smooth performance of voluntary motor activities.

Lesion : dysarthria, dysmetria, dysdiadochokinesia, intention tremors.

The Cerebellum

2 Hemispheres (Right and Left)  
separated by the Vermis



(c) Posterior view

Internal structure of cerebellum

00:06:49

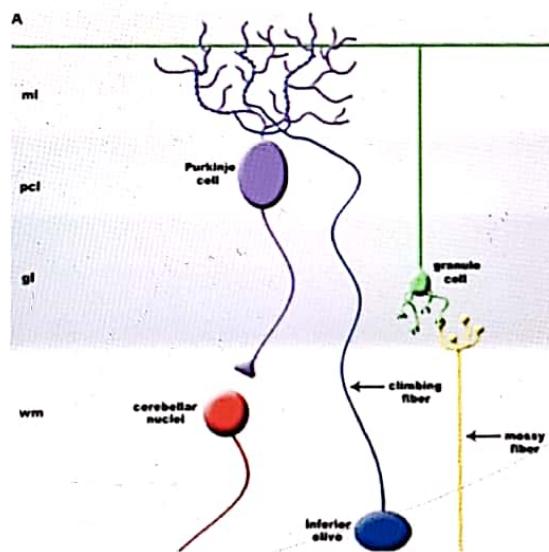
Three layers :

Inner layer : contains Golgi cells and granule cells.

Middle layer / Purkinje layer : contains Purkinje cells (flask shaped).

Outer molecular layer : contains stellate cells and basket cells.

**Note :** All the cells in cerebellum are inhibitory, except granule cells.



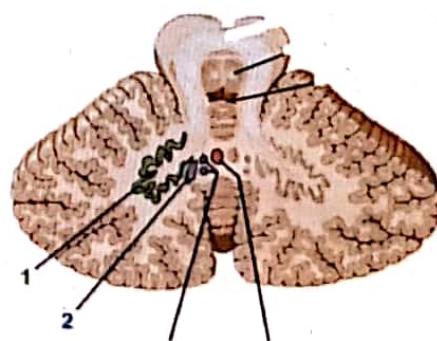
Purkinje cells :

gives dendrites : present in outer molecular layer.

gives axons : present in inner layer, that terminates in cerebellar nucleus. (ao18 Allms)

Cerebellar nuclei :

1. Dentate nucleus : lateral most.
2. Emboliform nucleus.
3. Globose nucleus.
4. Fastigial nucleus : medial most



Emboliform nucleus + Globose nucleus are known as nucleus interpositus.

Efferent fibres from cerebellum: by cerebellar nucleus.  
 Efferent fibres from cerebral cortex: by Purkinje cells.

#### Climbing fibre:

Comes from contralateral inferior olive nucleus.

Gives fibre directly to **only one** Purkinje cell.

#### mossy fibre:

Divides into 4 to 5 terminals.

Each terminal anastomoses with golgi and granular cells forming cerebelloglomeruli.

#### T-shaped fibre:

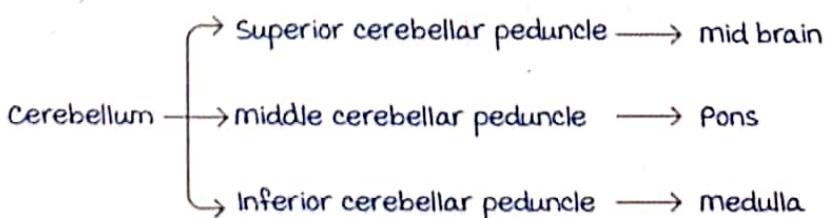
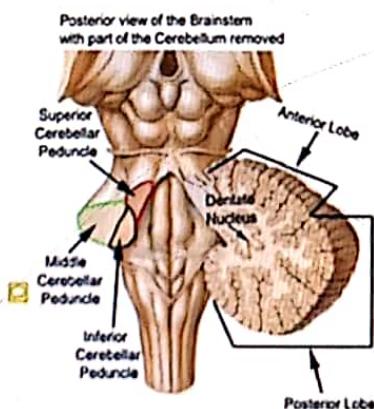
Given by each granule cell.

Anastomoses with **1000s** of Purkinje cells.

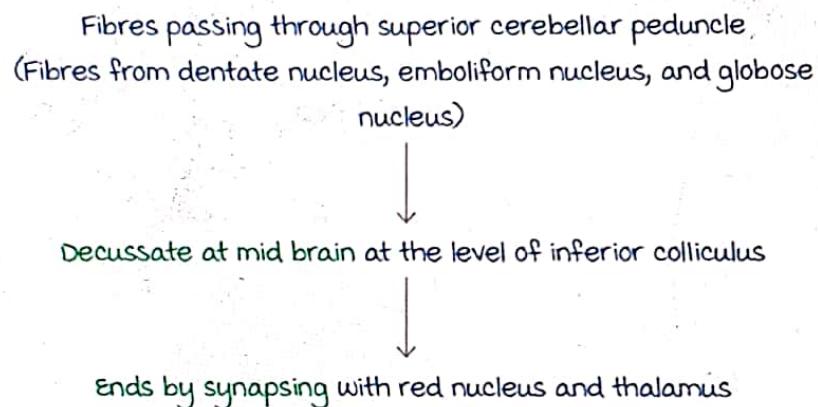
## Cerebellar peduncle

00:19:53

Cerebellum is connected to the brain stem by the means of cerebellar peduncle.



Active space



Afferent fibres to superior cerebellar peduncle is given by -  
Anterior spinocerebellar tracts.  
Tectocerebellar tract.

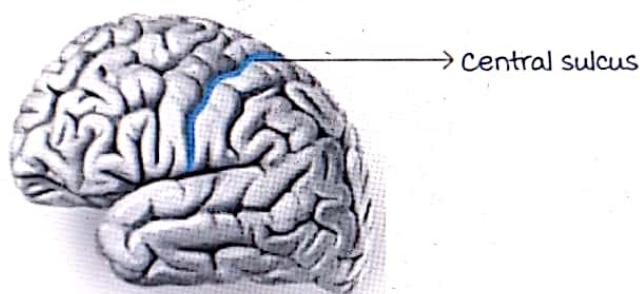
middle cerebellar peduncle -  
Largest cerebellar peduncle.  
Afferent fibres given by : pontocerebellar fibres.  
No efferent fibres.

Inferior cerebellar peduncle -  
Fibres from fastigial nucleus passes through it.

# CEREBRUM

## Sulci and gyri

00:00:03



### Sulci

- Limiting sulcus :

Separates two different functional areas.

Example : central sulcus (motor and sensory gyrus).

- Axial sulcus :

Formed in the homogenous area.

Example : posterior part of the calcarine sulcus (visual cortex).

- Operculated sulcus :

Similar as limiting sulcus but the wall and the lip contains the third area.

Example : lunate sulcus.

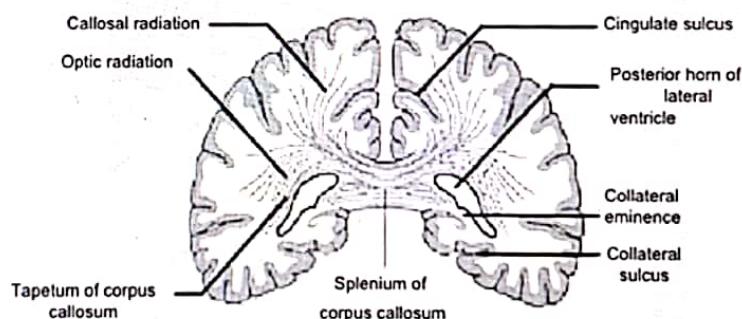
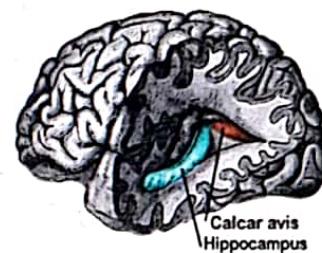
- Complete sulcus :

They are deep sulcus.

Gives impression the lateral ventricle.

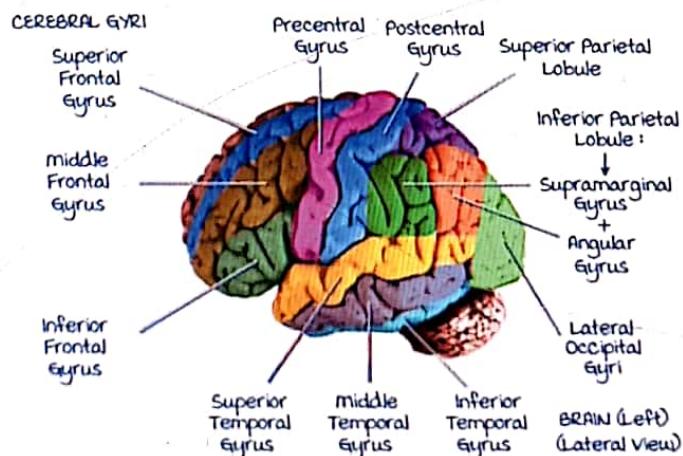
Example : anterior part of the calcarine sulcus (gives impression of the calcar avis).

Collateral sulcus (gives impression of the collateral eminence).



## Cerebral gyri

00:05:50



### Frontal lobe :

- Precentral gyrus : area 4 : primary motor area.
- Superior frontal gyrus : area 6 : premotor area.
- middle frontal gyrus : area 8 : frontal eye field.
- Inferior frontal gyrus : area 44 and 45 : Broca's area  
(motor area for speech).

**Parietal lobe :**

- Posterior central gyrus : area 3, 1 and 2 : primary sensory area.
- Superior parietal lobe : area 5 and 7 : sensory association area.
- Inferior parietal lobe : coordinating hand - eye movement.

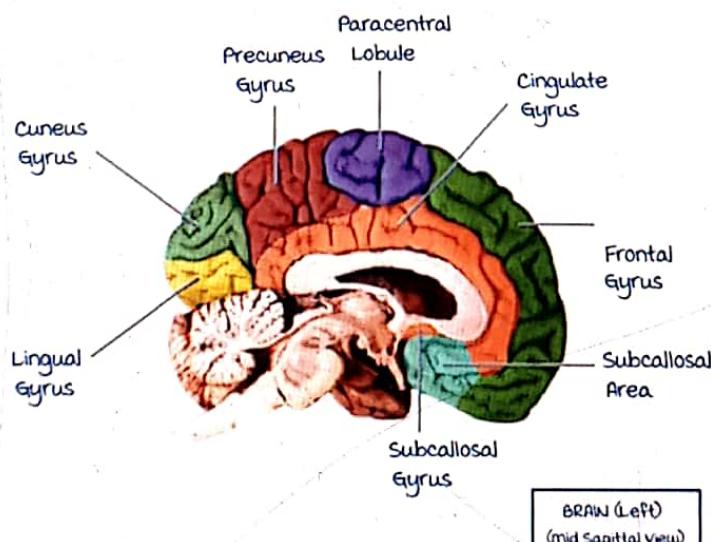
Occipital lobe : area 17, 18 and 19 : visual cortex area.

**Superior temporal lobe :**

- Anterior part : area 41 and 42 : auditory area (Heschl's gyrus).
- Posterior part : area 22 : Wernicke's area (sensory area for speech).

Middle temporal gyrus.

Inferior temporal gyrus.

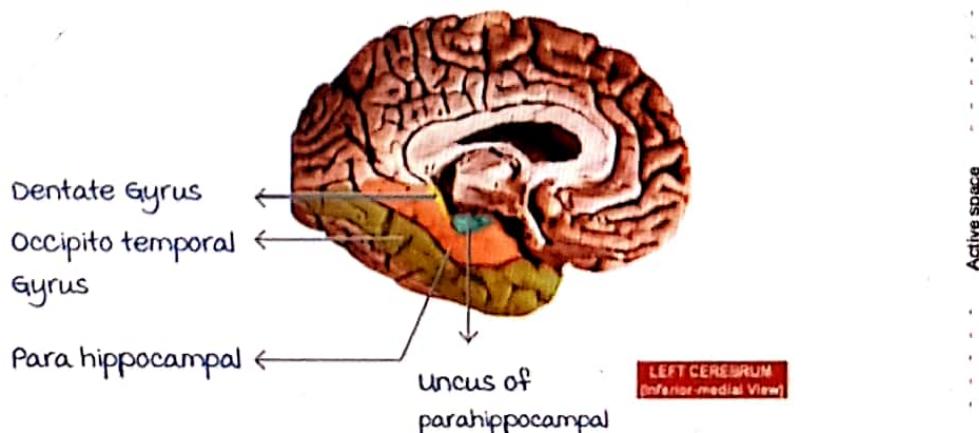


- Cingulate gyrus : limbic system.

- Paracentral lobule :

Centre for lower limb and perineum.

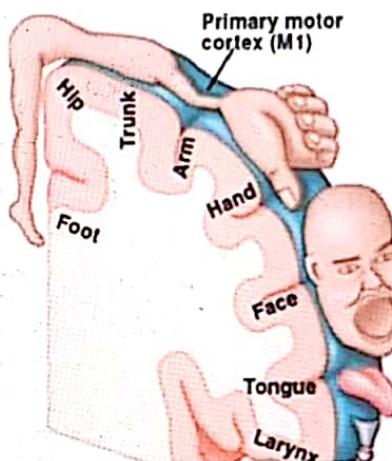
Highest area for micturition and defaecation.



- Uncus of Para hippocampal gyrus : area 28 : olfactory area.

## Areas of presentation in the cerebrum

00:20:22



Depends on the skill of the organ, and **not** the size.

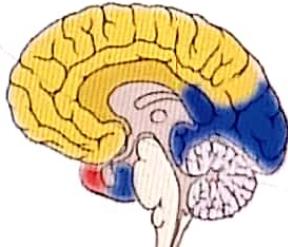
Areas are represented in the inverted manner.

Lower limb and the perineum : represented on the medial surface of the cerebrum.

**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

## Blood supply :

00:22:08

Lateral BrainMedial Brain

- Anterior Cerebral Artery
- Middle Cerebral Artery
- Posterior Cerebral Artery

- Lesion in the middle cerebral artery :

Contralateral sensory and motor loss involving upper limb and the face. **Broca's and Wernicke's aphasia.**

- Lesion in the anterior cerebral artery :

Contralateral sensory and motor loss involving the lower limb and the perineum.

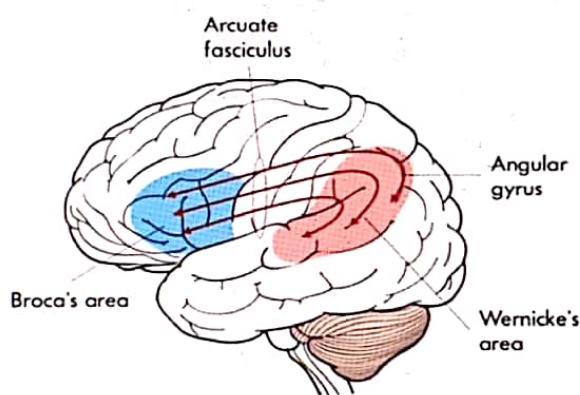
- Lesion in the posterior cerebral artery :

Contralateral homonymous hemianopia with macular sparing (normal middle cerebral artery).

Aphasias

00:25:22

Broca's area is connected to Wernicke's sensory and motor area by arcuate fasciculus.



Aphasia	Comprehension	Fluency	Repetition
Broca's (motor) aphasia	Normal	Affected	Affected
Wernicke's (sensory) aphasia	Affected	Normal	Affected
conduction aphasia (lesion in arcuate fasciculus)	Normal	Normal	Affected

# WHITE MATTER OF CEREBRUM

## Types of fibres

00:00:03

- Association fibre :  
Connects different areas within the same hemisphere, in the same lobe.  
Example : fornix
- Commissural fibre :  
Connects the identical areas of opposite sides.  
Example : corpus callosum, fornix.
- Projection fibre :  
Connects cortical area to subcortical area.  
Example : corona radiata, internal capsule, fornix.

**Note :** All these fibres are present in fornix.  
(for answers consider A>C>P).

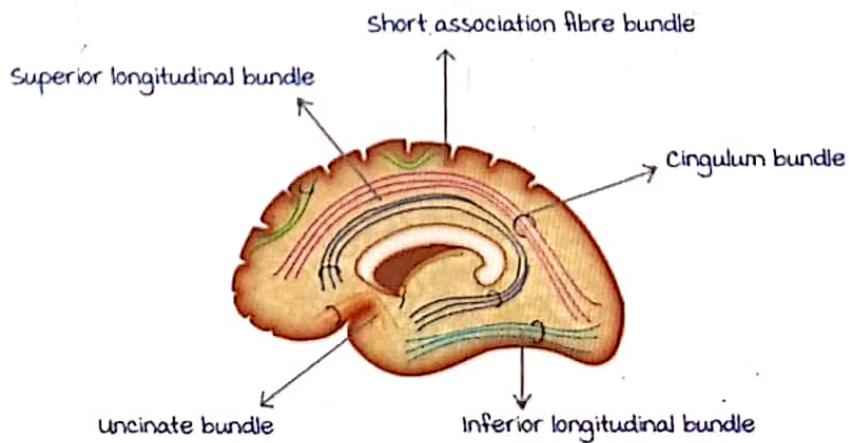
## Association fibres

00:02:47

Divided into short and long association fibres.

Long association fibres include:

- Cingulum bundle,
- Uncinate bundle
- Superior and inferior longitudinal bundles.



Active space

## Commissural fibre

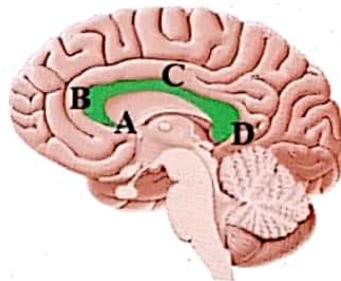
00:04:23

A : Rostrum.

B : Genu.

C : Body.

D : Splenium.

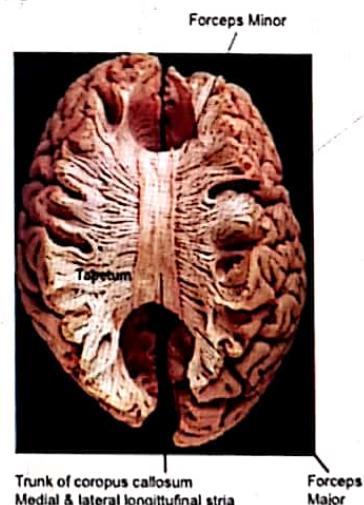


- Rostrum connects : two orbital surfaces of frontal lobe (2017 AIIMS)
- Genu connects : frontal lobes.
- Body connects : parietal and temporal lobes.
- Splenium connects : two occipital lobes.

Forceps major : fibres from splenium projecting into the occipital lobe.

Forceps minor : Fibres arising from genu, sweeping into the frontal lobe.

Fibres from the body and splenium of corpus callosum form the roof and lateral wall of posterior horn of lateral ventricle.



## Internal capsule

00:10:03

Internal capsule is an example for projection fibres. (2019 NEET)

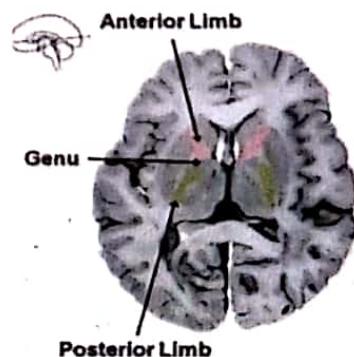
It connects the cortical structures to subcortical structures.

Relations of internal capsule :

- medially : caudate nucleus and thalamus.
- Laterally : lentiform nucleus.

Parts of internal capsule :

- Anterior limb.
- Genu.
- Posterior limb.

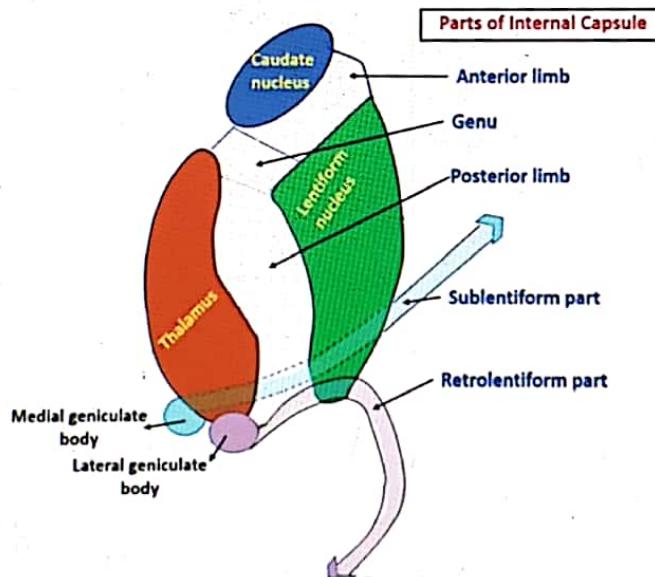


Relations of anterior limb of internal capsule :

- medially : caudate nucleus.
- Laterally : lentiform nucleus.

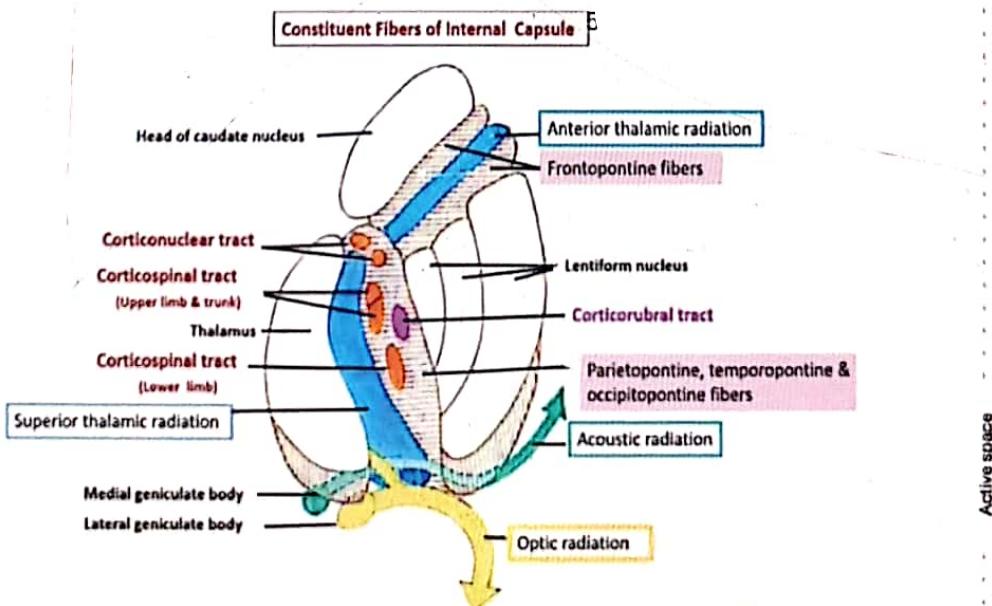
Relations of posterior limb of internal capsule :

- medially : thalamus.
- Laterally : lentiform nucleus.



### Fibres passing through internal capsule

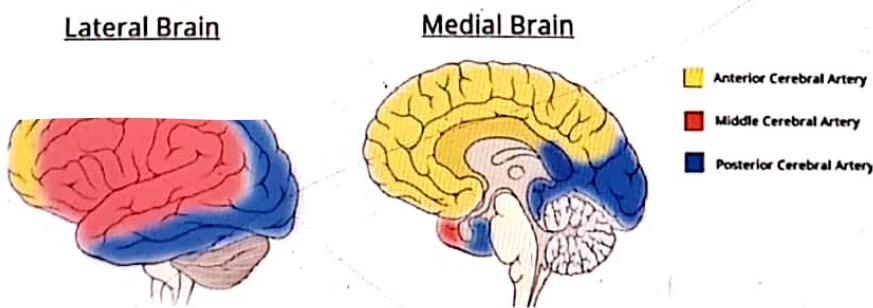
00:15:13



Parts	motor fibres	Sensory fibres
Anterior limb	Frontopontine fibres	Anterior thalamic radiation fibre
Genu	Corticounuclear tract	Superior thalamic radiation fibre
Posterior limb	Corticospinal tract Corticorubral tract	Superior thalamic radiation fibre
Retro-lentiform	Parietopontine fibres and occipitopontine fibres	Optic radiation fibre
Sub-lentiform	Parietopontine fibres and temporopontine fibres	Auditory radiation fibre

### Blood supply of internal capsule

00:22:27

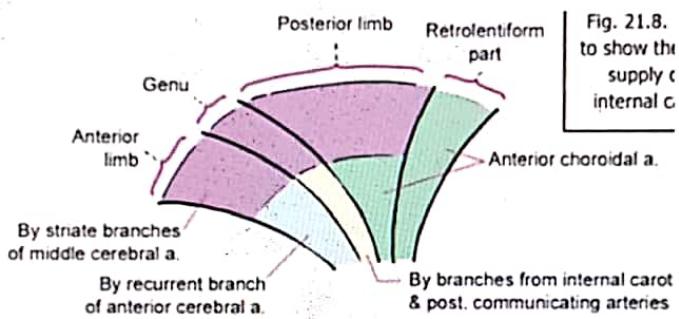


Cerebral arteries give three types of branches :

1. Cortical branch : supplies outer surface.
2. Central / striate branches : supplies inner surface.
3. Choroidal artery : forms choroid plexus.

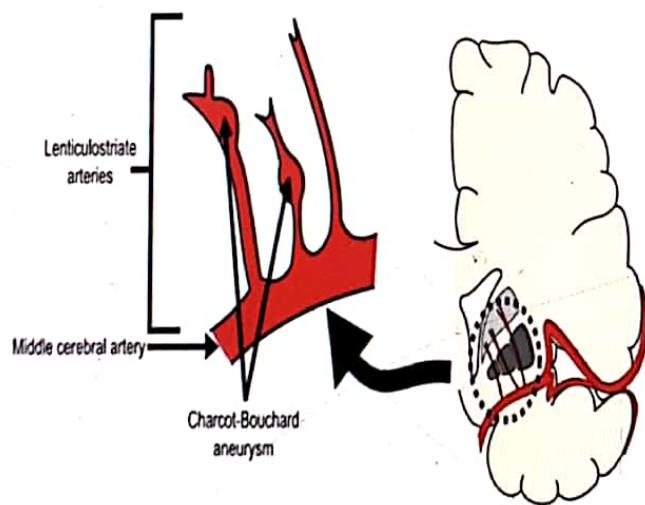
Internal capsule is majorly supplied by the striate branches.

- medial striate branch : branch of anterior cerebral artery.
- Lateral striate branch : branch of middle cerebral artery.
- Posterior striate branch : branch of posterior cerebral artery.



## Charcot-Bouchard aneurysm

00:26:34



It's an aneurysm most commonly seen in striate branches from middle cerebral artery.

Artery of Charcot haemorrhage : lateral striate artery. (IPMER 2018)

Recurrent artery of Heubner : medial striate artery.

Active space

## Blood supply of parts of internal capsule

00:28:13

Anterior limb	superior part : lateral striate artery	inferior part : recurrent artery of Heubner
Genu	superior part : lateral striate artery	Inferior part : direct branches from internal carotid artery
Posterior limb	superior part : lateral striate artery	Inferior part : anterior choroidal artery
Retro-lentiform	Anterior choroidal artery	
Sub-lentiform	Anterior choroidal artery	

**Note :** Posterior limb is also supplied by posterior cerebral artery.

# BLOOD SUPPLY OF BRAIN

## Introduction

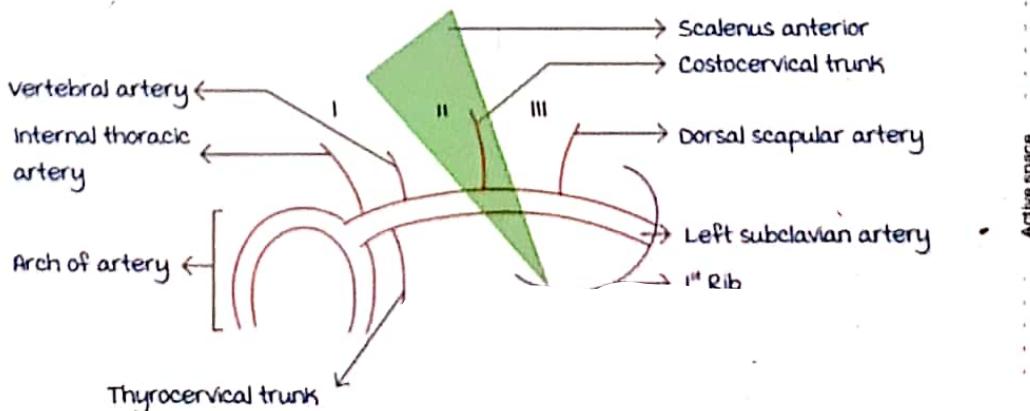
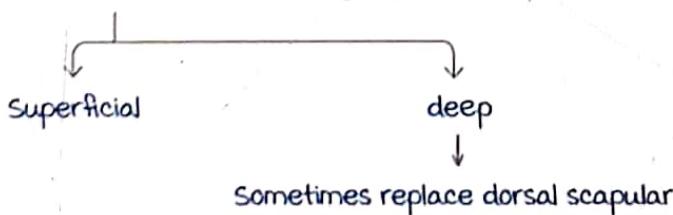
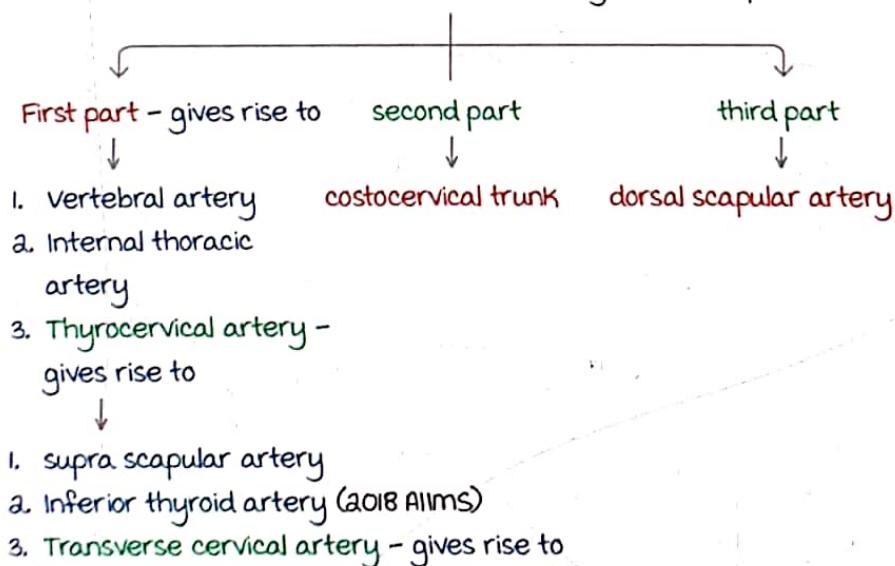
00:00:01

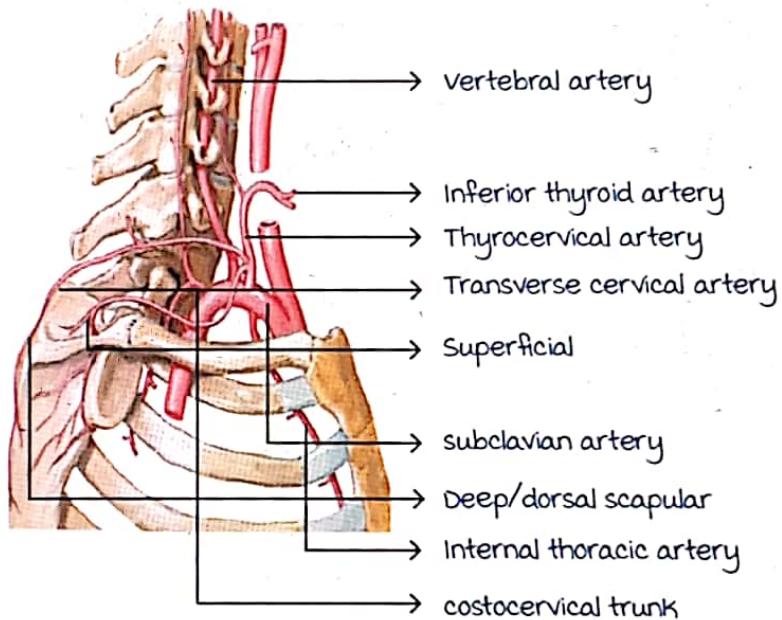
The brain is supplied by two vessels—carotidobasilar

- Carotid = internal carotid artery
- Basilar artery = formed by two vertebral arteries (a branch of first part of subclavian artery).

Left subclavian artery arises from arch of aorta.

The scalenus anterior muscle divides the artery into three parts:





## Vertebral artery (VA)

00:07:08

It is a branch from first part of subclavian present in neck (deeply located). It is related to stellate ganglion located at the level C7. Therefore, the block is not given at the level of C7 and can be at C6. At C7, foramen transversarium does not transmit vertebral artery.

At the level of C6



vertebral artery enters foramen transversarium (feature of cervical vertebrae) and part of VA



Ascends to C1



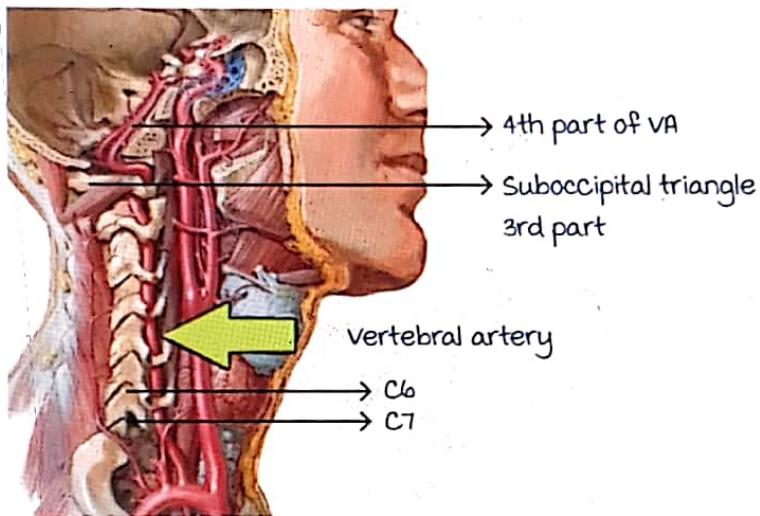
In the Suboccipital triangle (a triangle below the occipital bone) third part of VA



The VA enters cranial cavity through foramen magnum fourth part of VA

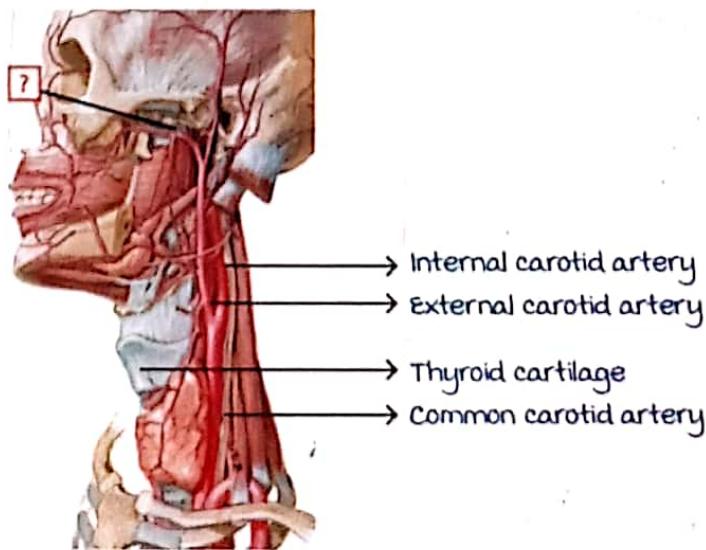
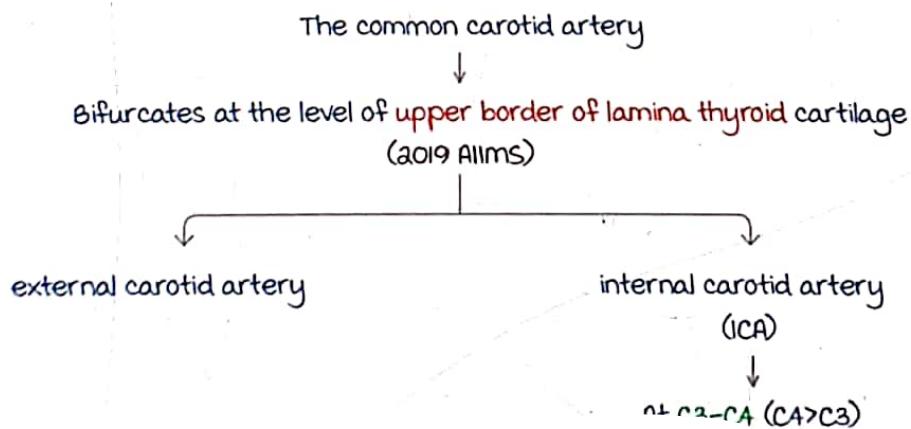


The two vertebral arteries join to form basilar artery.



### Internal carotid artery

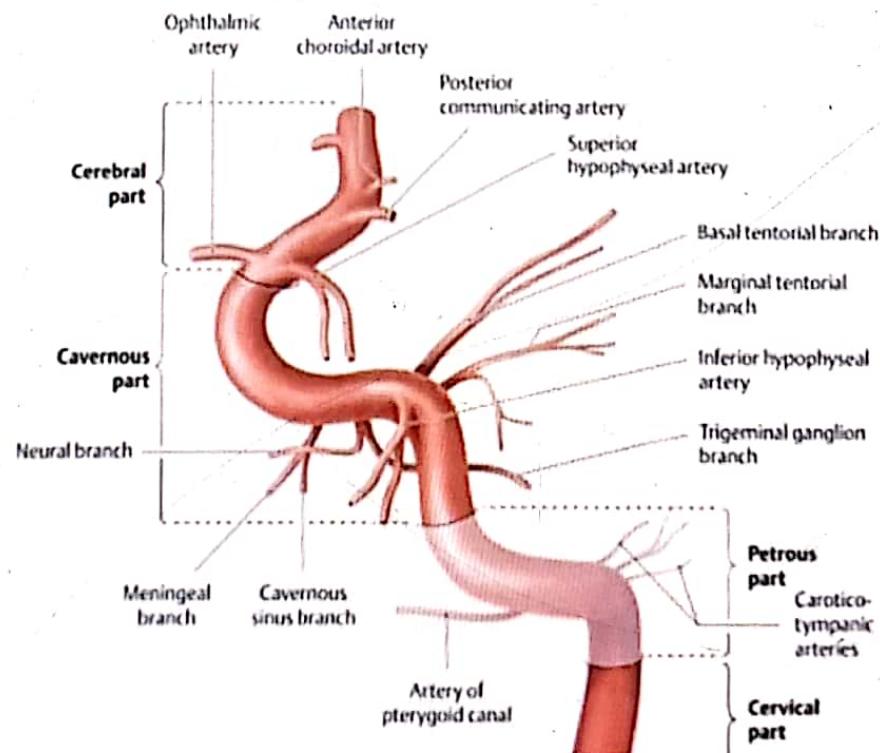
00:12:36



Active space

## Parts of ICA:

- First part - **cervical** - gives no branch in the neck
- Second part - **petrous**  
ICA enters the cranial cavity through the carotid canal and traverses the superior part of foramen lacerum.
- Third part - **cavernous**  
ICA passes inside the cavernous sinus along with the abducens nerve.
- Fourth part - **cerebral**  
Gives rise to middle (largest branch of ICA) and anterior cerebral artery (terminal arteries).



## Branches of petrous:

1. **Carotidotympanic arteries**
2. **Artery of pterygoid canal**

## Branches of cavernous:

1. **Hypophyseal branch**
2. **Ganglionic branch supplies trigeminal ganglion**
3. **meningeal branch**

Branches of cerebral:

1. Posterior communicating artery
2. anterior choroidal artery
3. Ophthalmic artery

## Blood supply of the spinal cord, medulla, pons and midbrain

00:18:38

Blood supply of spinal cord

1. Anterior spinal artery (ASA) - supplies anterior 2/3rd.
2. Posterior spinal artery (PSA) - supplies posterior 1/3rd. It can arise from VA or PICA (posterior inferior cerebellar artery).

Blood supply of medulla

1. PSA
2. ASA
3. VA
4. PICA
5. medullary branch from basilar artery.

Clinical correlation:

medial medullary syndrome - ASA

Lateral medullary syndrome - VA > PICA

Blood supply of pons

1. AICA (anterior inferior cerebellar artery)
2. Superior cerebellar artery
3. Pontine branch of basilar artery

The labyrinthine artery arises from AICA or basilar artery  
(AICA > basilar artery 2015 AIIMS)

Blood supply of cerebellum (2020 NEET)

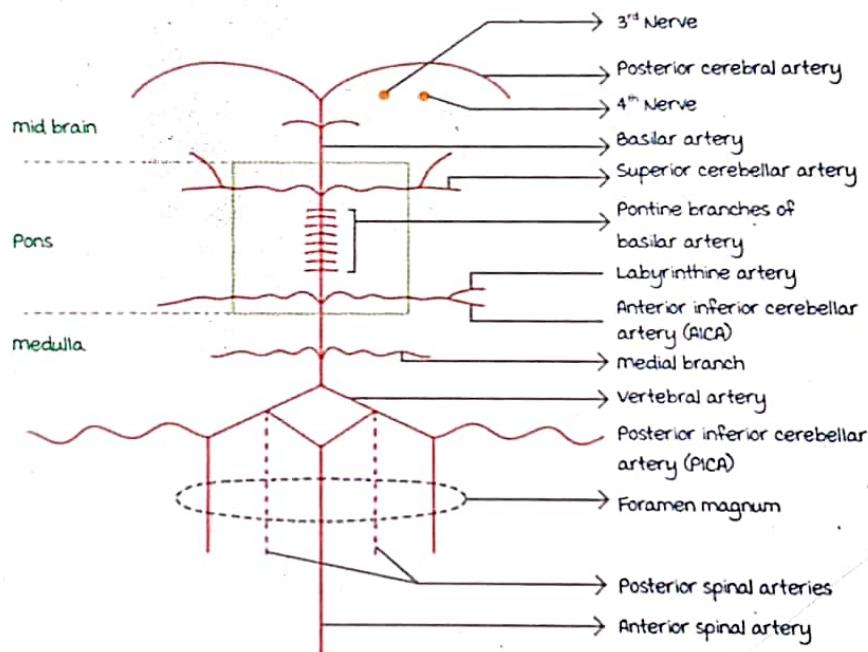
1. Superior cerebellar artery - branch of basilar
2. AICA - branch of basilar
3. PICA - branch of VA

The 3rd nerve and 4th nerve are present between posterior cerebral and superior cerebellar artery (2017 JIPMER)

Active space

### Blood supply of midbrain

1. Posterior cerebral artery
2. Branches from basilar artery
3. Superior cerebellar artery

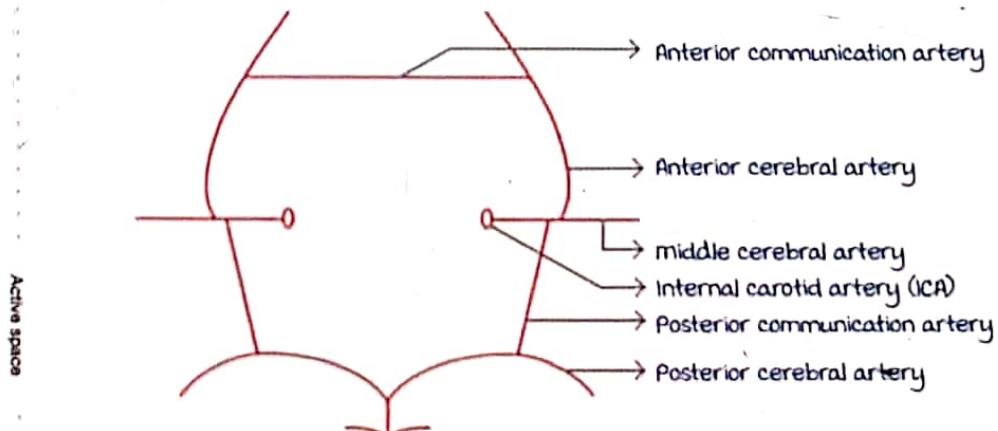


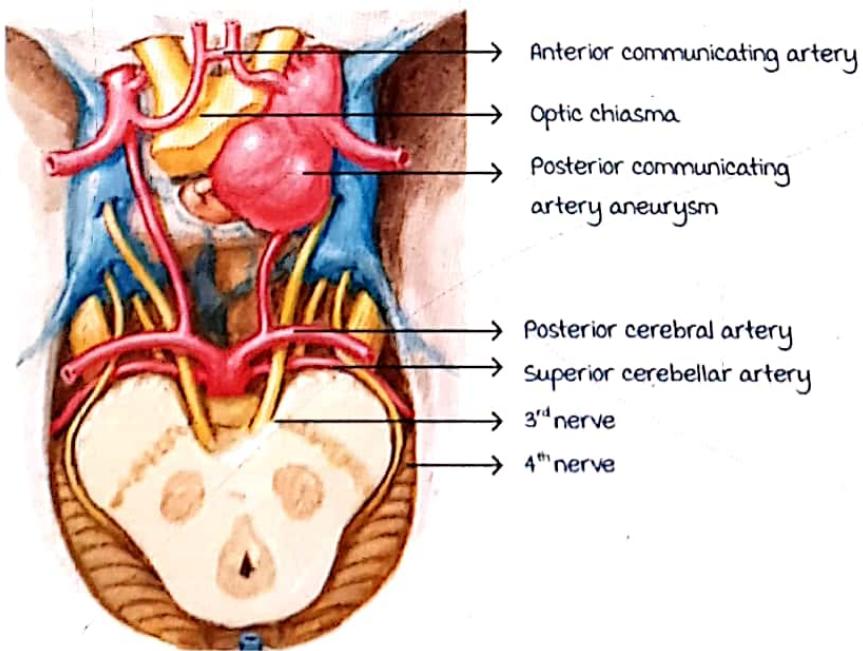
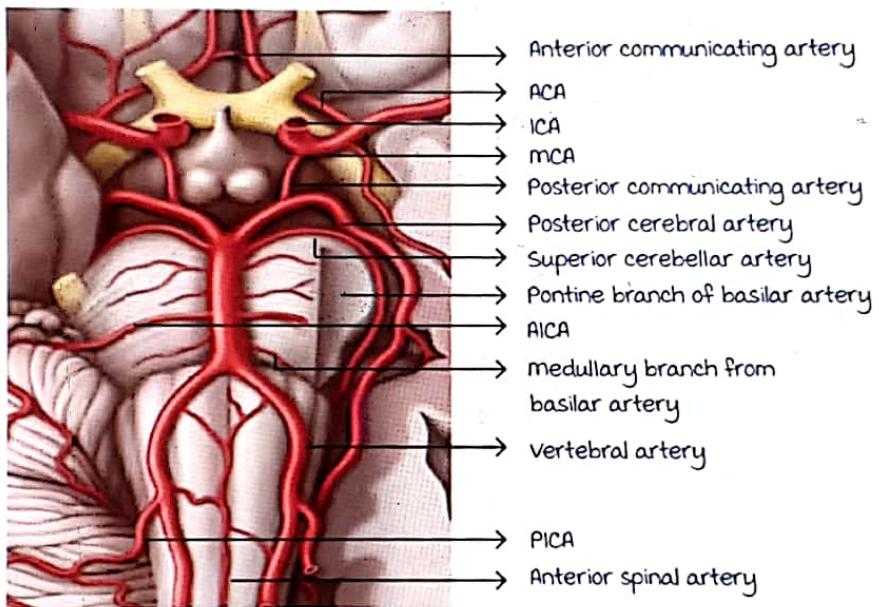
**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

### Circle of Willis

00:29:18

middle cerebral artery is **not** involved in circle of willis





The third nerve is compressed in the aneurysm of posterior communicating artery.

The optic chiasma is compressed in the aneurysms of anterior communicating artery.

Active space

## Blood supply of optic chiasma, optic tract

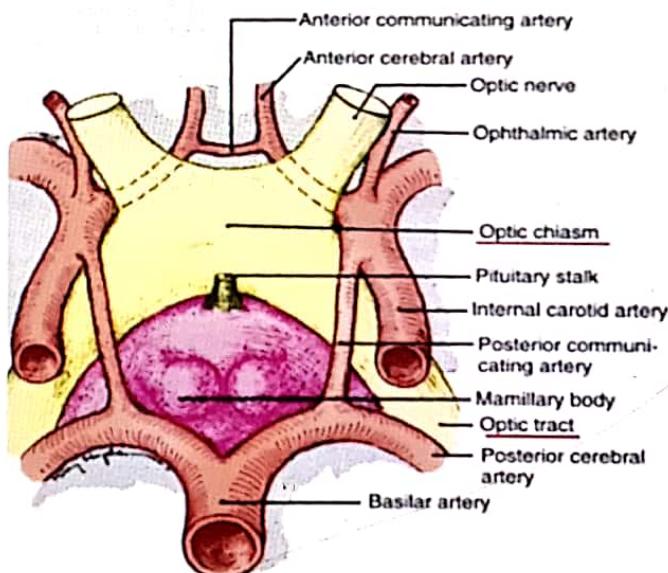
00:35:41

Optic chiasma supplied by

1. Anterior cerebral artery
2. ICA

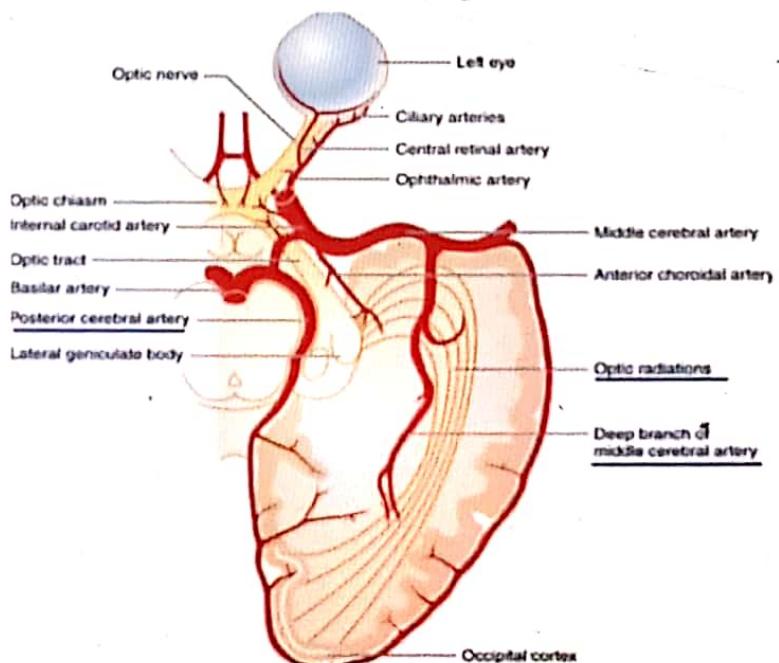
Optic tract supplied by

1. Posterior communicating artery
2. Anterior choroidal artery



Optic radiations supplied by :

1. Posterior cerebral artery
2. Deep branch of middle cerebral artery



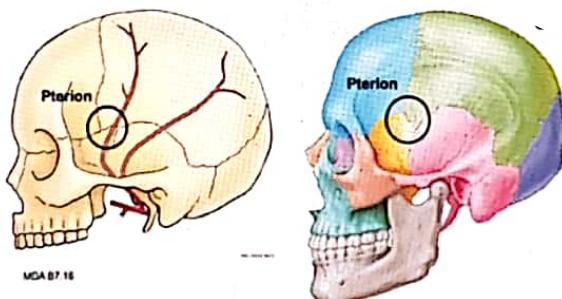
Clinical correlation (2020 AIIMS) :

Pterion is a meeting of the sphenoid, temporal, parietal and frontal bones.

Fracture of the pterion causes laceration of anterior branch of middle meningeal artery



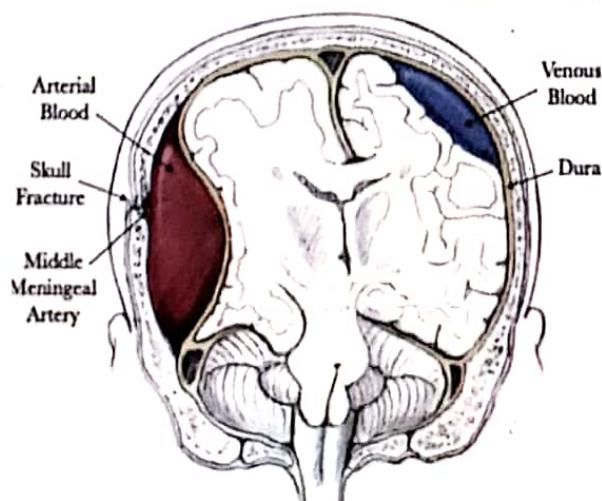
Leads to epidural haemorrhage.



Fracture of pterion can be especially dangerous due to potential laceration of a branch of the middle meningeal artery

epidural haemorrhage (EDH)	Subdural haemorrhage (SDH)
Rupture of middle meningeal artery	Rupture of bridging veins
Lucid interval present (EDH > SDH)	Lucid interval present

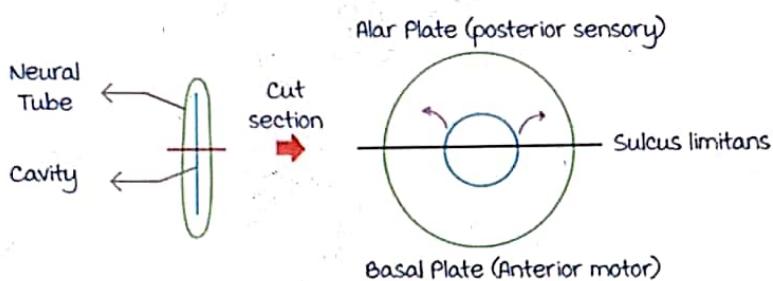
Epidural Hematoma  
(Does Not Cross Suture Line)



Subdural Hematoma  
(Crosses Suture Line)

Active space

## FUNCTIONAL COLUMNS OF CRANIAL NERVE NUCLEUS



All the motor components are derived from basal plate

Eg : Hypoglossal nucleus

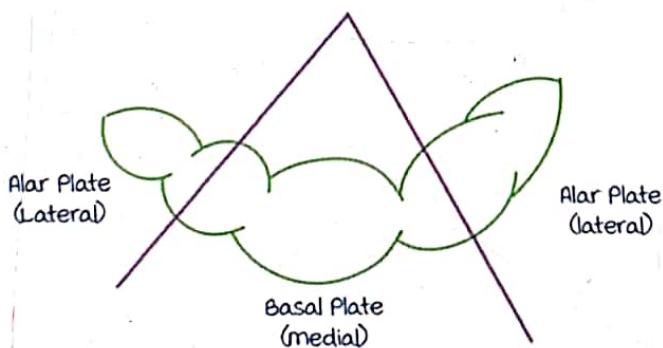
All the sensory components are derived from the alar plate

Eg : vestibular nucleus

When the cavity is open,

Anterior (motor) becomes medial

Posterior (sensory) becomes lateral

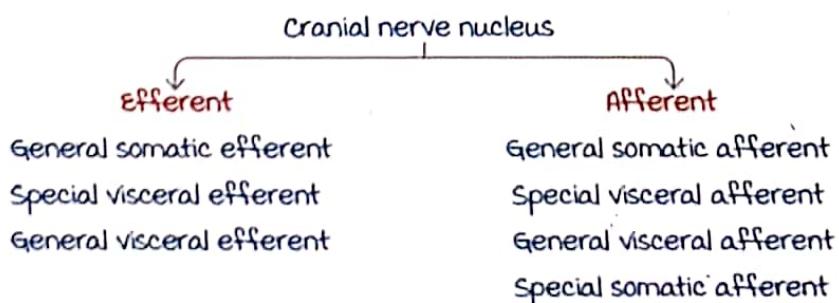


In medial medullary syndrome, **motor** component affected.

In lateral medullary syndrome, **sensory** component affected.

### Classification of cranial nerve nucleus

00:07:42



Active space

### General somatic efferent:

- Somatic origin - head & neck muscles
- Occipital somites - tongue muscles (supplied by 12<sup>th</sup> cranial nerve)
- Pre-occipital somites - extra ocular muscles (by 3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup> cranial nerve)
- Cervical somites - diaphragm.

Contains 3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, 12<sup>th</sup> cranial nerve nucleus

### Special visceral efferent:

motor fibres to pharyngeal arch muscles.

1<sup>st</sup> pharyngeal arch - mandibular nerve - motor nucleus of Trigeminal nerve

2<sup>nd</sup> pharyngeal arch - facial nerve - motor nucleus of facial nerve

3<sup>rd</sup> pharyngeal arch - glossopharyngeal nerve - nucleus ambiguus

4<sup>th</sup> pharyngeal arch - superior laryngeal nerve - nucleus ambiguus

6<sup>th</sup> pharyngeal arch - recurrent laryngeal nerve - nucleus ambiguus

### Nucleus ambiguus

- it is a group of large motor neurons situated deep in the medullary reticular formation.
- Fibers from it are distributed to the pharyngeal constrictors, intrinsic laryngeal muscles and striated muscles of the palate and upper oesophagus
- Nerves related to nucleus ambiguus : 9,10 > 9,10,11

Pharyngeal plexus formed by 9<sup>th</sup>, 10<sup>th</sup> nerve + superior cervical ganglion.

- Almost all of the nerve supply to pharynx, motor and sensory is derived from the Pharyngeal plexus.

### General visceral efferent

00:16:31

Parasympathetic column - carries Secretomotor fibres.

- Inferior salivatory → IX → nucleus Otic → ATN → ganglion Parotid

IX nerve : preganglionic

## Parasympathetic

## Parotid

## Otic ganglion

- Superior salivatory  $\xrightarrow{VII}$  submandibular  $\longrightarrow$  submandibular gland nucleus ganglion sublingual gland
  - Lacrimal nucleus  $\xrightarrow{VII}$  pterygopalatine ganglion  $\longrightarrow$  Lacrimal  
(Caudal part of sup.  
Salivatory nucleus) Nasal  
Palatal
  - Edinger west-  $\xrightarrow{III}$  ciliary ganglion  $\longrightarrow$  sphincter pupillae  
phal nucleus ciliaris
  - Dorsal nucleus of vagus

Nucleus in general visceral efferent:

## Inferior salivatory nucleus

## Superior salivatory nucleus

## Edinger westphal nucleus

## Dorsal nucleus of vagus

Cranial nerve with parasympathetic function : 3<sup>rd</sup>, 7<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>.

## Afferent columns

00:26:22

### Special Visceral afferent (SVA)

### General visceral afferent (GVA)

 nucleus tractus solitarius  
(general + taste sensation)

Special visceral afferent: taste pathway

Anterior 2/3<sup>rd</sup> of tongue - 7<sup>th</sup> nerve

Posterior 1/3<sup>rd</sup> of tongue - 9<sup>th</sup> nerve

Posterior most part of tongue- 10<sup>th</sup> nerve

General somatic afferent (GSA) :

General sensations from the face (only by Trigeminal nerve)

- mesencephalic nucleus - midbrain
- Chief sensory nucleus - pons
- Spinal nucleus - medulla and C1, C2 of spinal cord

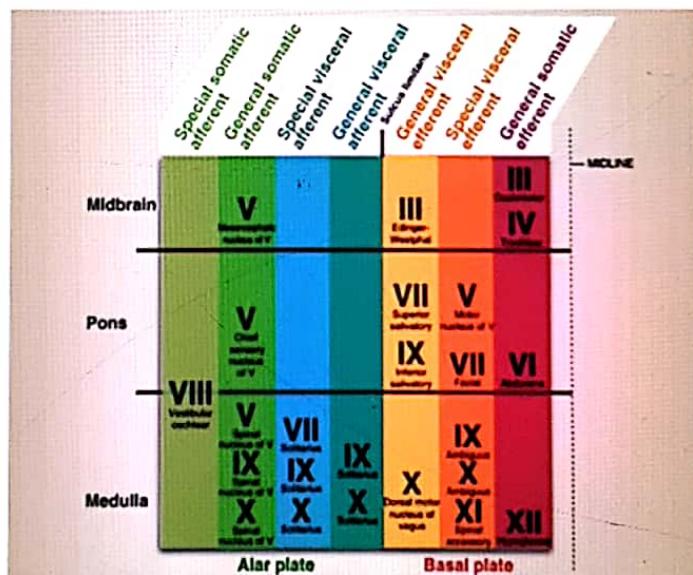
mesencephalic nucleus carries proprioceptive fibres

Trigeminal nerve : 4 nuclei

3 general somatic afferent + 1 special visceral efferent

Special somatic afferent (SSA) :

- Vestibular nucleus
- Cochlear nucleus



# DEVELOPMENT OF OSTEOLGY AND UPPER LIMB

## Development of upper limb

00:00:43

Upper limb bud develops by the end of the fourth week.  
 Lower limb bud develops by the end of fifth week.

The muscles are derived from the **myotome** of the somite (paraxial mesoderm).

The bones are derived from a **somatic layer** of lateral mesoderm.

The upper limb bud rotates 90° laterally

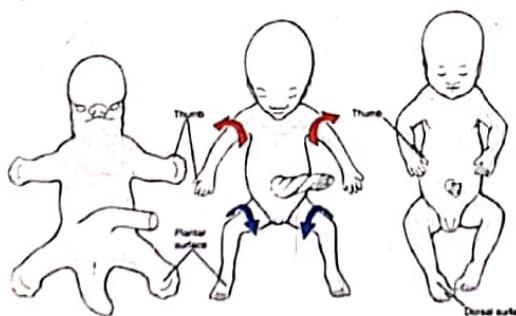
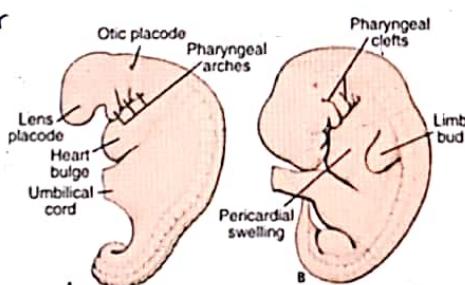
Flexor - anterior

Extensor - posterior

The lower limb rotates 90° medially

Extensor - anterior

Flexor - posterior



## Dermatomes

00:03:38

Active space

The tip of the shoulder - **C4**

(Phrenic nerve - C3, **C4**, C5, if irritated pain radiates to tip of the shoulder).

Lateral side of the arm- C5

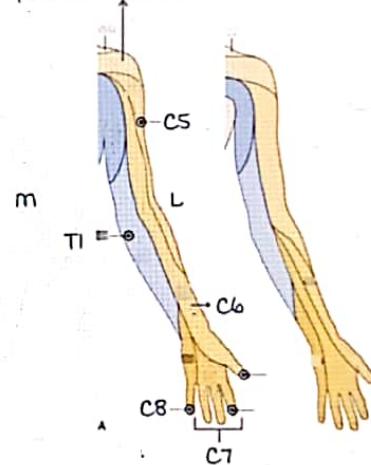
Lateral side of the forearm & thumb- C6

middle three fingers- C7

Little finger and medial side of forearm- C8

medial side of forearm- T1

Tip of the shoulder : C4



## Osteology: Clavicle/collar bone

00:06:29

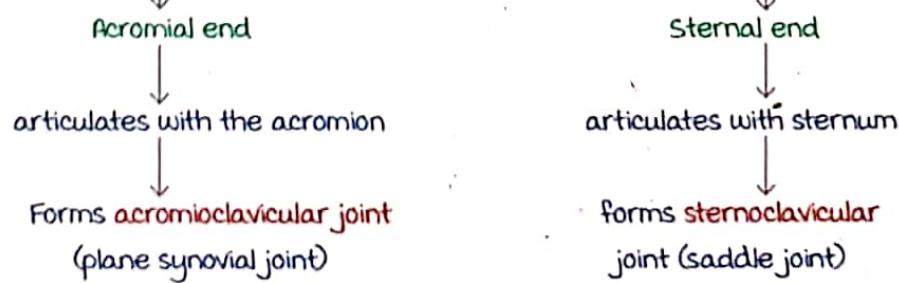
Clavicle/collar bone

It is a modified long bone, because :

- It is horizontally located
- It is subcutaneous
- There is no medullary cavity
- It ossifies by means of membrane.

There are two ends

Active space



Clinical correlation :

MC site for the fracture of clavicle - junction between medial  $\frac{2}{3}$ rd and lateral  $\frac{1}{3}$ rd.

(lateral  $\frac{1}{3}$ rd - flat, medial  $\frac{2}{3}$ rd - round/cylindrical).



### Ligaments involved in transmitting weight

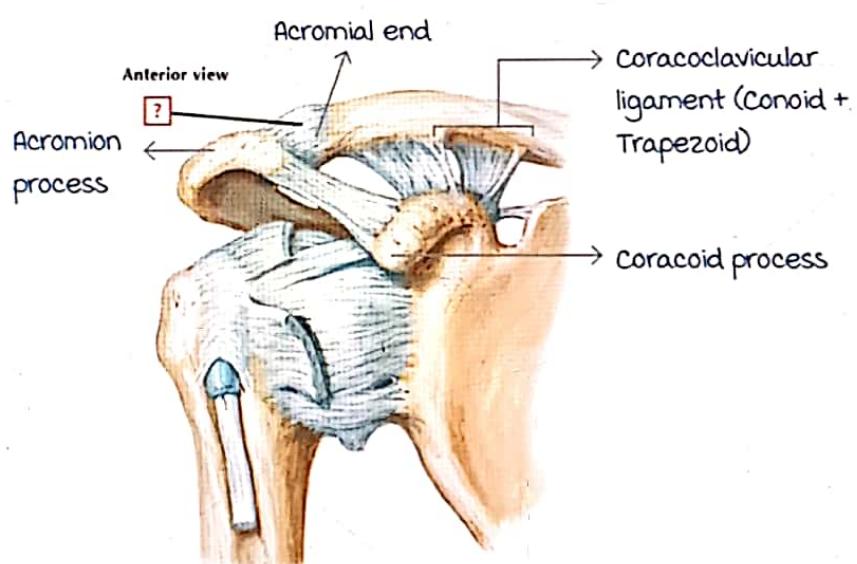
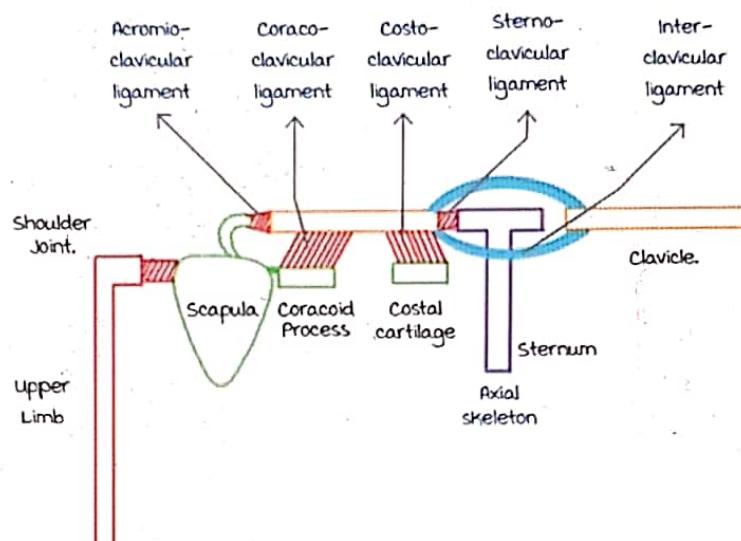
00:10:23

The ligaments involved in transmitted weight from appendicular skeleton to axial skeleton are :

- Acromioclavicular ligament
- Coracoclavicular ligament
- Sternoclavicular ligament
- Costoclavicular ligament
- Inter-clavicular ligament

The joints involved are :

- Acromioclavicular joint
- Sternoclavicular joint



## Scapula

00:16:10

**Borders:**

medial border - serratus anterior muscle inserted.

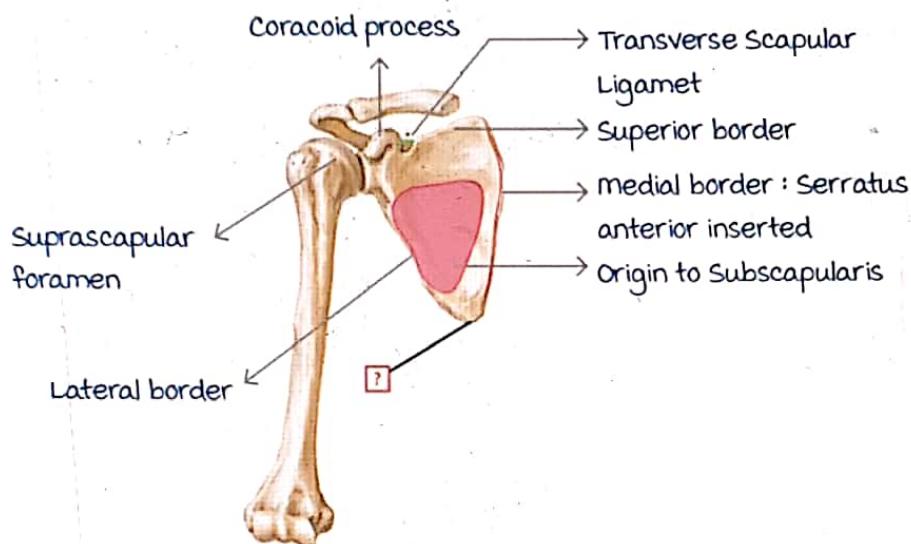
Lateral border and front of the scapula - origin of subscapularis.

Superior border - transverse ligamentis present

Creates suprascapular foramen

Transmits suprascapular nerve.

Active Space



Note : Suprascapular artery passes above the suprascapular foramen.

Coracoid process :

**Three muscles attached:**

1. Pectoralis minor
2. Coracobrachialis
3. Short head of biceps

Angles of scapula

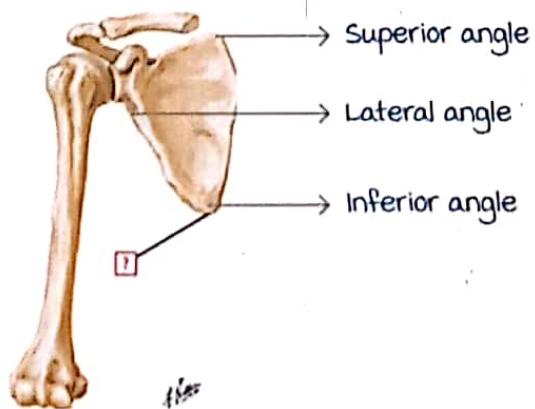
Superior angle - located at the level of T2

Inferior angle - located at T7 spine, T8 body (2019 FMGE)

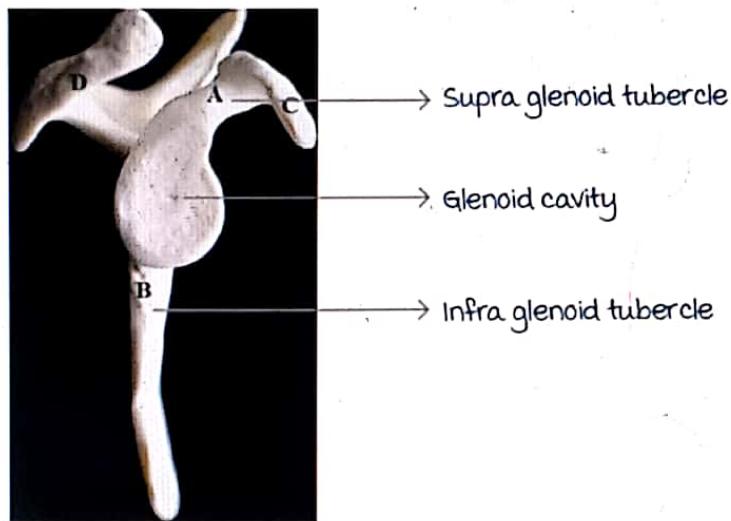
Lateral angle - glenoid cavity articulates with head of humerus



Forms shoulder joint



Active space



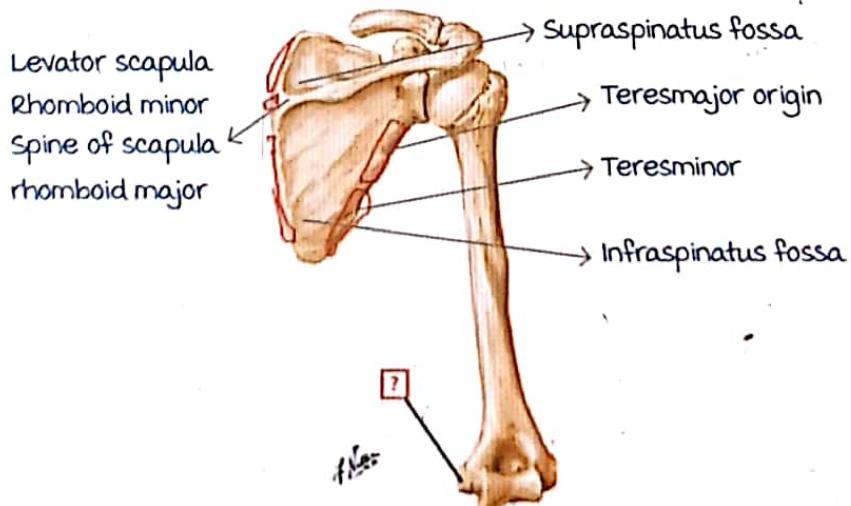
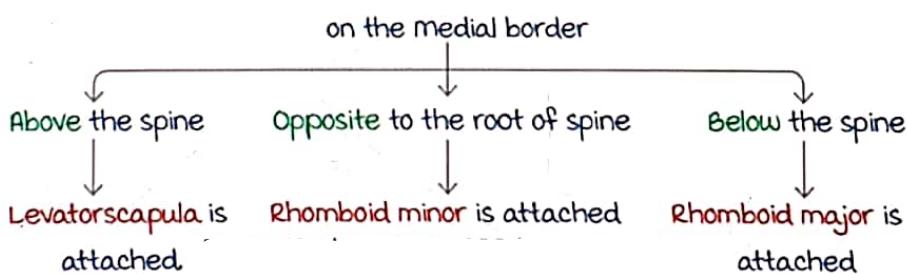
Supra glenoid tubercle- long head of biceps is attached.

Infra glenoid tubercle- long head of triceps is attached.

Supraspinatus fossa- supraspinatus is attached.

Infraspinatus fossa- infraspinatus is attached.

Lateral border of posterior surface- origin of teres minor and teres major muscles.



Scapula- posterior view

medial border - only of insertion

- Anteriorly serratus anterior
- Posteriorly levator scapula, rhomboid minor and major.

Lateral border - only for origin

- Anteriorly subscapularis
- Posteriorly teres minor and major

## Humerus

00:25:25

Upper end of humerus parts :

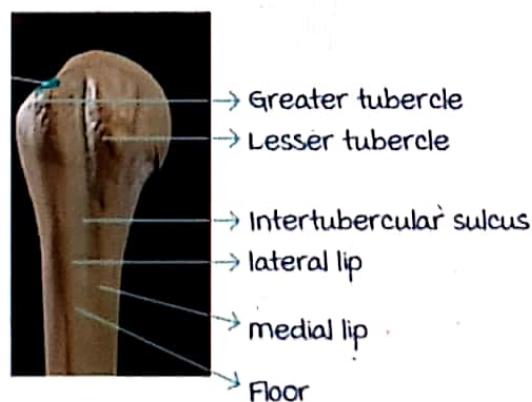
- Head of humerus
- Neck of humerus - related to axillary nerve
- Lesser tubercle - subscapularis muscle is attached
- Greater tubercle - supraspinatus  
Infraspinatus  
Teres minor } + subscapularis - form rotator cuff muscles
- Intertubercular sulcus - lateral lip - pectoralis major is attached  
medial lip - latissimus dorsi is attached  
Floor - teres major is attached

The axillary nerve

It supplies deltoid and teres minor muscles

It gives rise to upper lateral cutaneous nerve of arm

Injury causes a regimental batch of anaesthesia.



medial border- only of insertion

- Anteriorly serratus anterior
- Posteriorly levator scapula, rhomboid minor and major.

Lateral border- only for origin

- Anteriorly subscapularis
- Posteriorly teres minor and major

## Humerus

00:25:25

Upper end of humerus parts :

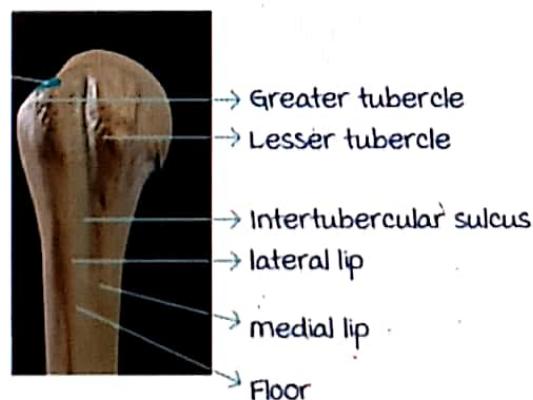
- Head of humerus
- Neck of humerus- related to axillary nerve
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Infraspinatus  
Teres minor
- + subscapularis- form rotator cuff muscles
- Intertubercular sulcus- lateral lip- pectoralis major is attached  
medial lip- latissimus dorsi is attached  
Floor- teres major is attached

The axillary nerve

It supplies deltoid and teres minor muscles

It gives rise to upper lateral cutaneous nerve of arm

Injury causes a regimental batch of anaesthesia.



## Spaces in the axilla

00:33:07

Quadrangular space:

**Boundaries:** above - teres minor

Below - Teres major

medially - long head of triceps

Laterally - surgical neck of humerus

Contents - axillary nerve

Posterior circumflex humeral vessel

Triangular interval:

**Boundaries:** above - teres major

medially - long head of triceps

Laterally - shaft of humerus

Contents - radial nerve

Profunda brachii artery

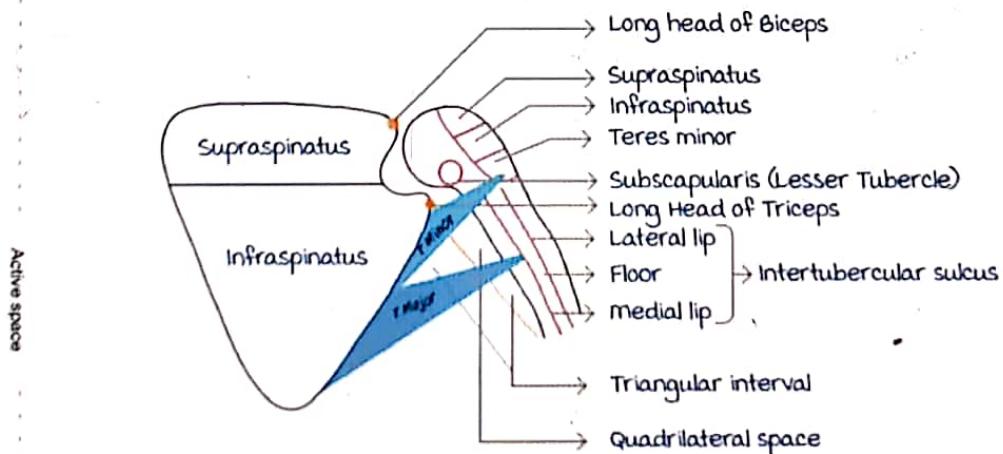
Triangular space:

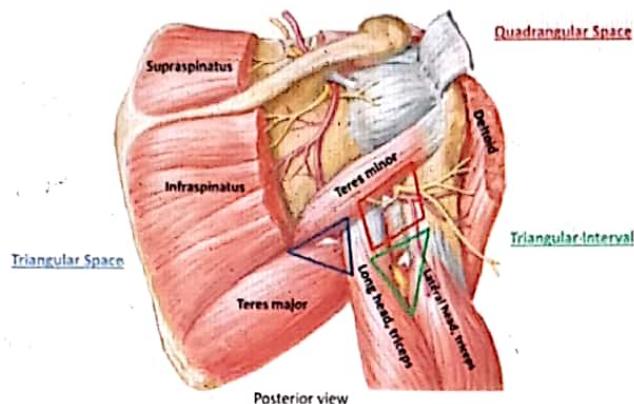
**Boundaries:** above - teres minor

Below - teres major

Base - long head of triceps

Contents - circumflex scapular vessel.





## Axilla: Boundaries, contents and lymphatic drainage

00:39:21

### Boundaries :

Anterior- pectoralis major and minor

Posterior- subscapularis muscle, teres major, latissimus dorsi

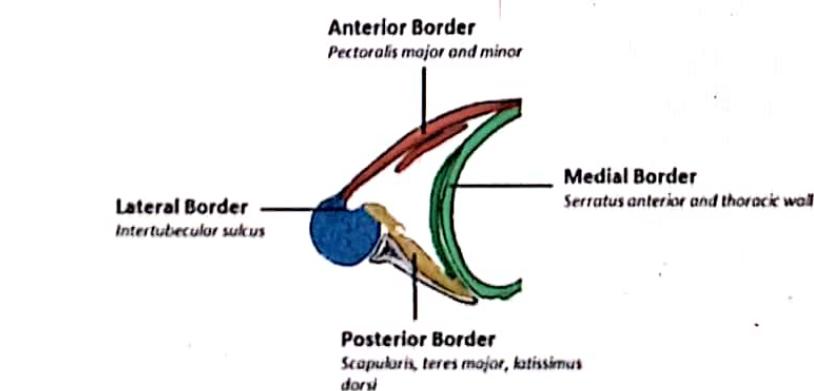
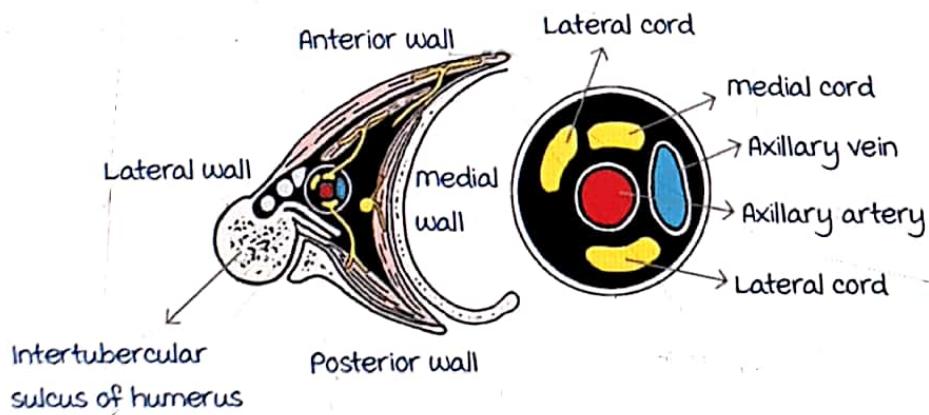
medial- rib, serratus anterior - supplied by long thoracic nerve

Lateral - intertubercular sulcus of humerus

### Contents of axilla - axillary vein

Axillary artery

Cords of brachial plexus (medial, lateral, posterior).



Active space

### Axillary lymph nodes

There are five groups:

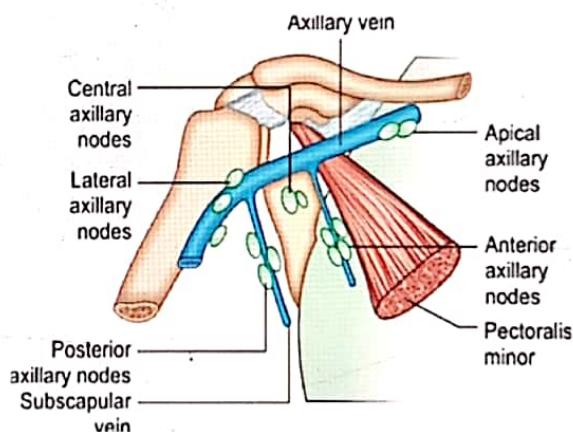
- Anterior- pectoral nodes- accompanied by lateral thoracic vein
- Lateral- humeral nodes- accompanied by axillary vein
- Posterior- subscapular nodes- accompanied by subscapular vein
- Central
- Apical

### Lymph drainage pathway

Anterior + posterior + lateral nodes

↓  
Central nodes

↓  
Apical nodes



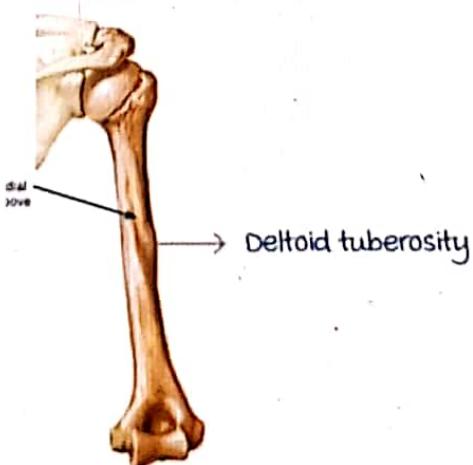
### Shaft and lower end of humerus

00:46:11

Shaft of humerus parts:

- Radial groove- radial nerve  
Profunda brachii artery
- Deltoid tuberosity- deltoid muscle insertion

Posterior View



### Lower end of the humerus

Parts :

- Trochlea
  - Capitulum
  - Coronoid fossa
  - Radial fossa
  - medial epicondyle
  - Lateral epicondyle
- **Intracapsular structures** (present inside the capsule)  
 (Except medial and lateral epicondyle)

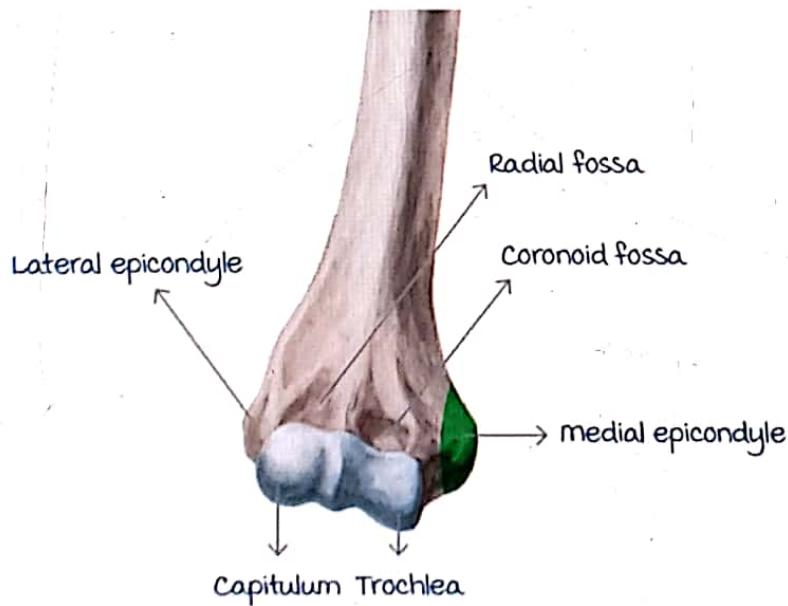
medial epicondyle - ulnar nerve is present behind the medial epicondyle.

Trochlea - articulates with trochlear notch of the ulna

↓  
 forms **Humeroulnar joint**

Capitulum - articulates with head of the radius

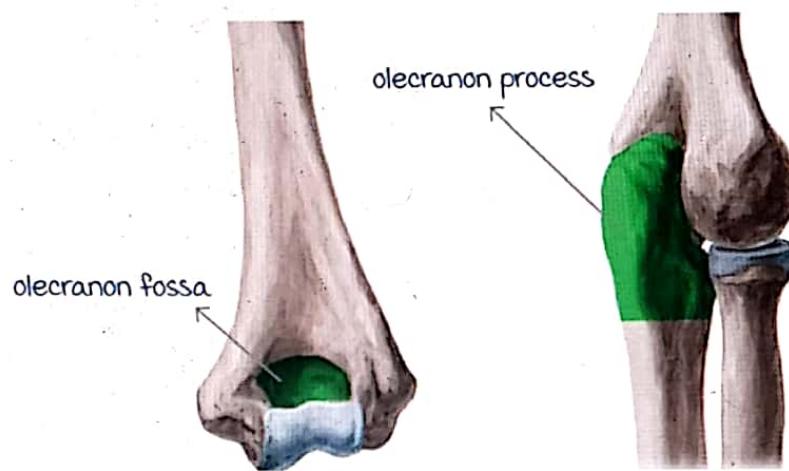
↓  
 forms **Humeroradial joint**



Active space

The olecranon fossa - articulates with **olecranon process** of ulna.

**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.



The medial epicondyle- common origin to flexors.

The lateral epicondyle- common origin to extensors.

### Radio ulnar joint

00:53:20

ulnar tuberosity- brachialis muscle is attached.

Radial tuberosity- biceps muscle is attached.

### Radio ulnar joint

Three parts- superior- pivot joint

middle- syndesmosis

Inferior- pivot joint

### Pronation and supination :

movement of radius over stationary ulna.

It occurs at three joints : humeroradial joint, superior and inferior radioulnar joint.

Pronation is done by- pronator teres(supplied by median nerve)

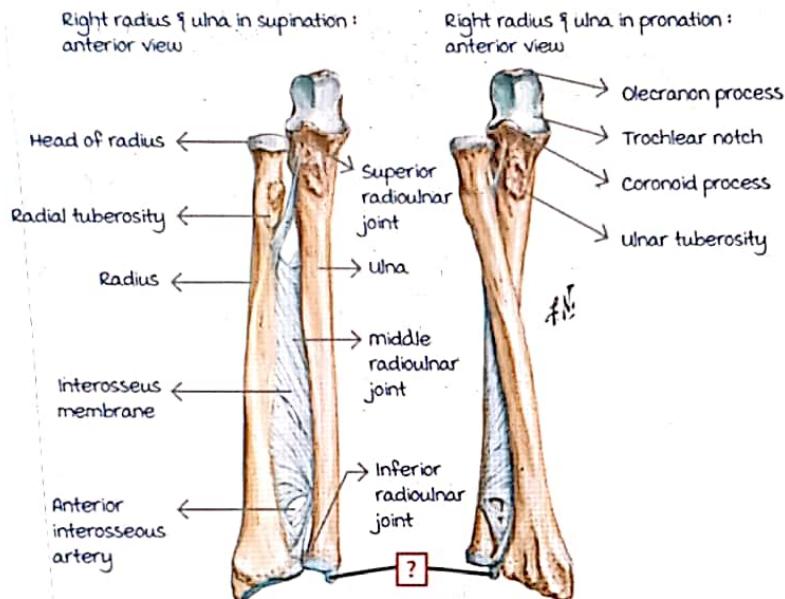
Pronator quadratus (supplied by anterior interosseous nerve)

Supination is done by- supinator (supplied by posterior interosseous nerve)

Biceps (supplied by musculocutaneous nerve)

### Interosseous membrane

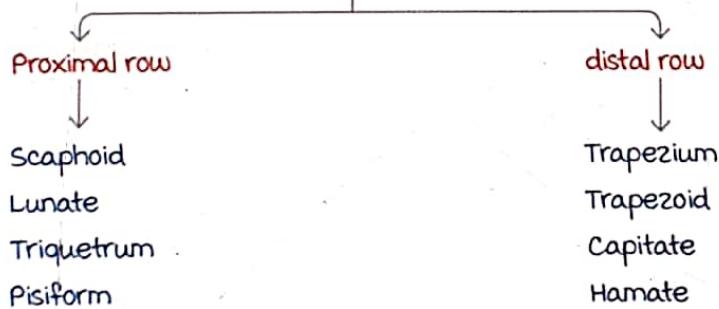
It is pierced by anterior interosseous artery.



### Carpal bones

00:59:44

They are eight in number and arranged in two rows:



Wrist joint:

Bones involved in wrist joint formation:

Proximally - lower end of radius

Distally - scaphoid, lunate, triquetrum

Ulna bone is not involved in the wrist joint formation (2018 AIIMS).

mc fractured bone - scaphoid

C/F - pain in the anatomical snuff box

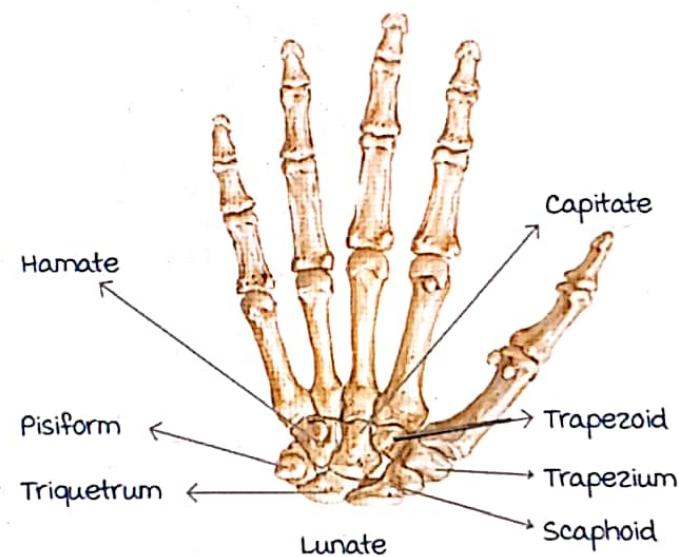
mc dislocated bone - lunate

**Pisiform bone**

- It is a sesamoid bone
- It is formed in the tendon of flexor carpi ulnaris
- It is the smallest bone
- It is the last carpal bone to ossify

**Capitate**

- It is the largest bone
- It is the first carpal bone to ossify

**Metacarpal bone**

01:05:58

They are five in number from lateral to medial side

**First metacarpal bone**

It does not articulate with other metacarpal bones.

It articulates only with the trapezius.

Base is convexo-concave forms saddle joint

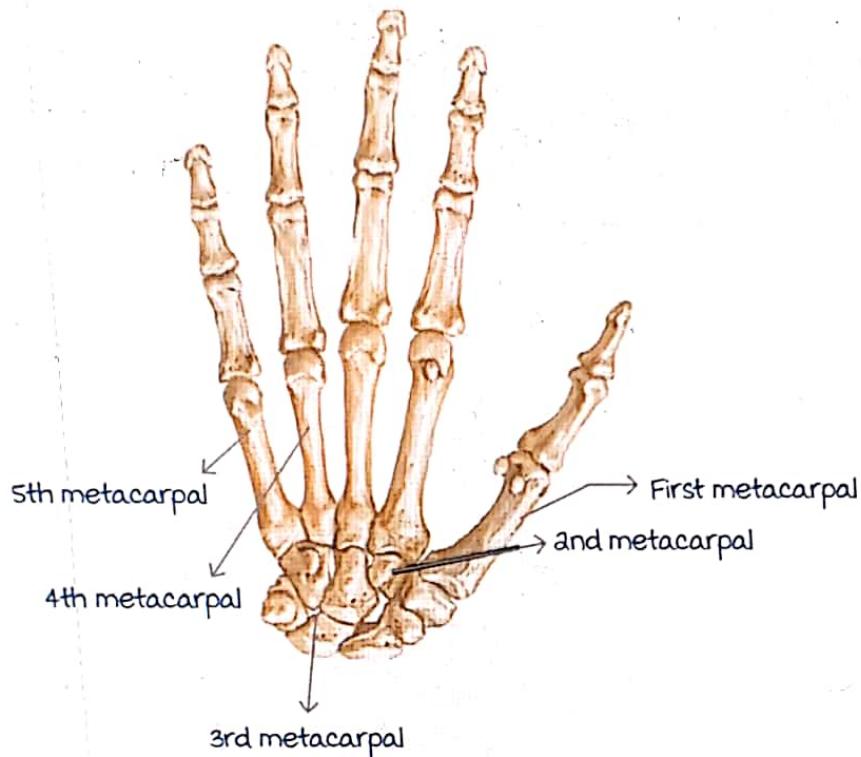
The ossification centre- for 1st metacarpal appears at base

For remaining metacarpal appears at head

**Aberrant epiphysis (not usually present)**

If ossification centre- for 1st metacarpal appear at head

For remaining metacarpal base



Active space

## MUSCLES OF BACK AND PECTORAL REGION

Posterior view of the back

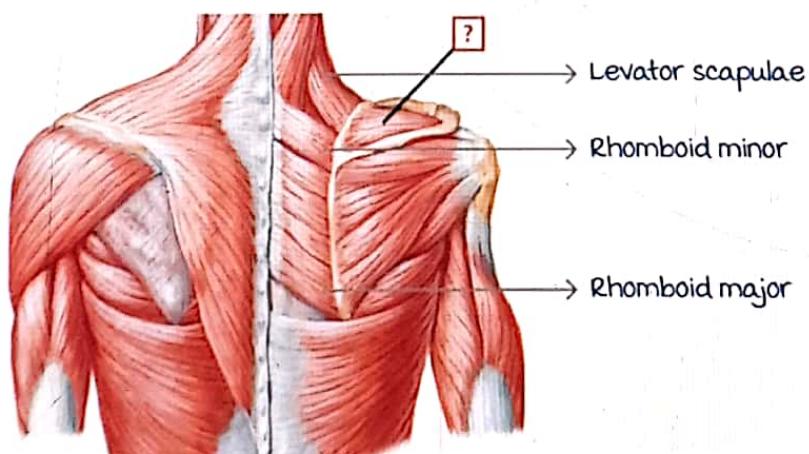
00:00:06

Trapezius :

- It is a triangular shaped muscle.
- Nerve supply : Spinal part of accessory nerve
- Actions :
  1. Elevation of scapula along with Levator scapulae muscle
  2. Retraction of scapula along with Rhomboids muscle
  3. Overhead abduction of the shoulder joint along with the Serratus anterior

Abduction of the shoulder joint :

- movements :
  - 0-15° : Supraspinatus
  - 15-90° : Deltoid
  - 90-180° : Trapezius + Serratus anterior
- Requires Gleno humeral elevation + Scapular rotation in ratio 2 : 1



Levator scapulae :

- C<sub>3</sub>, C<sub>4</sub>
- C<sub>5</sub>- Dorsal scapular nerve

Rhomboid minor :

- Dorsal scapular nerve

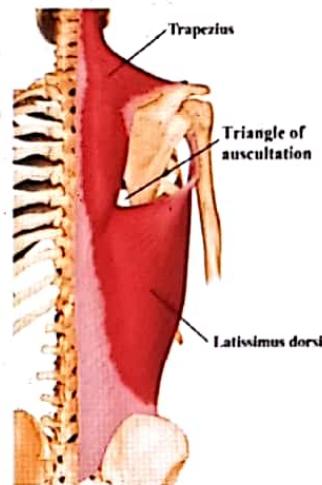
Rhomboid major :

- Dorsal scapular nerve

Active space

## Triangles in the back

00:06:03

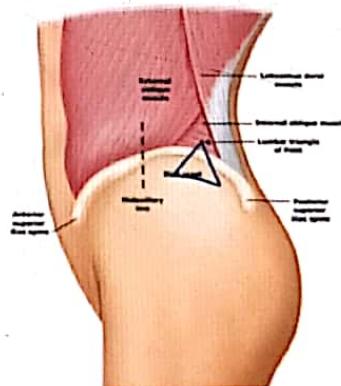


### Triangle of Auscultation:

- Boundaries :
  - medially : lateral border of trapezius
  - Laterally : medial border of scapula
  - Base : latissimus dorsi muscle
- We can auscultate the lung sounds and cardiac orifice of the stomach

### Lumbar Triangle of Petit:

- Boundaries :
  - Anteriorly : external oblique muscle
  - Posteriorly : latissimus dorsi muscle
  - Base : iliac crest
- Potential site of internal hernia

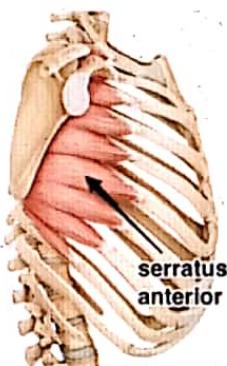


**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

Latissimus dorsi muscle is forming boundary to both Triangle of Auscultation and Triangle of Petit

**Serratus anterior muscle**

00:09:30



Origin : upper 8 ribs by means of 8 digitations

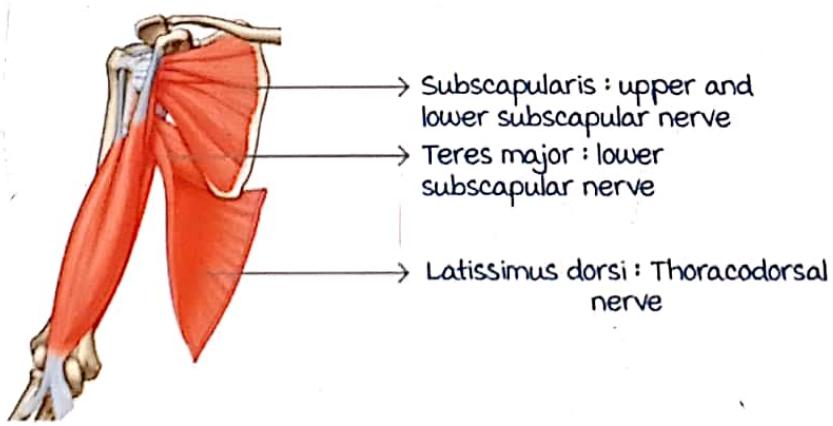
Insertion : medial border of the scapula

Nerve Supply : Ling Thoracic nerve ( $C_5, C_6, C_7$ )

Action :

- Protraction of scapula along with pectoralis minor
- Overhead abduction of the shoulder joint along with trapezius

Nerve injury : Winging Scapula (due to unopposed action of retractors)



Active space

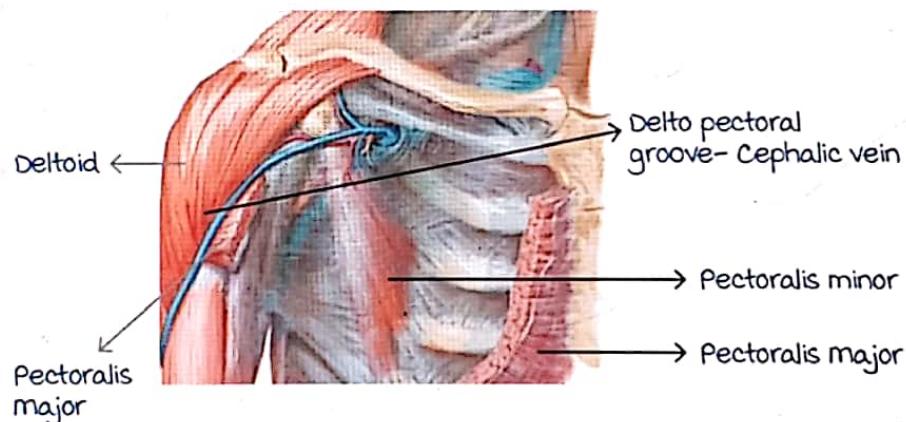
In upper limb there is no separate compartment for adduction of arm.

Muscles taking origin from trunk and inserting into the humerus perform adduction of the arm

	Latissimus dorsi	Pectoralis major
Origin	Back of the trunk	Front of the trunk
Insertion	Floor of intertubercular sulcus	Lateral lip of intertubercular sulcus
Action	Adduction and medial rotation Extension	Adduction and medial rotation Flexion

## Pectoral Region

00:17:34



### Pectoralis minor :

- Origin : 3,4,5 rib
- Insertion : coracoid process
- Action : Protraction of scapula
- **No** action at shoulder joint

## Clavipectoral Fascia

00:20:20

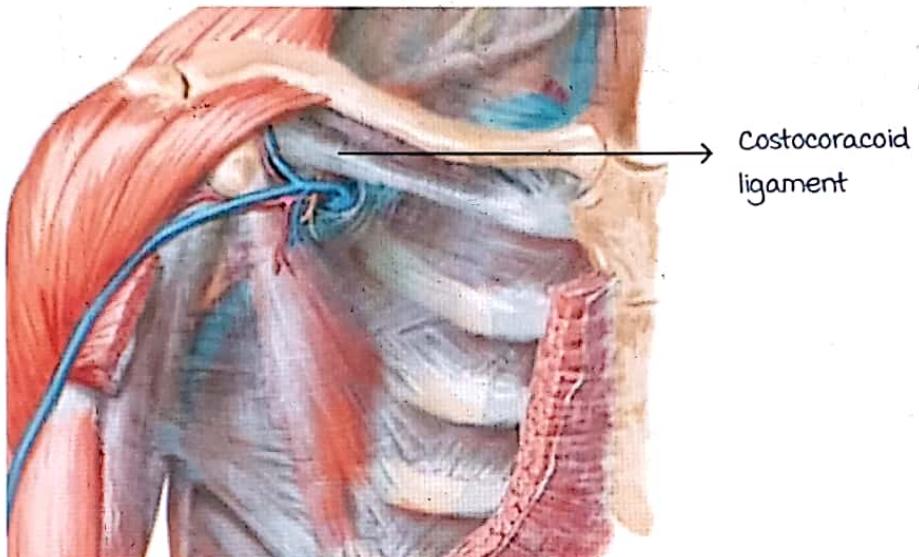
Present between clavicle and pectoralis minor muscle under the cover of pectoralis major muscle

Muscles enclosed :

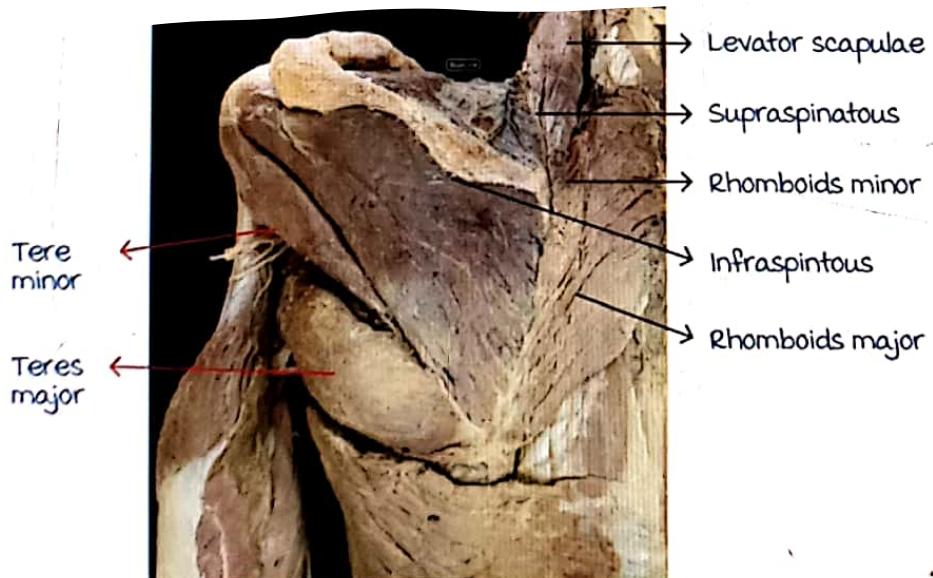
- Subclavius
- Pectoralis minor

Ligaments derived :

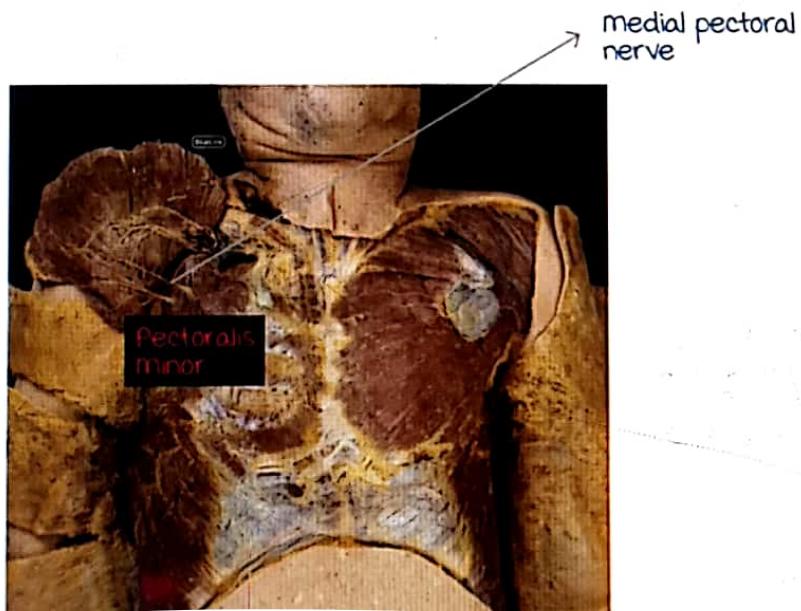
- Costocoracoid ligament
- Gerdy's ligament : Suspensory ligament of axilla



- Structures piercing the Clavipectoral fascia :
  - 1) Cephalic vein
  - 2) Lateral pectoral nerve
  - 3) Thoraco acromial artery



Active space



# BRACHIAL PLEXUS AND ITS INJURIES

## Brachial plexus

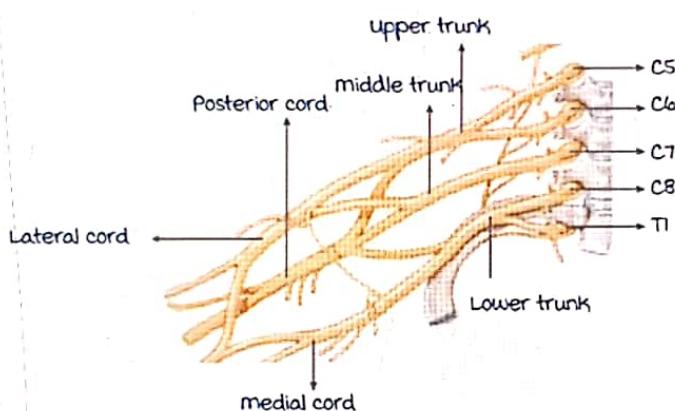
00:00:03

Roots - C5, C6, C7, C8, T1.

Trunk - upper, middle, and lower.

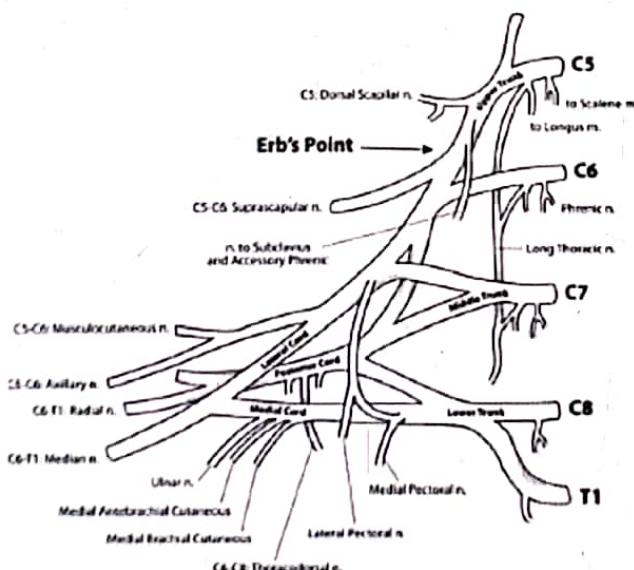
Divisions of each trunk - anterior and posterior division.

Cord - lateral cord, medial cord, and posterior cord.



## Branches from various parts of brachial plexus

00:03:15



Branches from the root:

- Dorsal scapular nerve.
- Long thoracic nerve.

Branches from the trunk:

- Suprascapular nerve.
- Nerve to subclavius.

Branches from the lateral cord:

- Lateral pectoral nerve.
- musculocutaneous nerve

Active space

Branches from the medial cord : Branches from the posterior cord :

- medial pectoral nerve.
- medial cutaneous nerve of forearm.
- upper subscapular nerve.
- Thoraco-dorsal nerve.
- Lower subscapular nerve

**Note :**

- Suprascapular nerve

The Suprascapular nerve (C5, C6) usually arises as the first branch of the upper trunk but it frequently springs directly from the ventral primary ramus of C5. It innervates supraspinatus and infraspinatus.

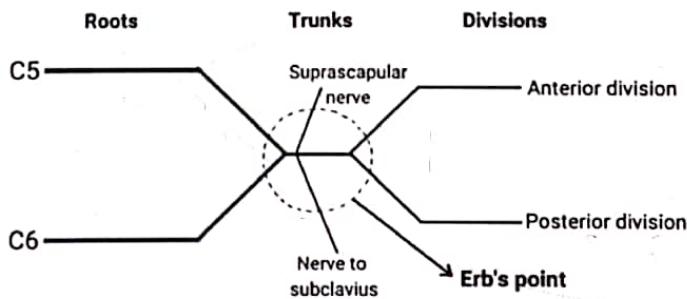
- Nerve to subclavius

The slender nerve to subclavius (C5, C6) springs from the upper trunk and passes anteriorly. It descends anterior to the plexus and the subclavian artery and passes above the subclavian vein to supply subclavius muscle.

### Erb's point and Erb's palsy

00:13:29

Erb's point is the meeting point of the 6 nerves.



Injury to Erb's point leads to Erb's palsy.

Common causes of injury to Erb's point :

- Direct fall on shoulder.
- Obstetric complications.



Nerves and muscles affected in Erb's palsy :

- Suprascapular nerve - supraspinatus and infraspinatus muscles.
- Radial nerve - brachioradialis, extensor carpi radialis longus and supinator muscles.
- Musculocutaneous nerve - biceps brachii and brachialis muscles.
- Axillary nerve - deltoid and teres minor muscles.
- Nerve to subclavius - subclavius muscle.

Deformity of Erb's palsy (policeman's tip deformity) :

Shoulder joint - adducted and medially rotated.

Elbow joint - extended.

Forearm - pronated.



### Klumpke's paralysis (Claw hand)

00:19:37

Cause - lower trunk injury (C8, T1).

Nerves affected - ulnar nerve and median nerve.

Muscles affected - small muscles of the palm.

Deformity - extension of metacarpophalangeal joints

+

flexion of interphalangeal joints.



Active space

# RADIAL NERVE

## General Information

00:00:04

- It is the largest branch of brachial plexus
- Root value: C5, C6, C7, C8, T1

## Course

00:00:25

Formed in the Axilla.

↓ (gives branch to medial head and

↓ long head of triceps)

Leaves axilla

↓ ( $\Delta$  Interval)

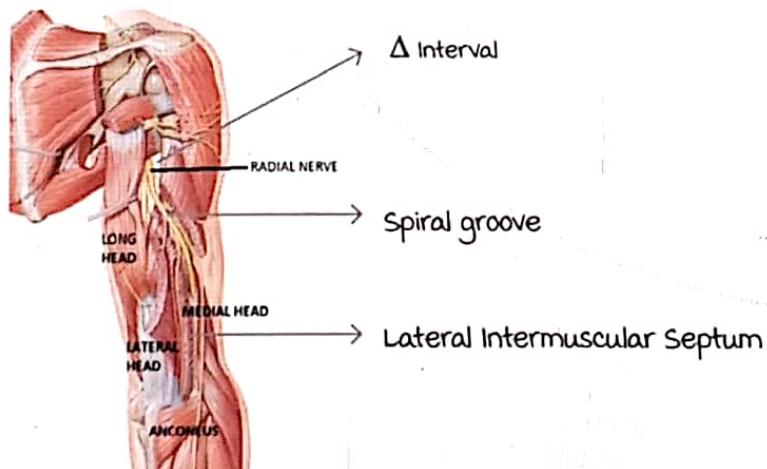
Posterior compartment of arm

↓

Passing in spiral groove along with Profunda brachii artery

↓

Enters the lower aspect of anterior compartment of arm by piercing  
the lateral intermuscular septum



## Branches

00:04:26

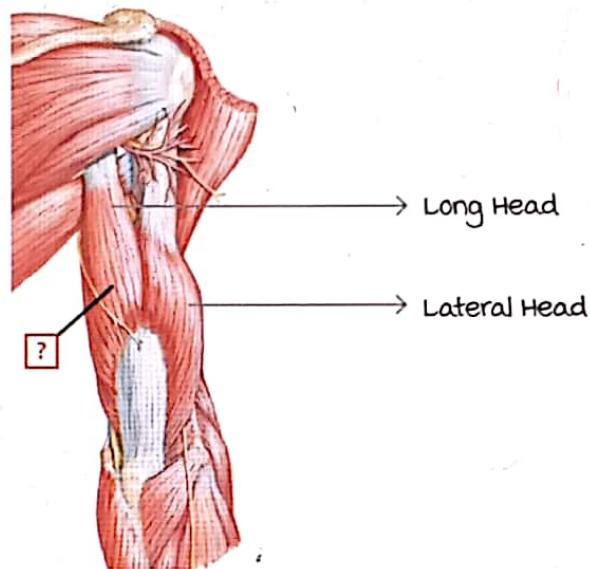
Branches in the spiral groove:

- Branch to medial head and lateral head of triceps
- Branch to medial head descends down and also supplies Anconeus muscle

Active space

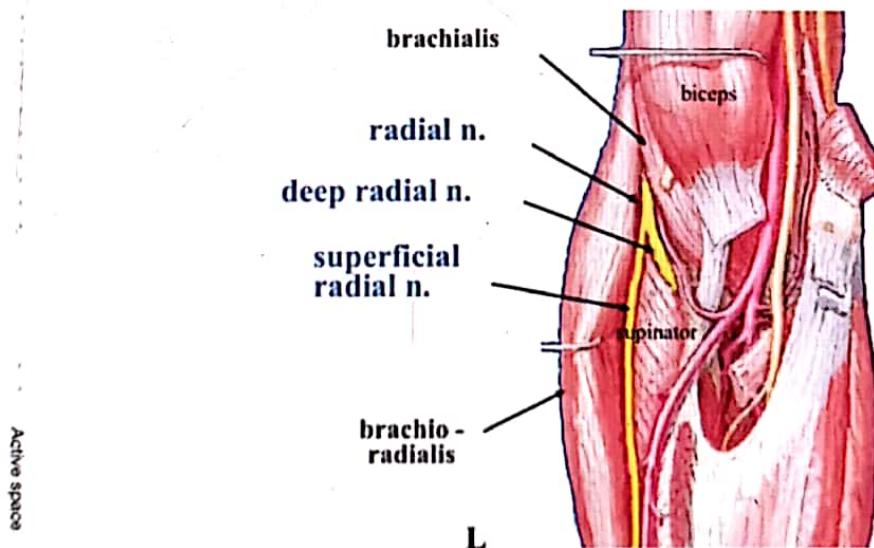
Injury below spiral groove:

- Triceps muscle normal (extension of elbow normal)
- Anconeus muscle normal (assists normal)



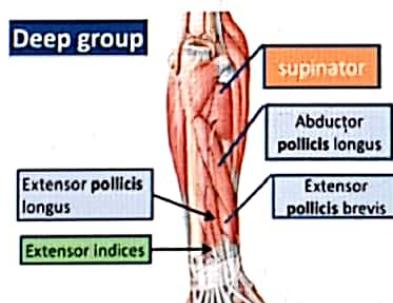
Radial nerve in front of the arm:

- Present between brachialis and brachioradialis (supplies these both muscles)
- Supplies to extensor carpi radialis longus muscle [ECRL]

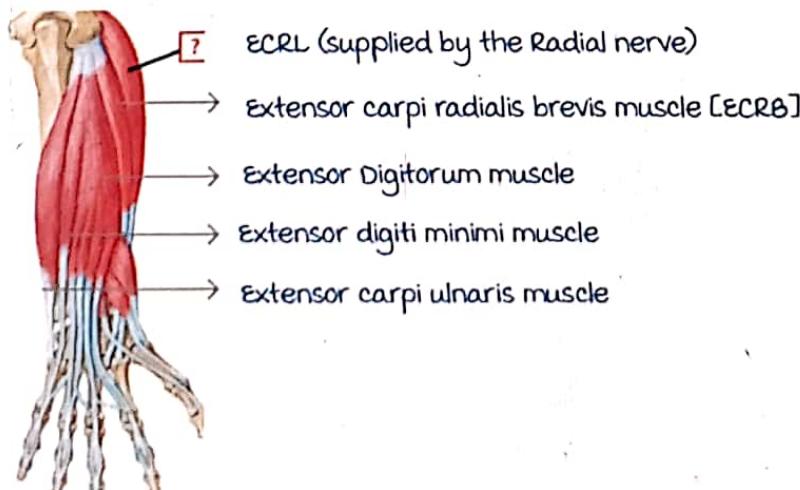


- Radial nerve divides below the elbow joint

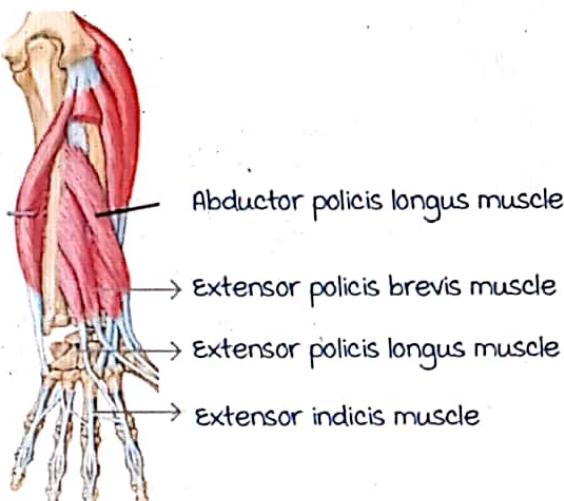
Radial Nerve	
Superficial (sensory)	Deep (motor) (Posterior interosseous nerve) [PIN]
- passing under the cover of brachioradialis	- Nerve of posterior compartment
- Sensory supply to the lateral 3 and $\frac{1}{2}$ digits in dorsum	- pierces supinator muscle to enter Posterior aspect of forearm
	- supplies all muscles in post compartment except:
	1. Anconeus
	2. Brachioradialis
	3. ECRL



Posterior compartment of Forearm :

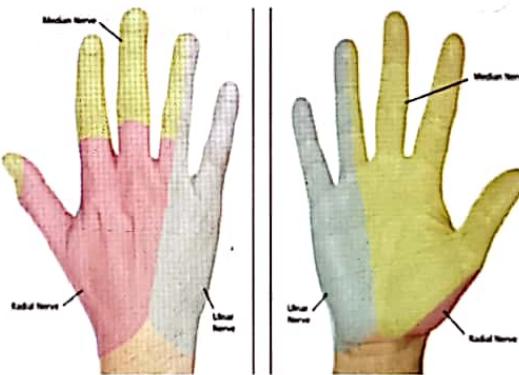


Active space



Sensory supply of superficial branch of Radial Nerve :

- Sensory supply to the lateral 3 and  $\frac{1}{2}$  digits in dorsum



Recent note: Sensory supply to the lateral 2 and  $\frac{1}{2}$  digits only (in dorsum by the superficial branch of Radial Nerve)

## Injuries

00:18:47

Wartenberg Syndrome:

- Compression of the superficial branch of radial nerve while below the brachioradialis
- Loss of sensation in lateral 2 and  $\frac{1}{2}$  digits in dorsum ( $2 \frac{1}{2} > 3 \frac{1}{2}$ )



### Wartenberg sign:

- Little finger **not** adducted towards ring finger
- Palmar interosseus is affected
- Ulnar nerve injury



### Lower Radial Nerve Injury:

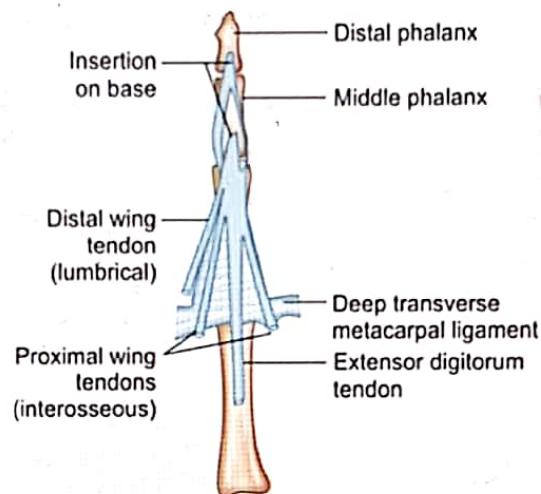
- Injury below the elbow joint but before dividing into superficial and deep branch.
- 5 muscles normal:
  1. Triceps (extension of elbow normal)
  2. Anconeus (extension of elbow normal)
  3. Brachialis
  4. Brachioradialis (weak flexor of elbow - Shunt muscle)
  5. ECRL (extension of wrist)
- Sensory loss present

### PIN Palsy:

- Extension of elbow is normal (triceps normal)
- Extension of wrist is normal (ECRL normal)
- Extension of metacarpophalangeal joint lost
- Finger drop
- **No** wrist drop
- No sensory nerve

## Dorsal digital expansion

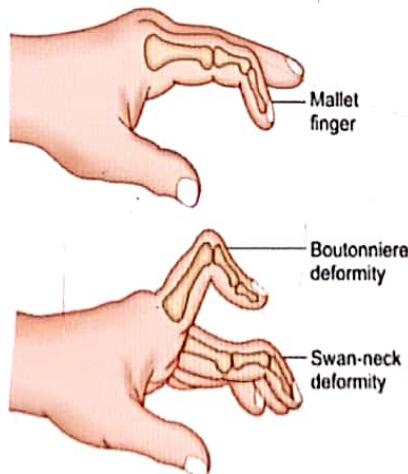
Extensor tendons reach distal phalanx by special arrangement called dorsal digital expansion [DDE]



### Bands:

- medial band crosses the proximal interphalangeal [PIP] joint posteriorly (extends to the proximal interphalangeal joint)
- Lateral band crosses the distal interphalangeal [DIP] joint posteriorly (extends to the distal interphalangeal joint)
- Interosseous and Lumbrical are inserted to DDE (Wing Tendons)

### Avulsion of Lateral Band:



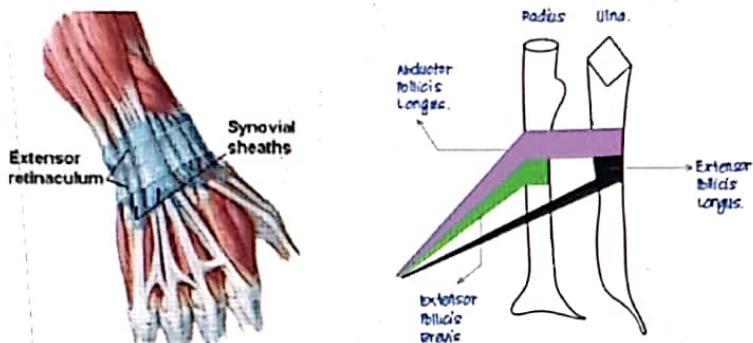
**Swann Neck Deformity :** DIP joint flexed + PIP joint hyperextended  
(seen in rheumatoid conditions)

**Boutonniere Deformity :** PIP flexed (Avulsion of the medial band)

## Extensor Retinaculum

00:34:02

- Consist of 6 compartments (lateral to medial side)



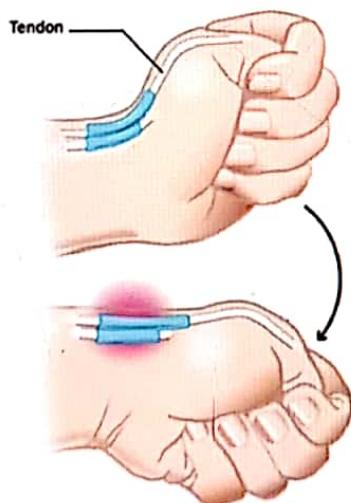
- I. 1<sup>st</sup> compartment : (Lateral most)

- Abductor pollicis longus
- Extensor pollicis brevis

Inflammation of these 2 results in de Quervain's synovitis

Finkelstein Test: (make fist → ulnar deviation)

If painful at lower end of the radius then the test is positive.

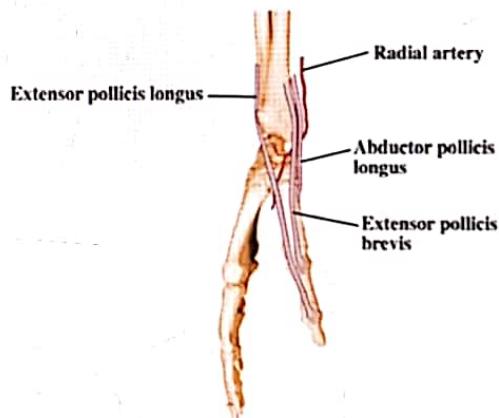


#### Anatomical Snuffbox: Boundaries

- medially :
  - 3rd compartment tendon: Extensor pollicis longus [EPL]
- Laterally :
  - 1st compartment tendon: Abductor pollicis longus + Extensor pollicis brevis

Active space

- Roof:
  - skin
  - superficial fascia
  - deep fascia
  - cephalic vein
  - superficial branch of radial nerve
- Content : radial artery
- Floor :
  - Lower end of radius
  - scaphoid
  - trapezium
  - base of 1st metacarpal bone
  - ECRL/ECRB



- a. 1st compartment : ECRL/ECRB
- b. 2nd compartment : EPL
- c. 3rd compartment : EPL
- d. 4th compartment :
  - Extensor digitorum
  - Extensor indicis
  - Posterior Interosseous nerve
  - Anterior Interosseous artery
- e. 5th compartment : Extensor digiti minimi
- f. 6th compartment : Extensor carpi ulnaris

## MEDIAN NERVE

Trunk of median nerve is formed by

- medial root (medial cord)
- Lateral root (lateral cord)

median nerve crosses over the brachial artery from lateral to medial side.

It doesn't supply any muscle in the arm.

In the cubital fossa - median nerve is the medial most structure.

### Cubital fossa

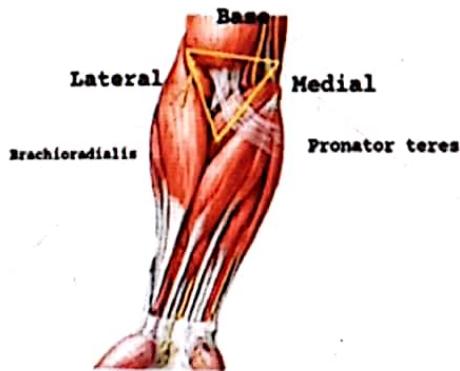
00:02:01

A triangular shaped fossa in front of the elbow.

medially - Lateral border of pronator teres

Laterally - medial border of brachioradialis

Base - imaginary line connecting the two epicondyles of humerus



The floor is formed by the Brachialis muscle and supinator muscle

Contents of the Cubital fossa :

Mnemonic : meBS. (2019 AllMS)

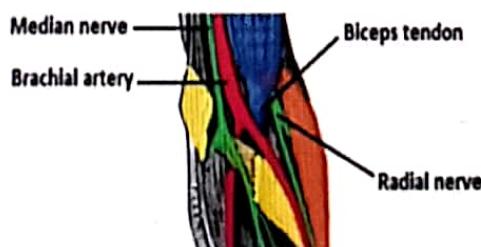
(from medial to lateral)

Median nerve

Brachial artery

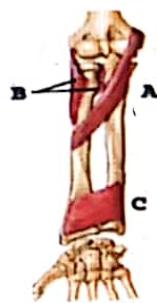
Biceps tendon

Superficial branch of Radial nerve



**Flexors of the forearm**

00:05:50



median nerve enters forearm by passing between the heads of pronator teres.

- A. Pronator teres (PT)  
(By median nerve)
- B. Supinator
- C. Pronator quadratus(PQ)  
(Anterior interosseous nerve)

**Flexor carpi radialis(FCR)**

- Flexion of wrist
- Radial deviation
- Supplied by median nerve

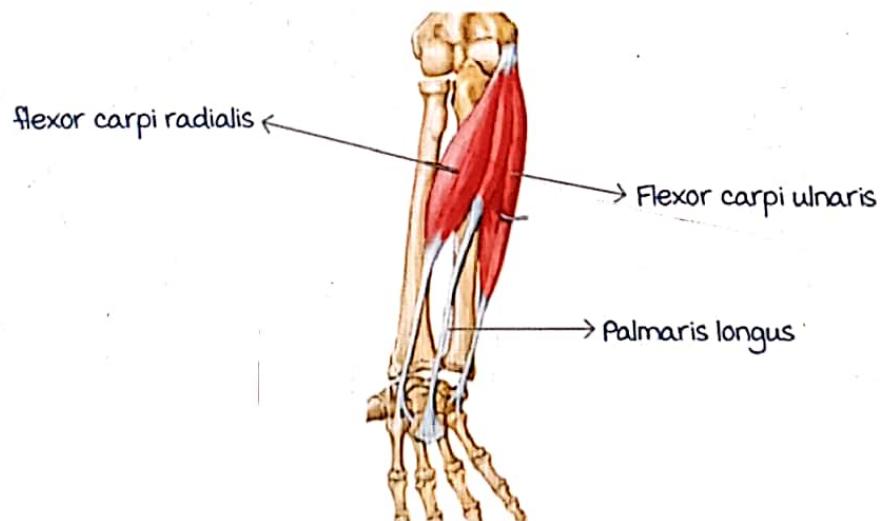
**Flexor carpi ulnaris(FCU)**

- Flexion of wrist
- Ulnar deviation
- Supplied by ulnar nerve

**Palmaris longus (PL)**

Forms modification in palm called palmar aponeurosis

Supplied by median nerve



**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

### Flexor digitorum superficialis (FDS)



Goes up to the middle phalanx  
 Flexion of wrist  
 Flexion of metacarpo-phalangeal joints  
 Flexion of proximal inter-phalangeal joint

Flexor digitorum  
 Superficialis

### Flexor digitorum profundus (FDP)

Goes upto distal phalanx

- Flexion of wrist
- Flexion of metacarpo-phalangeal joints
- Flexion of proximal & distal Interphalangeal joints

FDP is split into lateral and medial half

- Lateral half : Index & middle finger - Anterior interosseous Nerve  
 (Branch of median nerve)
- medial half : Ring & little finger - Ulnar nerve

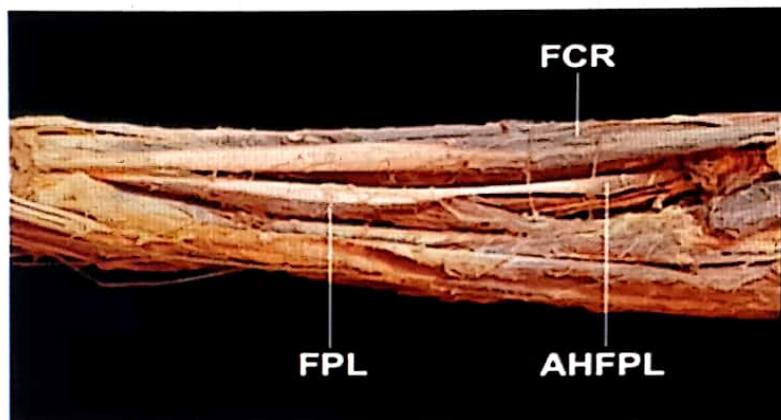
### Flexor pollicis longus (FPL) : Anterior interoseus nerve

Superficial	Deep
Pronator Teres - median nerve	Flexor digitorum profundus Lateral 1/2 : Anterior interosseous nerve medial 1/2 : ulnar nerve
Flexor carpi radialis - median nerve	Flexor Pollicis longus - Anterior Interosseous nerve
Palmaris longus - median nerve	Pronator quadratus - anterior interosseous nerve
Flexor carpi ulnaris - ulnar nerve	
Flexor digitorum superficialis - median nerve	

## Gantzers muscles and Jersey finger

00:15:36

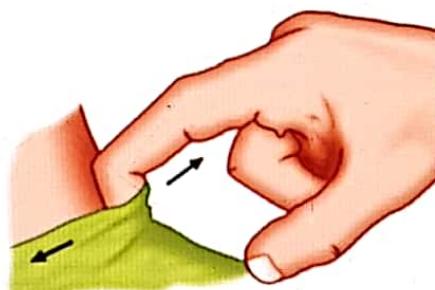
## GANTZERS MUSCLE



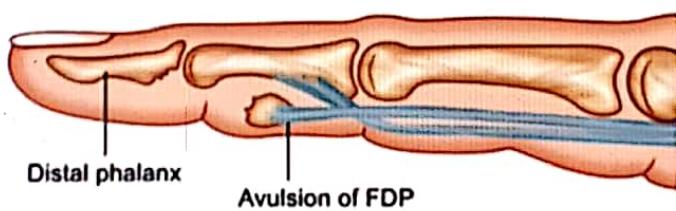
In some patients, the flexor pollicis longus may have an accessory head called as Accessory head of flexor pollicis longus (AHFPL).

If AHFPL is present – it compresses the anterior interosseous nerve

## Jersey finger



Avulsion of flexor digitorum profundus tendon



caused by violent traction on flexed distal phalanx,  
as in catching on jersey of running football player

Active space

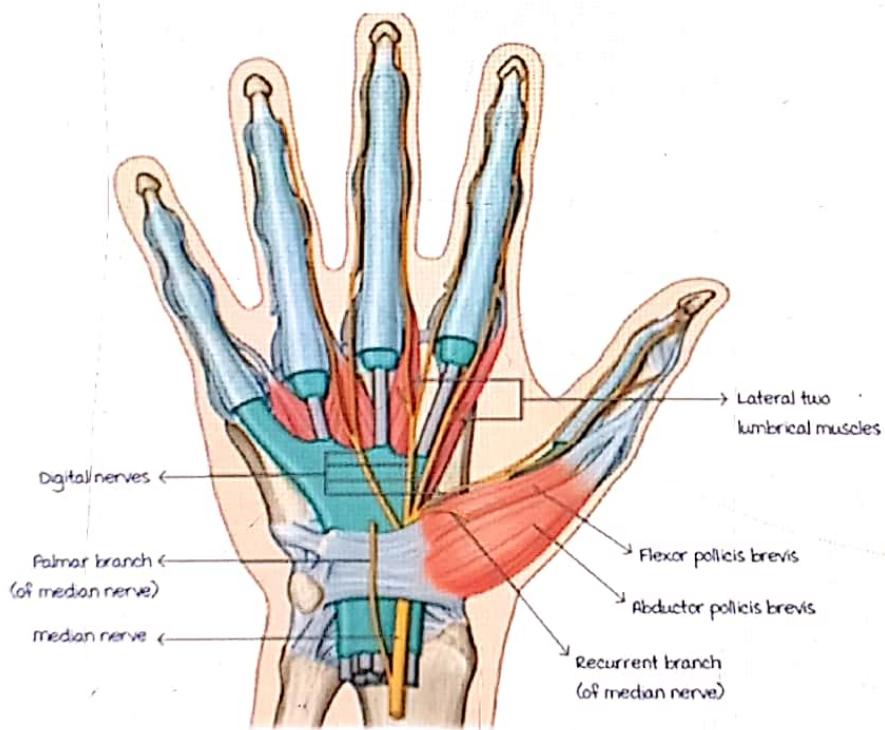
Avulsion of flexor digitorum profundus tendon causes loss  
of flexion of distal Interphalangeal joint (JIPMER 2018)

## Median nerve distribution in the palm

00:17:22

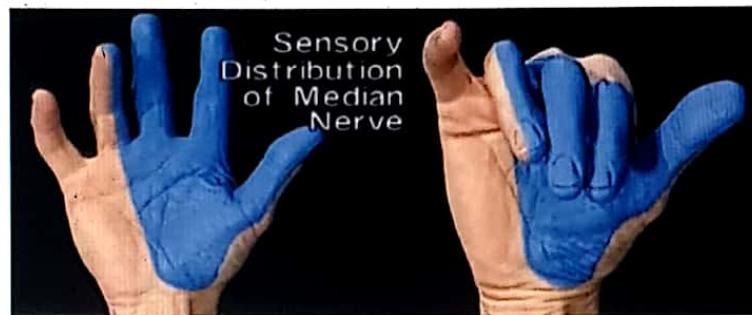
median nerve enters the palm - by passing below the flexor retinaculum

- In the palm it is divided into medial and lateral branches
- Before dividing, it gives **motor branch - Recurrent branch** which supplies: Thenar eminence
  - Lumbricals (1,2)
- muscles supplied by the median nerve in the palm -
  - They're also the Thenar eminence muscles
  - Mnemonic: "**LOAF**"
- Lumbricals - 1,2
- Opponens pollicis
- Abductor pollicis brevis
- Flexor pollicis brevis



- The medial and lateral branch subdivide into:
  - Proper palmar digital branch
  - Palmar branch
- Proper palmar digital branch - sensory distribution
  - Supplies - lateral 3 1/2 digits on the palmar side
  - Distal and middle phalanx of the lateral 3 1/2 digits

- The palmar branch of median nerve passes above the flexor retinaculum  
Gives sensory supply to Thenar eminence



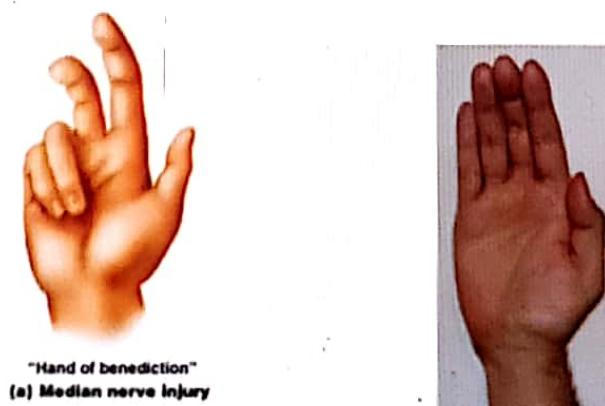
### Median nerve injury

00:22:35

In supracondylar fracture of humerus

- most affected - Anterior interosseous nerve > median nerve (Allms 2018)
- The forearm flexors supplied by median nerve are paralysed
- Loss of pronation - both pronator teres and pronator quadratus affected
- On wrist flexion - wrist deviates to ulnar side, flexor carpi ulnaris normal (because flexor carpi ulnaris is supplied by ulnar nerve)
- Flexor digitorum profundus :  
Lateral 1/2 affected : loss of flexion of proximal/distal IP joint of index, middle finger - **Benediction hand deformity**  
If index finger affected - **pointing index finger deformity**
- Flexor digitorum superficialis - paralysed
- "LOAF" muscles - paralysed causing thenar eminence atrophy
- Loss of sensation over the lateral 3 1/2 digits and the thenar eminence
- Ape thumb deformity - Opponens pollicis involvement

ACTIVE SPACE



## Wrist slash injury

00:28:25

- most affected - median nerve.
- Injury to the median nerve during suicidal cuts
- All the forearm flexors supplied by median nerve are normal
- Pronation is not affected
- No ulnar deviation on wrist flexion
- The lateral half of flexor digitorum profundus and flexor digitorum superficialis are normal. Hence,
  - No Benediction hand deformity
  - No pointing index finger
- "LOAF" muscles are paralysed - atrophy of thenar muscle  
Resulting in ape thumb deformity
- Loss of sensation over thenar eminence and the lateral 3 1/2 digits

## Carpal tunnel syndrome

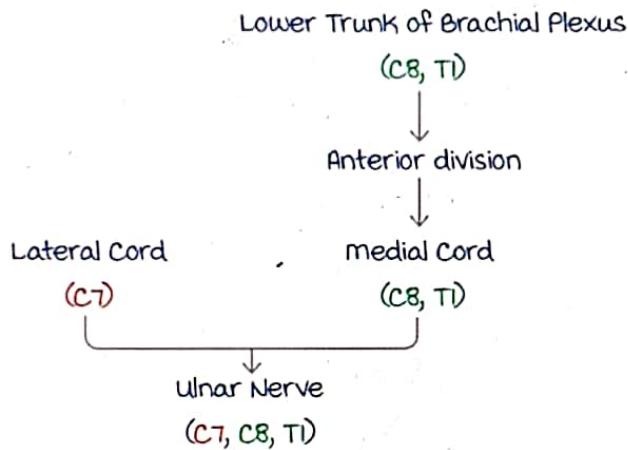
- Compression of median nerve while passing below the flexor retinaculum
- Features are the same as wrist slash injury except it has intact sensory supply over thenar eminence  
(palmar branch of median nerve passes above the flexor retinaculum)

# ULNAR NERVE

## Course and Muscles supplied by Ulnar Nerve

00:00:02

Root value of ulnar nerve :



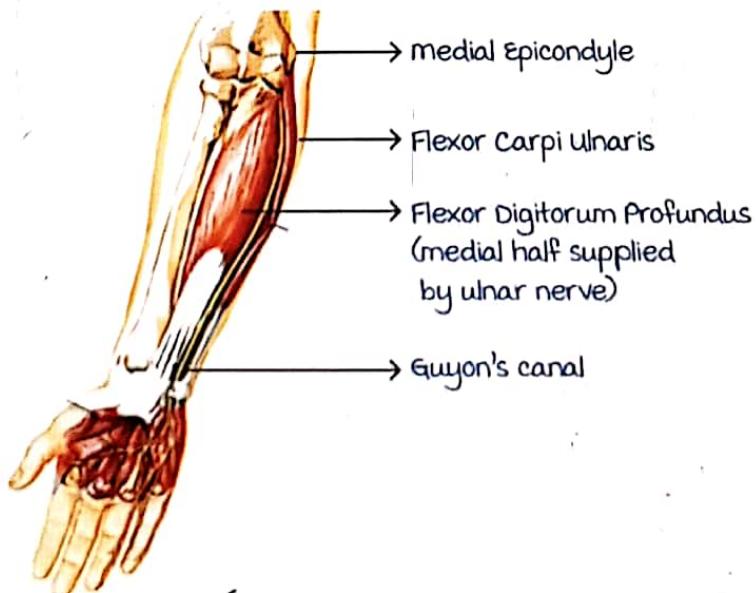
C8, T1 - Root value for nerve supply to muscles of palm

C7 - Root value for nerve supply to 1 and 1/2 muscles of forearm

- Flexor Carpi Ulnaris
- Flexor Digitorum Profundus (medial half)

Course of ulnar nerve in the forearm :

- Ulnar nerve passes behind medial epicondyle and enters forearm.
- It supplies Flexor Carpi Ulnaris (FCU) and medial half of Flexor Digitorum Profundus (FDP).
- It passes above Flexor Retinaculum through Guyon's canal and enters palm.



Active space

## Course of Ulnar nerve in the palm:

Ulnar Nerve - passes **above** Flexor Retinaculum and enters palm

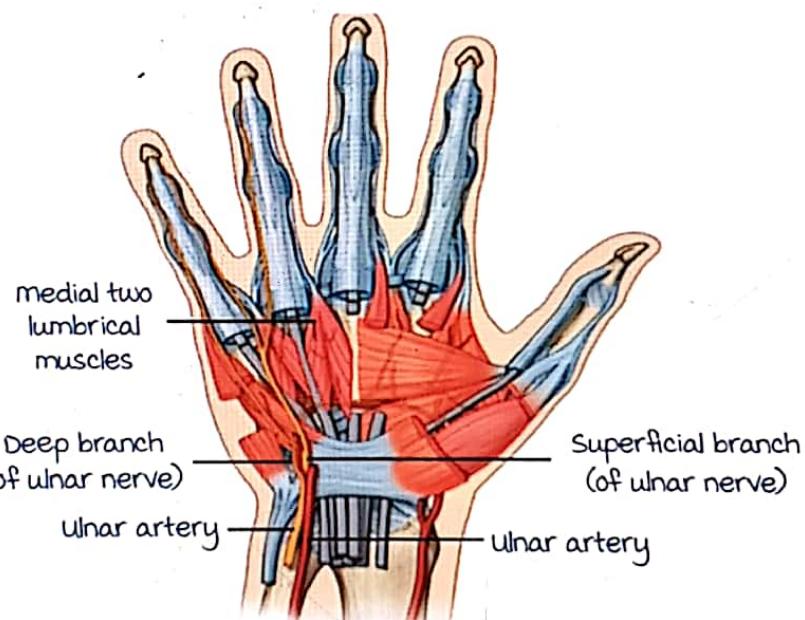
**Superficial**

**motor:** Supplies Palmar Brevis.  
Thereafter,

**Sensory:** Supplies medial 1 and 1/2 digits.

**Deep (motor branch)**

Supplies all muscles of palm except "LOAF" muscles.

Clinical tests for Ulnar Nerve injury

00:04:20

## Pollock's Sign

- Patient is **not able to flex the little finger and ring finger.**
- muscle affected:** medial half of FDP.
- Nerve affected:** Ulnar nerve.



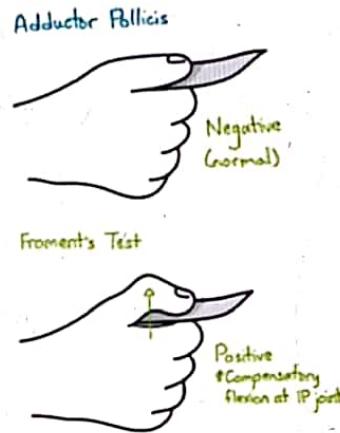
## Wartenberg Sign

- Loss of adduction of little finger towards ring finger.**
- muscle involved:** Palmar Interossei.
- Nerve affected:** Ulnar nerve.



**Froment Test**

- Patient holds card between thumb and index finger but with **compensatory flexion of interphalangeal joint of thumb.**
- muscle affected:** Adductor Pollicis muscle (deep branch of ulnar nerve).
- Nerve affected:** ulnar nerve.

**Muscles of Hand - Lumbricals**

00:07:20

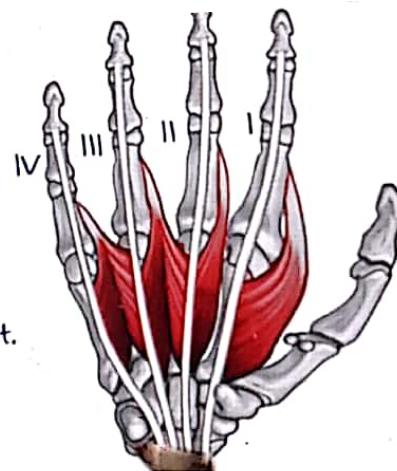
There are **four** Lumbricals, numbered from lateral to medial.

I and II Lumbricals : **Unipennate** and supplied by **median nerve**.

III and IV Lumbricals : **Bipennate** and supplied by **ulnar nerve** (deep branch).

Attachments :

- Origin :** Flexor Digitorum Profundus tendon.
- Insertion :** As wing tendon Dorsal Digital Expansion (DDE).



Actions : (NEET 2018, 19)

- Flexion of metacarpophalangeal joint.
- Extension of interphalangeal joint.

**Muscles of hand – Dorsal Interossei**

00:09:53

There are **4** Dorsal Interossei, numbered from lateral to medial.

They are **bipennate** muscles.

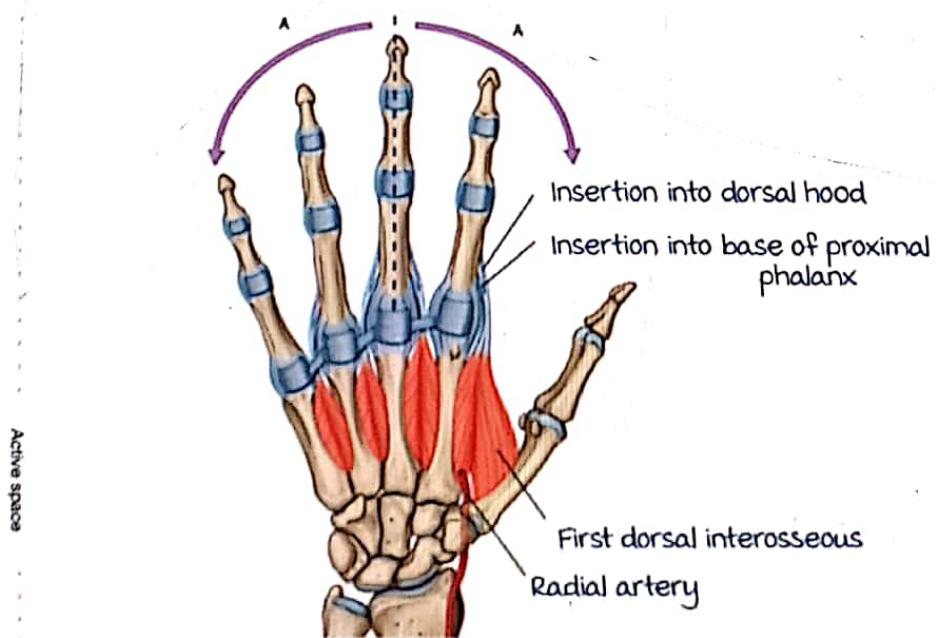
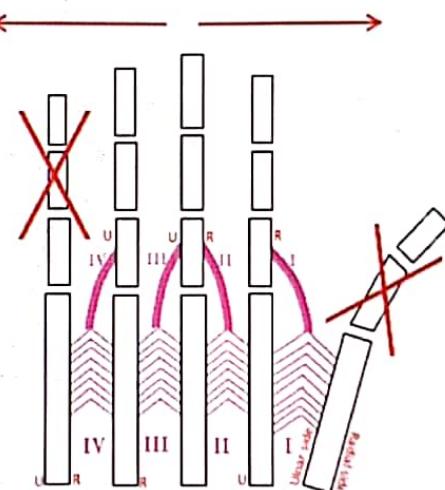
Action : mnemonic : **DAB** (Dorsal- **A**bduction).

- Abduction** of fingers.
- Flexion of metacarpophalangeal joint.
- Extension interphalangeal joint

**Thumb and little finger :** No attachment for Dorsal Interosseous (since they have separate abductors – Abductor pollicis longus, Abductor pollicis brevis, Abductor digiti minimi).

## Attachments of dorsal interossei : (Allms)

1 <sup>st</sup> dorsal interosseous	Radial side of base of proximal phalanx of index finger and its DDE
2 <sup>nd</sup> dorsal interosseous	Radial side of the base of proximal phalanx of middle finger and its DDE.
3 <sup>rd</sup> dorsal interosseous	Ulnar side of base of proximal phalanx of middle finger and its DDE.
4 <sup>th</sup> dorsal interosseous	Ulnar side of base of proximal phalanx of ring finger and its DDE



## Muscles of Hand – Palmar Interossei

00:18:13

There are 4 Palmar Interossei, numbered from lateral to medial.

They are unipennate muscles.

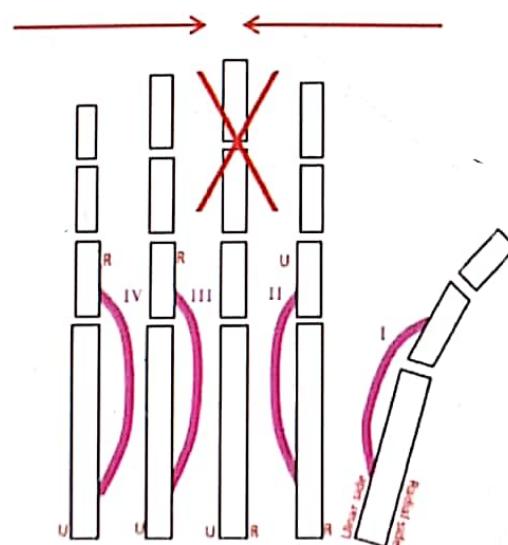
Action : mnemonic : PAD (Palmar- ADDuction).

- Adduction of fingers.
- Flexion of metacarpophalangeal joint.
- Extension interphalangeal joint.

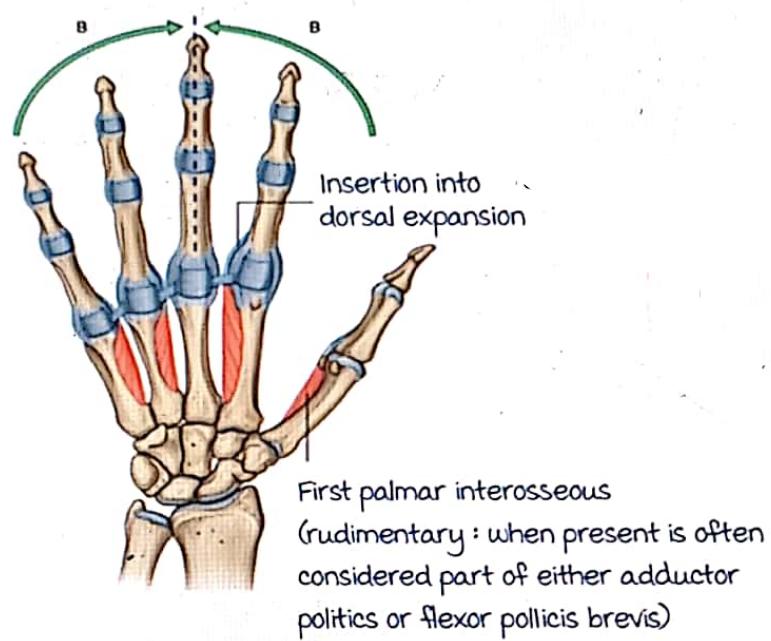
**middle finger** : no attachment of Palmar Interosseous.

Attachments of dorsal interossei : (Allms 2019)

1 <sup>st</sup> palmar interosseous	Origin : ulnar side of 1 <sup>st</sup> metacarpal bone Insertion : Same side of DDE.
2 <sup>nd</sup> palmar interosseous	Origin : ulnar side of 2 <sup>nd</sup> metacarpal bone Insertion : Same side of DDE.
3 <sup>rd</sup> palmar interosseous	Origin : Radial side of 4 <sup>th</sup> metacarpal bone Insertion : Same side of DDE
4 <sup>th</sup> palmar interosseous	Origin : Radial side of 5 <sup>th</sup> metacarpal bone Insertion : Same side of DDE



Active space



Active space

# VESSELS OF THE UPPER LIMB

## Axillary Artery

00:00:03

The Axillary artery is the continuation of Subclavian artery from the outer border of the 1<sup>st</sup> rib.

It continues as the Brachial Artery from the lower border of Teres major muscle.

It is divided into 3 parts with respect to the Pectoralis minor muscle.

Branches of Axillary Artery :

From 1<sup>st</sup> Part :

- Superior Thoracic artery.

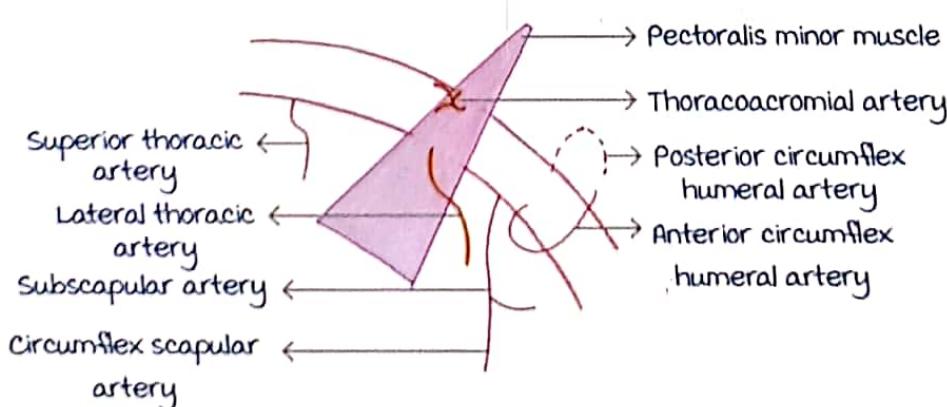
From 2<sup>nd</sup> part :

- Lateral Thoracic artery
- Thoracoacromial artery which further gives rises to 4 branches  
: mnemonic : APCD
  1. Acromial branch
  2. Pectoral branch
  3. Clavicular branch
  4. Deltoid branch

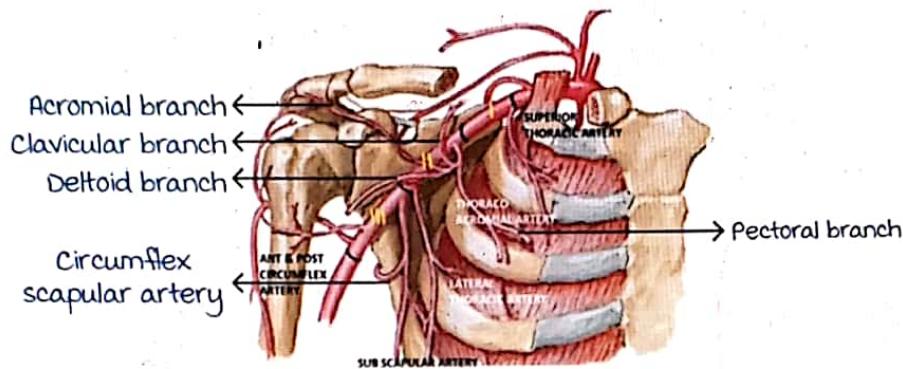
Thoracoacromial artery pierces the Clavipectoral fascia.

From 3<sup>rd</sup> part :

- Subscapular artery which in turn gives : Circumflex scapular artery
- Anterior Circumflex Humeral artery.
- Posterior Circumflex Humeral artery.



Active space



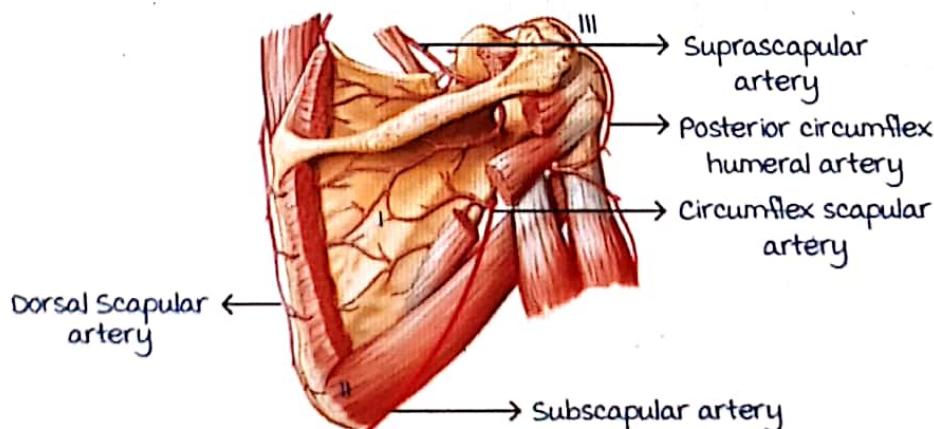
## Anastomosis around the Scapula

00:05:27

The anastomosis around the scapula is between **Subclavian artery** and **Axillary artery**.

Areas of anastomoses :

1. Anastomoses of the **Body of scapula** (**major site**)
  - **Dorsal scapular artery** (Branch of 3<sup>rd</sup> part of Subclavian artery).
  - **Suprascapular artery** (Branch of Thyrocervical trunk which is a branch of Subclavian artery).
  - **Circumflex scapular artery** (Branch of subscapular artery which is a branch of 3<sup>rd</sup> part Axillary artery).
2. Anastomosis at **Inferior angle of scapula** (**major site**)
  - **Subscapular artery** (Branch of Axillary artery).
  - **Dorsal Scapular artery** (Branch of 3rd part of Subclavian artery).
3. minor Anastomosis over **Acromion process** (**minor site**)
  - **Suprascapular artery**
  - **Posterior circumflex humeral artery**
  - **Acromial branch of Thoracoacromial artery**



## Brachial Artery and Ulnar Artery

00:13:13

Brachial artery is the continuation of **Axillary artery** from lower border of **Teres major muscle**.

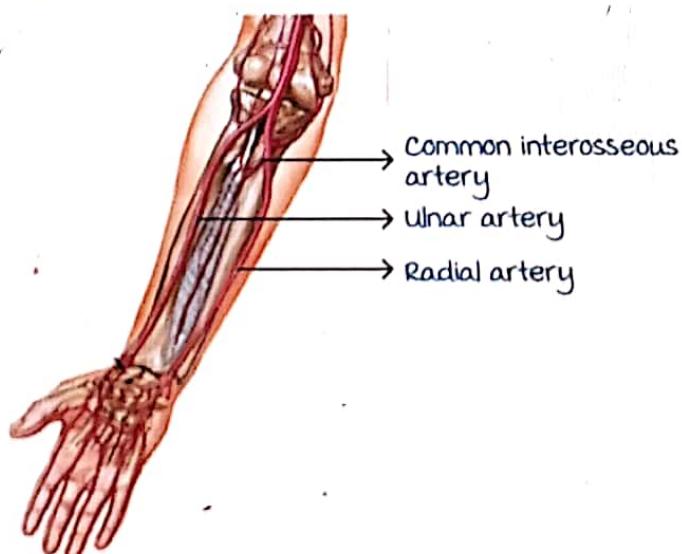
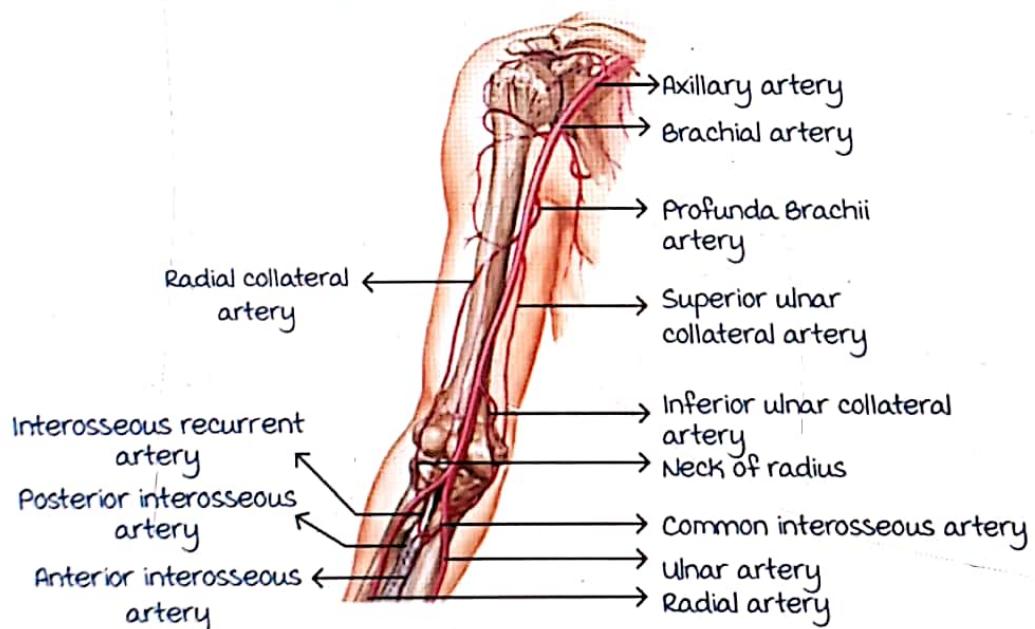
At the level of neck of radius it divides into **Radial and ulnar arteries**.

Branches of **Brachial Artery**:

- Profunda Brachii artery, which in turn gives: Radial collateral artery
- Superior ulnar collateral
- Inferior ulnar collateral

Branches of **Ulnar Artery**:

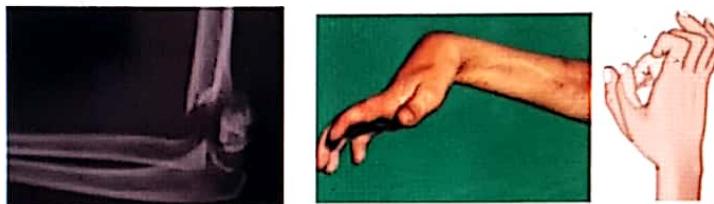
- Common interosseous artery which in turn branches into
- Anterior interosseous artery
- Posterior interosseous artery, which in turn gives: **Interosseous recurrent artery.** (NEET)



### Volkmann's Ischaemic Contracture :

Laceration of brachial artery causes ischaemic necrosis of flexor muscles which results in Volkmann's Ischaemic contracture.

Brachial artery laceration may be seen in Supracondylar fracture of Humerus (Nerve damaged : Anterior Interosseous Nerve > median Nerve affected).



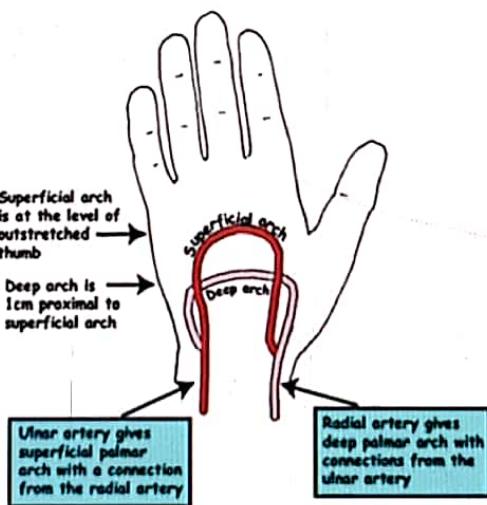
### Radial Artery and Superficial Palmar Arch

00:19:01

Ulnar artery continues as Superficial Palmar Arch which completes on lateral side with contribution from Radial artery.

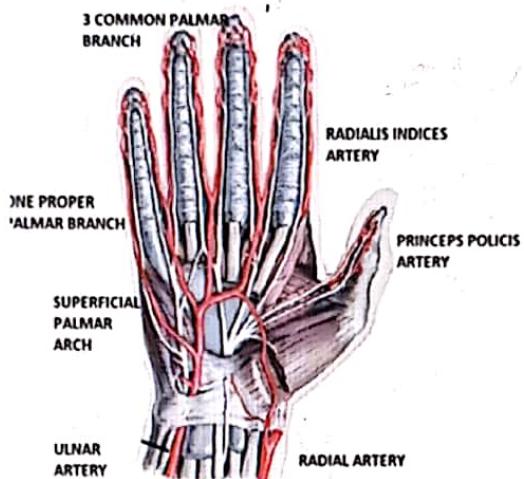
Radial artery continues as Deep Palmar Arch which completes on medial side with contribution from ulnar artery.

The Deep palmar arch is 1cm proximal to Superficial palmar arch.



Radial artery supplies the internal 1 and 1/2 digits by the following branches :

- Princeps pollicis artery (principle artery supplying both radial and ulnar side of thumb).
- Radialis Indicus artery.



### Superficial Palmar Arch :

The Superficial palmar arch is the continuation of ulnar artery and completes on lateral side with contribution from Radial artery.

It supplies the medial 3 and 1/2 digits.

The superficial palmar arch has 1 proper branch + 3 common branches.

Proper palmar branch supplies ulnar side of little finger.

Each common branch divides into a proper branches :

- 1<sup>st</sup> common branch : Supplies adjacent sides of little and ring fingers.
- 2<sup>nd</sup> common branch : Supplies adjacent sides of ring and middle fingers.
- 3<sup>rd</sup> common branch : Supplies adjacent sides of middle and index fingers.

### Allen's test : (Allims 2019)

Allen's test is done to check the patency of ulnar artery and radial artery. (Allims)

Pressure given on both sides of wrist and on making a fist the palm loses blood supply and becomes pale.

- If pink colour is restored when pressure is released on one side, the artery on that side is **patent**.
- If the palm remains pale on releasing pressure, the corresponding artery is **occluded**.

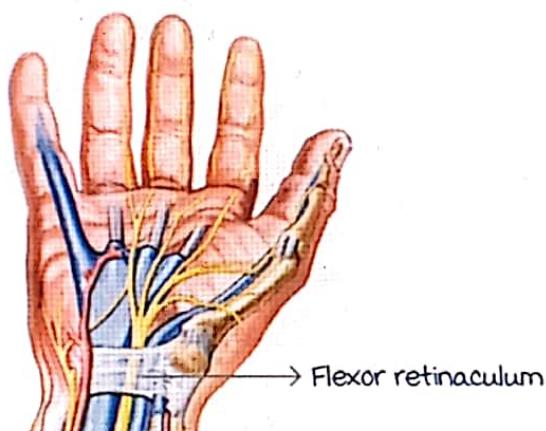
## FLEXOR RETINACULUM AND SPACES IN THE HAND

### Flexor retinaculum

00:00:03

Flexor retinaculum is a band present in the flexor compartment.

- Extent – extends over the carpal bones.
- Laterally – tubercle of scaphoid and crest of trapezium.
- Medially – pisiform bone and hook of hamate.



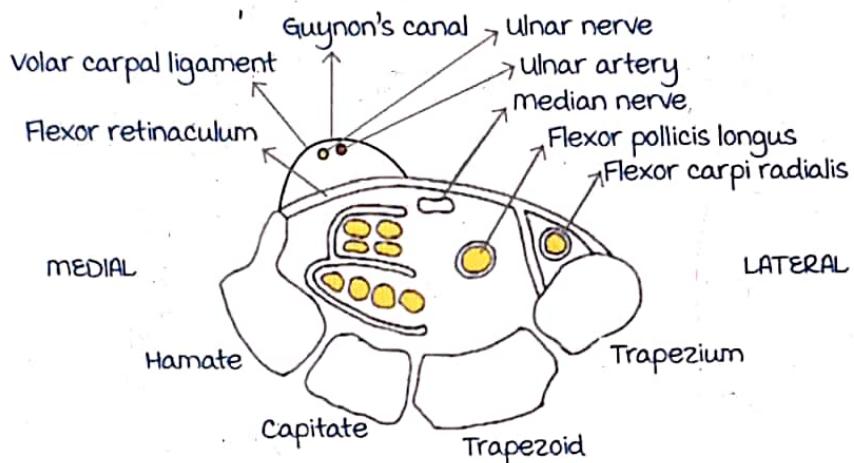
Flexor tendons passing through the retinaculum:

1. Tendon of flexor carpi radialis – passes between the slips of retinaculum laterally.
2. Tendon of palmaris longus – passes above the retinaculum.
3. Tendon of flexor digitorum superficialis (FDS) – passes below the retinaculum.
4. Tendon of flexor digitorum profundus (FDP) – passes below retinaculum.
5. Tendon of flexor pollicis longus (FPL) – passes below retinaculum.

**Ulnar bursa** – synovial sheath enclosing the FDS and FDP muscle.

**Radial bursa** – synovial sheath enclosing the FPL muscle.

**Median nerve** – present between radial bursa and ulnar bursa.



### Volar carpal ligament

00:05:17

Volar means flexor.

Location – present on the medial side of the flexor retinaculum.

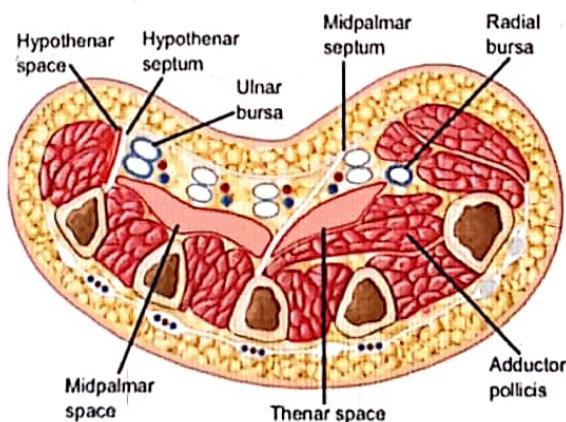
#### Guynon's canal

Formed by the volar carpal ligament.

Content – ulnar nerve and ulnar artery.

### Spaces in the hand

00:08:57



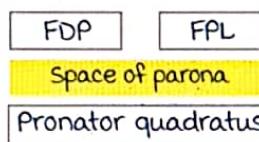
#### Relations of mid palmar space :

- medially – medial palmar septum.
- Laterally – intermediate palmar septum.
- Anteriorly – palmar aponeurosis + superficial palmar arch + tendons of FDS and FDP + ulnar bursa + 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> lumbricals.
- Posteriorly – fascia over interosseous muscles.

- Proximally - both the spaces (thenar space and mid palmar space) extend to space of parona.
- Distally - mid palmar space extends to 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> web spaces through 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> lumbral canals.

### Space of parona:

Location - present between the deep flexor retinaculum.



**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

### Relations of thenar space :

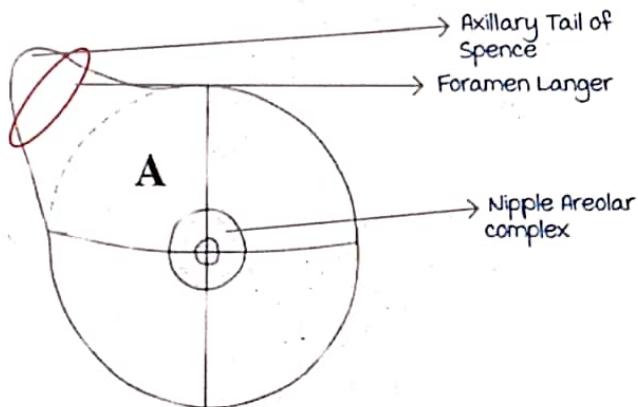
- medially - intermediate palmar septum.
- Laterally - lateral palmar septum.
- Anteriorly - tendons of FDS and FDP + FPL with radial bursa + 1<sup>st</sup> lumbral.
- Posteriorly - adductor pollicis muscle.
- Proximally - both the spaces (thenar space and mid palmar space) extend to space of parona.
- Distally - extends to 1<sup>st</sup> web space through 1<sup>st</sup> lumbral canal.

**Note :** infection from index finger spreads to thenar space via 1<sup>st</sup> lumbral canal.

# MAMMARY GLAND

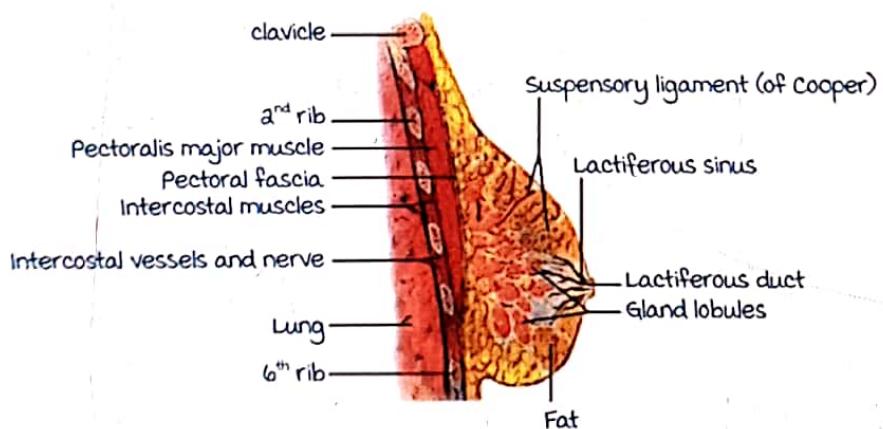
Breast

00:00:02



- Contain the mammary gland in the superficial fascia and the nipple areolar complex
- Axillary tail of Spence :
  - Is the elongation in the **upper outer quadrant**
  - passes through the **Foramen of Langer** to enter axilla

Sagittal Section



- Nipple :
  - In 4<sup>th</sup> intercostal space in nulliparous women
  - Supplied by the 4<sup>th</sup> intercostal nerve
  - Pierced by 15-20 lactiferous ducts
- Areola :
  - Circular pigmented area beneath the nipple
- Suspensory ligament of Cooper : extends from skin to underlying pectoral fascia

Active space

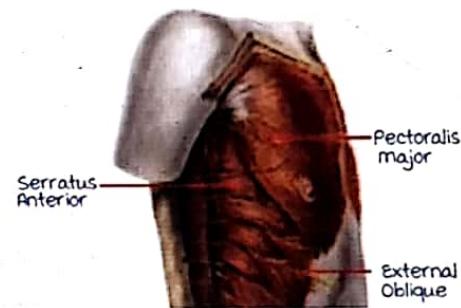
- Extension of breast:
- Vertically : 2<sup>nd</sup> rib – 6<sup>th</sup> rib midclavicular line
- Horizontally : Lateral border of the sternum to mid axillary line along 4<sup>th</sup> rib

## Mammary Gland

00:04:10

mammary gland is a modified **sweat** gland.

Bed of the mammary gland



### Retromammary Space :

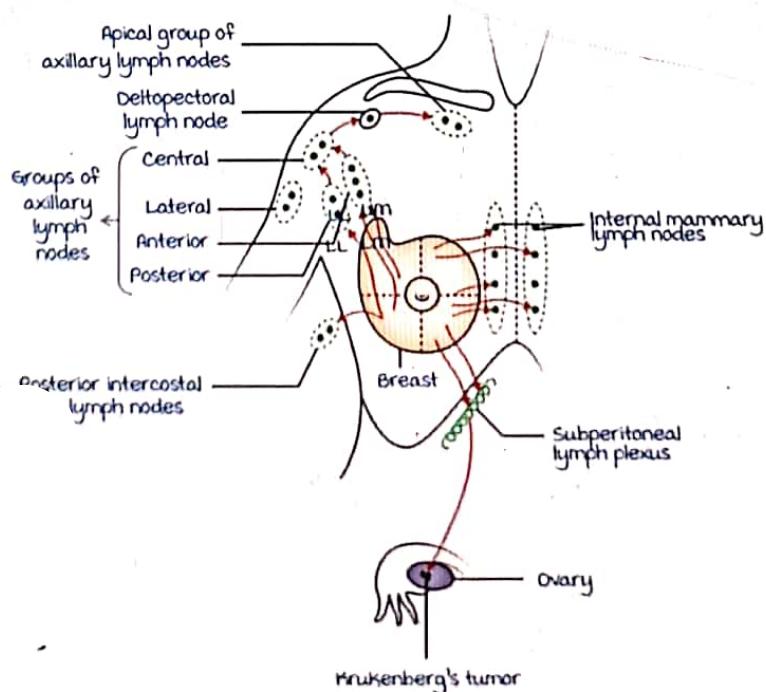
- Space between deep part of the gland and the pectoralis fascia
- Contains loose connective tissue

### Blood supply :

- Perforating branch of internal thoracic artery (branch of 1<sup>st</sup> subclavian artery)
- All branches of axillary artery except circumflex humeral artery
- Intercostal arteries

Nerve Supply : 4<sup>th</sup> – 6<sup>th</sup> intercostal nerve

### Lymphatics :

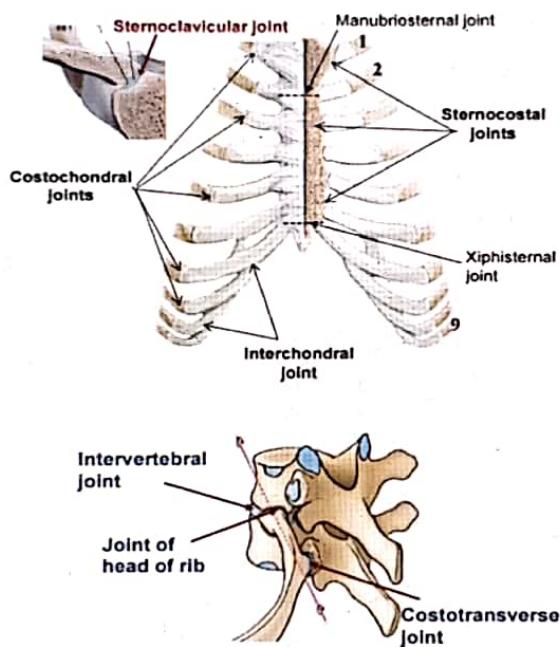


# OSTEOLOGY OF THORAX

## Various joints of thoracic cage

00:00:03

majority - Plane type of synovial joints (sternocostal joints, interchondral joints, costotransverse joints, costovertebral joints).



### Exceptions

#### First Sternocostal joint :

- Not plane type of synovial joint.
- It is a fibrous joint (synarthrosis type of joint).
- Immobile joint.

#### Sternoclavicular joint :

- Saddle type of synovial joint.

#### Midline joints (manubriosternal joint, xiphisternal joint) :

- Secondary cartilaginous joint.

#### Costochondral joint :

- Primary cartilaginous joint.

## Events occurring at the sternal angle

00:04:42

Sternal angle (**angle of Louis**) – junction between manubrium and body of sternum.

Vertebral level	T4 to T5
Costal cartilage	2 <sup>nd</sup> costal cartilage
mediastinum junction	Superior (above sternal angle) – Inferior (below sternal angle)
Dermatome	Above sternal angle – C4 Below sternal angle – T2
Arch of aorta	Beginning and termination
Superior venacava	Pierces fibrous pericardium
Thoracic duct deviation	At the level of T5 (from right to left)
Tracheal bifurcation (in cadaver)	At T4

## Note :

In Grey's anatomy 39<sup>th</sup> edition – tracheal bifurcation (in living) is at T4.

In Grey's anatomy 40<sup>th</sup> edition – tracheal bifurcation (in living) is at T5.

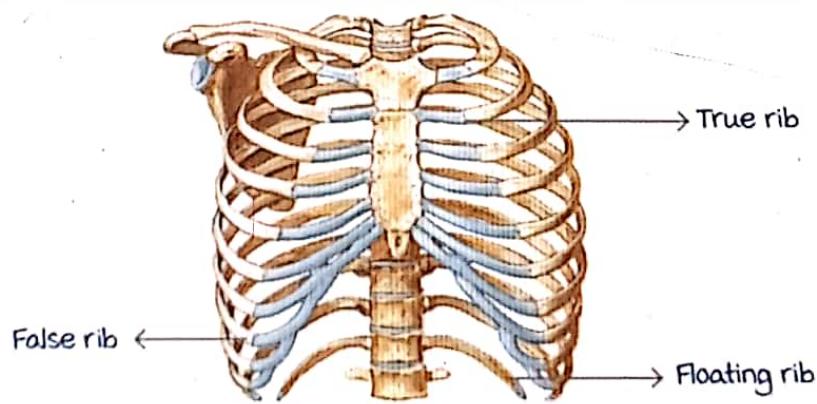
In Grey's anatomy 41<sup>th</sup> edition – tracheal bifurcation (in living) is at T6.

Thus, for exam purposes consider T4 > T6 level for tracheal bifurcation (in living).

## Types of ribs

00:09:29

Active space



## True ribs :

Attached to the sternum directly by its costal cartilage.

Example – 1<sup>st</sup> to 7<sup>th</sup> ribs.

**False ribs :**

Attached to sternum by joining with the previous costal cartilage.

Example - 8<sup>th</sup> to 10<sup>th</sup> ribs.

**Floating ribs :**

Not attached to the sternum.

Example - 11<sup>th</sup> and 12<sup>th</sup> rib.

**Typical ribs :**

Share common features.

Example - 3<sup>rd</sup> to 9<sup>th</sup> ribs.

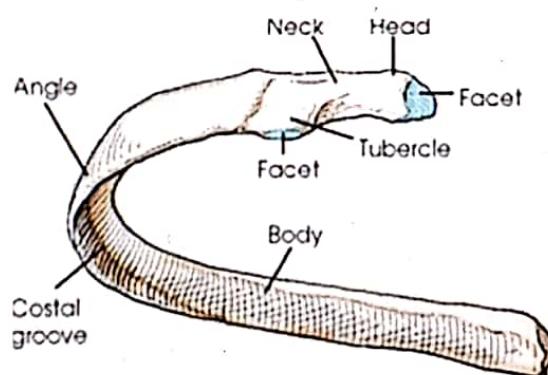
**Atypical ribs :**

Have special features.

Example - 1<sup>st</sup>, 2<sup>nd</sup>, 10<sup>th</sup>, 11<sup>th</sup> and 12<sup>th</sup> ribs.

**Parts of the rib**

00:12:54



- Head (facet) - articulates with the body of thoracic vertebra and forms costovertebral joint.
- Tuberclle (facet) - articulates with the transverse process and forms costotransverse joint.

**Costal groove** - transmits neurovascular structures.

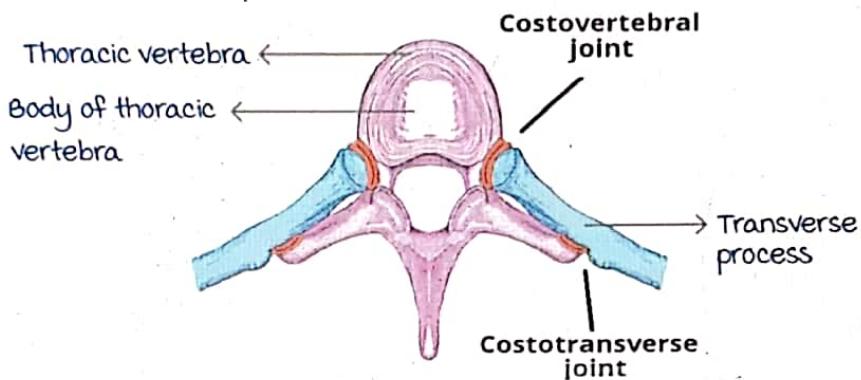
- From above downwards V-A-N arrangement is seen.

V - intercostal vein.

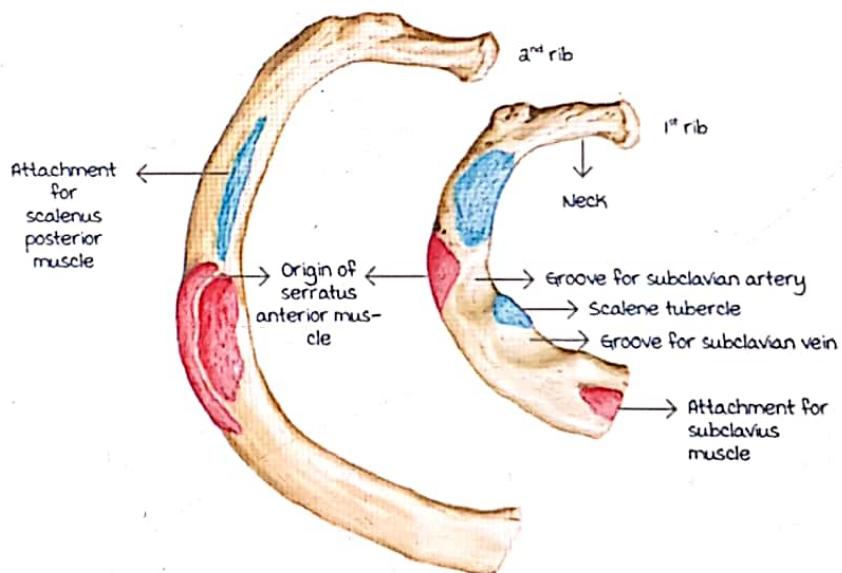
A - intercostal artery.

N - intercostal nerve.

**Note :** Costal groove is absent in the 1<sup>st</sup> rib.



### Features of 1<sup>st</sup> rib



Inner border of 1<sup>st</sup> rib – gives attachment to Sibson's fascia.

Scalene tubercle – gives attachment to scalenus anterior muscle.

### Neurovascular structures between neck of 1<sup>st</sup> rib and apex of lung

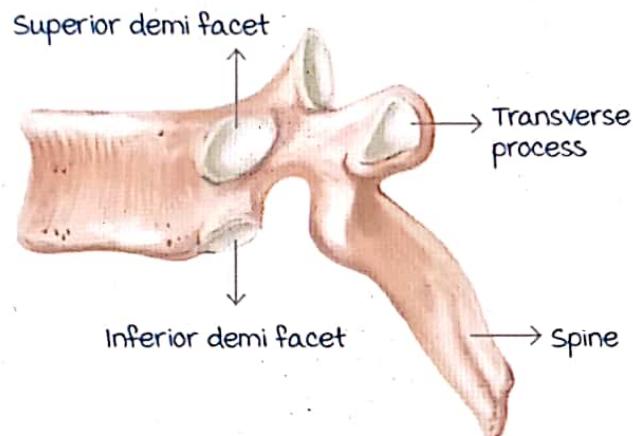
00:20:31

From medial to lateral

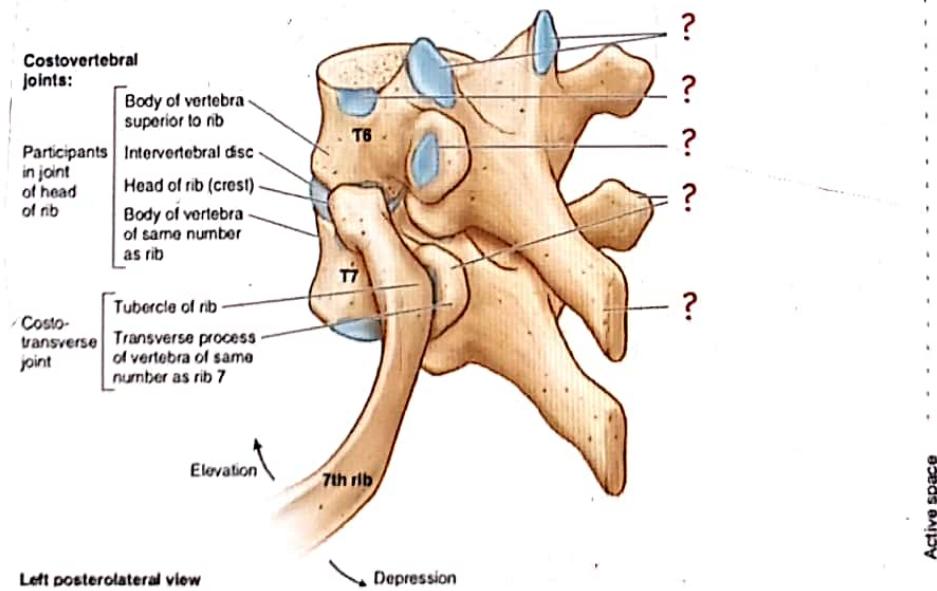
1. Sympathetic chain.
2. 1<sup>st</sup> posterior intercostal vein.
3. Superior intercostal artery.
4. 1<sup>st</sup> thoracic nerve.

## Thoracic vertebra

00:23:03



- Superior demi facet – gives attachment to the corresponding rib (head).
- Inferior demi facet – gives attachment to the lower succeeding rib (head).
- Transverse process – articulates with the tubercle of the corresponding rib.
- Spine – inclined downwards; situated at the body of the lower vertebra.



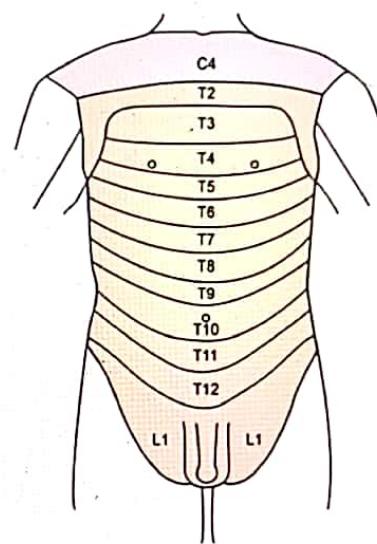
## Dermatomes of thorax and abdomen

00:28:33

T<sub>2</sub> to T<sub>6</sub> – dermatomes of thorax

T<sub>7</sub> to T<sub>12</sub> – supplies the anterior abdominal wall.

### DERMATOMES OF THORAX AND ABDOMEN



## INTERCOSTAL SPACES AND ITS CONTENTS

The space between the adjacent ribs is called intercostal space.

The intercostal space **contents** are :

- Intercostal muscle
- Intercostal vein
- Intercostal artery
- Intercostal nerve

### Intercostal muscle

00:00:39

- Origin - lower border of upper rib and upper border of lower rib.
- Direction of **external muscle** - downwards, forwards and medially.
- Direction of **internal & innermost muscle** - downwards, backwards and laterally.
- Neurovascular structures

They pass between the internal and innermost intercostal muscle.

In the costal groove, they are arranged as **VAN** - Intercostal vein

Intercostal artery

Intercostal nerve

- Actions of intercostal muscles :

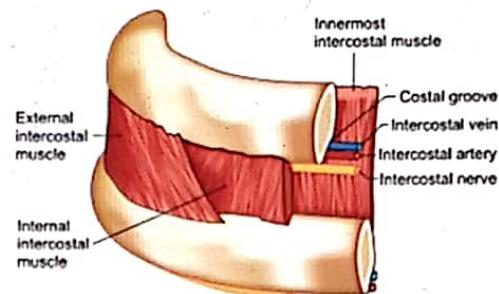
External intercostal muscle along with diaphragm helps in **inspiration**.

Accessory muscles of inspiration are :

- Scalene muscle
- Sternocleidomastoid muscle
- Serratus anterior and posterior muscles
- Erector spinae muscle
- Pectoralis major and minor muscles

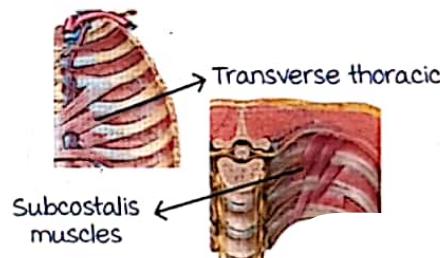
Active space

Expiration is a passive process assisted by abdominal muscles and internal and innermost intercostal muscles.



muscles in the thoracic cage :

- Transverse thoracic- anteriorly
- Subcostalis muscle- posteriorly



### Intercostal arteries

00:06:26

There are two arteries- anterior and posterior intercostal arteries.

	Anterior intercostal artery	Posterior intercostal artery
Number	Two in each space	One in each space
In 10th and 11th intercostal space	absent	present
spaces	For 1 to 6 - Comes from Internal thoracic artery	For 1,2 - Comes from superior intercostal artery (branch of costocervical trunk)
	For 7, 8, 9 - Comes from musculophrenic artery	Remaining spaces- descending thoracic aorta

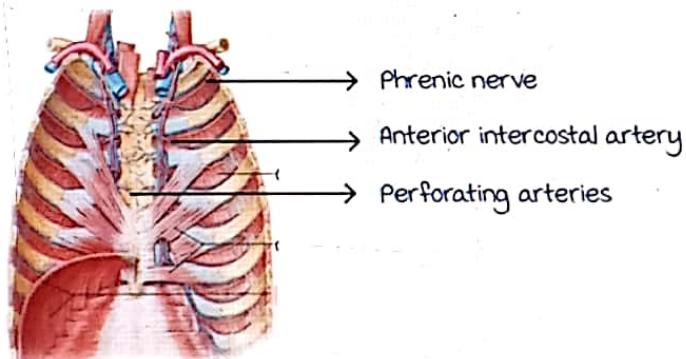
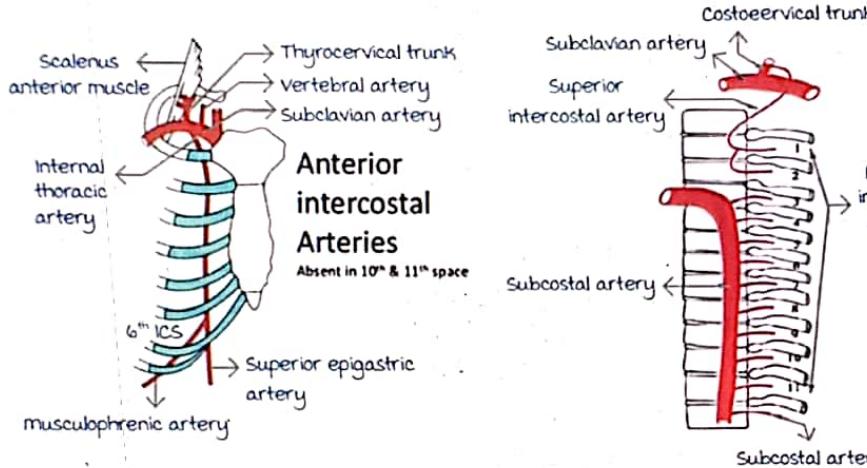
The phrenic nerve is crossing the artery from lateral side to medial side.

The branches of intercostal artery are :

- musculo phrenic artery
- Superior epigastric artery



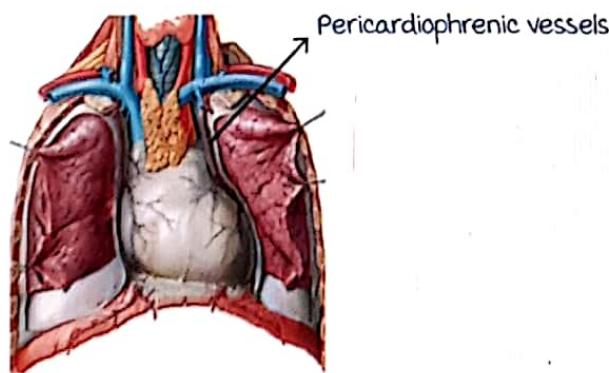
- Anterior intercostal artery
- Perforating arteries
- Pericardiophrenic vessels



#### Pericardiophrenic vessels :

They pass **anterior** to the hilum of the lungs.

They are accompanied by **phrenic nerve**.



Note : at the 10th intercostal space only posterior intercostal artery is present.

Active space

## Intercostal veins

00:14:26

There are two veins anterior and posterior intercostal veins.

- Anterior intercostal veins (AICV) :

They follow the anterior intercostal artery.

1 to 6 AICV drain into the internal thoracic vein.

7,8,9 AICV drain into the musculophrenic vein.

- Posterior intercostal vein (PICV)

- Right side :

First PICV drains into right brachiocephalic vein

2,3,4 PICV join together and form a superior intercostal vein drain into the arch of azygos.

5,6,7,8,9,10,11 PICV drain into the azygos vein.

- Left side :

First PICV drain into left brachiocephalic vein

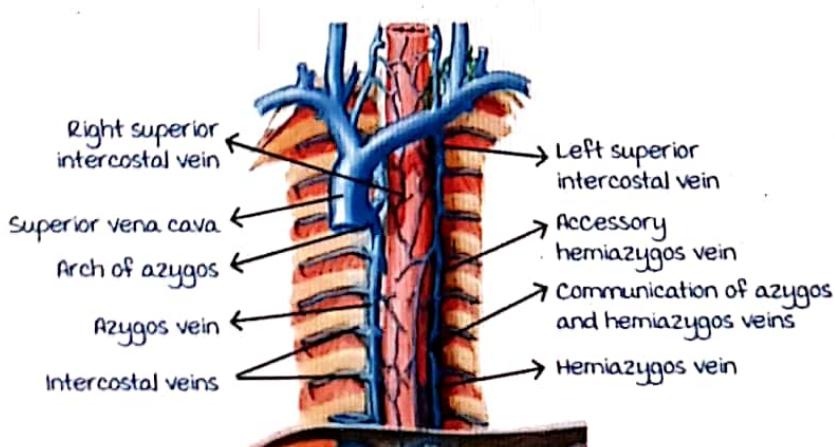
2,3,4 PICV join together and form the left superior intercostal vein drain into the left brachiocephalic vein (Alms).

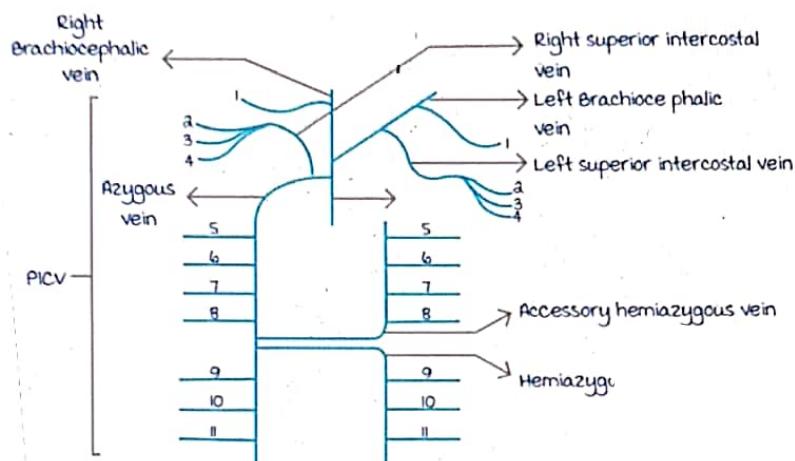
5,6,7,8 PICV drain into accessory hemi azygos vein

↓  
Drain into the azygos vein at the level of T7.

9,10,11 PICV drain into hemi azygos vein

↓  
Drain into azygos vein at the level of T8.





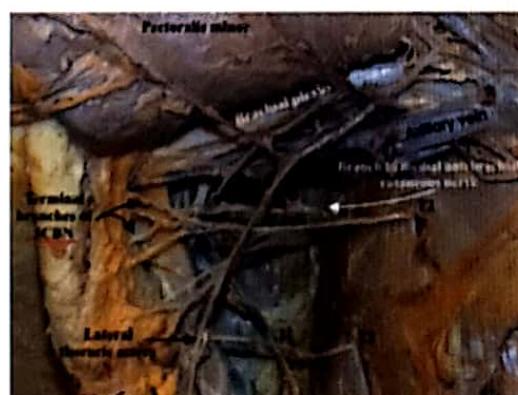
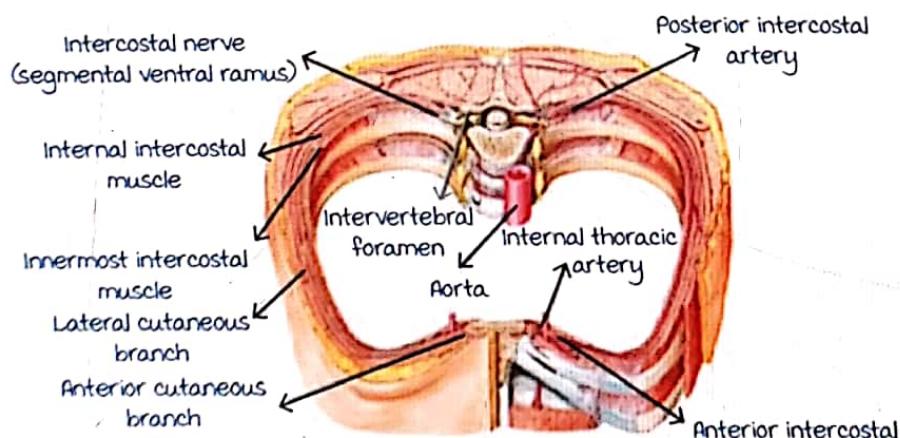
## Intercostal nerve

00:22:21

It is the **ventral rami** of the ventral branch of the thoracic spinal nerve.

T<sub>3</sub> to T<sub>6</sub> is the typical intercostal nerve.

- T<sub>1</sub>- involved in brachial plexus- supply upper limb
- T<sub>2</sub>- forms **intercostobrachial nerve**- supplies intercostal space and arm
- T<sub>3</sub> to T<sub>6</sub>- supply thorax
- T<sub>7</sub> to T<sub>12</sub>- supply anterior abdominal wall.



### Pleural tapping

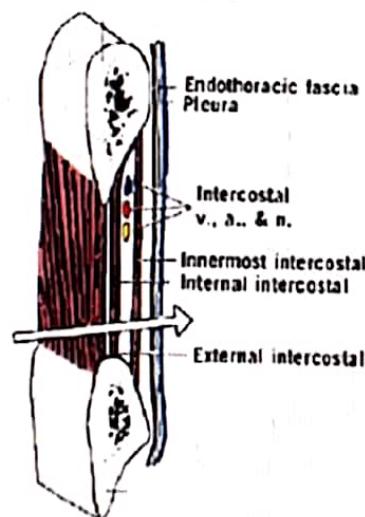
It is done on the **upper border of the lower rib** (neurovascular structures are present in the lower border of a rib).

**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

It is done in the mid axillary line - **7,8,9th intercostal space**.

The **structures pierced** are :

- Skin
- Superficial fascia
- Deep fascia
- Serratus anterior muscle
- external intercostal muscle
- internal intercostal muscle
- innermost intercostal muscle
- Endothoracic fascia
- Parietal pleura



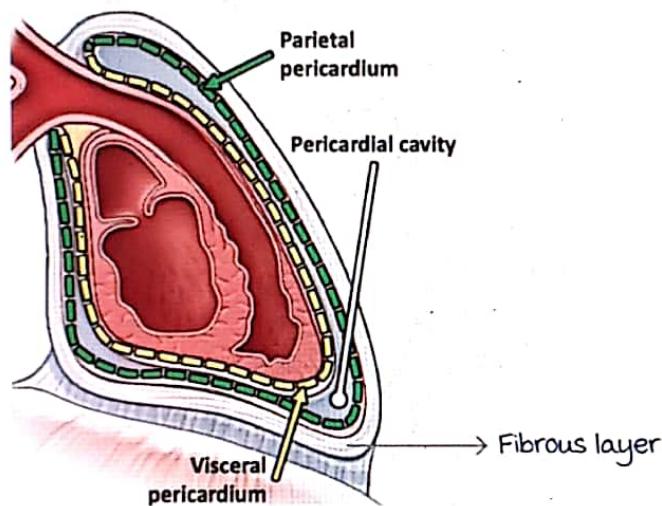
Active space

# PERICARDIUM AND HEART

## Pericardium

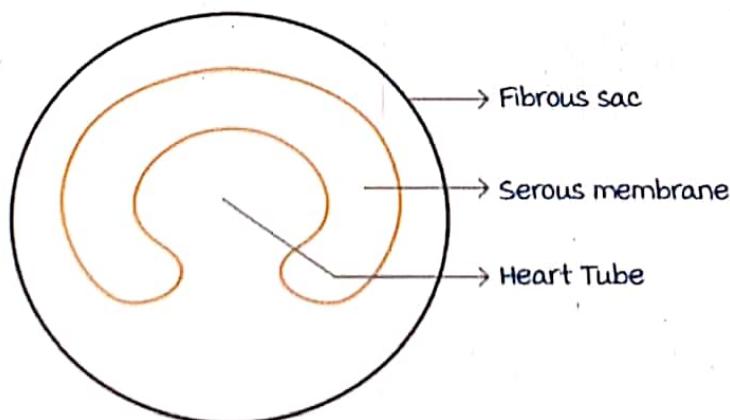
00:00:05

Fibro-serous layer : Outer fibrous and inner serous (visceral and parietal)



Origin :

- Fibrous layer : septum transversum (central tendon of diaphragm also derived from septum transversum)
  - Serous layer :
    - Parietal - parietal layer of lateral mesoderm
    - Visceral - visceral layer of lateral mesoderm
- Heart is **Intrafibrous and Extraserosus**.



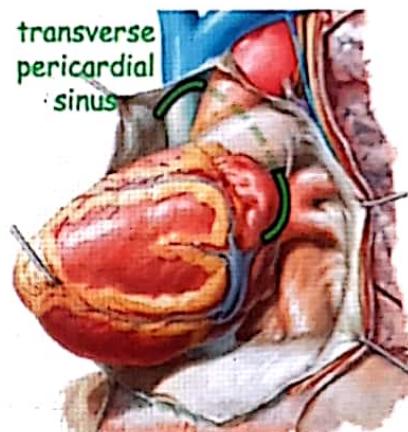
Active space

**Nerve supply :**

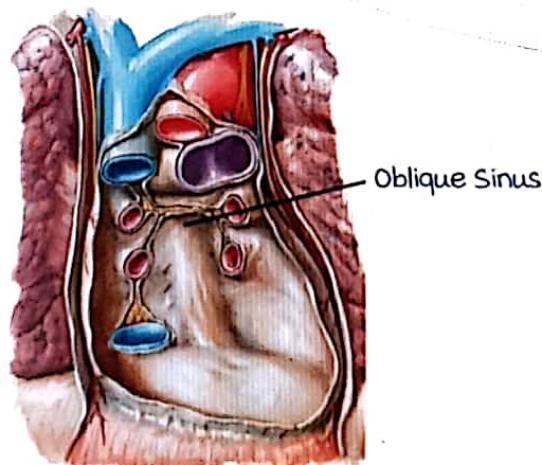
- Phrenic nerve : Fibrous layer and parietal layer of serous pericardium
- Autonomic nervous system : visceral layer of serous pericardium.

**Spaces :****D) Transverse pericardial Sinus :**

- a. Anteriorly : Aorta and Pulmonary trunk
- b. Behind : Superior Vena Cava
- c. Below : Left atrium

**a) Oblique Sinus :**

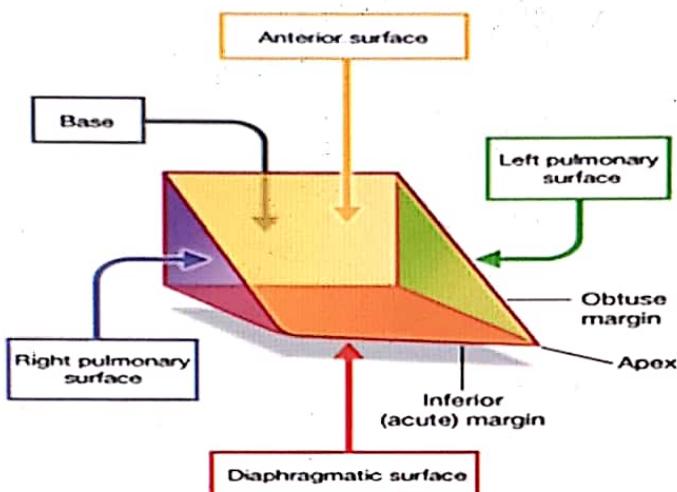
- a. Anteriorly : Left atrium
- b. Posteriorly : parietal layer serous pericardium
- c. Either sides : 4 pulmonary veins



- Below transverse sinus : Left atrium
- In front of oblique sinus : Left atrium

External features of the heart

00:08:05



## 1. Right border:

- Formed by right atrium
- Extends from SVC opening to IVC opening

## 2. Inferior border:

- Formed by left ventricle [LV] and right ventricle [RV]
- Extends from IVC opening to apex of heart

## 3. Left border:

- Formed by left auricle and left ventricle

- Apex : Formed by left ventricle
- Base : Formed by  $\frac{1}{3}$  Right atrium and  $\frac{2}{3}$  Left atrium

## 1. Anterior surface :

- formed by Right atrium + part of right auricle + part of left auricle +  $\frac{2}{3}$  RV +  $\frac{1}{3}$  LV

## 2. Diaphragmatic surface:

- formed by  $\frac{1}{3}$  RV +  $\frac{2}{3}$  LV

## 3. Left surface

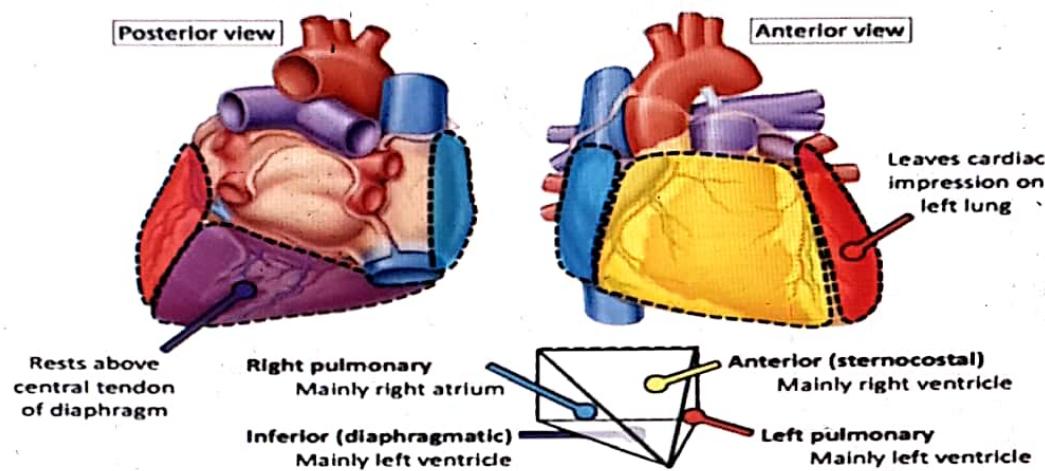
- formed by left auricle and left ventricle

## 4. Right surface

- formed by Right atrium

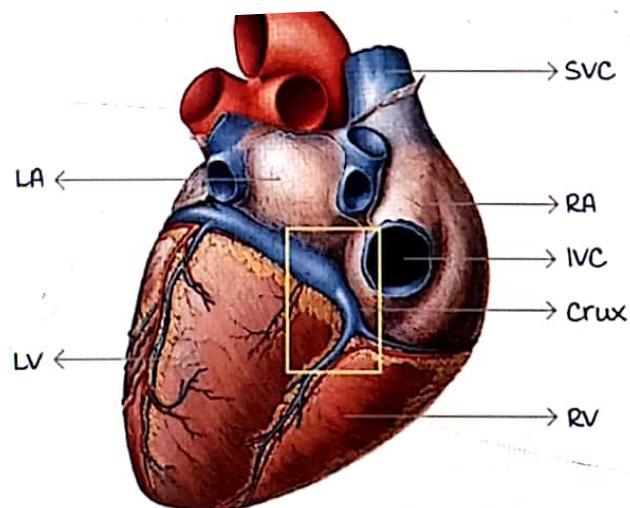
Active space

Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.



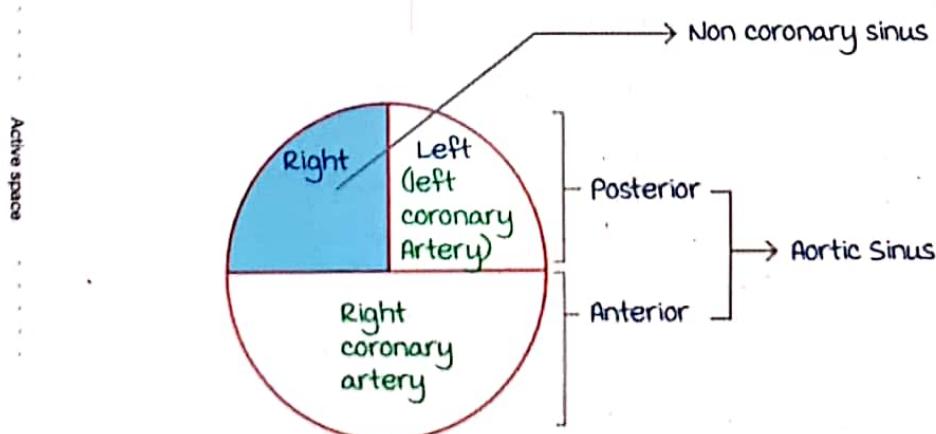
### Crux of the heart:

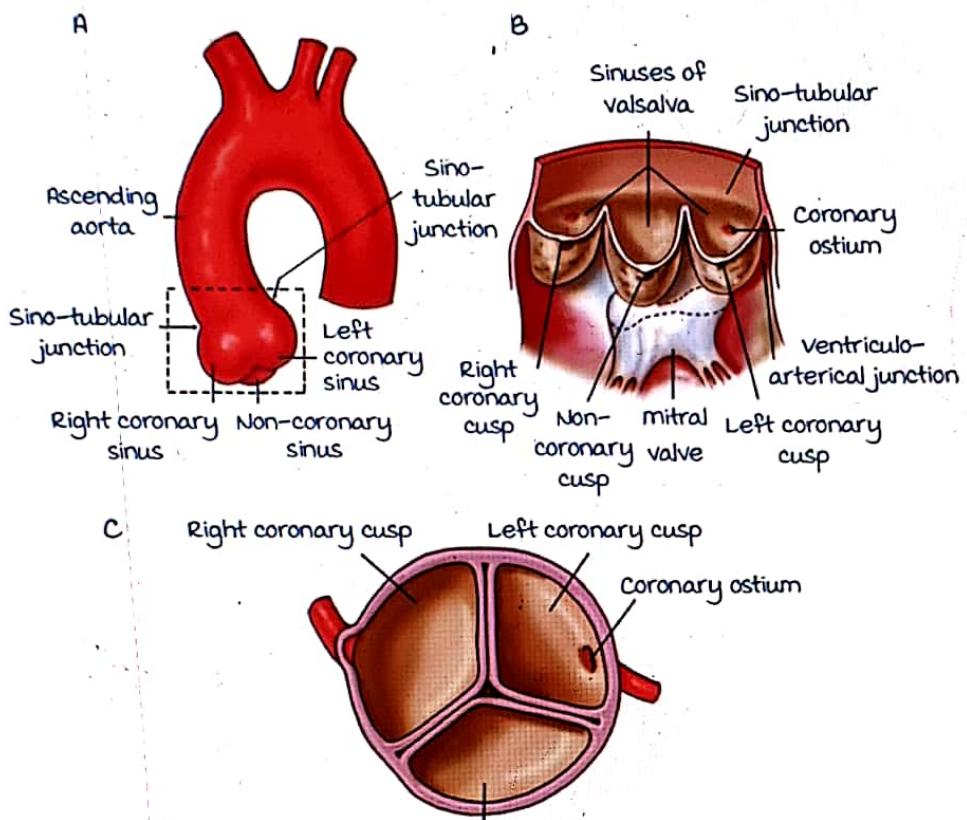
- meeting point of
  - Inter atrial septum
  - Interventricular septum
  - Post part of atrio ventricular septum



### Blood supply of the heart

00:17:05

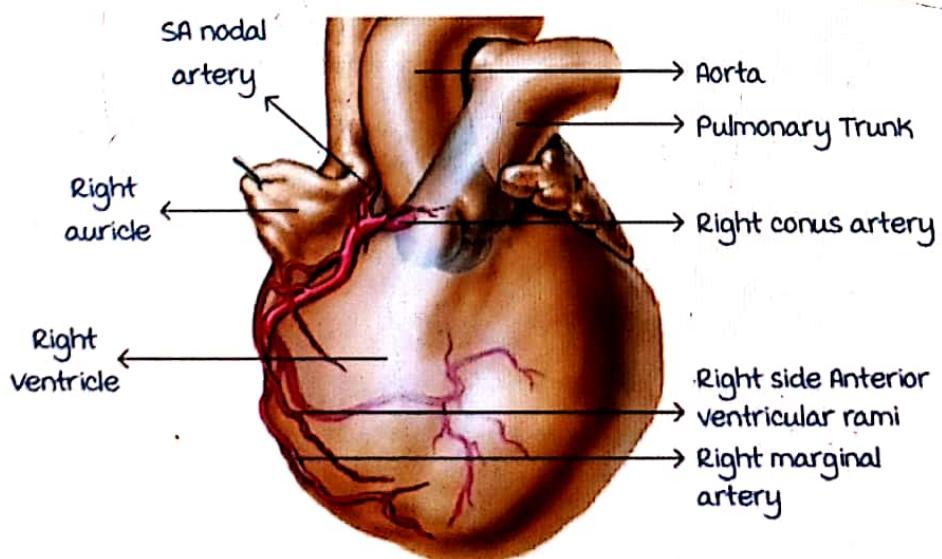




Right coronary artery: Non-coronary cusp

1. Course:

- descends between right auricle and pulmonary trunk
- descends between RA and RV
- wind around inferior border to reach posterior part of atrioventricular septum
- reach the crux of the heart to anastomose with circumflex artery.



Active space

## II. Branches:

## 1. Right conus artery:

- supplies the infundibulum of right ventricle
- sometimes takes origin from aortic sinus : then called as **3<sup>rd</sup> coronary artery**

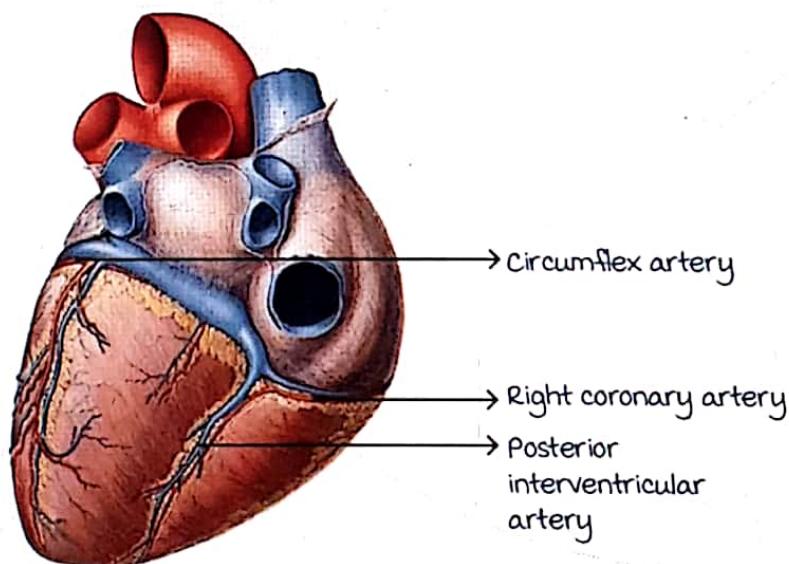
## 2. SA nodal artery:

- Originates from RCA in 65% cases and circumflex in 35% cases
- Ascends between ascending aorta and right auricle : arch laterally to supply SA node

## 3. Right side Anterior ventricular rami : Supply anterior surface of the right ventricle.

## 4. Right marginal artery

- Called as acute marginal artery
- Reach upto the apex of the heart

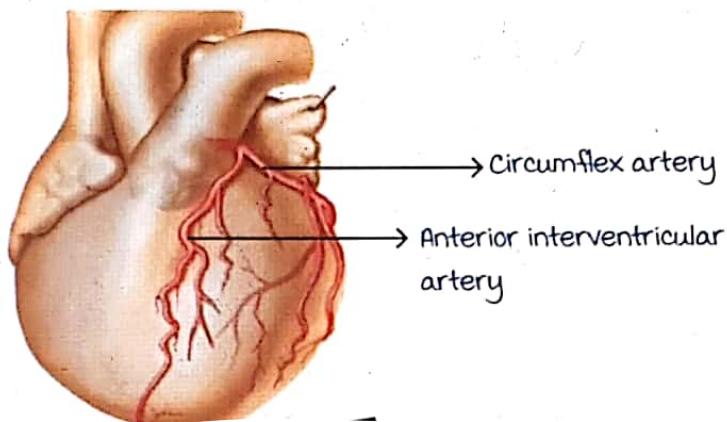


## 5. Posterior interventricular artery:

- Arises from right coronary artery.
- Wind around the inferior border to anastomose with anterior interventricular artery
- In some cases it arises from the circumflex artery
- Branches :

- i. Supplies the diaphragmatic surface of the RV/LV
- ii. Septal branch : Supplies posterior  $\frac{1}{3}$  interventricular septum and also supplies the AV node

Left coronary artery :



- I. Diameter : LCA > RCA
- II. descends between pulmonary trunk and left auricle and in turn divide into Anterior interventricular artery [AlVA] and circumflex artery :

a. AlVA :

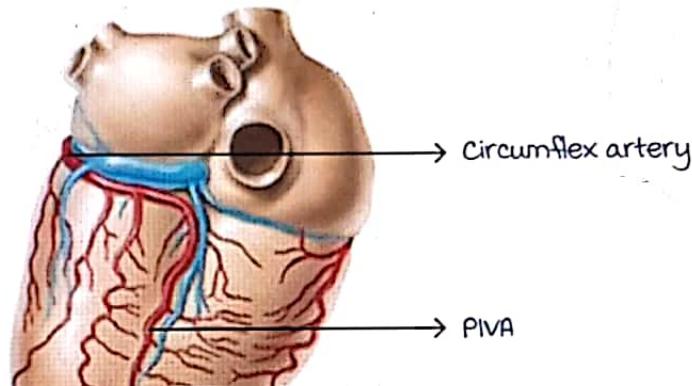
- Accompanied by great cardiac vein
- Descends into anterior interventricular group
- And wind around the inferior border and anastomose with posterior interventricular artery
- Branches :
  1. ventricular Rami : supplies the sternocostal surface of the right ventricle and left ventricle
  2. Diagonal branch : supplies the anterior and lateral surface of the left ventricle
  3. Septal branch : supplies the anterior  $\frac{2}{3}$ rd of the interventricular septum

b. Circumflex artery :

- Descends between left auricle and left ventricle
- And wind around the left border
- Passing in the posterior part of atrioventricular sulcus and then it reach the crux of the heart to anastomose with RCA
- Branches :
  1. Branches to left atrium and left ventricle :
  2. Left marginal artery (obtuse artery) : Reach upto apex

3. A branch supplies the SA nodal artery in 35% of the cases
4. Atria branch: anastomose with similar branch from RCA in atrial wall (Kugel's artery)

### III. Dominance :

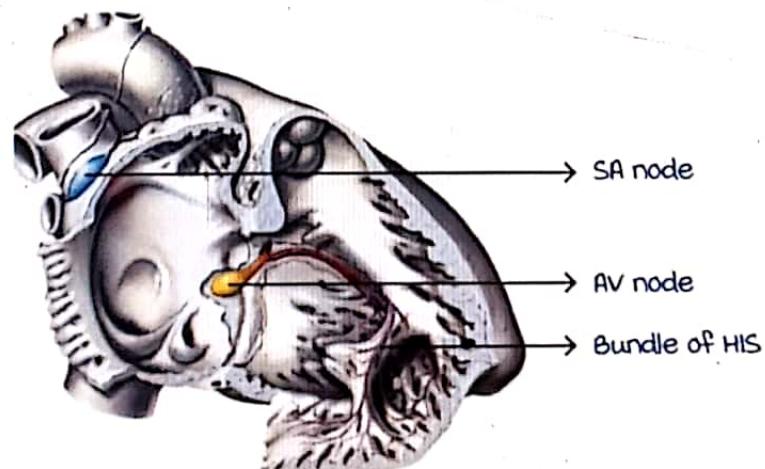


- Left Coronary Dominance :  
PIVA arises from Circumflex "Bad Prognosis"
- Right Coronary Dominance :  
PIVA arises from RCA in majority of the cases.
- Balanced Coronary Dominance :  
PIVA arises from both RCA and Circumflex.

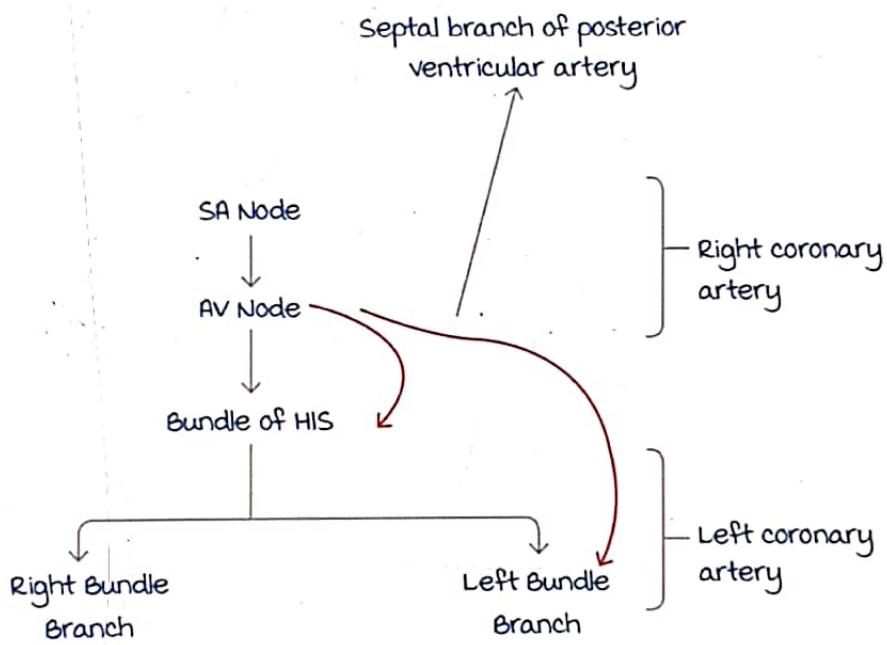
## Blood supply of conducting system of the heart

00:40:35

Active space



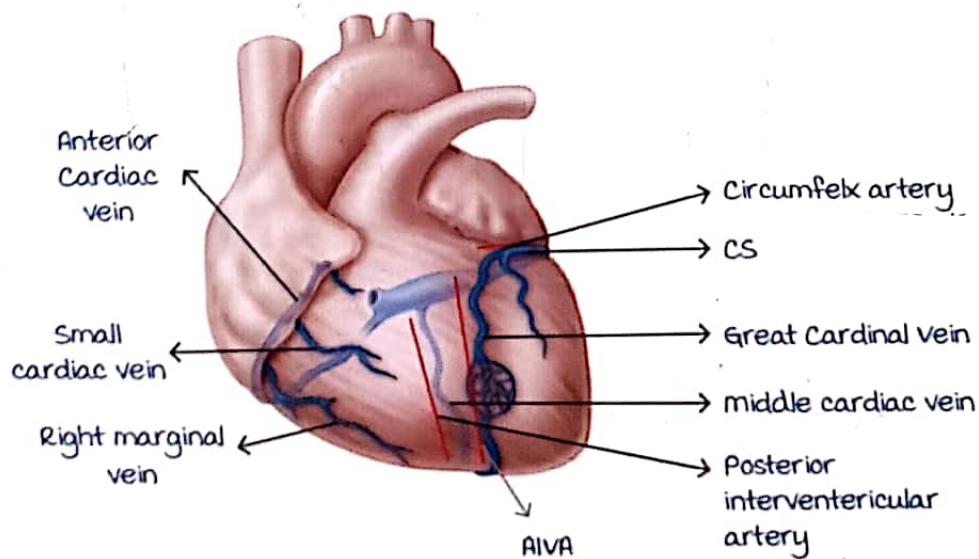
1. SA node : located at
  - Junction of SVC opening into right atrium
  - Upper end of crista terminalis
  - Junction between posterior smooth wall and anterior rough wall
2. AV node : located in Triangle of Koch
3. Bundle of HIS : divided into right bundle branch and left bundle branch



- RBB - only part of our conducting system **not** supplied by RCA

## Venous drainage of the heart

00:44:15



Coronary Sinus :

Venous blood drained by coronary sinus

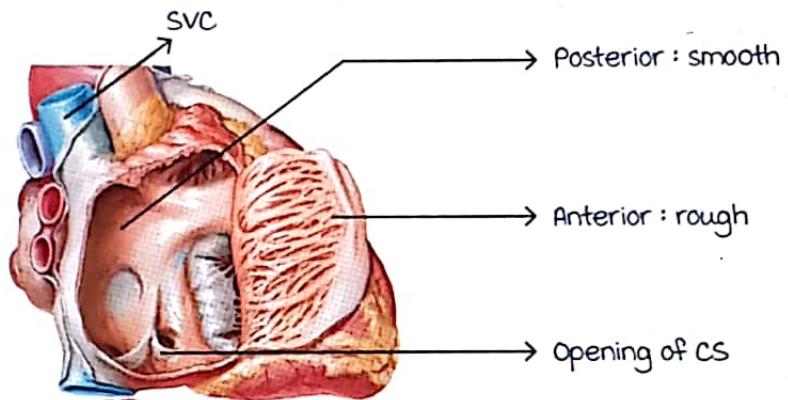
Begins at the left part of Atrio ventricular sulcus



wind around the left border



Passing in the posterior part of atrioventricular sulcus → opening into the posterior smooth part of right atrium (Thebasian's valve)



Tributaries :

1. Great cardiac vein : accompanied by AlVA and Circumflex artery
2. middle cardiac vein : accompanied by Posterior interventricular artery
3. Small cardiac vein : accompanied by RCA
4. Right marginal vein : continues as small cardiac vein
5. Posterior vein of left ventricle
6. Oblique vein of Left atrium

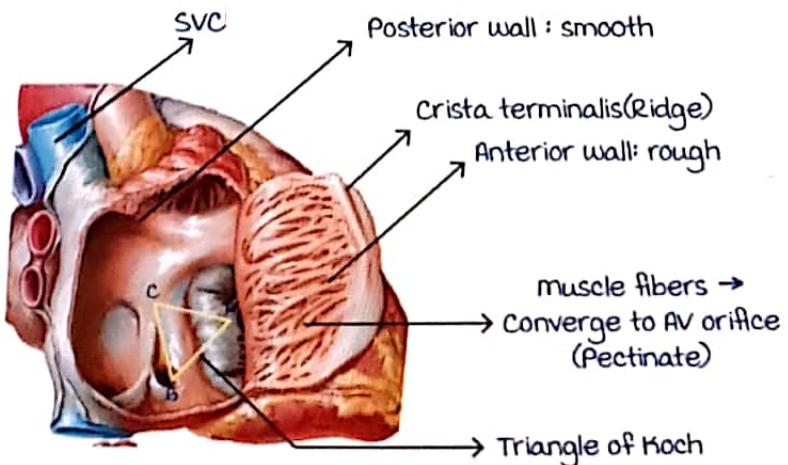
Anterior cardiac artery **not** a tributary of coronary sinus, but drains directly into the anterior wall of Right atrium.

## Interior of Heart

00:52:15

Interior of Right atrium :

Active space



In posterior smooth wall opening of :

- SVC
- IVC (guarded by the Eustachian valve)
- CS (guarded by the Thebasian's valve)

In Septal wall :

- Fossa ovalis- Remnant of septum primum
- Limbus (L) fossa ovalis- present over upper and posterior margin of fossa ovalis and derived from septum secundum

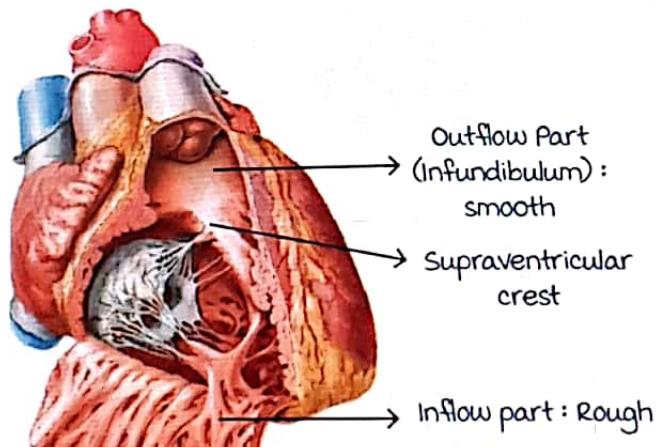
Triangle of Koch : AV node located here

A- Base of septal leaflet

B- Coronary sinus

C- Tendon of Todaro

Interior of Right ventricle :



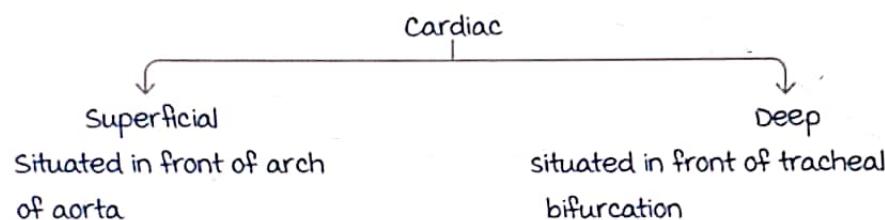
Inflow part: Rough

- Contains Trabeculae carneae which in turn are;
  - Ridges : linear elevations. E.g. supraventricular crest
  - Bridges :
    - ends are connected **but** free in middle
    - extends from ventricular septal wall to Anterior papillary muscle
  - Septomarginal Trabeculae :
    - also called as moderator band-
    - prevents the over distension of RV
    - contains right bundle branch
  - Pillars :
    - Base is fixed and apex is free
    - Papillary muscle: apex gives attachment to chordae tendinae

Right Ventricle	Left Ventricle
Thin	Thick
3 Papillary muscle (Ant, Post, Sep)	2 Papillary muscle
moderator band present	absent

Nerve supply of the heart

01:04:00



- Ganglion of Wrisberg : present in superficial plexus and connects to the deep plexus.

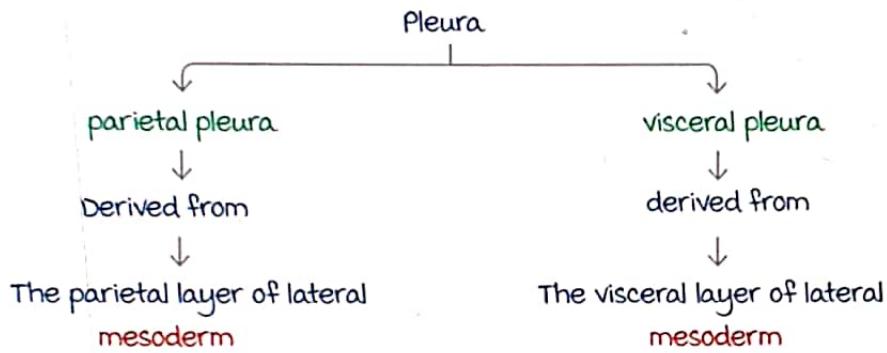
Right			Left
Sympathetic	Para sympath (vagus)	Para sympath	Symp
Superior cerv gang	Superior cervical cardiac	SCC Br	SCG
middle cerv gang	Inf cerv card Br	Icc Br	mca
inf cerv gang	RLN	RLN	ICG
TI - TS			TI - TS

Superficial cardiac Plexus : Superior cervical ganglion of left side + Inferior cervical cardiac branch from left vagus.

# PLEURA AND LUNGS

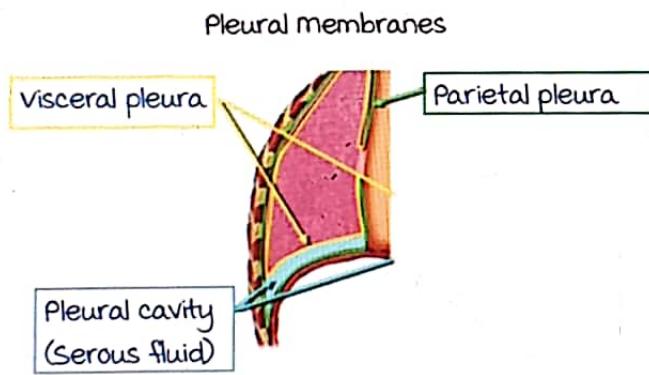
## Pleural membrane

00:00:04

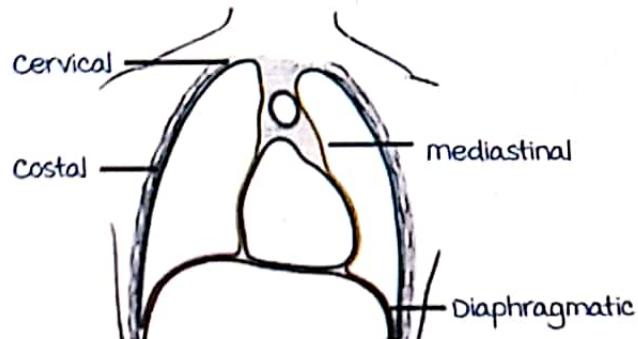


The visceral pleura - covers the lung supplied by autonomic nervous system.

The parietal pleura - supplied by somatic nervous system.



The **parietal pleura** can be - cervical pleura  
mediastinal pleura  
costal pleura  
diaphragmatic pleura



Active space

Suprapleural membrane [2018 NEET] :

- It is present above the cervical pleura.
- It is A/K/A Sibson's fascia.
- It contains scalenus minimus muscle.
- It is the degenerated part of scalenus medius muscle.

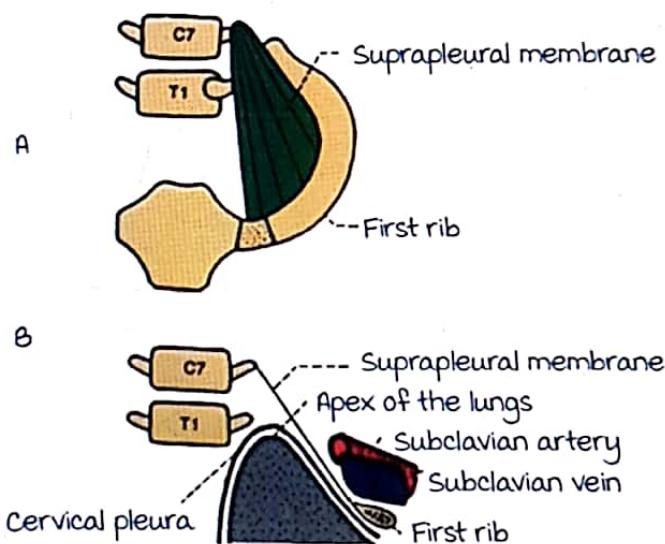
Attachments :

Anteriorly - inner border of first rib.

Posteriorly - C7 transverse process.

Superiorly - the subclavian artery and vein, brachial plexus

arch above the suprapleural membrane.



## Pleural reflection

00:05:08

Costo-mediastinal line of reflection

It starts from sternoclavicular joint [right & left side - upto 4th costal cartilage (CC)].

Right side extends upto - 7th CC [xiphisternal joint]

↓  
costo - mediastinal line of reflexion on right side.

Left side the line deviates for 2 to 2.5cm and

↓  
reaches 6th CC

↓

costo - mediastinal line of reflection on the left side.

Active space

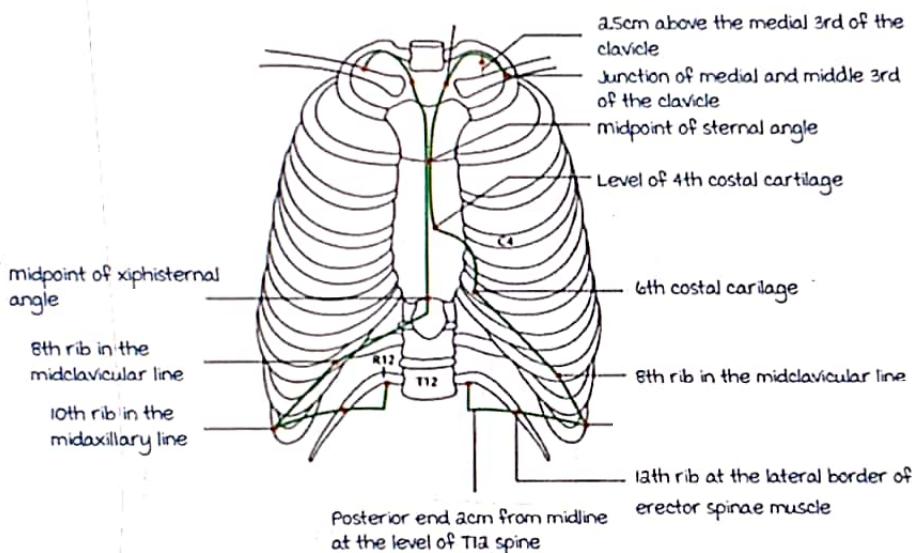
Costo-diaphragmatic line [CDL] of reflection formed by:

- 8th rib in midclavicular line
- 10th rib in midaxillary line
- 12th rib in scapular line

On the right side - CDL starts from 7th CC.

On the left side - CDL starts from 6th CC.

### PLEURAL REFLECTIONS



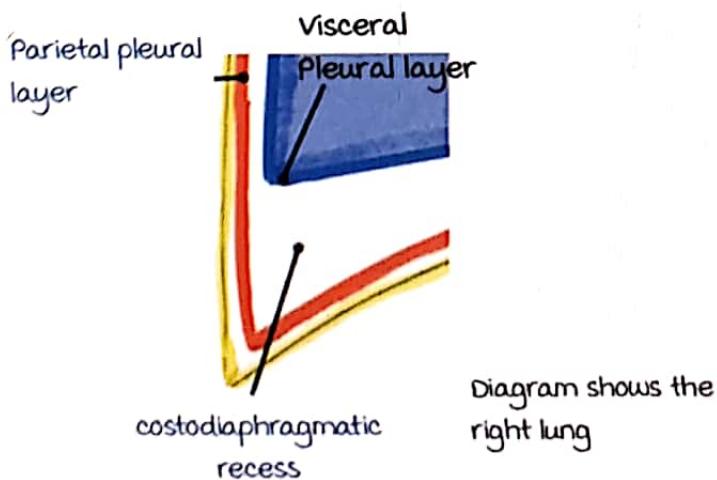
Lower border of lungs is formed by :

- 8th rib in midclavicular line
- 10th rib in midaxillary line
- 12th rib in scapular line

Between the lower border of lungs and the lower border of the pleura.



There is a space called costodiaphragmatic recess.



The nerve supply of pleura :

The costal pleura and peripheral margins of pleura supplied by  
 ↓  
 Intercostal nerve.

The mediastinal pleura and central part of diaphragmatic pleura  
 ↓  
 Supplied by the **phrenic nerve**.

### Mediastinal relations of right lung

00:12:33

Right lung

In Hilum, structures are arranged as :

1. Eparterial bronchus
2. Pulmonary artery
3. Hyparterial bronchus
4. Lower pulmonary vein

In the hilum, arrangement of structures from anterior to posterior :

1. Pulmonary vein
2. Pulmonary artery
3. Bronchus

In front of the hilum - **cardiac area**

- Right atrium
- Right ventricle

In the vertical groove present above the hilum :

- superior vena cava
- Right brachiocephalic vein

Above the hilum - Arch of azygos, trachea.

Behind the hilum - oesophagus.

Nerves - behind the hilum - right vagus nerve

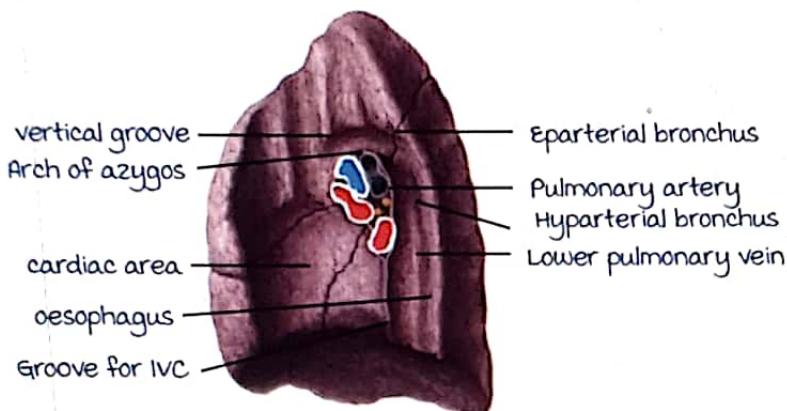
In Front of the hilum - **right phrenic nerve**

Posteroinferior aspect of cardiac impression

It is the groove for inferior vena cava [IVC]

Structures passing through IVC orifice

- IVC
- Right phrenic nerve



### Mediastinal relations of left lung

In Hilum, structures are arranged as :

1. Pulmonary artery
2. Hyparterial bronchus
3. Lower pulmonary vein [PV].

In front of hilum - cardiac surface :

1. Left atrium
2. Left ventricle

Above the hilum - arch of aorta impression.

Behind the hilum - descending thoracic aorta impression.

Pulmonary ligament [PL] - modification of mediastinal pleura.

Provides dead space for expansion of the lower PV  
It contains Lymph nodes.

Between the PL and descending aorta - impression for oesophagus.

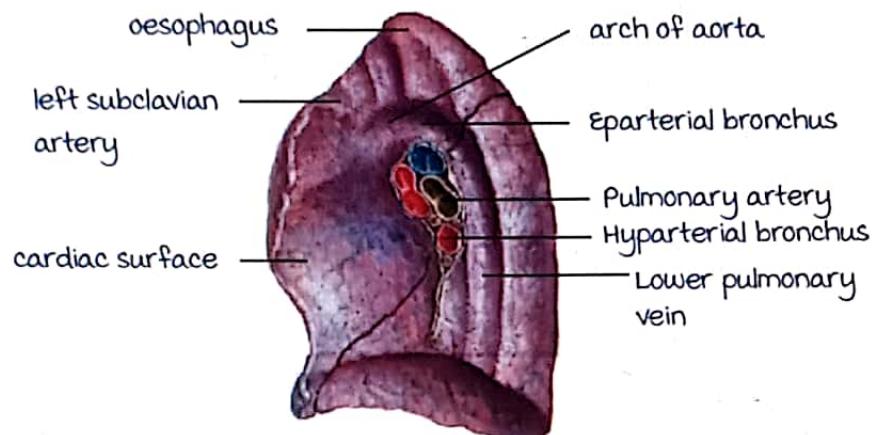
From the arch of aorta - impression for left subclavian artery.

Behind that oesophagus impression.

Active space

Nerves - behind the hilum - vagus nerve

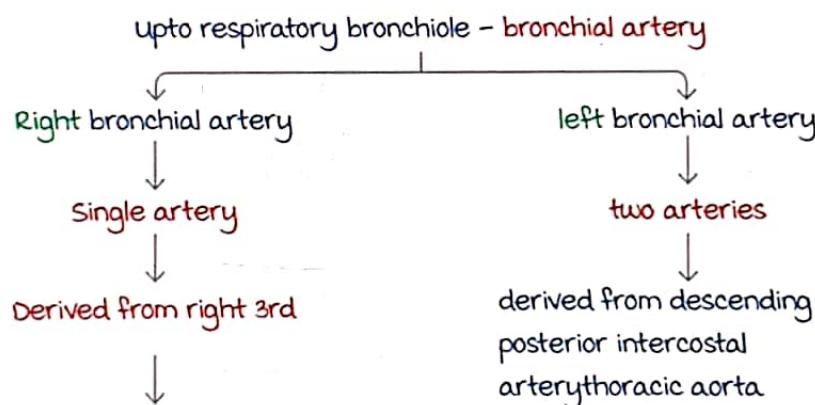
In front of the hilum - phrenic nerve.



Below the respiratory bronchiole - pulmonary artery

### Blood supply of the lung

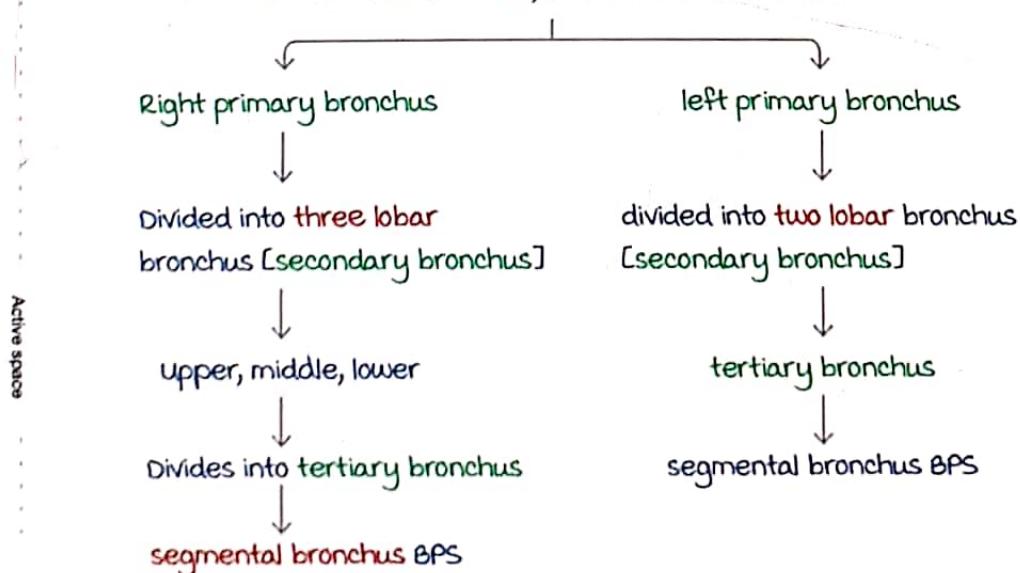
00:24:37

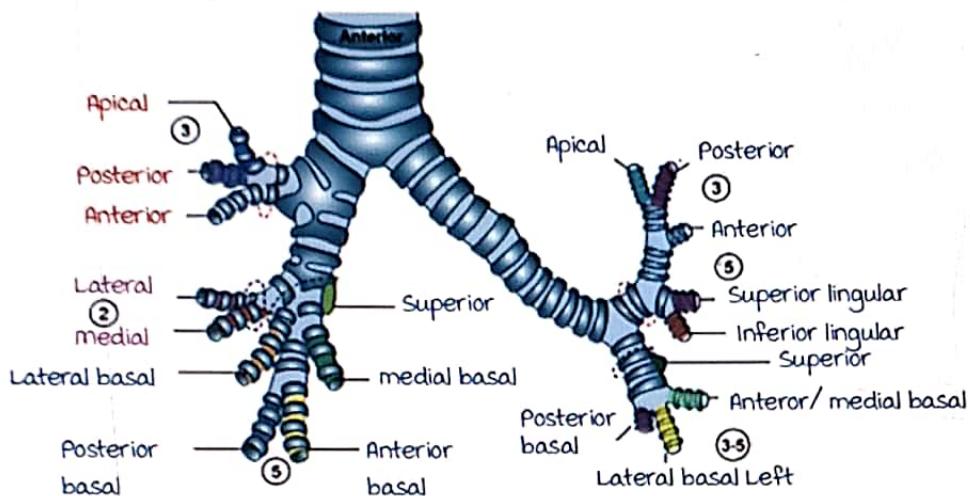


### Bronchopulmonary segment [BPS]

00:26:14

At the level of T4>T6, trachea bifurcated into





## BPS

- Segmental bronchus aerated by tertiary bronchus.
- Surgically resectable segment.
- Wedge shaped.

## Alveolar septum

It is present between the segments

Derived from visceral pleura

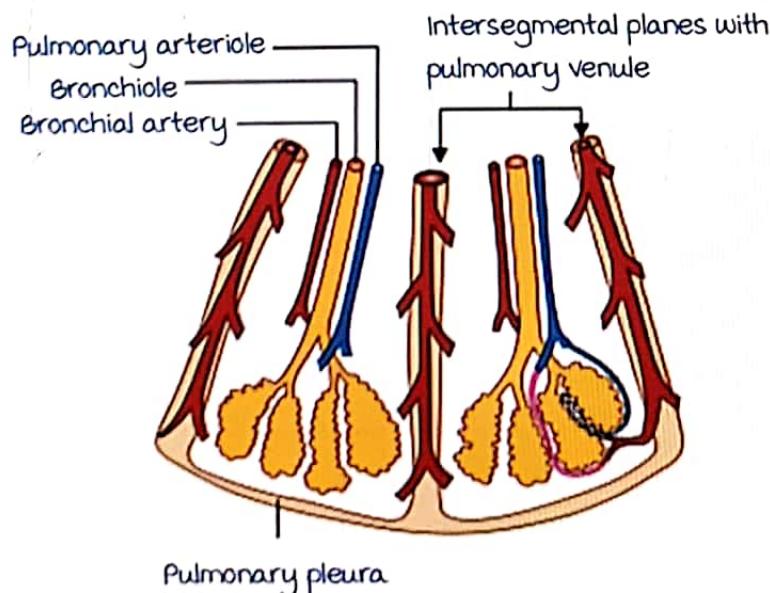
The tributaries of PV are present in the septum.

Intrasegmental structures - bronchial artery

Tertiary bronchus

Pulmonary artery

Intersegmental structure - pulmonary vein.



Active space

Segments in right and left lung

00:32:52

	Right lung	Right lung
Upper lobe	Apical Anterior Posterior	Apical Anterior Posterior
Middle lobe	medial lateral	Superior lingular Inferior lingular
Lower lobe	Apical Anterior basal Posterior basal medial basal Lateral basal	Apical Anterior basal Posterior basal medial basal Lateral basal

Sometimes, left medial basal segment is not well developed.

Sometimes medial basal fuse with anterobasal segment- Anteromedial basal segment.

Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

Right lung - 10 segments

Left lung - 10 segments > 9

Clinical correlation:

Dependant BPS:

Right lung - lower lobe

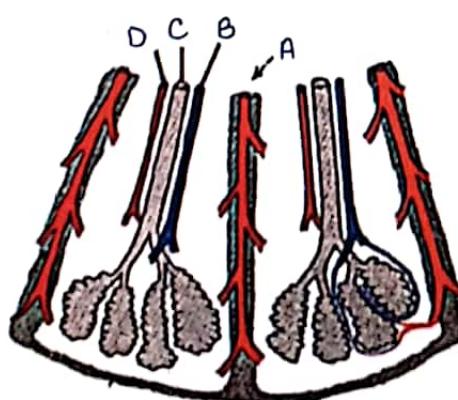
Dependant BPS on standing position:

Posterior basal segment of lower lobe right lung.

Dependant BPS in supine position:

Apical segment of lower lobe of right lung.

Active space



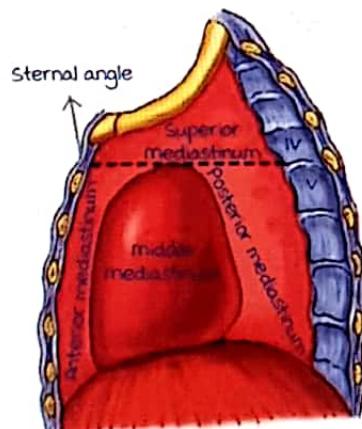
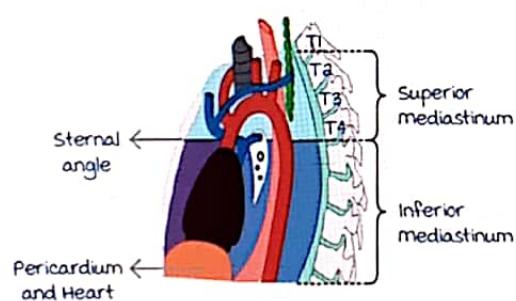
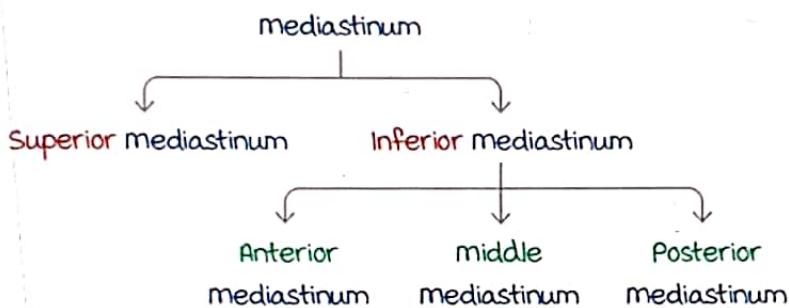
- C. Pulmonary vein
- D. Pulmonary artery
- E. Tertiary bronchus
- F. Bronchial artery

# MEDIASTINUM CONTENTS AND DIAPHRAGM

## Superior Mediastinum and its Contents

00:00:01

The mediastinum is a **mobile septum** which is present between the two **pleural sacs**.



### Superior mediastinum

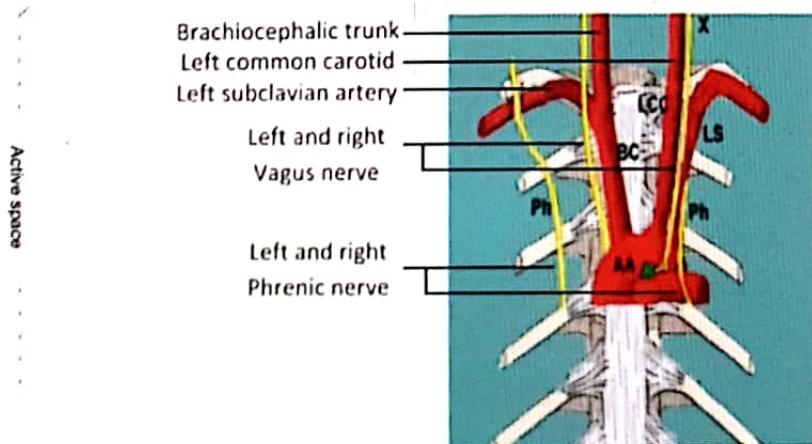
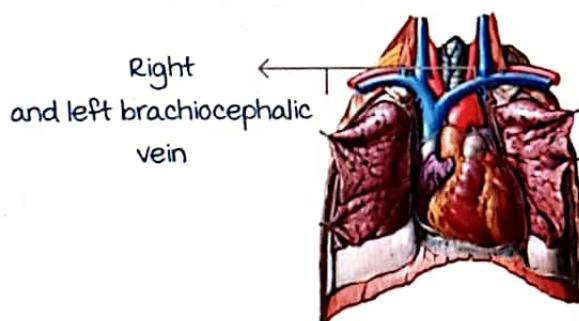
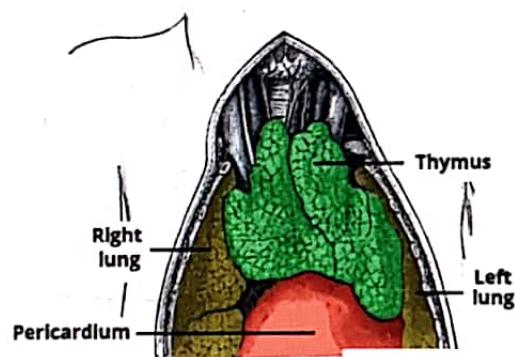
**Boundaries :**

- Anterior : manubrium
- Posterior : T1 – T4
- Below : Imaginary line from the sternal angle to T4.

Active space

Contents of Superior mediastinum :

- Thymus (also extends to the anterior mediastinum).
- Right and left brachiocephalic vein.
- Arch of aorta and its branches:
  1. Brachiocephalic trunk.
  2. Left common carotid artery.
  3. Left subclavian artery
- Left and right Phrenic nerve.
- Left and right Vagus nerve.
- Vertical structures :
  - Trachea
  - Esophagus
  - Thoracic duct.



## Inferior Mediastinum and its Contents

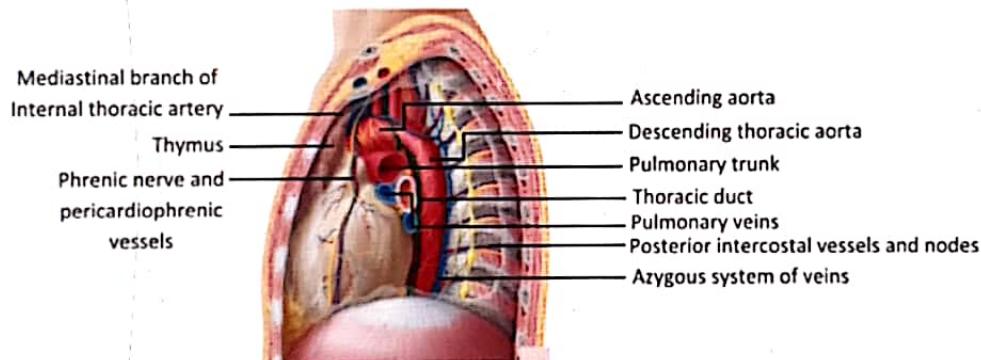
00:04:37

### Anterior mediastinum :

4. Thymus
5. Sternopericardial ligaments.
6. mediastinal branch of internal thoracic artery.

### middle mediastinum

1. Heart and Pericardium.
2. Ascending aorta.
3. Pulmonary trunk.
4. Pulmonary veins.
5. Trachea and bronchus.
6. Phrenic nerve and pericardiophrenic vessels

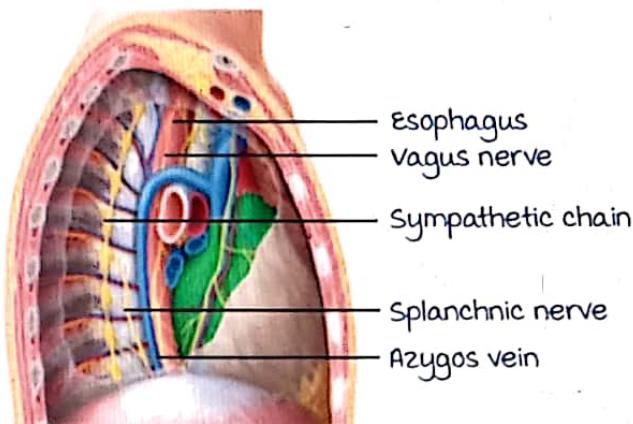


### Posterior mediastinum : mnemonic: "DATES VP"

1. Descending thoracic aorta.
2. Azygous system of veins.
3. Thoracic duct.
4. Esophagus.
5. Splanchnic nerve and Sympathetic chain.
6. Vagus nerve.
7. Posterior intercostal vessels and node.

Active space

Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

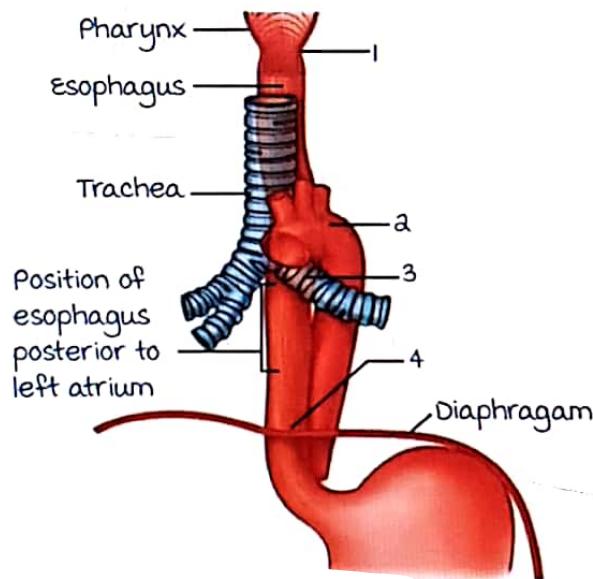


## Esophagus

00:09:18

Parts of the esophagus :

1. Cervical part
2. Thoracic part
3. Abdominal part



Constrictions of the esophagus :

1. At the level of C6
  - Situated at the cricopharyngeal junction.
  - 6 inches from incisor teeth.
2. At the level of T4
  - This constriction is due to the crossing of arch of aorta.
  - 9 inches from incisor teeth.

3. At the level of T6

- This constriction is due to the crossing of left bronchus.
- 11 inches from incisor teeth.

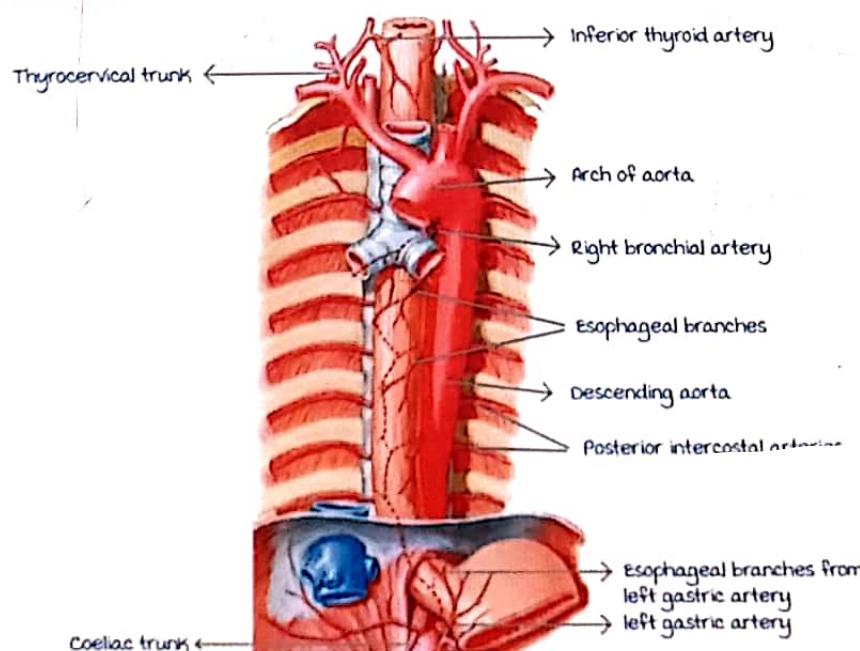
4. At the level of T10

- Due to esophagus passing through the esophageal orifice of the diaphragm.
- 15 inches from incisor teeth.

Arterial supply and venous drainage of esophagus :

	Arterial	Venous
Cervical part	Inferior Thyroid artery (branch of Throcervical trunk) (Allms 2016)	Inferior Thyroid vein
Thoracic part	Bronchial artery and direct branches from descending thoracic aorta	Azygous system of veins.
Abdominal part	Esophageal branches from left gastric artery. (branch of coeliac trunk)	Partly to Left gastric vein (tributary of portal vein) and partly to azygous system of veins (Part of caval system).

The lower part of the esophagus is the site of Portocaval anastomosis.



Active space

## Thoracic Duct

00:15:43

Thoracic duct is the **largest lymphatic vessel**.

It is **beaded** in appearance due to the presence of numerous valves.

It drains the **entire part of the body except**:

1. Right side of head and neck
2. Right thoracic wall.
3. Right upper limb.
4. Right lung.
5. Right surface of the heart.
6. Liver.
7. Superior surface of the liver.

**Course of the thoracic duct:**

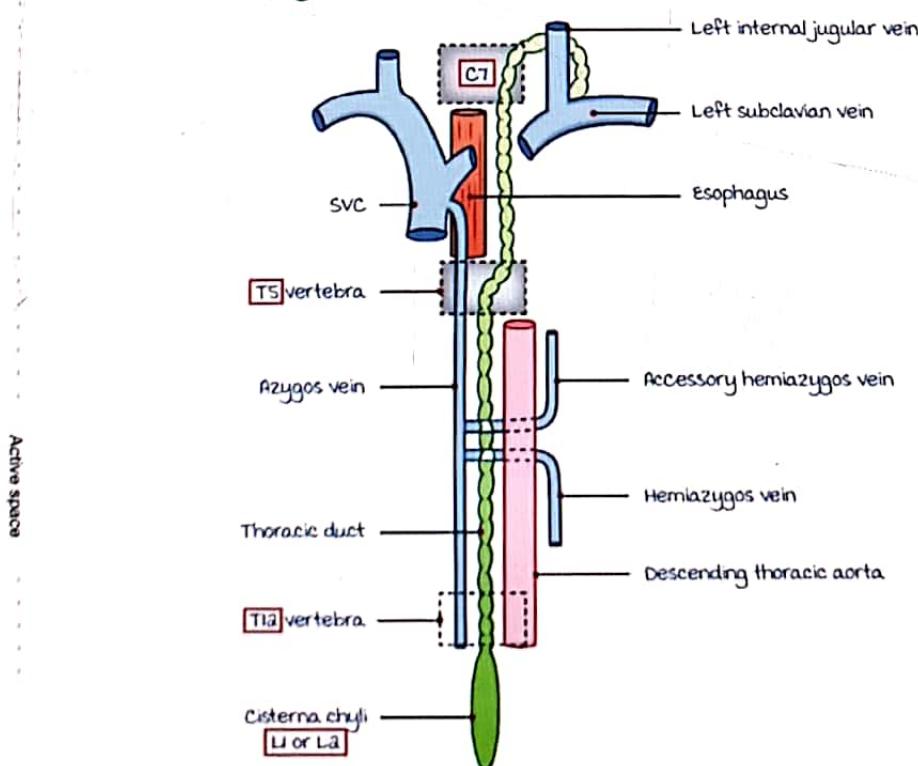
The thoracic duct begins from the **Cisterna Chyli**.

- Cisterna chyli is a dilated lymphatic sac.
- The position is highly variable.
- It is usually located at **L1 or L2**.

At the level of **T12**: Thoracic duct then passes through **aortic orifice of the diaphragm** along with the aorta.

At the level of **T5**: The thoracic duct **deviates from the right side** to the left.

At the level of **C7**: It **ends** by draining into angle between left internal jugular vein and left subclavian vein.

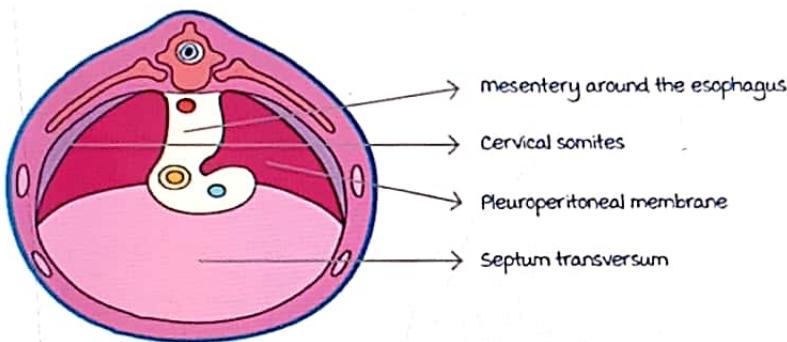


## Diaphragm

00:19:53

Sources contributing to the development of the diaphragm : (2016 AIIMS)

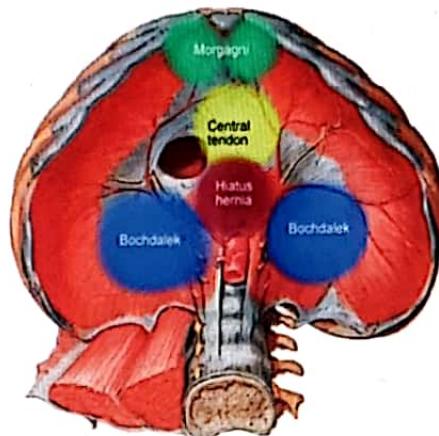
1. Cervical somites
2. mesentery around the esophagus.
3. Septum transversum
4. Pleuroperitoneal membrane



### Congenital Diaphragmatic Hernia

Bochdalek Hernia	morgagnian Hernia
m/c congenital diaphragmatic hernia	
most commonly seen in the left side	m/c on right side
Due to defect in pleuroperitoneal membrane. (2016 AIIMS)	Due to enlarged space of Larry. (Space of Larry : The gap between sternal and costal origins of diaphragm)
The defect is posterolateral in location.	The defect is anteromedial in position. mnemonic : RAM Right Anteromedial

Active space



**Orifices of the Diaphragm and Structures passing through them :**  
mnemonic : "Indian Olympic Association"

**Inferior Vena Cava opening :** At the level of T8.

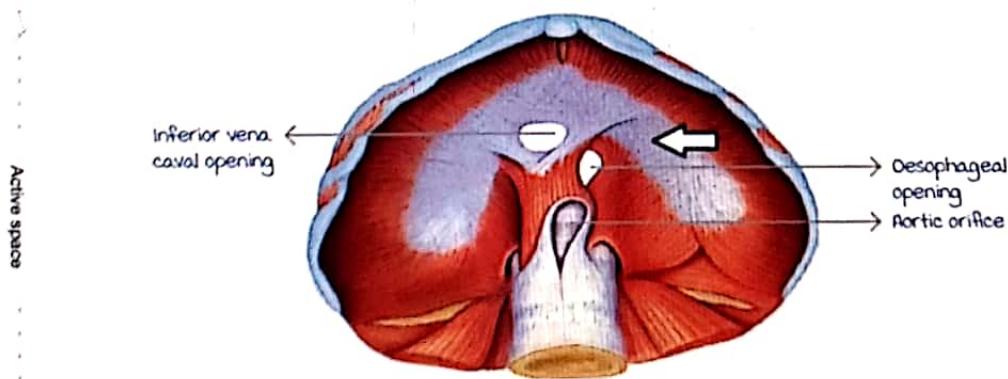
- IVC
- Right phrenic nerve

**Oesophageal :** At the level of T10.

- Esophagus
- Left vagus nerve
- Right vagus nerve
- Esophageal branch of left gastric artery and its corresponding tributary.

**Aortic Orifice :** At the level of T12. (NEET 2018).

- Aorta
- Thoracic duct
- Azygous vein (sometimes)

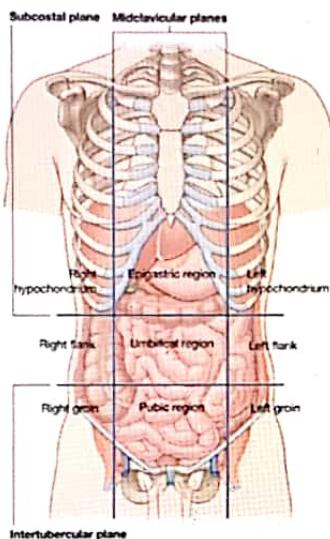


# ANTERIOR ABDOMINAL WALL

## Planes of anterior abdominal wall

00:00:08

Planes divide the anterior abdominal wall into 9 quadrants



Vertical planes - right and left mid clavicular planes.

Horizontal planes - subcostal plane, intertubercular plane and transpyloric plane.

- **Subcostal plane :**

Passes through the lower border of L2 vertebra.

- **Intertubercular plane :**

Connects the tubercles of the iliac crests.

Passes through the upper border of LS vertebra.

- **Transpyloric plane :**

Passes through the lower border of L1.

Structures meeting up at transpyloric plane :

1. Tip of 9<sup>th</sup> costal cartilage.
2. Pylorus of stomach.
3. Hilum of kidney.
4. Origin of superior mesenteric artery.
5. Termination of spinal cord.
6. Fundus of gall bladder.
7. Formation of portal vein.

Active space

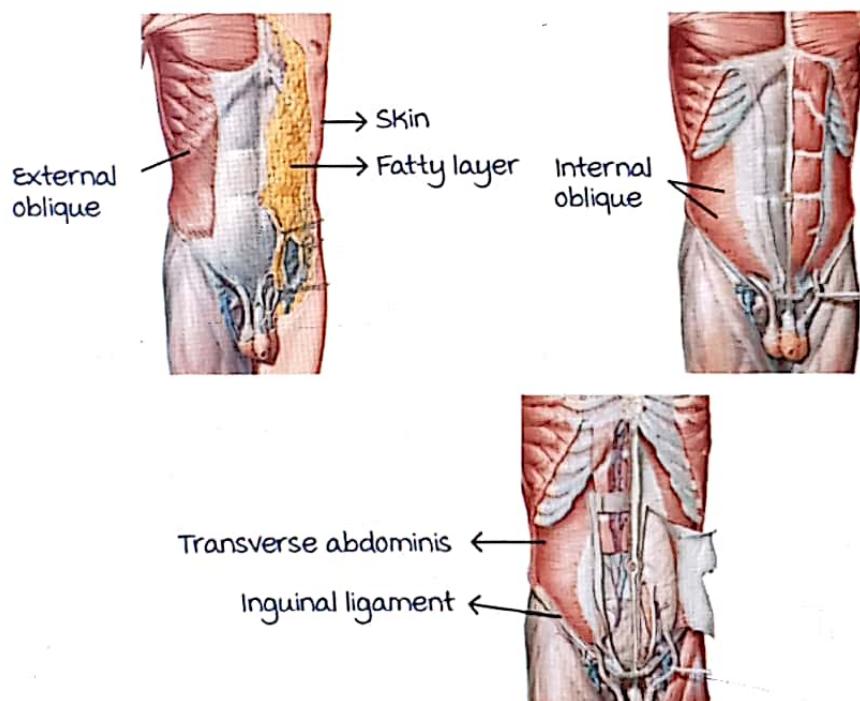
## Layers of anterior abdominal wall

00:03:50

(From outwards)

- Skin.
- Superficial fascia (fatty and membranous layers).
- External oblique muscle.
- Internal oblique muscle.
- Transverse abdominis muscle.
- Fascia transversalis.
- Parietal layer of peritoneum.

Rectus sheath – formed by aponeurosis of external oblique, internal oblique and transverse abdominis muscles.



## Inguinal ligament

00:08:14

It is a thickening of aponeurosis of external oblique muscle.

Extent – from anterior superior iliac spine (ASIS) upto pubic symphysis.

mid-inguinal point – midpoint of line joining from ASIS to pubic symphysis.

Deep inguinal ring – situated 1.25cms above mid inguinal point.

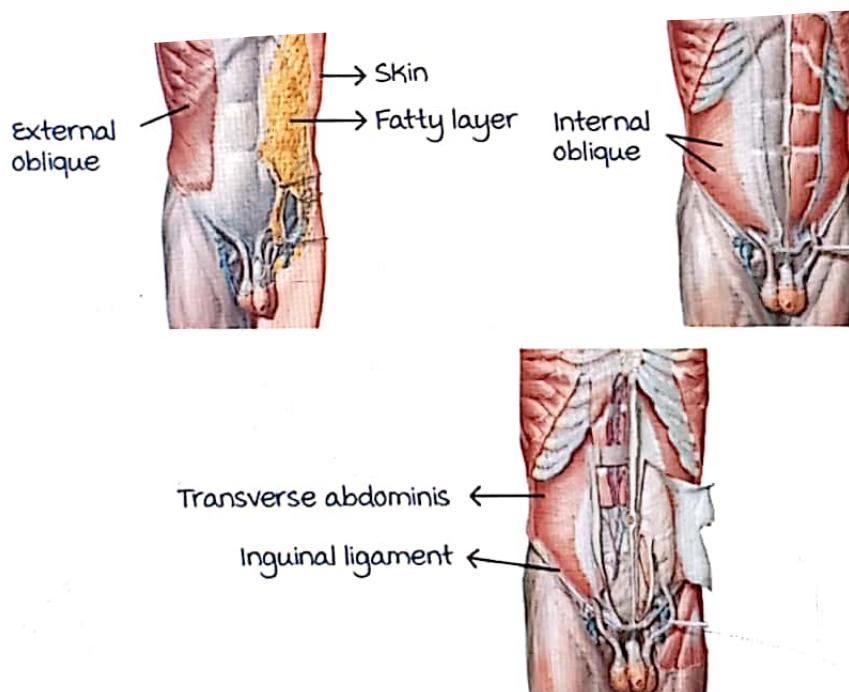
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00:03:50

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## Inguinal ligament

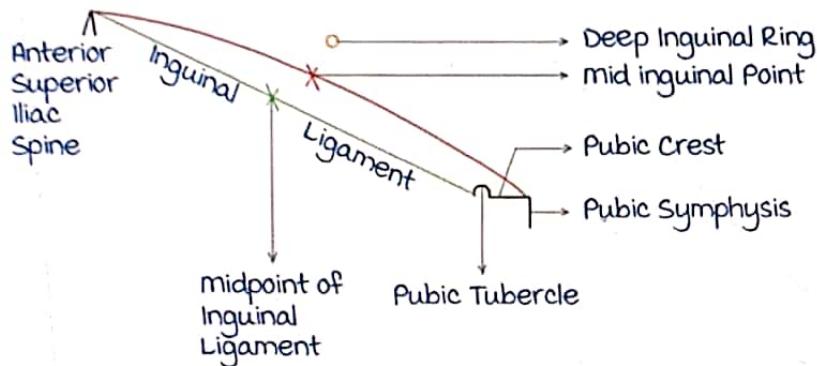
00:08:14

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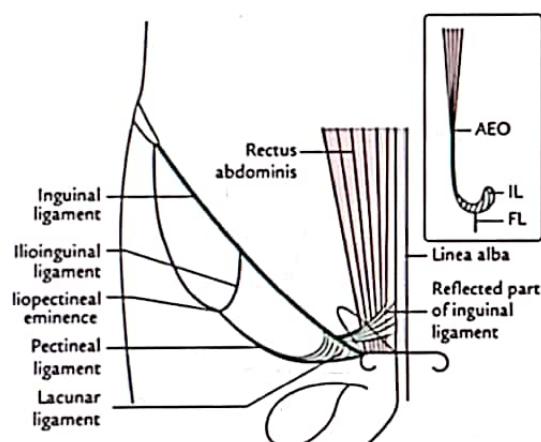
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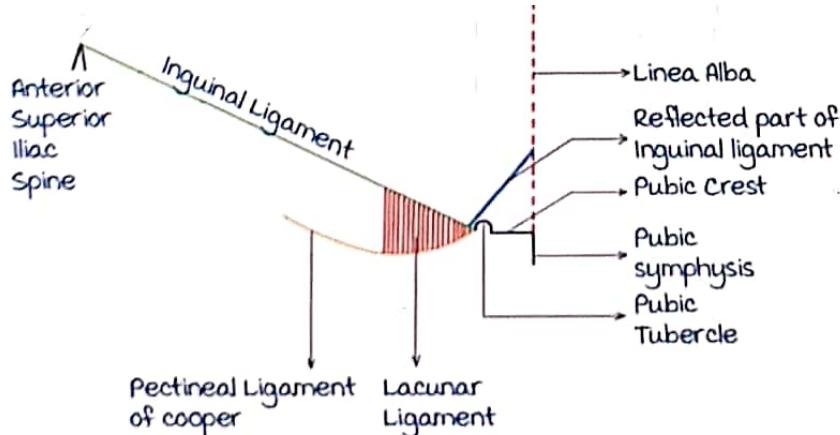
Deep inguinal ring – situated 1.25cms above mid inguinal point.



modifications of inguinal ligament:



1. Reflected part of inguinal ligament – extension of inguinal ligament from pubic tubercle to linea alba.
2. Pectenial ligament of Cooper – extension of inguinal ligament from pubic tubercle to ileopectinate line.
3. Lacunar ligament – extension of inguinal ligament in its base towards pectenial ligament of Cooper.



Active space

**Actions of various muscles of anterior abdominal wall** 00:13:48

Common actions of external oblique, internal oblique and transverse abdominis muscles:

1. maintains abdominal tone.
2. Increases intra-abdominal pressure.

External oblique and internal oblique – causes lateral flexion of the trunk.

Nerve supply of all three muscles – T7 to T12 intercostal nerves.

**Note :** Neurovascular (1st TL) structures are present between internal oblique and transverse abdominis muscles.

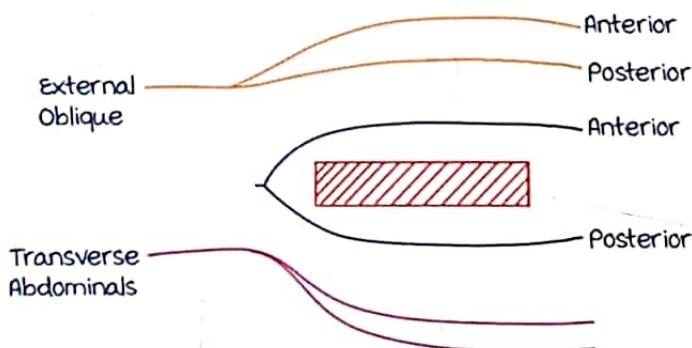
**Rectus abdominis formation** 00:16:22

Arcuate line – present between umbilicus and pubic symphysis.

- Formation above the arcuate line :

Anterior wall – 2 lamellae of external oblique + anterior lamellae of internal oblique.

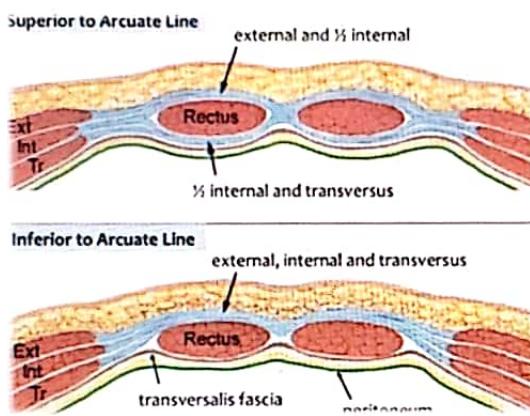
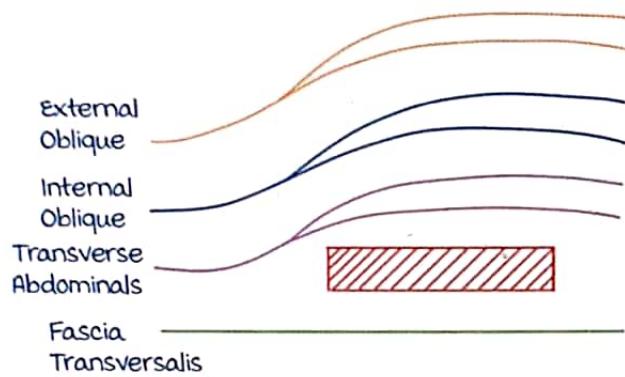
Posterior wall – posterior lamellae of internal oblique + 2 lamellae of transverse abdominis.



- Formation below the arcuate line :

Anterior wall – 2 lamellae each from external oblique + internal oblique + transverse abdominis.

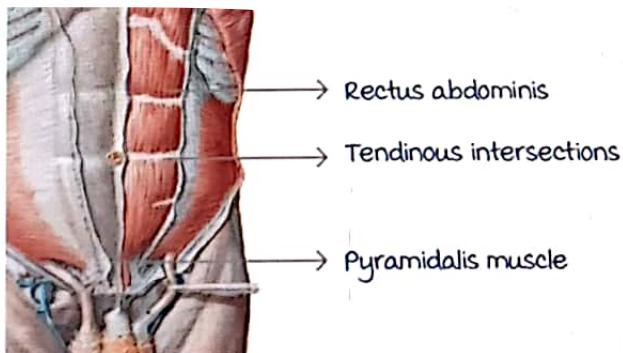
Posterior wall – fascia transversalis.



## Contents of rectus sheath

00:22:30

- 2 muscles – rectus abdominis and pyramidalis.  
2 vessels – superior and inferior epigastric artery.



### Pyramidalis muscle:

- Origin – pubic symphysis.
- Insertion – linea alba.
- Nerve supply – subcostal nerve.
- Action – tensor of linea alba.

Rectus abdominis muscle :

- Origin - pubic crest and pubic tubercle.
- Insertion - 5<sup>th</sup>, 6<sup>th</sup>, and 7<sup>th</sup> costal cartilage.
- Nerve supply - T7 to T12 intercostal nerves.
- Action - flexion of trunk, maintenance of abdominal tone, and increases intraabdominal pressure.
- Tendinous intersections - prevents bow-stringing of rectus abdominis muscle.

Superior epigastric artery - terminal branch of internal thoracic artery (present in lateral umbilical fold).

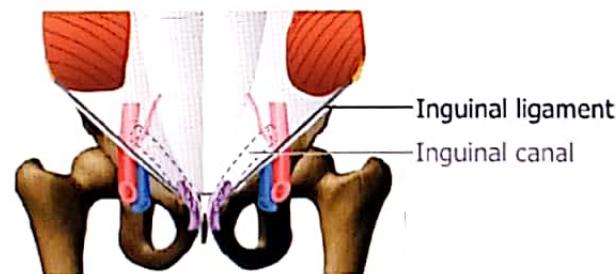
Inferior epigastric artery - branch of external iliac artery.

medial umbilical fold - obliterated umbilical artery.

median umbilical fold - urachus.

### Inguinal canal

00:29:42



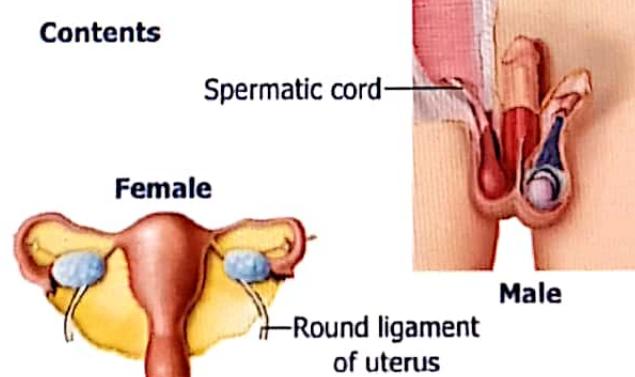
Location - lower medial side of inguinal ligament.

True contents :

In male - spermatic cord.

In female - round ligament of uterus.

Active space



Pseudo/false/partial content – ilioinguinal nerve.

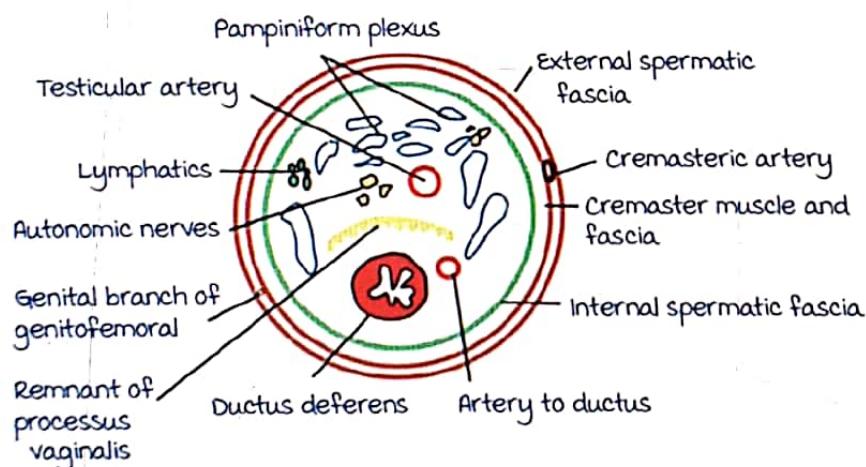
Spermatic cord

Covering (from outwards) :

1. External spermatic fascia (derived from external oblique).
2. Cremasteric muscle and fascia (derived from internal oblique).
3. Internal spermatic fascia (derived from fascia transversalis).

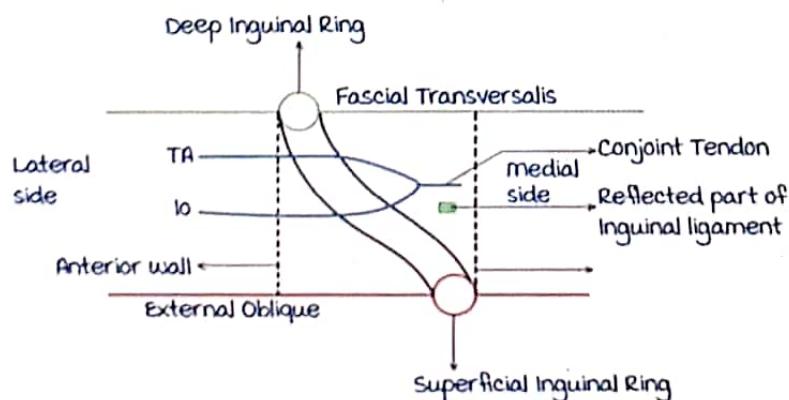
Contents :

- Testicular artery (branch of abdominal aorta).
- Pampiniform plexus of veins.
- Testicular nerve.
- Remnant of processus vaginalis.
- Vas deferens.
- Artery to vas deferens (branch of superior vesicular artery).
- Genital branch of genito-femoral nerve.
- Cremasteric artery (branch of inferior epigastric artery) and cremasteric vein.



## Relations of inguinal canal

00:36:02



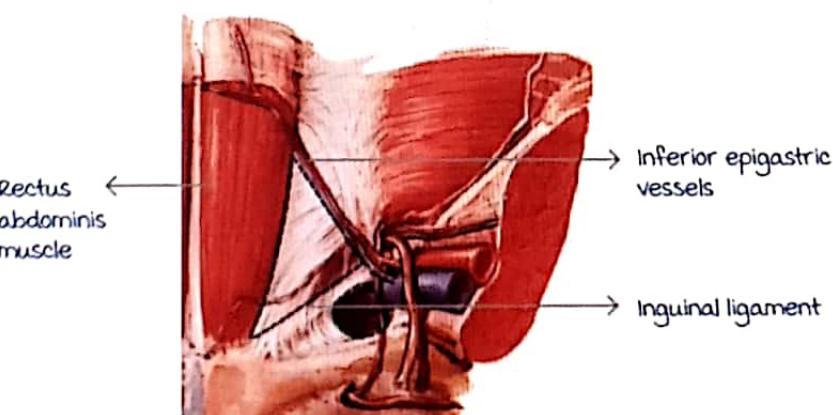
Active space

- Deep inguinal ring :  
Defect in fascia transversalis.  
Situated 1.25cms above mid-inguinal point.  
Acts as inlet of inguinal canal.
  
- Superficial inguinal ring :  
Defect in external oblique muscle.  
Situated above and medial to pubic tubercle.  
Acts as outlet of inguinal canal.
  
- Conjoint tendon :  
Formed by internal oblique muscle + transverse abdominis muscles + reflected part of inguinal ligament.
  
- Anterior wall relations of inguinal canal :  
Skin.  
Superficial fascia.  
External oblique muscle.
  
- Laterally - anterior wall is strengthened by internal oblique muscle.
  
- Posterior wall relations of inguinal canal : Fascia transversalis.
  
- medially - posterior wall is strengthened by conjoint tendon.
  
- Roof - internal oblique + transverse abdominis.
  
- Floor - inguinal ligament.

### Hesselbach's triangle

00:47:26

Active space



Boundaries :

- medially - rectus abdominis muscle.
- Laterally - inferior epigastric vessels.
- Base - inguinal ligament.

**Importance** - it is the site for the occurrence of direct inguinal hernia.

Differences between direct and indirect inguinal hernia :

Direct hernia	Indirect hernia
Occurs through Hesselbach's triangle	Occurs through inguinal canal
Old age group	Young age group
Acquired (due to weakness of abdominal muscles)	Congenital
Inferior epigastric artery is situated lateral to the neck of the sac	Inferior epigastric artery is situated medial to the neck of the sac
Doesn't reaches the scrotum	Reaches the scrotum
Not covered by spermatic fascia	Covered by spermatic fascia

## Triangle of Doom

00:52:13

Boundaries :

- Apex - deep inguinal ring.
- medially - vas deferens.
- Laterally - testicular vessels.

Contents - external iliac vessels.

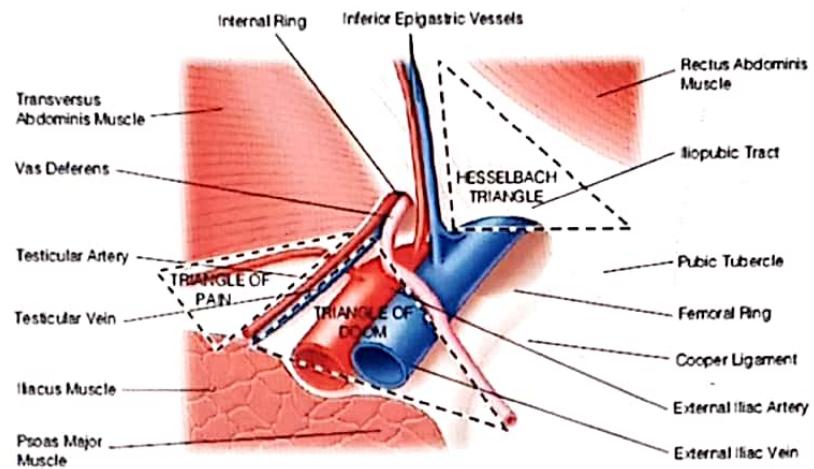
## Triangle of pain

Boundaries :

- medially - testicular vessels.
- Laterally - ilio-pubic crest.
- Base - skin reflection.

**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

Contents - genitofemoral nerve, anterior femoral cutaneous nerve and lateral femoral cutaneous nerve.



Active space

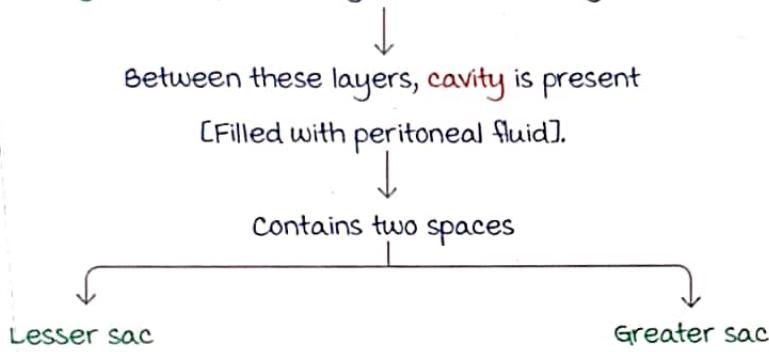
# PERITONEUM

## Peritoneum

00:00:07

It is the **serous membrane** that lines the abdomen and pelvic region.

It has two layers : the parietal layer and visceral layer.



The stomach rotates in **clockwise direction** and creates the lesser sac.

## Lesser sac

00:02:49

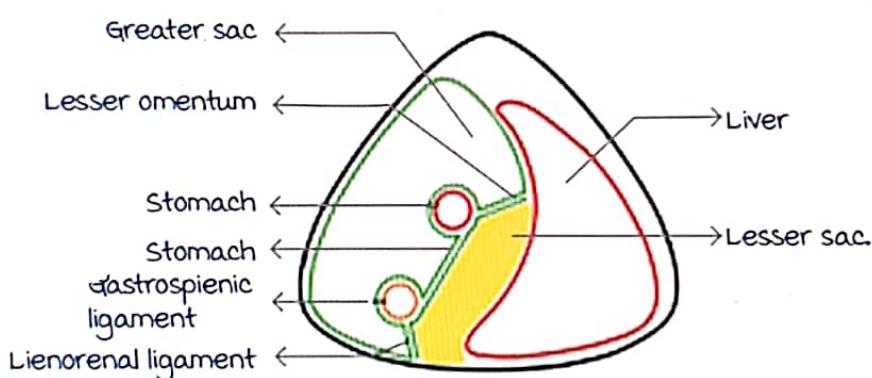
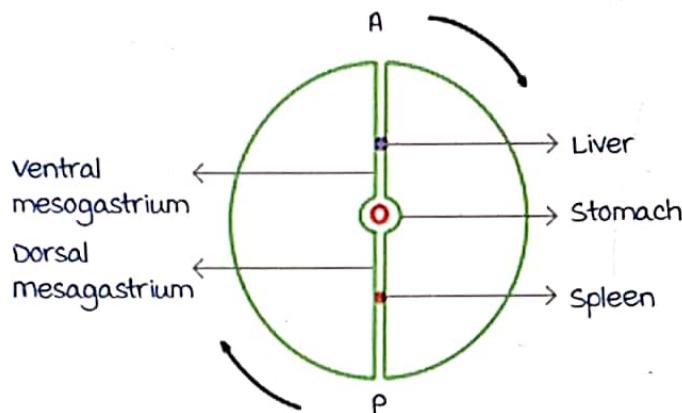
Lesser sac is also known as the omental bursa/left side subhepatic recess.

- The **ventral meso gastrum** connects the stomach to anterior abdominal wall.
- The **dorsal meso gastrum** connects the stomach to posterior abdominal wall.
- The liver is formed in ventral mesogastrium [anteriorly].
- The spleen is formed in dorsal mesogastrium [posteriorly].

Due to the stomach rotation in the clockwise direction

↓  
the liver is on right side and spleen

The spleen projects into greater sac [Allms]



### Boundaries of lesser sac

00:07:15

Anteriorly - caudate lobe of the liver

Lesser omentum

Stomach

1st & 2nd layers of greater omentum

Posteriorly - 3rd & 4th layers of greater omentum

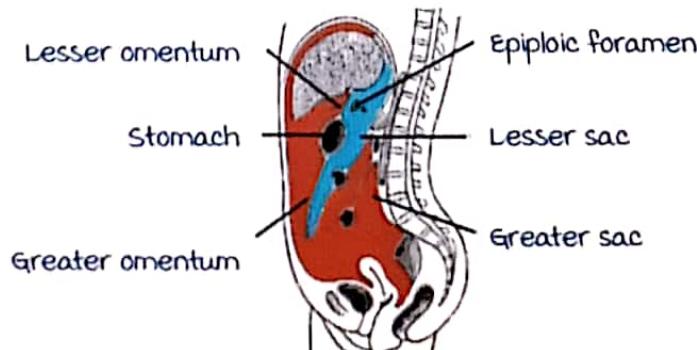
Transverse colon

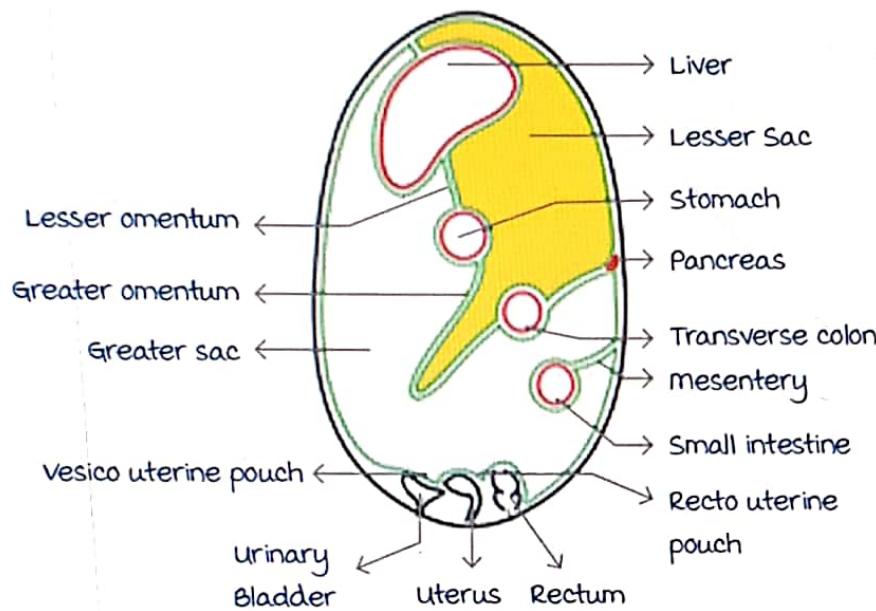
Transverse mesocolon

Pancreas

Inferiorly - 3rd layer of greater omentum.

Active page





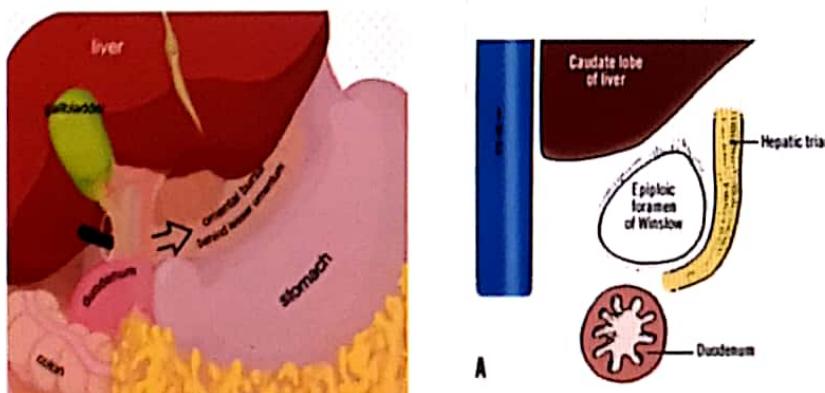
## Epiploic foramen

00:15:08

It connects the lesser sac with the greater sac.

### Boundaries

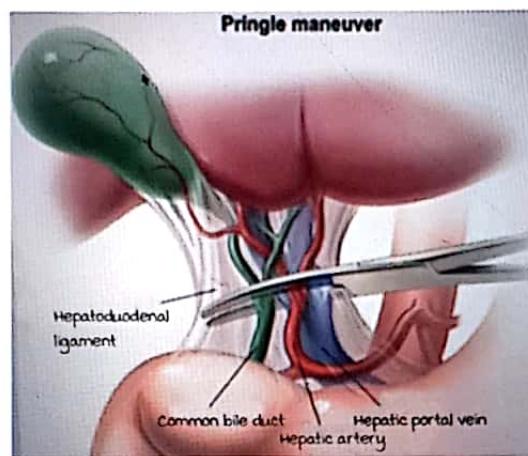
- Superiorly - caudate lobe of liver
  - Inferiorly - first part of duodenum
  - Anteriorly - right free margin of lesser omentum [hepatoduodenal part]
- ↓
- Containing hepatic triad [portal vein, hepatic artery and common bile duct].
- Posteriorly- inferior vena cava.



Active space

Clinical correlation:

Pringle's manoeuvre - clamp in the right free margin of lesser omentum.



Hepato renal pouch of morrison

It is present on the right side and is also called as right subhepatic recess.

It is the most dependent space on the supine position.

Boundaries - left side epiploic foramen

Anteriorly inferior margin of liver

Posteriorly right Kidney



## Peritoneal folds

00:23:42

It is the **visceral layer** of peritoneum

It suspends the organs from posterior abdominal wall

It conveys the blood vessels.

They are :

- I. Omentum - Connects stomach to

liver  
[lesser omentum]

Transverse colon  
[greater omentum]

2. mesentery- suspends the jejunum and ileum from the posterior abdominal wall.

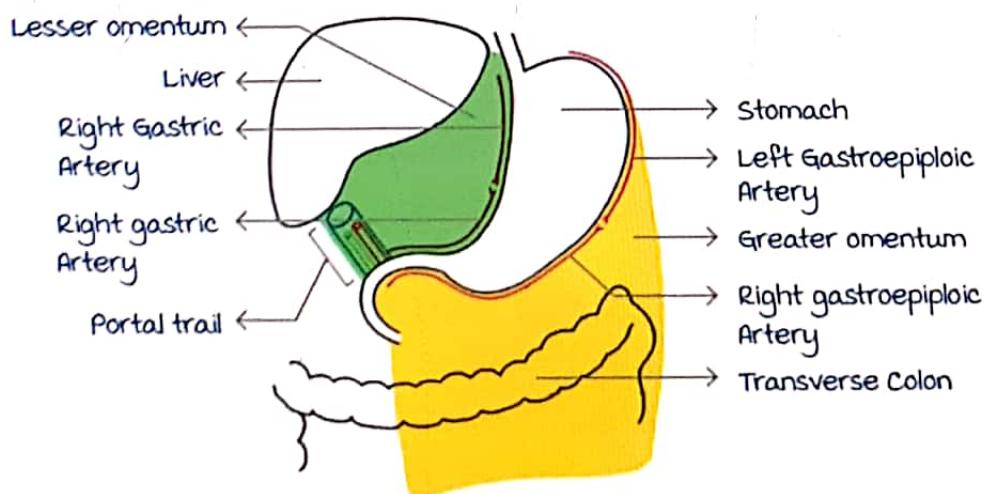
3. mesocolon- suspends colon from the posterior abdominal wall

Transverse mesocolon - middle colic vessel.

Sigmoid mesocolon - sigmoid vessel and superior rectal vessel.

### Omentum

00:26:51



## Mesentery

It suspends the jejunum and ileum from the posterior abdominal wall.

The root of mesentery extends from

↓  
duodenojejunal junction [left side] or left of L2

↓  
to ileocaecal junction [right side] or right sacroiliac joint.

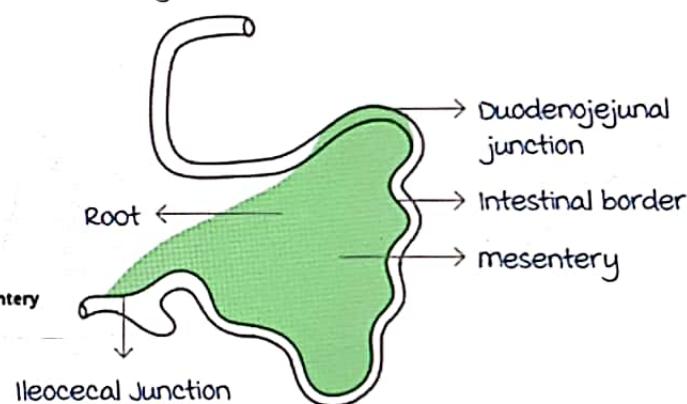
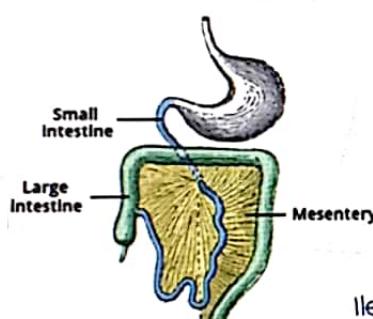
Contents - superior mesenteric artery

Superior mesenteric vein

Jejunal and ileal artery [branches of SMA]

Jejunum

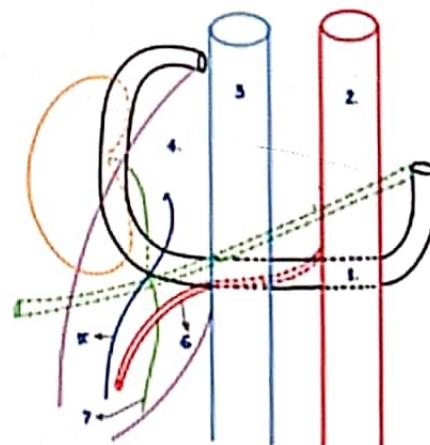
Ileum



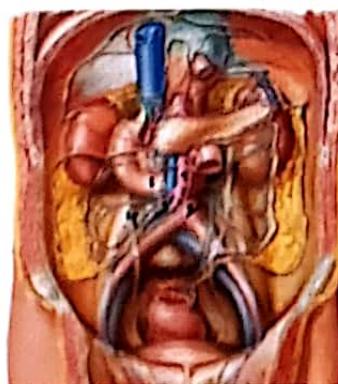
## Structures crossed by the root of mesentery

00:36:11

1. Third part of duodenum
2. Aorta
3. inferior vena cava
4. Right psoas major muscle
5. Right genitofemoral nerve
6. Right gonadal vessel
7. Right ureter



Active space



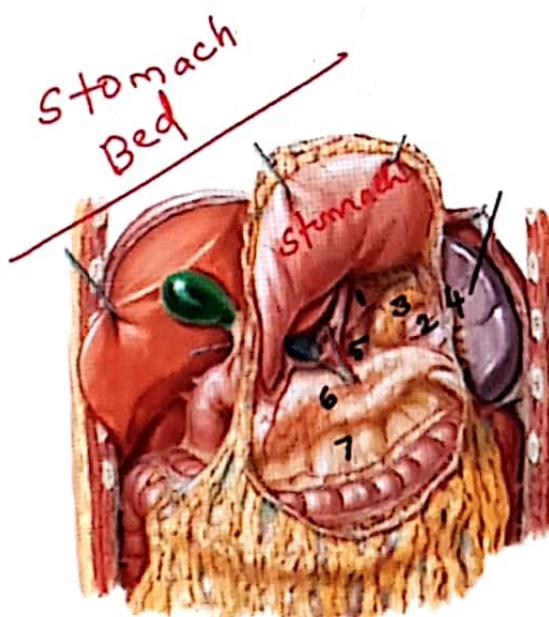
# STOMACH

## Stomach bed, arterial supply and venous drainage

00:00:16

The posterior relations are :

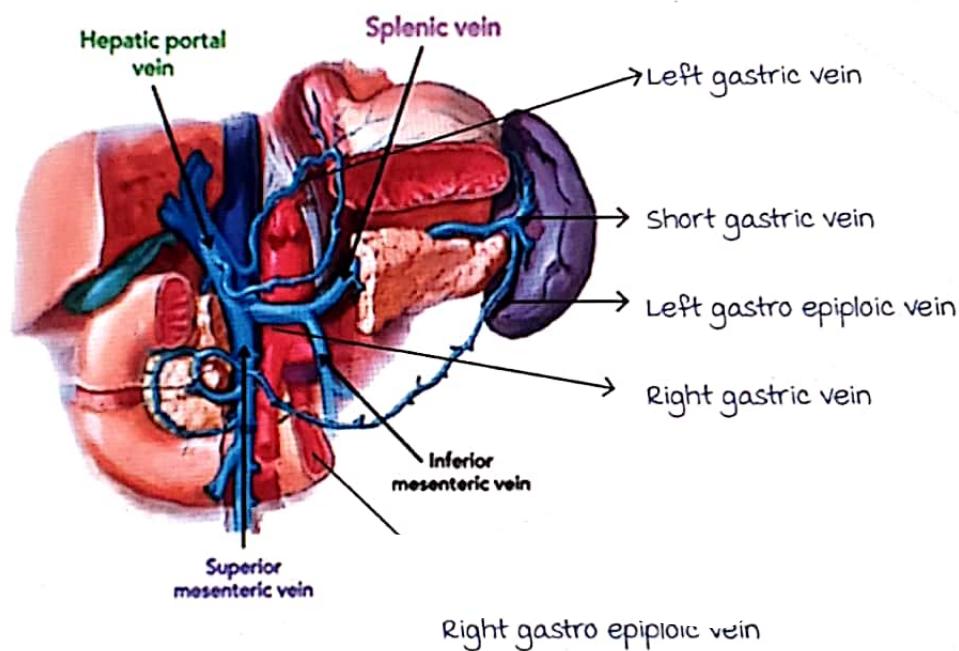
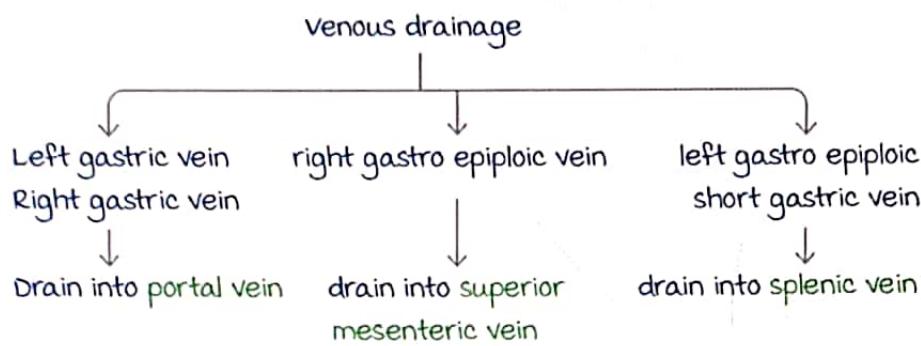
1. Left crus of diaphragm
2. Left kidney
3. Left suprarenal gland
4. Spleen
5. Splenic artery
6. Pancreas [except tail]
7. Transverse mesocolon



### Arterial supply

1. Left gastric artery - branch of celiac trunk principle artery to the stomach
  2. Right gastric artery - branch of common hepatic artery
  3. Right gastroepiploic artery - branch of gastroduodenal artery
  4. Left gastroepiploic artery - branch of splenic artery
  5. Short gastric artery - branch of splenic artery
- venous drainage

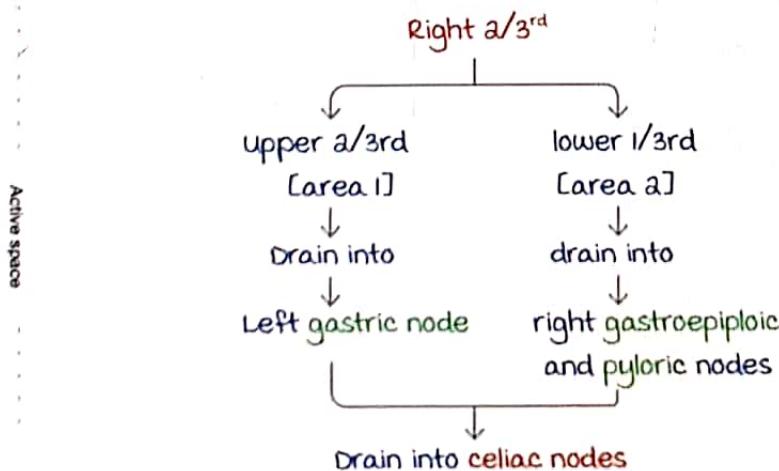
Active space

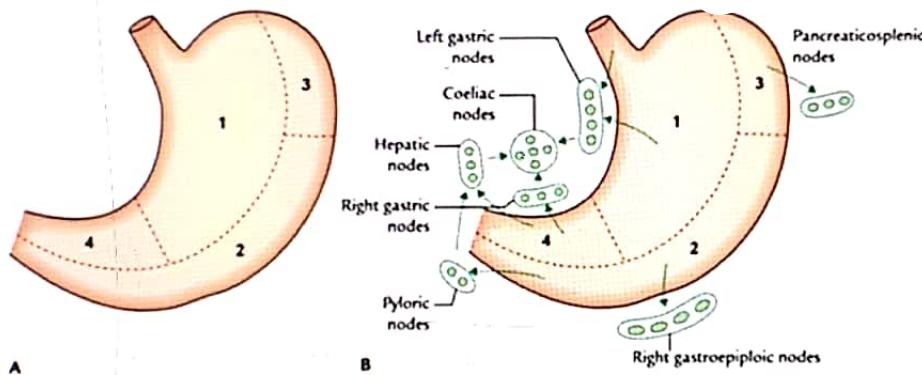
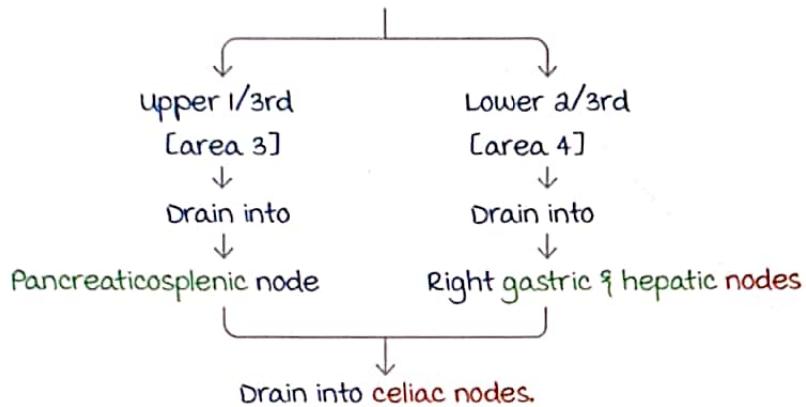


## Lymphatic drainage

00:06:29

The stomach is divided into - right upper  $2/3^{\text{rd}}$  and left  $1/3^{\text{rd}}$



Left 1/3<sup>rd</sup>

**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

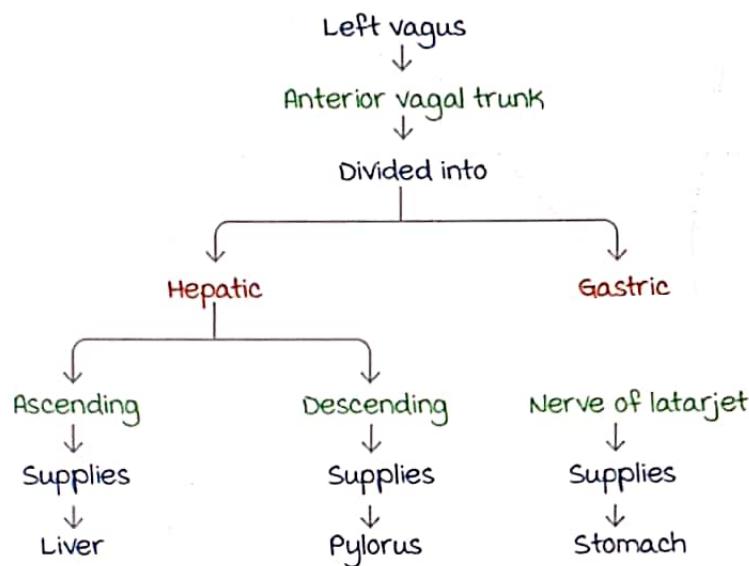
## Nerve supply of the Stomach

00:08:53

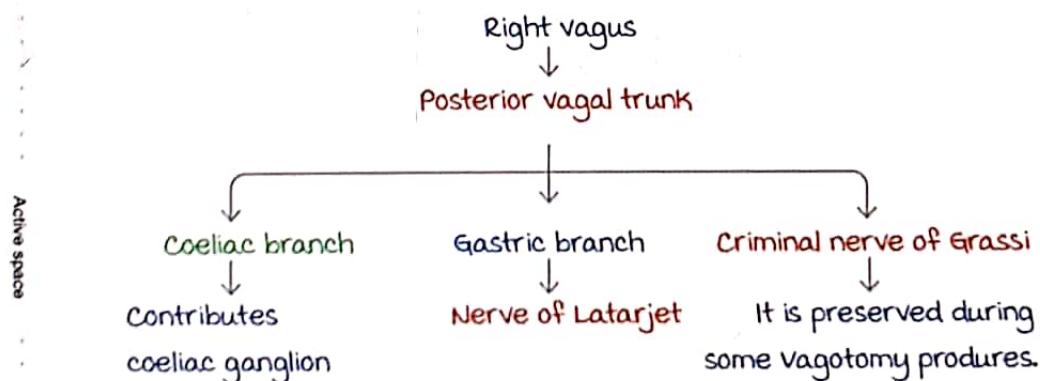
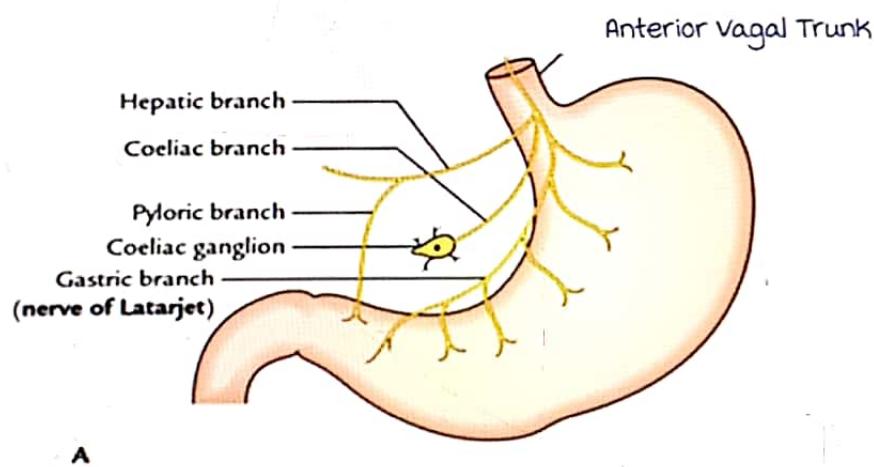
Nerve supply - both sympathetic and parasympathetic.

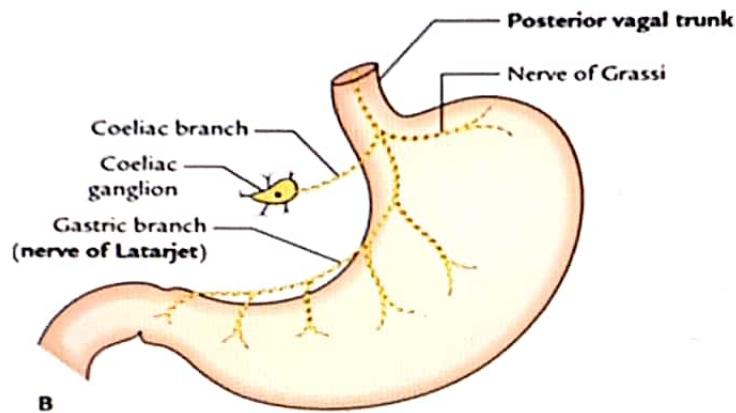
Sympathetic	Parasympathetic
Greater splanchnic nerve [T5 to T9]	Vagus nerve
vasomotor	secretomotor
Inhibit gastric mucosa and stimulate pylorus	Inhibits the pylorus and stimulates gastric muscles
Carries pain fibres	

## Parasympathetic innervation



## Extra biliary system





## Vagotomy procedures

00:13:24

1. Truncal vagotomy - entire trunk is removed [anterior and posterior]
2. Selective vagotomy - only gastric branch remove

Disadvantage - pylorus is affected, which affects gastric emptying.

3. High selective vagotomy - only the cranial nerve of Grassi is removed



Pylorus is preserved - gastric emptying not affected.

# SMALL INTESTINE

## Duodenum

00:00:03

Duodenum has four parts :

- First part - 5cm
- Second part - 8-10cm
- Third part - 10cm
- Fourth part - 2.5 cm

Features of first part :

- The proximal segments are intraperitoneal (hepatoduodenal part of lesser omentum).
- It contains numerous Brunner's glands (its secretions neutralise the HCL).
- There are no circular folds.
- On contrast study duodenal cap is seen

The common bile duct (CBD) passes behind the first part of duodenum.

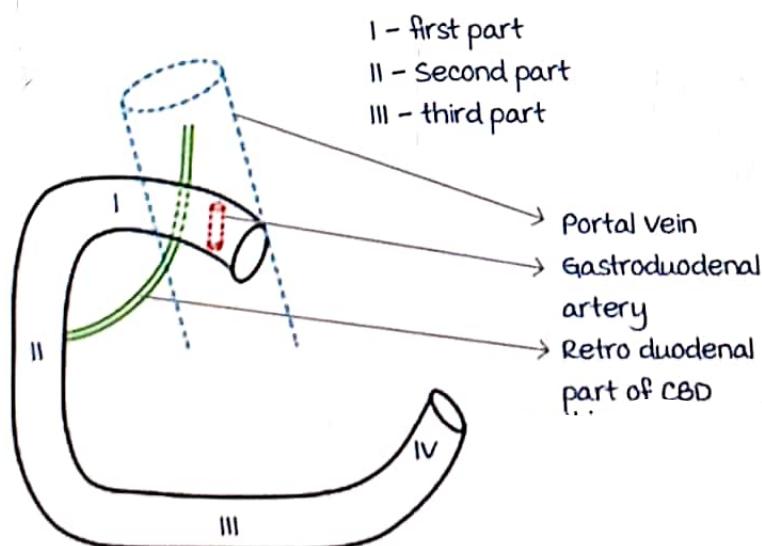
CBD is divided into three parts - supra duodenal

Infra duodenal

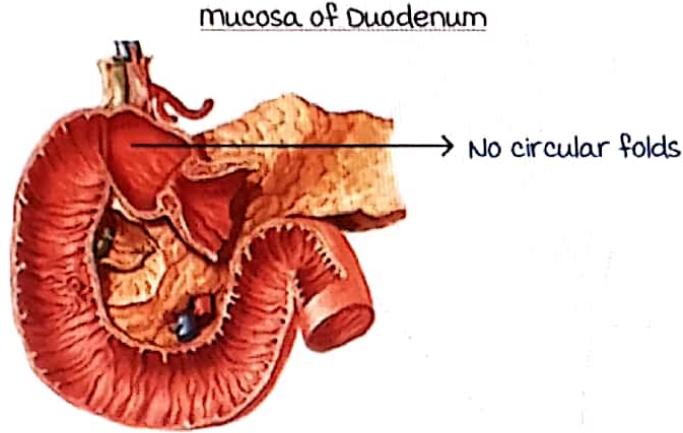
Retro duodenal

Structures present behind the first part of duodenum (Alims)

1. Portal vein
2. Gastroduodenal artery
3. Retro duodenal part of CBD



Active space



Clinical correlation :

A perforating ulcer at the first part of duodenum damages the gastroduodenal artery.

## Second part of the duodenum

00:06:21

The second part extends from the L1 to L3.

It passes in front of the hilum of the right kidney.

The head of pancreas is present between the concavity of the duodenum.

**Ampulla of vater** - Formed by joining of pancreatic duct and CBD

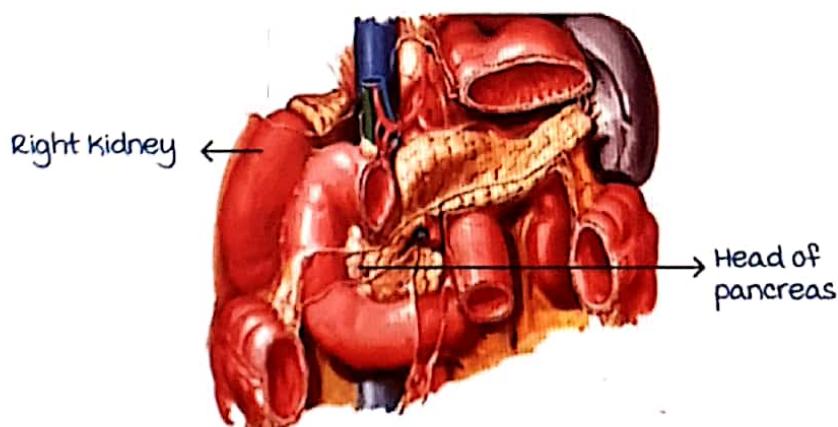


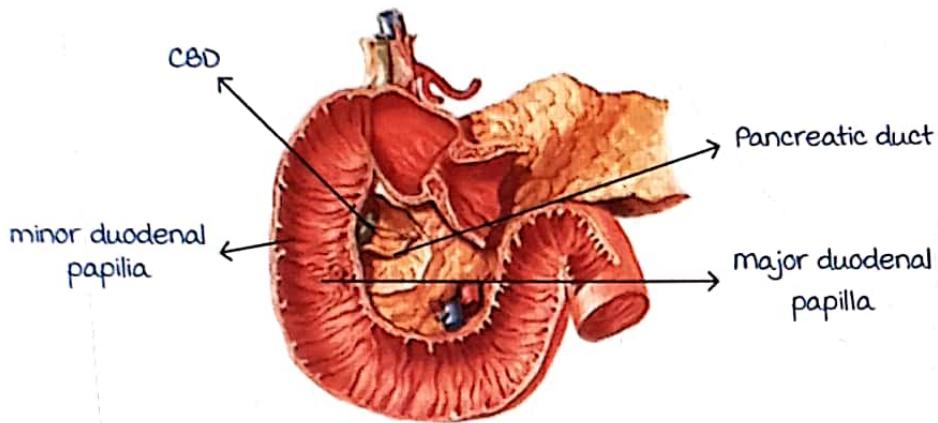
opens into the major duodenal papilla.

In the posteromedial part of second part of duodenum.

Accessory pancreatic duct opens into minor duodenal papilla.

## Pancreas in Situ



mucosa of DuodenumThird part of duodenum

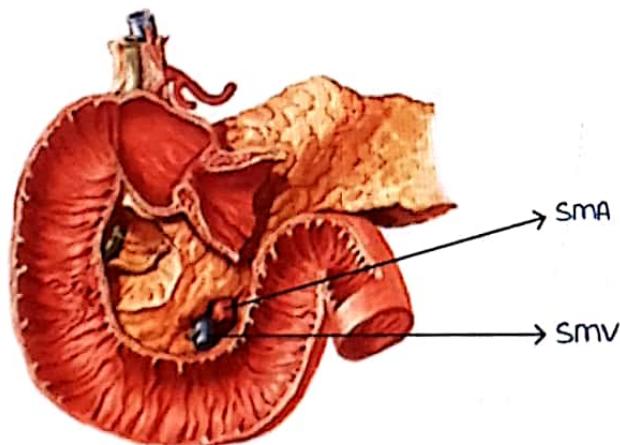
00:10:18

It is extending from the inferior duodenal flexure up to the aorta.

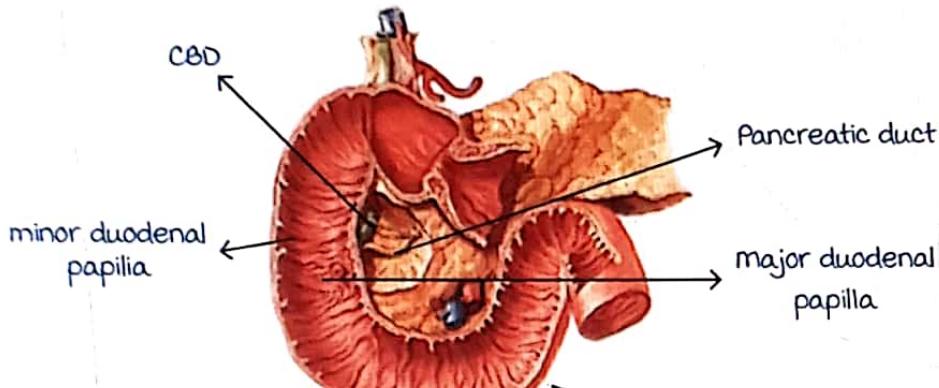
The anterior relations are- SMA (superior mesenteric artery)  
SMV (superior mesenteric vein)  
Root of mesentery

The posterior relations are- aorta

- IVC
- Right psoas muscle
- Right ureter
- Right genitofemoral nerve
- Right gonadal vessel

mucosa of Duodenum

Active space

mucosa of DuodenumThird part of duodenum

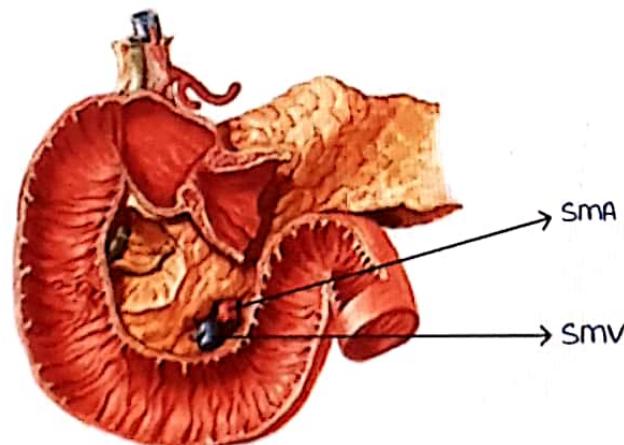
00:10:18

It is extending from the inferior duodenal flexure up to the aorta.

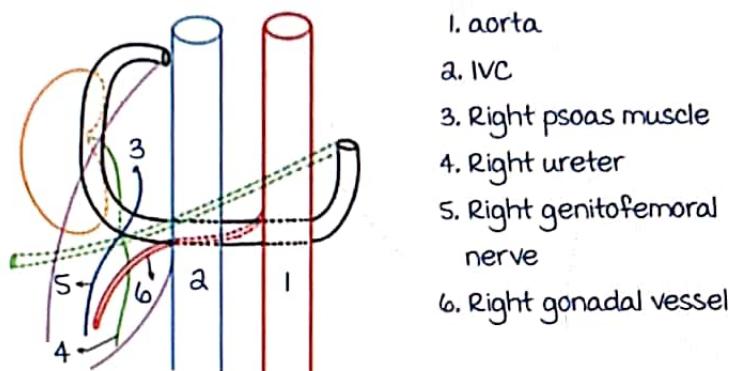
The anterior relations are- SMA (superior mesenteric artery)  
SMV (superior mesenteric vein)  
Root of mesentery

The posterior relations are- aorta

IVC  
Right psoas muscle  
Right ureter  
Right genitofemoral nerve  
Right gonadal vessel

mucosa of Duodenum

Active space



## Fourth part of duodenum

00:14:56

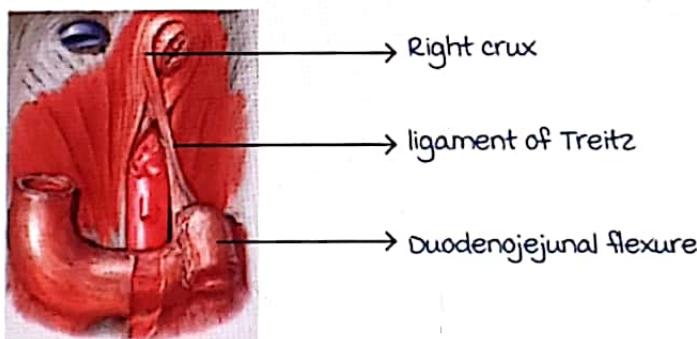
It extends from the aorta up to the duodenojejunal flexure.

The ligament of Treitz extends from the right crux up to duodenojejunal flexure



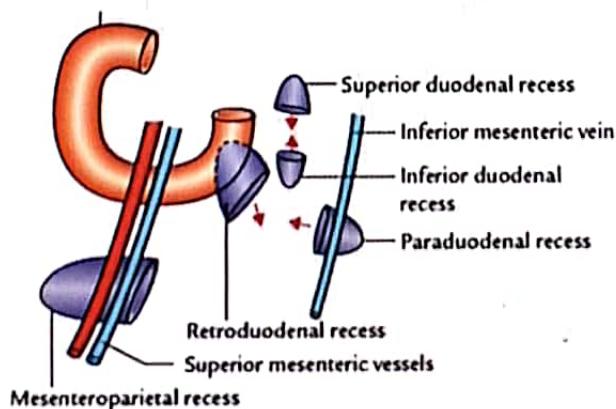
It is a remnant of the superior retention band of the primitive mid gut.  
mesenteric Relations of Intestine :

Suspensory muscle of Duodenum



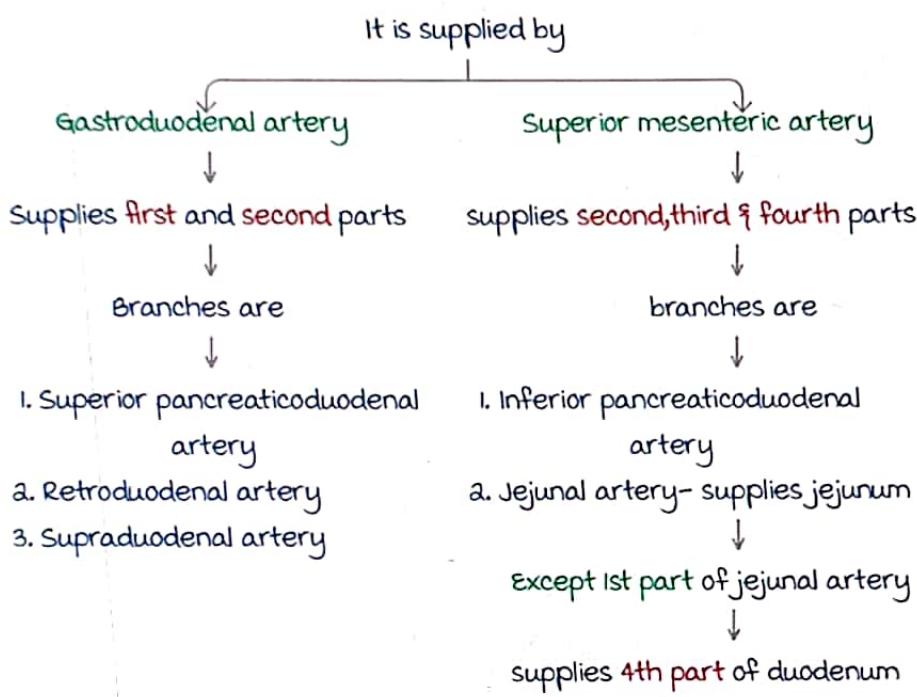
There are five duodenal recess :

1. Paraduodenal recess - contains inferior mesenteric vein.
2. mesenteroparietal recess - contains SMA and SMV.
3. Inferior duodenal recess - mc - present in 75% individuals.
4. Retroduodenal recess - it is the largest.
5. Superior duodenal recess



Blood supply of duodenum

00:18:05



The right gastric artery and right gastroepiploic artery also supply

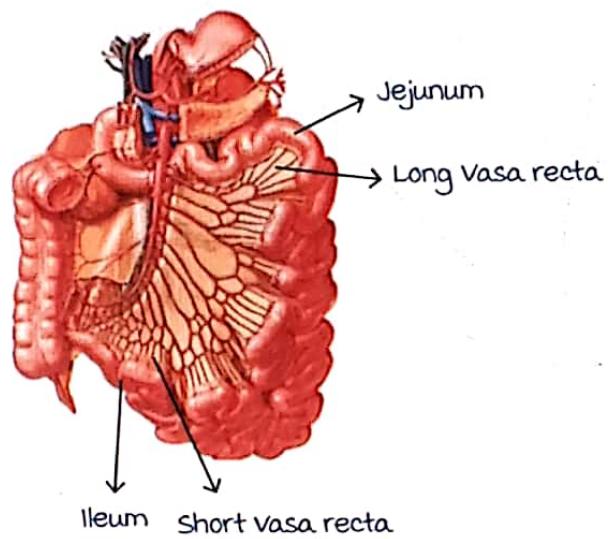
↓  
First and second part of the duodenum.

Iowan Old Style

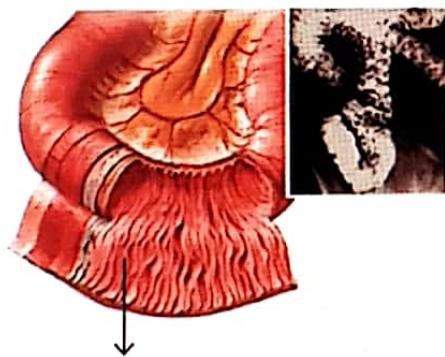
00:20:19

	Jejunum	Ileum
Location	upper lateral part	Lower medial part
Arterial arcades	1 or 2	3 to 5
Vasa recta	It is the long vessel	It is short
Villi	Large and leaf like	Finger like
Circular folds	maximum in number ↓ On contrast study feathery appearance	Present-except in terminal part
Peyer's patches	Absent	Present in the antimesenteric border

Arteries of Small Intestine

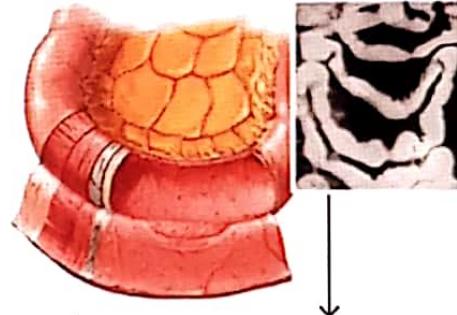


mucosa and musculature of Jejunum



Numerous circular folds  
On CT - feathery appearance

mucosa and musculature of ileum



No circular folds - terminal part

# LARGE INTESTINE

## Features of Large Intestine

00:00:03

- Tenia coli

It is an aggregation of longitudinal muscles.

Absent in

- Appendix
- Rectum

Sacculations present because of tenia coli.

- Appendices epiploicae :

These are fat filled peritoneal pouches.

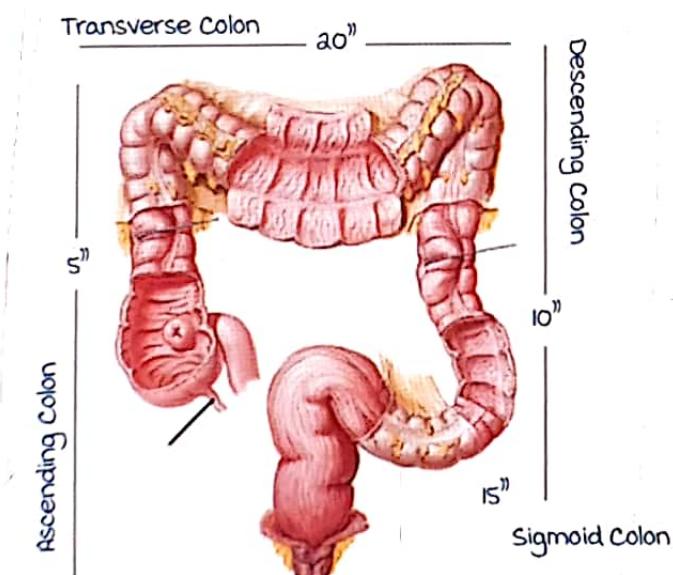
Absent in "CAR"

- Caecum
- Appendix
- Rectum

They are numerously seen in sigmoid colon and transverse colon.

## measurements of Large Intestine

5, 10, 15, 20 inches



Active space

## Anatomy of Appendix

00:03:54

It is a small diverticulum.

It is present on the posteromedial aspect of caecum.

The length: 2-10 cm.

It is derived from the midgut.

Arterial supply : Superior mesenteric artery (SMA).

Nerve Supply :

Sympathetic : Lesser splanchnic nerve ( $T_{10} - T_1$ ).

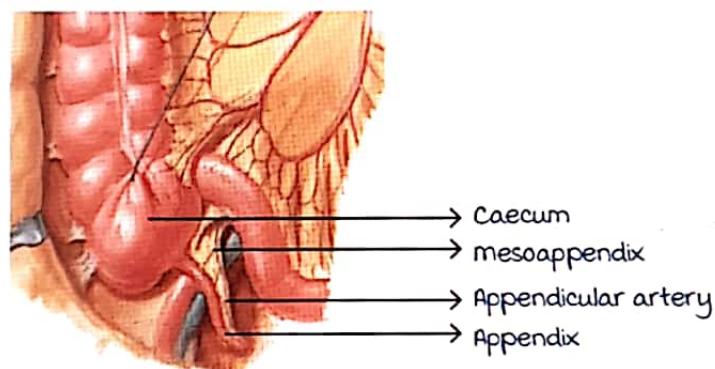
Parasympathetic : Vagus nerve.

Appendicitis pain referred to umbilicus due to same segmental innervation ( $T_{10}$ ).

### mesoappendix

It is a peritoneal fold around the appendix.

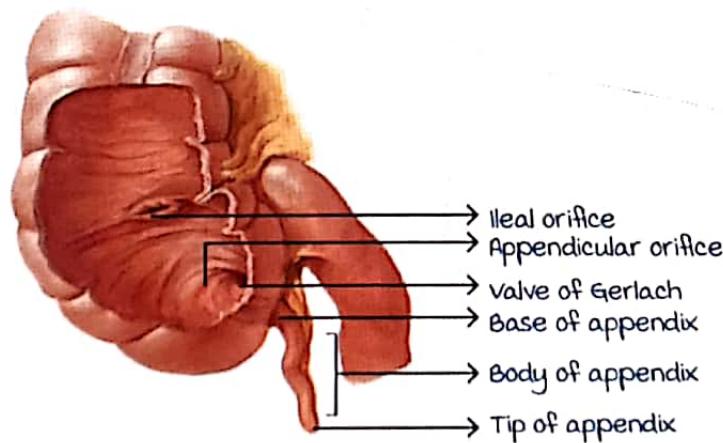
Contains end artery - appendicular artery, branch of ileocolic artery.



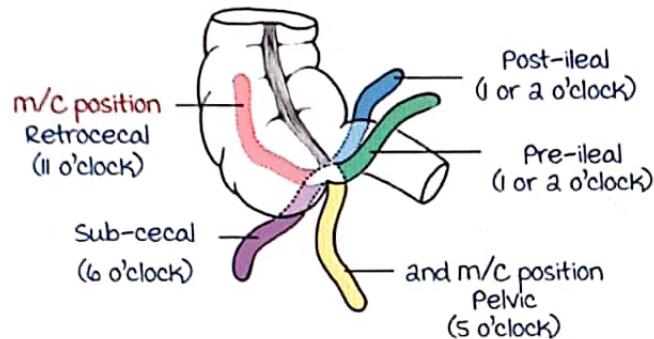
### Appendicular Orifice

It is situated 2cm posterior and medial to ileal orifice.

Valve of Gerlachis present.



- Base : situated in right iliac fossa.
- Body and Tip : can be present in any of the following positions (Clock Positions).



## Anatomy of Rectum

00:09:10

### 3 Lateral curves

2 on the right and 1 on the left.

- Houston's Valves :

These are permanent mucous folds.

There are 3 Houston's valves.

It contains reduplication of mucosa, submucosa and circular muscle.

Location : Concave side of lateral curve of rectum.

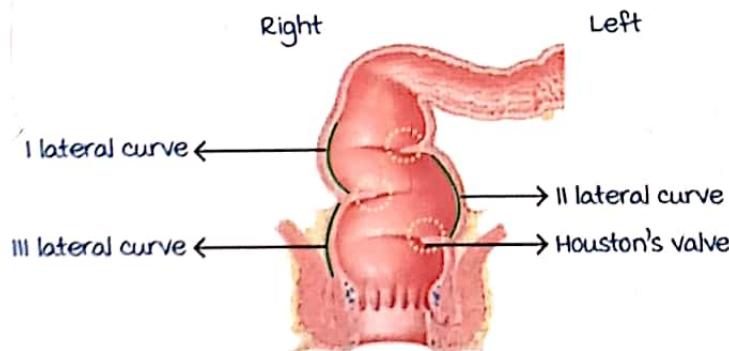
It becomes prominent when loaded with stools.

### II Valve :

The most constant valve

Location : opposite to left lateral curve (i.e. on right side)

Note : Clinical procedures involving anal route are done in Sims left lateral position in order to prevent damage to II valve and subsequent fecal incontinence.



Active space

## Anatomy of Anal Canal

00:14:01

Length : 3.8 cm

There are 2 lines:

1. Pectinate/ Dentate line

It acts as a watershed line.

2. Hilton's white line

The two lines demarcate the anal canal into 3 areas :

- Upper area

Above pectinate line.

Lined by simple columnar epithelium.

Length : 1.5cm

- Pecten area

Between Pectinate line and Hilton's line.

Lined by non-keratinized stratified squamous epithelium.

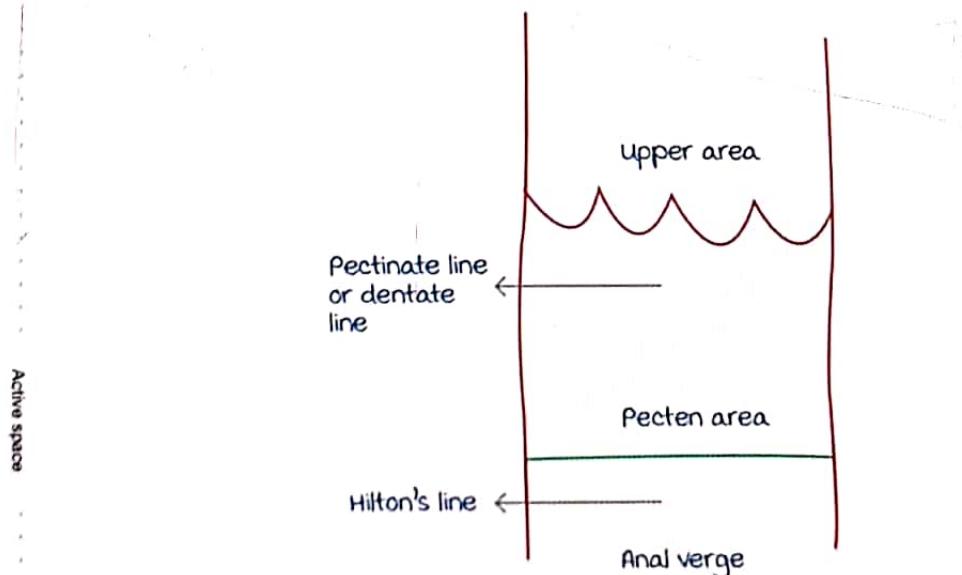
Length : 1.5cm

- Anal verge

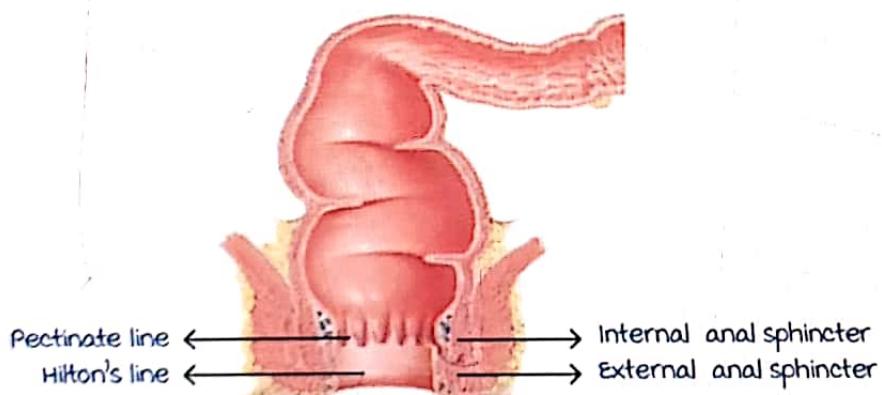
Below Hilton's line

Lined by keratinized stratified squamous epithelium.

Length : 0.8cm



	Above Dentate line	Below Dentate line
Arterial supply	Superior rectal artery (continuation of Inferior mesenteric artery)	Inferior rectal artery (branch of Internal pudendal artery)
Venous drainage	Superior rectal vein to Inferior mesenteric vein to splenic vein to portal vein	Inferior rectal vein to Internal pudendal vein to Common iliac vein to Inferior vena cava (caval system)
Nerve supply	Autonomic nervous system	Pudendal nerve (Somatic)
Presentation	Internal hemorrhoids Painless bleeding during defecation	External hemorrhoids Extremely painful
Lymphatic drainage	Internal iliac nodes	Superficial inguinal nodes
Derived from	Endoderm	Ectoderm

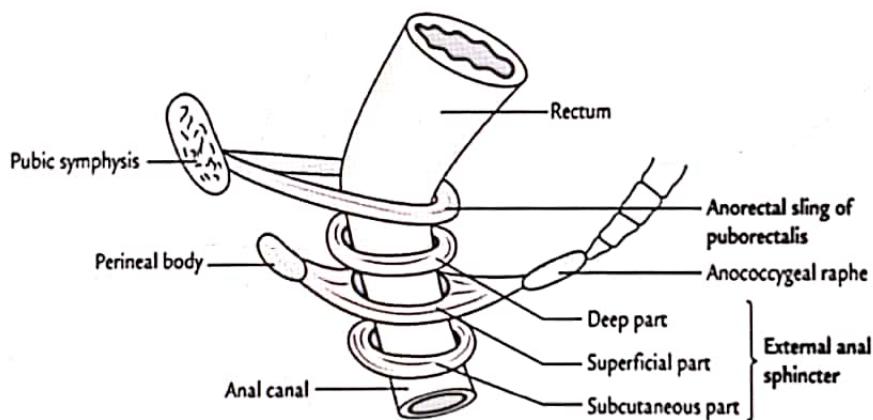


Active space

## Internal and External anal sphincters

00:21:55

Internal Anal Sphincter	External Anal Sphincter
Thickening of smooth muscle	Thickening of skeletal muscle. 3 components : <ul style="list-style-type: none"><li>• Subcutaneous part</li><li>• Superficial part</li><li>• Deep part</li></ul>
Nerve supply : Autonomic nervous system	Nerve Supply : Pudendal nerve



# LIVER AND EXTRA HEPATIC BILIARY APPARATUS

## Segmental Anatomy of Liver

00:00:30

- The liver is anatomically divided into left and right lobes by the Falciform ligament.
- The liver is functionally divided into segments by 3 major and 3 minor fissures.

**major Fissures (Not visible on the surface of liver) :**

1. **Cantle's Line or Main Fissure :**

- This line is drawn from the Inferior Vena Cava (IVC) groove to the fossa of gallbladder.
- It divides the liver into functional right lobe and functional left lobe. (DNB, NEET 2019)

2. **Left Fissure (Falciform ligament) :**

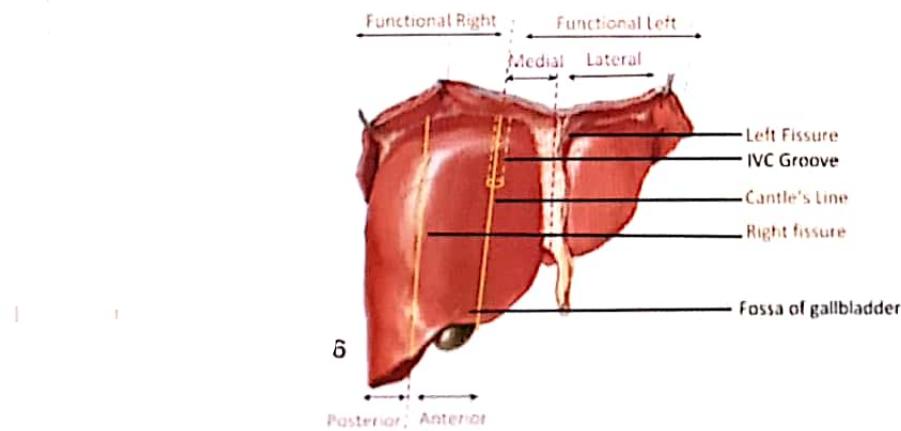
The left fissure subdivides the functional left lobe into Lateral and medial segments.

3. **Right Fissure :**

The Right Fissure subdivides the functional right lobe into Anterior and Posterior segments.

**Structures used to determine fissures :**

- Initially as proposed by French scientist, Couinaud : Portal vein and Hepatic vein (Portal vein > Hepatic vein) (AIIMS 2019).
- Now : Portal vein, Hepatic vein, Bile duct and Hepatic artery.
- Out of these, Hepatic artery is the least important. (AIIMS)



Active space

## Properties and segments of Right and Left functional lobe

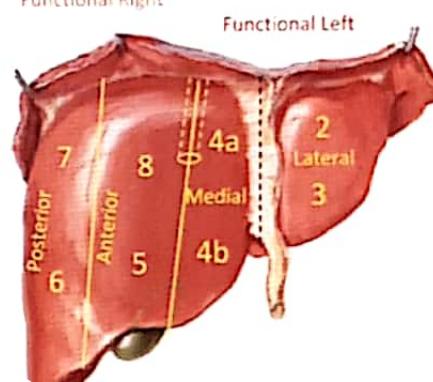
00:08:28

Properties	Left Functional Lobe	Right Functional Lobe
Blood Supply	Left Portal vein (80%) Left Hepatic artery	Right Portal vein Right Hepatic artery
Venous drainage	Left Hepatic vein to Inferior Vena Cava	Right Hepatic vein to Inferior Vena Cava
Bile drainage	Left Hepatic duct	Right Hepatic duct

Segments of Functional Left lobe : Functional Right

- 2 : Left Lateral superior.
- 3 : Left lateral inferior.
- 4a : Left medial superior.
- 4b : Left medial inferior.

(On the posterior side :  
4b forms Quadrate lobe of liver).

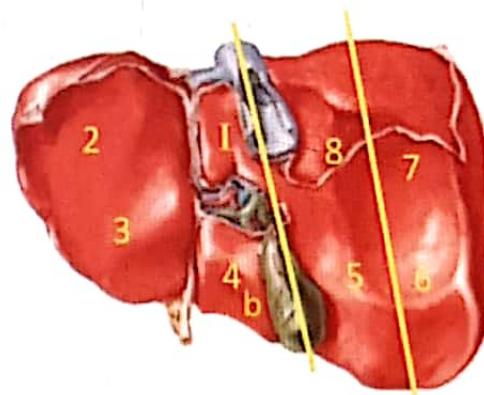


Segments of Functional Right Lobe :

- 5 : Right anterior inferior.
- 6 : Right posterior inferior.
- 7 : Right posterior superior.
- 8 : Right anterior superior.

Independent segment :

I. Caudate Lobe



Arterial supply :

- Right + Left portal vein.
- Right + Left hepatic artery.

Venous drainage : Inferior Vena Cava.

Bile drainage : Right + Left Hepatic duct.

## Minor Fissures of the liver

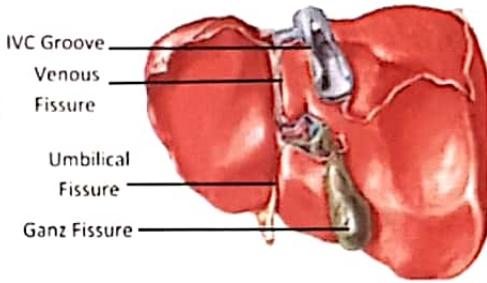
00:17:17

### 1. Venous Fissure

- Also Known as Fissure for Ligamentum Venosum.
- The fissure contains Ligamentum Venosum.
- Ligamentum Venosum is the remnant of Ductus Venosus.

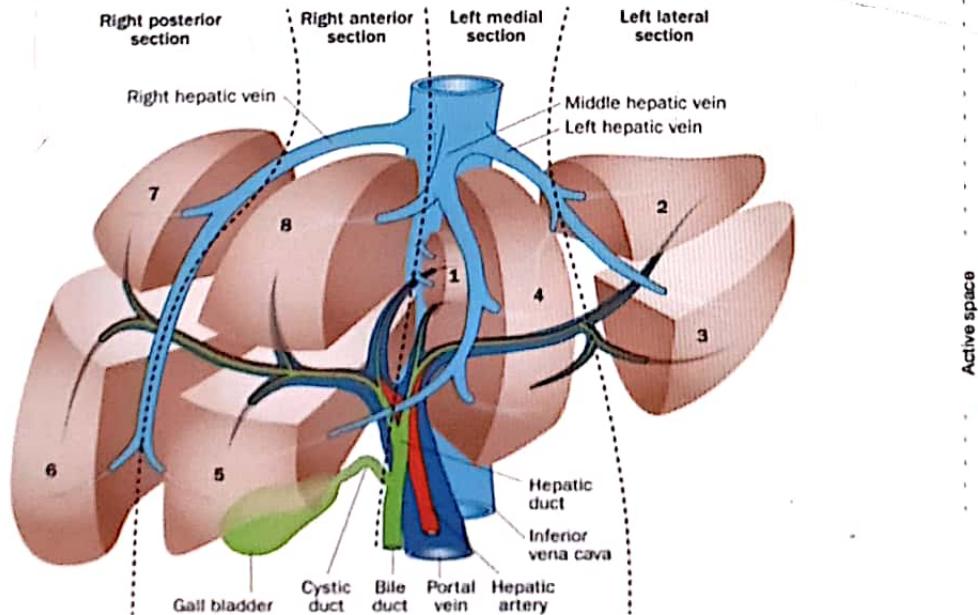
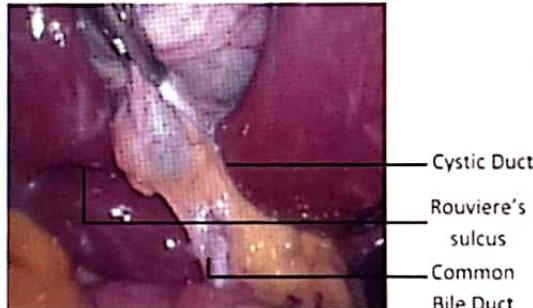
### 2. Umbilical Fissure

- Also Known as fissure for Ligamentum Teres.
- The fissure contains ligamentum Teres.
- Ligamentum Teres is the remnant of Left Umbilical vein.

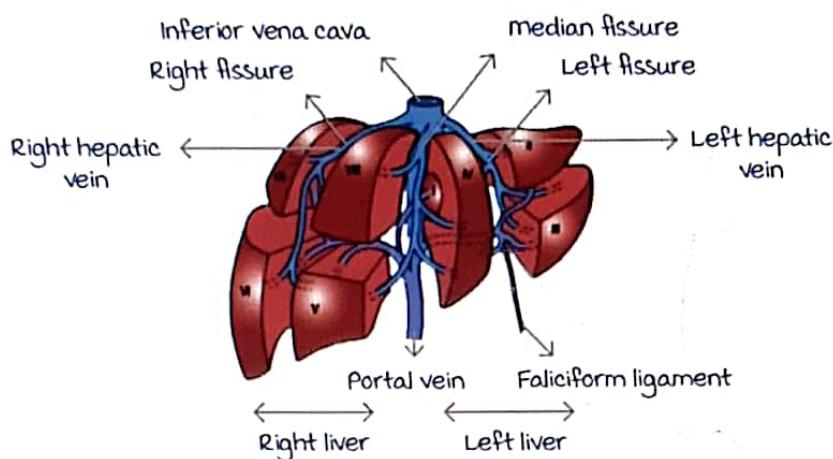


### 3. Ganz Fissure

- Also Known as Rouviere's sulcus.
- This is the fissure over the Fossa of gallbladder.
- Applied : It is used in Laparoscopic cholecystectomy in order to differentiate between cystic bile duct (above the sulcus) and common bile duct. (below the sulcus)



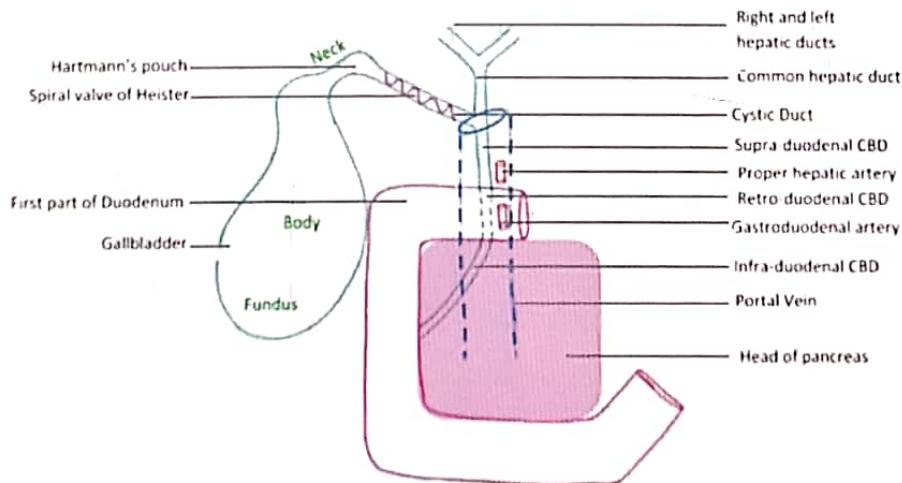
Active space



## Extrahepatic Biliary Apparatus

00:21:46

- The gallbladder opens into the **cystic duct**.
- Right and left hepatic duct carrying bile from the liver join to form the **common hepatic duct**.
- Common hepatic duct and Cystic duct join to form the **Common Bile Duct (CBD)**.
- The fundus of the Gall bladder is located in the **Transpyloric plane**.
- Hartmann's pouch**: Pathognomonic pouch present in neck of gallbladder where stones get lodged.
- Spiral valve of Heister**: Present in Cystic duct.  
(valve of Hasner is present in Nasolacrimal duct. NEET 2017).



Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

## Minor Fissures of the liver

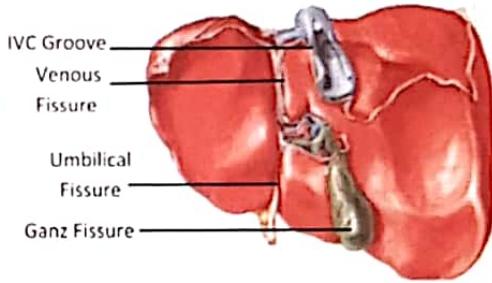
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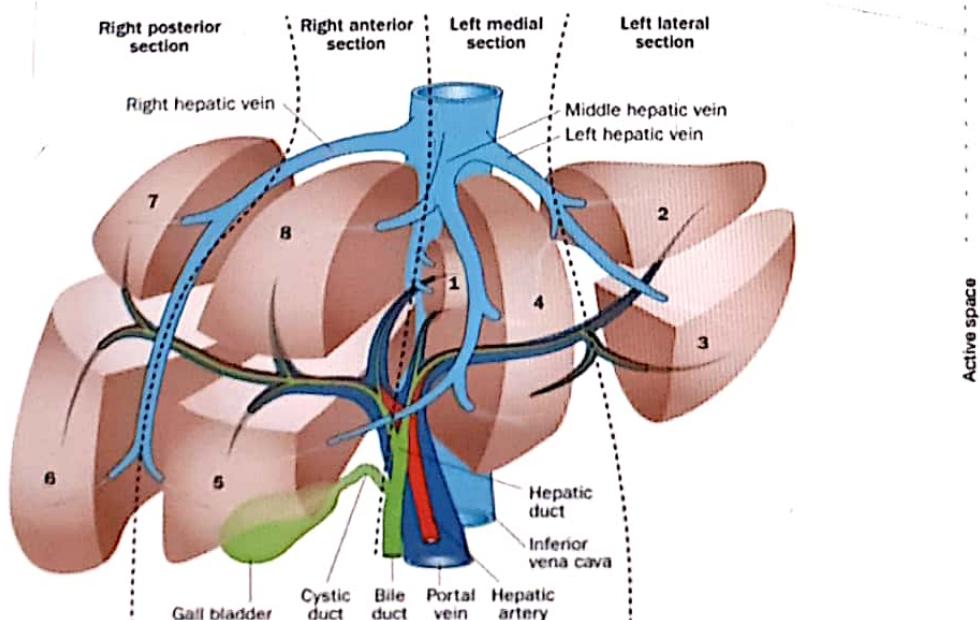
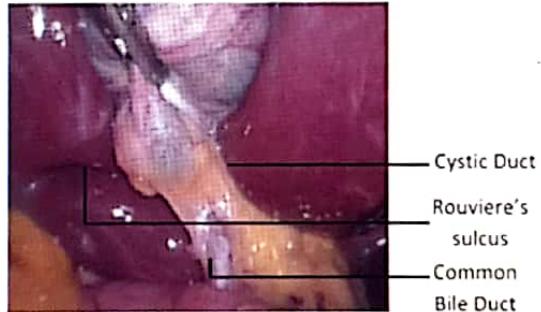
### 2. Umbilical Fissure

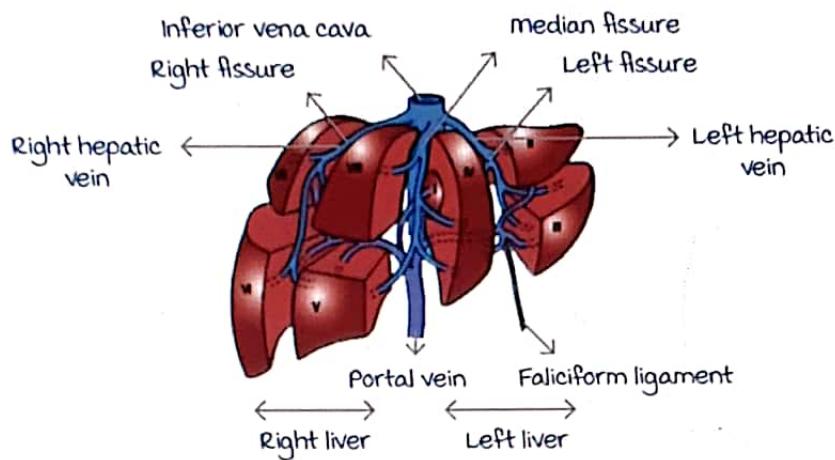
- Also Known as fissure for Ligamentum Teres.
- The fissure contains ligamentum Teres.
- Ligamentum Teres is the remnant of Left umbilical vein.



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- Applied : It is used in Laparoscopic cholecystectomy in order to differentiate between cystic bile duct (above the sulcus) and common bile duct. (below the sulcus)

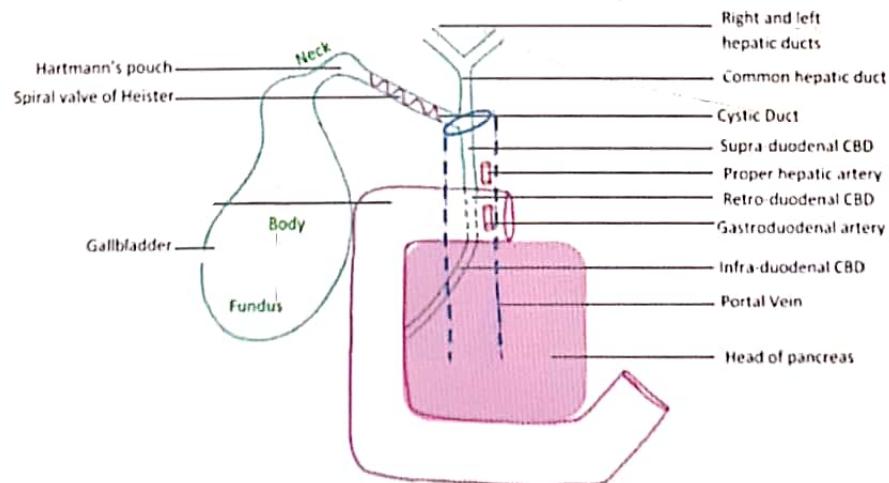




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## Common Bile Duct

00:25:25

The Common Bile Duct (CBD) is divided by means of the 1<sup>st</sup> part of duodenum :

1. Supraduodenal part
2. Retroduodenal part
3. Infraduodenal part

Relations of the Common Bile Duct :

Supra-duodenal part of the CBD :

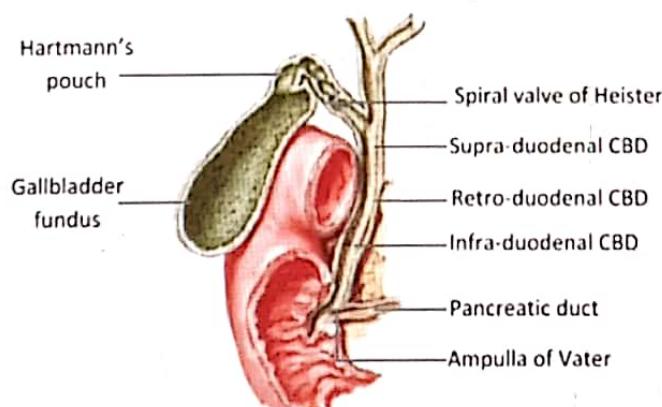
- Posterior : Portal vein, Inferior Vena Cava.
- Left side : Proper hepatic artery.

Retro-duodenal part of the CBD :

- Posterior : Portal Vein, Inferior Vena Cava.
- Anterior : First part of duodenum.
- Left : Gastro-duodenal artery.

Infra-duodenal Part of the CBD :

- Front : Head of pancreas (Within the concavity of the duodenum).
- Left side : Portal vein formation.
- Posterior : Inferior vena cava.



Applied anatomy of Common Bile Duct :

- Carcinoma of Head of Pancreas obstructs the infra-duodenal part of the CBD and results in obstructive jaundice.
- Stone in the infra-duodenal CBD irritates the head of pancreas and leads to acute pancreatitis.

Infra-duodenal CBD joins with pancreatic duct to form Ampulla of Vater.

- Ampulla of vater opens into the major duodenal papillae, situated in the posteromedial wall of the second part of the duodenum.

- Stone in Ampulla of Vater causes entry of bile into the pancreatic duct and leads to **pancreatitis**.

## Sphincter of Oddi complex

00:36:57

There are 4 Sphincters ( $4 > 3$ )

1. Sphincter of Boyden :

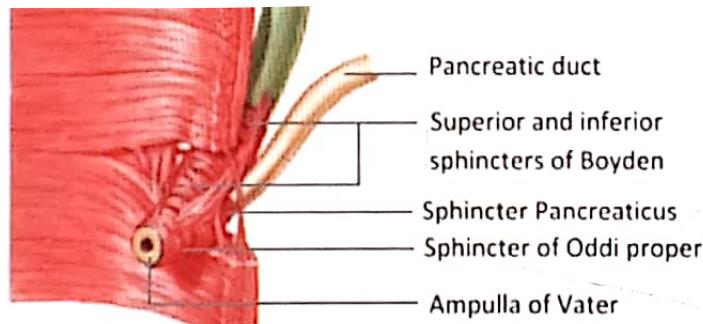
- Around the **CBD**.
- There are 2 Sphincters of Boyden :  
**Superior Sphincter of Boyden.**  
**Inferior Sphincters of Boyden.**

2. Sphincter **Pancreaticus** :

- Present over the  
**Pancreatic duct.**

3. Sphincter of Oddi proper :

- Present over  
**Ampulla of Vater.**



## Calot's Triangle and Hepatocystic Triangle

00:39:47

### Calot's Triangle

Boundaries :

- Above : **Cystic artery.**
- Below and Right side : **Cystic duct.**
- Below and left side : **Common hepatic duct.**

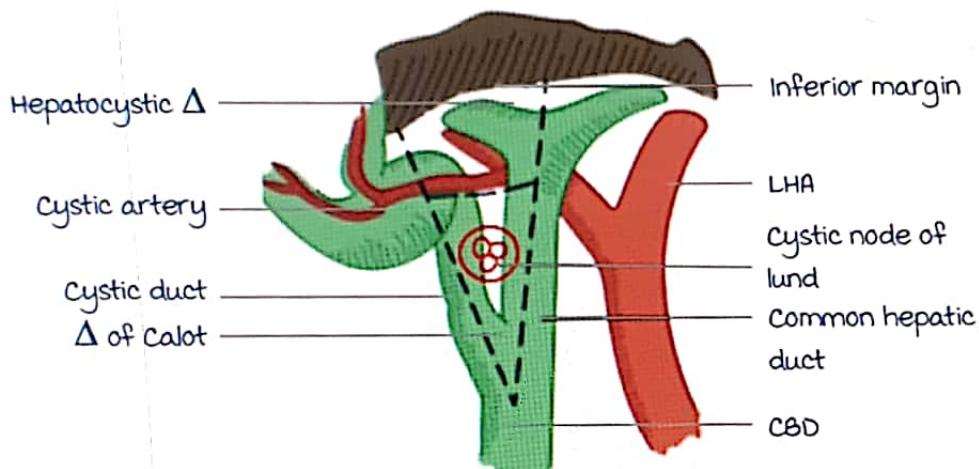
Contents :

**Cystic node of Lund.**

### Hepatocystic Triangle :

The hepatocystic triangle is similar to Calot's triangle except for 2 aspects :

1. Superior boundary : Inferior margin of Liver
2. Contents :
  - Cystic artery.
  - Cystic node of Lund.

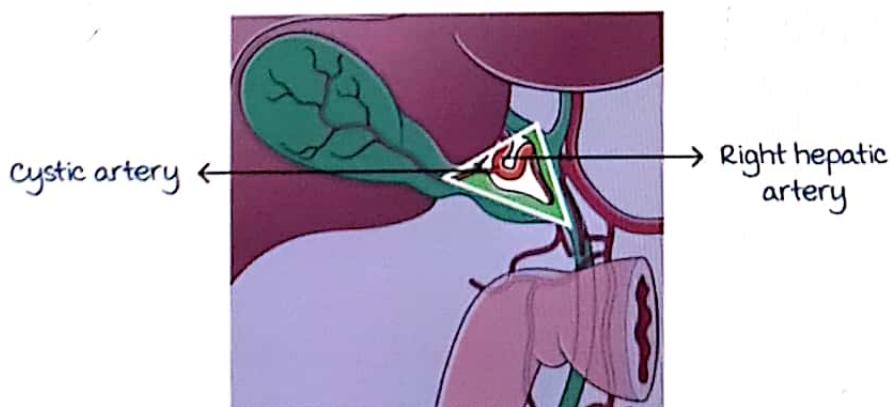


### Moynihan's Hump

00:43:45

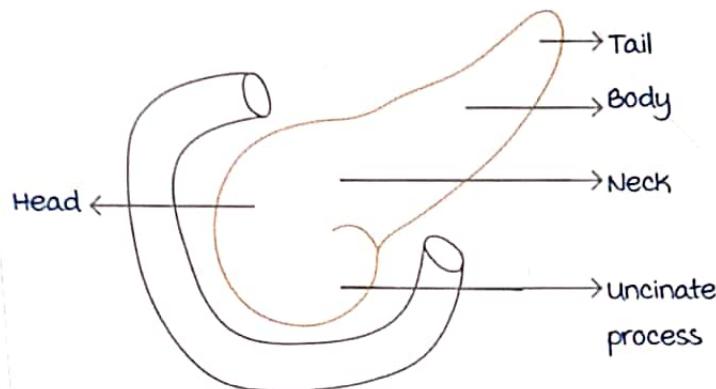
- Moynihan's hump is also known as Caterpillar hump.
- This is seen when the Right hepatic artery becomes tortuous and is present in Calot's triangle.

Note : During laparoscopic cholecystectomy, the surgeon has to rule out the presence of right hepatic artery in Calot's triangle to avoid damaging it and causing profuse haemorrhage.



Active space

## PANCREAS AND SPLEEN



Head of pancreas - present in the concavity of duodenum.

Behind head of pancreas - infra duodenal part of common bile duct.

**Uncinate process** - Extension of the head of pancreas.

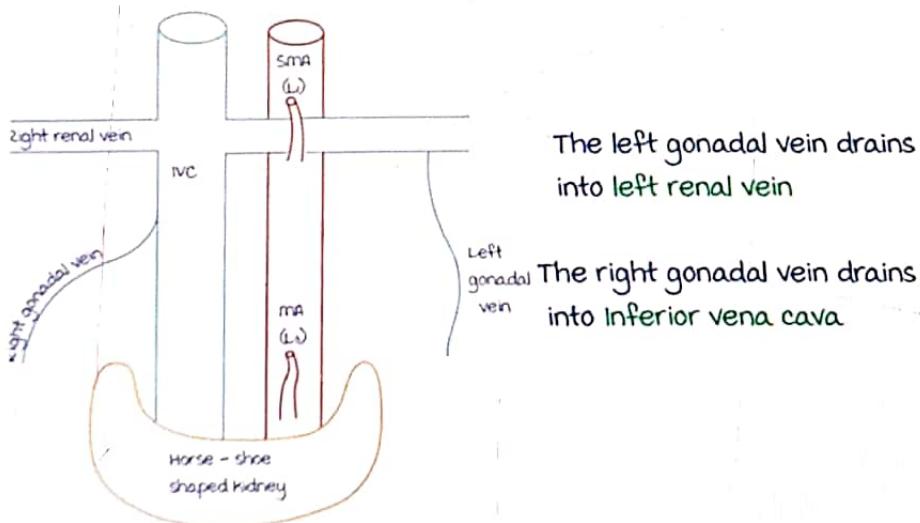
Behind neck of pancreas - formation of portal vein.

Pancreas is a **retro peritoneal organ**, except the tail.

Tail of pancreas - present in the **lienorenal ligament**.

### Relations of pancreas

00:02:24



most common anomaly in the development of Kidney is the **Horse shoe shaped kidney**. (Lower poles of the kidney fuse together)

Kidney is formed in the pelvis & ascends up.

Inferior mesenteric artery prevents ascent of the horse shoe shaped kidney.

Left renal vein crosses the aorta in front, below the superior mesenteric artery.

Active space

Compression of left renal vein in between the aorta and superior mesenteric artery will cause Nutcracker syndrome



Left gonadal vein gets dilated



Left Pampiniform plexus gets dilated



Varicocele (bag or worms consistency)

Posterior relations of head of pancreas

- Inferior vena cava
- Right renal vein
- Left renal vein

Anterior Relations of the uncinate process

- Superior mesenteric artery
- Superior mesenteric vein

### Relations of the neck and body of pancreas

00:12:00

Portal vein formed by Superior mesenteric vein + Splenic vein

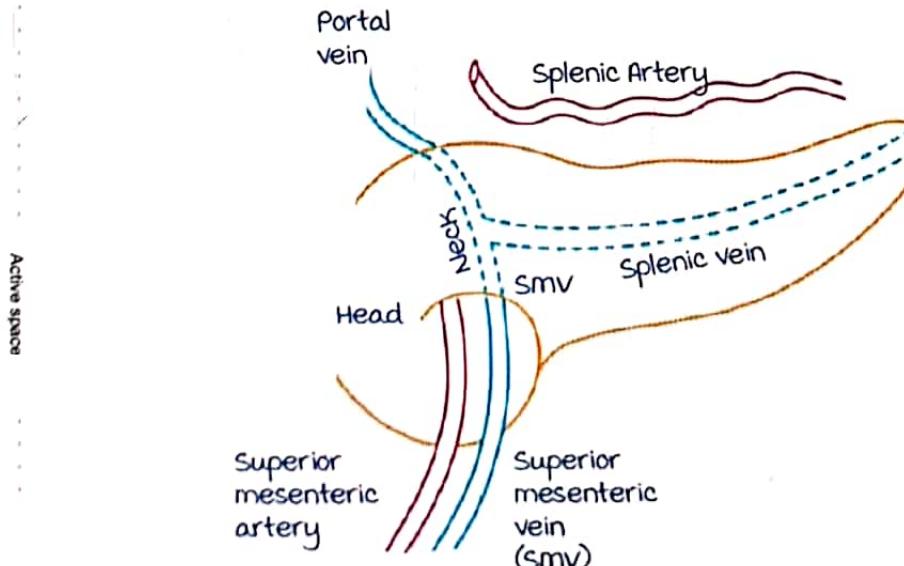
Posterior relations of the neck of the pancreas

- portal vein (in the upper part)
- Superior mesenteric vein (in the lower part)

Note : Superior mesenteric vein passes anterior to the uncinate  
But posterior to the neck of the pancreas.

Posterior relation of body of pancreas : **Splenic vein**

The **splenic artery** is at the upper border of the pancreas.



Active space

## Relations of the tail of pancreas

00:16:02

Tail is present in the lienorenal ligament  
maximum islets of langerhans are present in the tail only

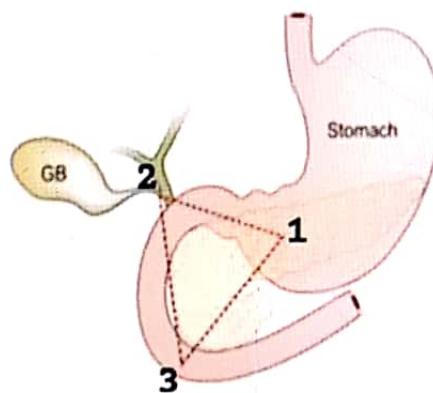
Double Duct sign :



Presence of simultaneous dilatation of Common bile duct and pancreatic duct.  
Seen in cancer of head of pancreas and periampullary tumours.

## Passaro's Triangle a/k/a Triangle of Gastrinoma

1. Junction of head & neck of pancreas with the Body of the pancreas
2. Junction of cystic duct with common bile duct
3. Junction between the 2<sup>nd</sup> and 3<sup>rd</sup> part of duodenum



## Spleen

00:18:36

Active space

Thickness : 1 inch (3cms)

Breadth : 3 inches (6cm)

Length: 5 inches (12cm)

Weight : 150gm (7oz)

This is also known as Harris dictum of odd numbers.

Spleen is related with 10, 11, 12<sup>th</sup> ribs > 9, 10, 11

Axis of spleen - 11<sup>th</sup> rib > 10th rib

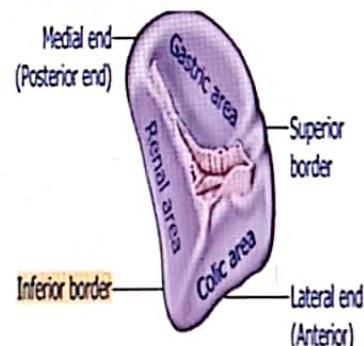
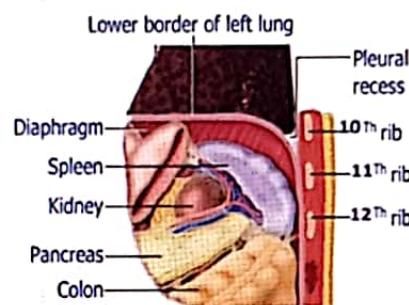
Superior border of spleen has the splenic notches.

Convex surface is related to the diaphragm.

Visceral surface (concave surface)

- Gastric area
- Renal area (left kidney)
- Colic area (Left colic flexure)

In hilum of the spleen, Tail of pancreas is seen



## Ligaments around spleen

00:22:21

### Gastrosplenic ligament

- Present in between the stomach and spleen.
- Derivative of dorsal mesogastrium
- Contains short gastric and left gastroepiploic vessels

### Lienorenal ligaments

- Between left kidney and spleen
- Derivative of dorsal mesogastrium
- Contains splenic artery and tail of pancreas

### Phrenico-colic ligament

Prevents downward displacement of spleen.

Hence, called as Sustentaculum lienis

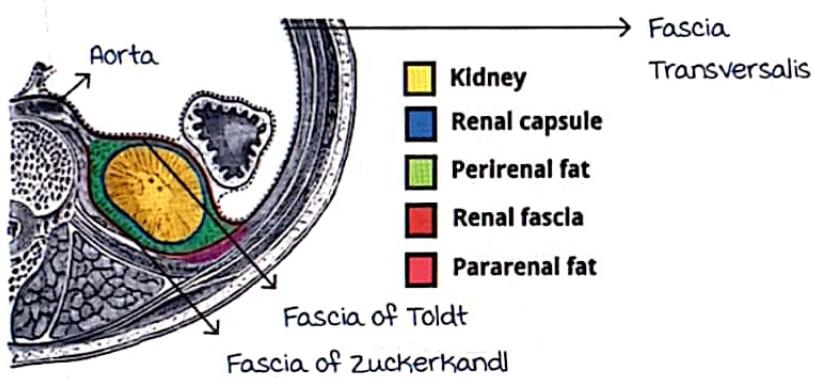
# KIDNEY AND URETER

Vertebral Level : T12 – L3

## Covering of Kidney

00:00:15

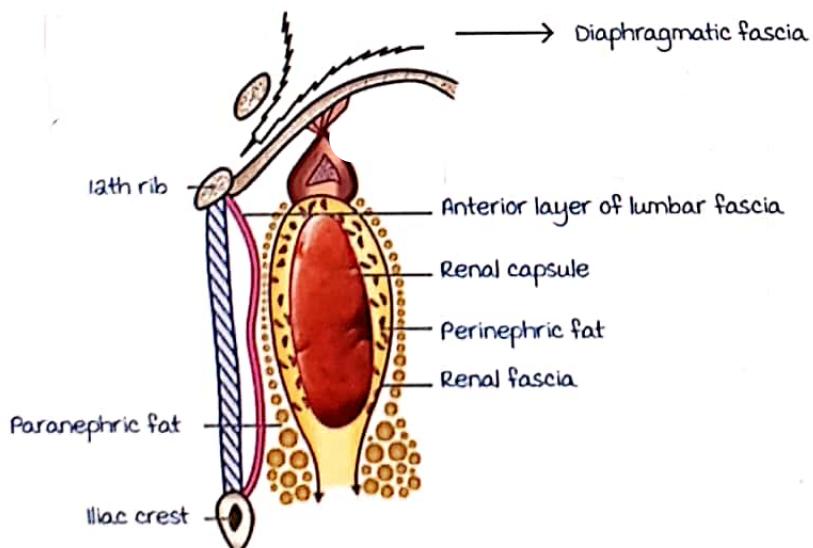
- From inside to outside:
  - Renal capsule: True capsule
  - Perirenal fat
  - Renal fascia: Fascia Gerota
  - Pararenal fat



- Fascia Gerota :

Two layers :

Anterior layer  
(Fascia of Toldt)      Posterior Layer  
(Fascia of Zuckerkandl)

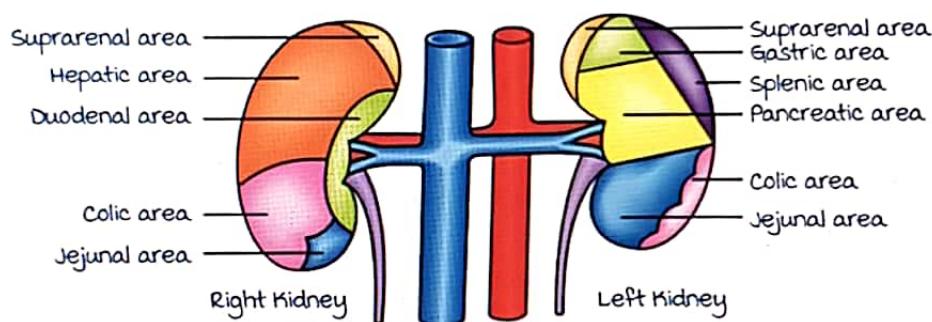


Active space

- Boundaries :
  1. Superiorly: it splits and encloses supra renal gland and blends with diaphragmatic fascia
  2. medially :
    - Fascia Toldt passing in front and blends with fascia over Aorta and IVC
    - Fascia Zuckerkandl passing behind the kidney and blends with fascia over psoas major and quadratus lumborum

## Relations of the kidney

00:06:15



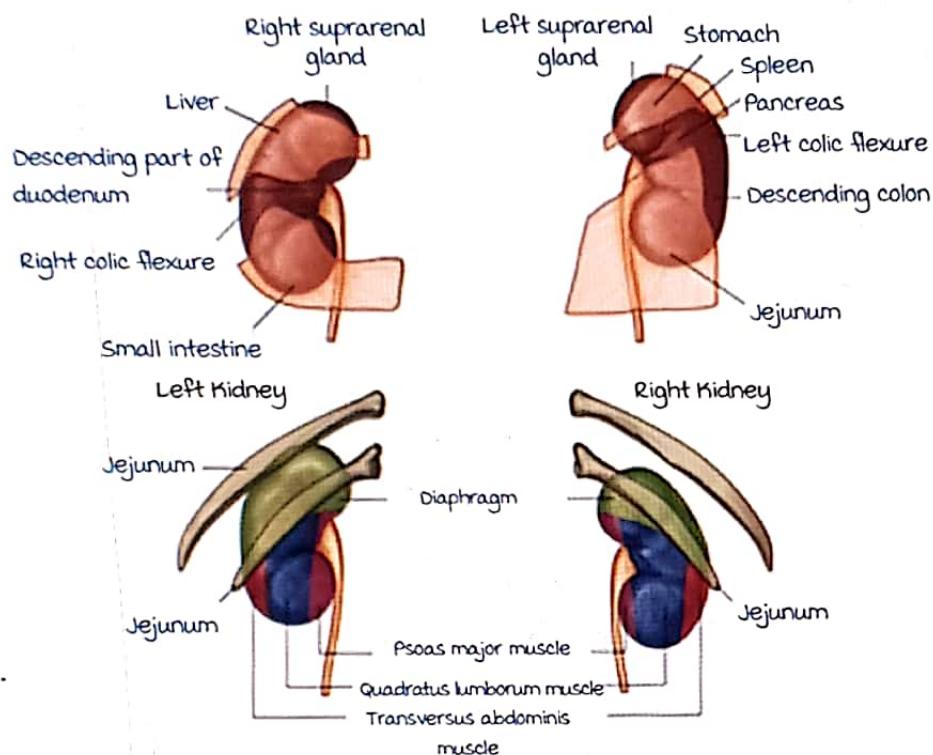
### Right Kidney :

- Upper part: supra renal gland
- Anterior 2/3rd: liver
- In front of Hilum: 2nd part of duodenum
- Lower 1/3rd (colic area and jejunal area): right colic flexure and few coils of jejunum
- Peritoneally covered areas :
  1. hepatic area
  2. jejunal area

### Left Kidney :

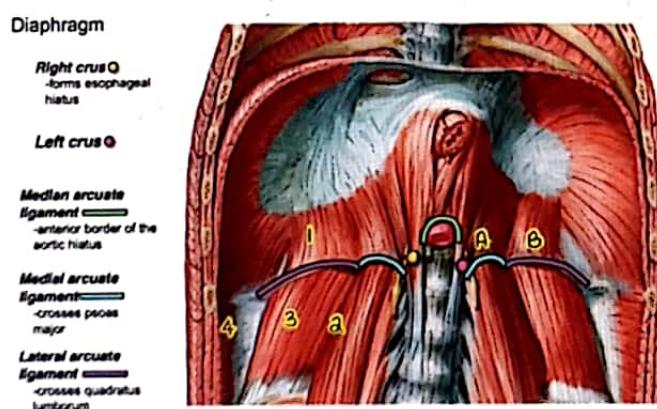
- upper part: supra renal gland, gastric area and, splenic area (more on the lateral side of the upper part)
- Anteriorly: Body of pancreas, left colic flexure, coils of jejunum
- Peritoneally covered areas :
  1. gastric area
  2. splenic area
  3. jejunal area

Posterior relations of the right and left kidney : (same on both right side and left side)



#### Bony :

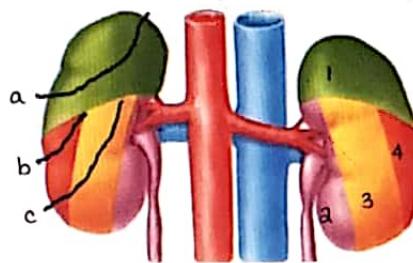
Posteriorly right kidney is related to only 12th rib whereas the left kidney is related to the 11th and 12th rib.



#### muscles :

1. Diaphragm : above
2. Psoas major
3. Quadratus lumborum
4. Transverse abdominis

Kidneys in Situ  
Posterior Relations of Kidneys



Nerves :

- a. Subcostal nerve
- b. Ilio hypogastric nerve
- c. Ilio inguinal nerve

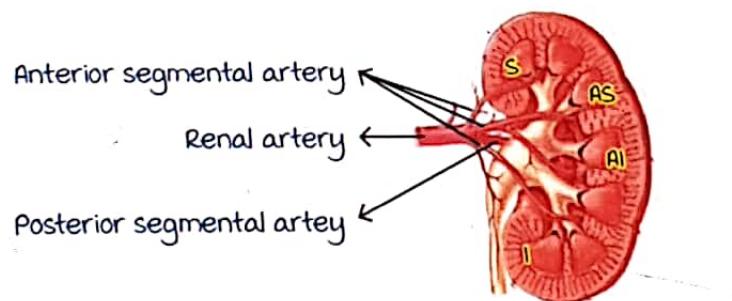
Ligaments :

- A. medial arcuate ligament
- B. Lateral arcuate ligament

### Blood Supply of the kidney

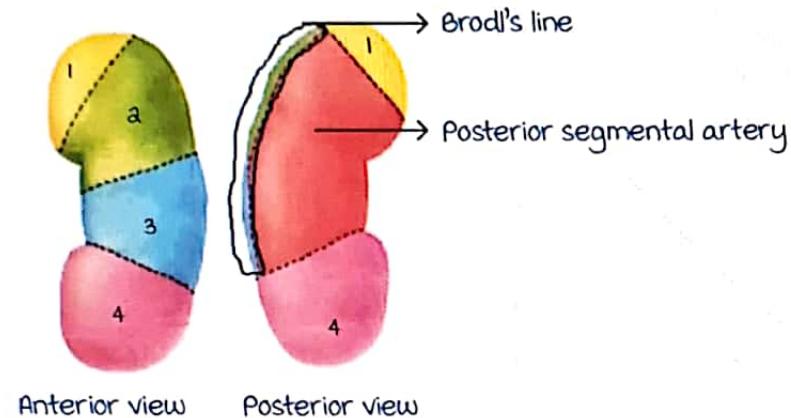
00:17:30

Intrarenal Arteries  
Frontal Section of Left Kidney - Anterior View



Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

- Renal artery divided into Anterior and Posterior segmental artery.
- Anterior segmental artery in turn divided into :
  1. Superior segmental artery
  2. Antero superior segmental artery
  3. Antero inferior segmental artery
  4. Inferior segmental artery

**Brodil's Line :**

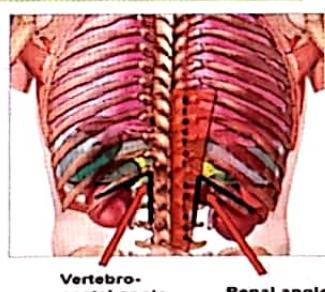
- situated between Anterior segmental artery and Posterior segmental artery
- avascular line: you can make incision in this line

**Angles of the kidney**

00:21:15

**Vertebrocostal & Renal Angles**

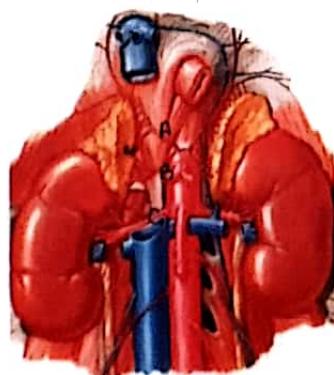
- The angle between the last rib and the lateral border of erector spinae muscle is occupied by kidney and is called the '**Renal angle**'
- The **Vertebrocostal angle** is occupied by the lower part of the pleural sac.



- Sacrospinalis is the other name for erector spinae muscle
- vertebrocostal angle: between the 12th rib and vertebrae

**Suprarenal gland**

00:22:44

**Renal Artery and Vein in Situ**

Active space

shape:

- Right suprarenal gland: pyramidal
- Left suprarenal gland: semilunar

Blood supply: Artery

- Superior suprarenal artery: derived from inferior phrenic artery
- middle suprarenal artery: direct branch of the abdominal aorta
- Inferior suprarenal artery: branch from renal artery

Blood supply: Vein

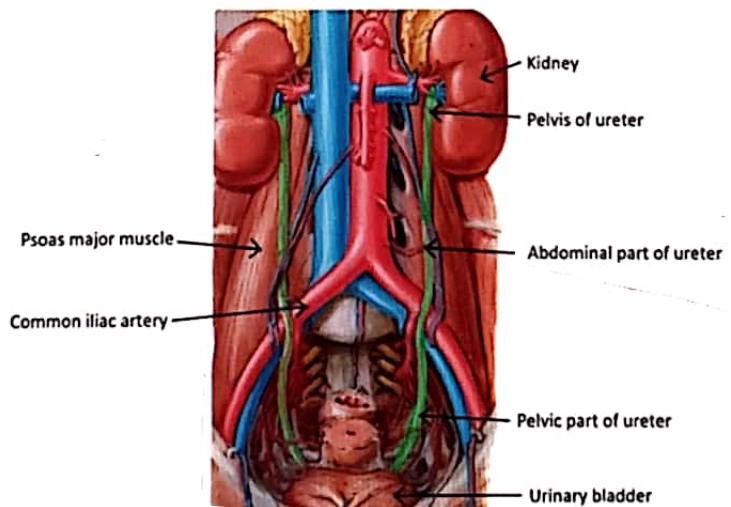
- Right suprarenal vein: drains into IVC
- Left suprarenal vein: drains into left renal vein

Tributaries of Left renal vein:

- Left suprarenal vein
- Left gonadal vein
- Left Inferior phrenic vein

## Ureter

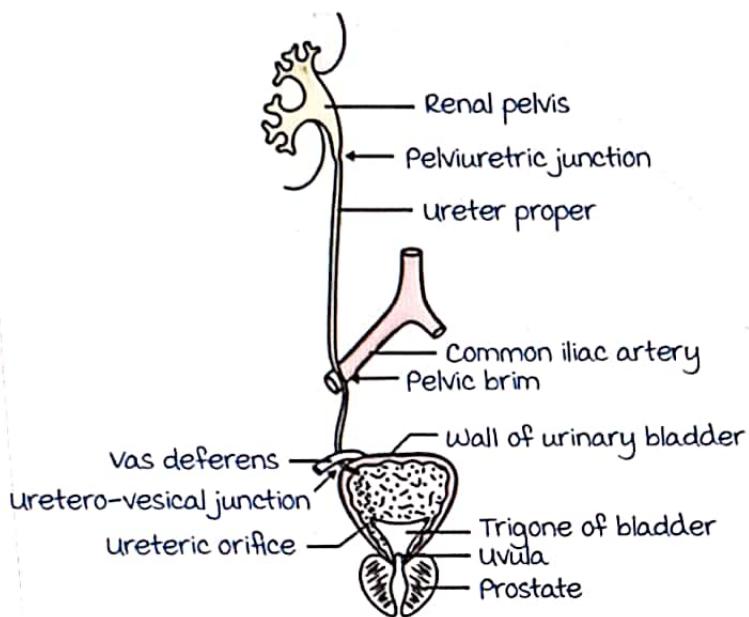
00:26:15



Parts of the ureter:

- Pelvis of ureter: extends from hilum of the kidney upto the lower border of the kidney
- Abdominal part of ureter: Lower border of the kidney and upto the common iliac artery bifurcation
- Pelvic part of ureter: remaining part

Constrictions of ureter :



A. Surgical constrictions :

- I. Pelviuretic junction
- II. Pelvic brim : area where ureter crosses the common iliac
- III. Crossing :
  - a. of vas deferens in males
  - b. of Broad ligament in females
- IV. Utero vesical junction
- V. Tip of the ureter
  - Narrowest part: 4 > 5 (Utero vesical junction > Tip of the ureter)

B. Anatomical constrictions:

- I. Pelviuretic junction
- II. Pelvic brim
- III. Utero vesical junction

Posterior relations of the ureter : (same on the right side and left side)

- a. Psoas major muscle
- b. Common iliac vessel/ External iliac vessel
- c. Genitofemoral nerve: pierces psoas major and then comes out

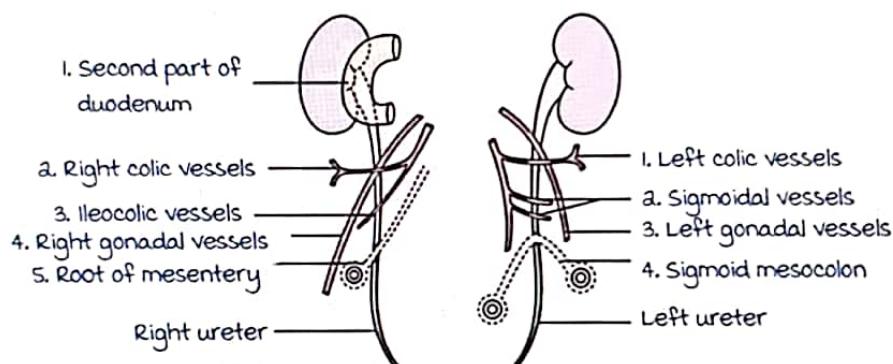
Structures crossing the ureter anteriorly : (not same on the right and left)

Right side:

- Second part of the duodenum
- Right colic artery: branch of superior mesenteric artery
- Ileocolic artery: branch of superior mesenteric artery
- Right gonadal vessels
- Root of mesentery

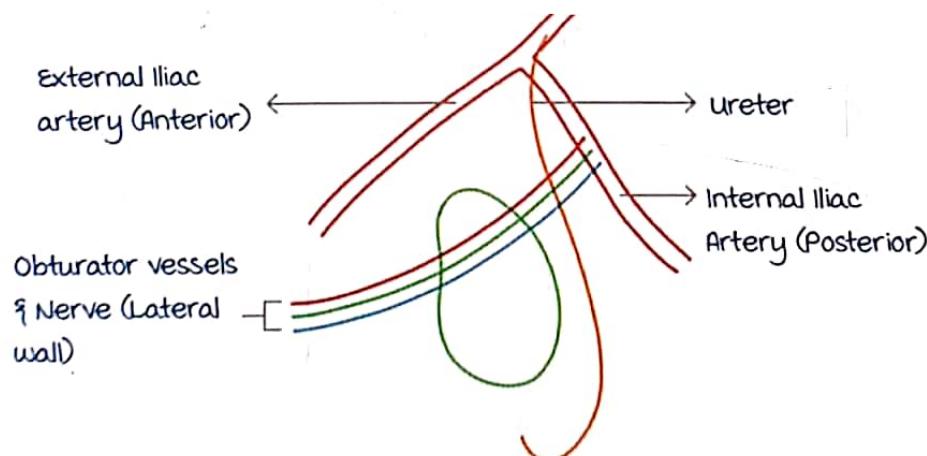
Left side:

- Left colic vessels: branch of inferior mesenteric artery
- Sigmoidal vessels: branch of inferior mesenteric artery
- Left gonadal vessels
- Sigmoid mesocolon



### Boundary of ovarian fossa

00:37:47

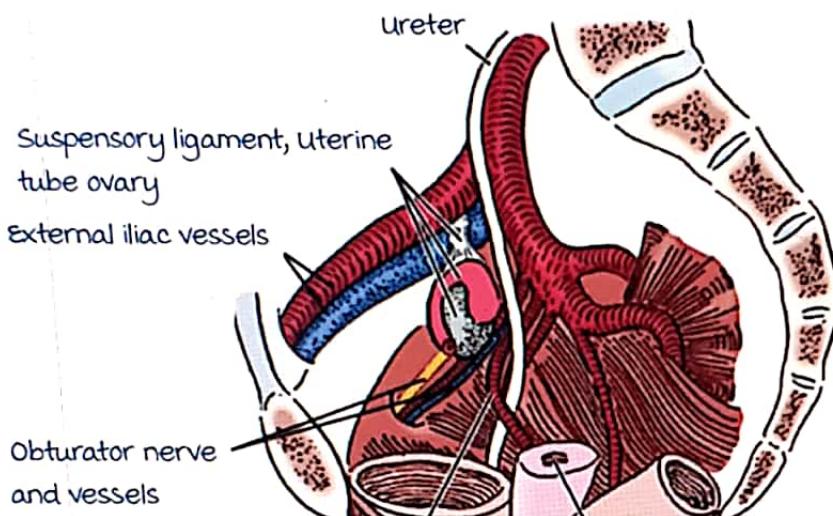


Ovary is situated in the fossa.

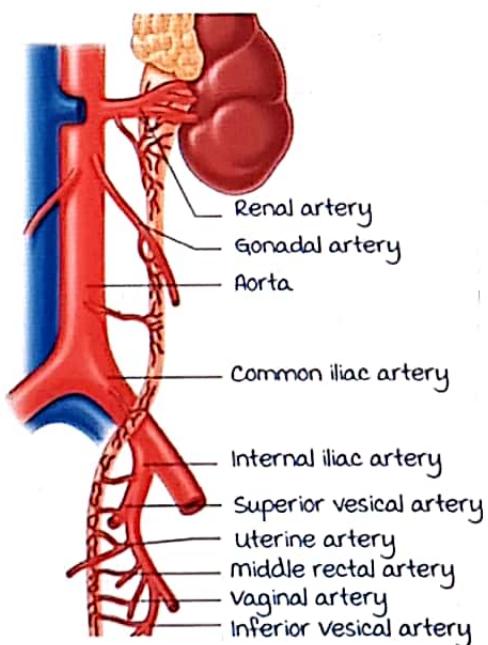
- Anteriorly: External iliac vessel
- Posteriorly: Internal iliac vessel and ureter
- Lateral wall: Obturator nerve and vessels

## Applied: Ovarian Pathology

- Pain is referred to the medial aspect of the thigh (due to irritation of obturator nerve)



## Blood supply of ureter:



- Renal artery
- Gonadal artery
- Common iliac artery
- Superior vesical artery
- Uterine artery
- Middle rectal artery
- Vaginal artery
- Inferior vesical artery

Active space

# BLOOD VESSELS OF THE ABDOMEN

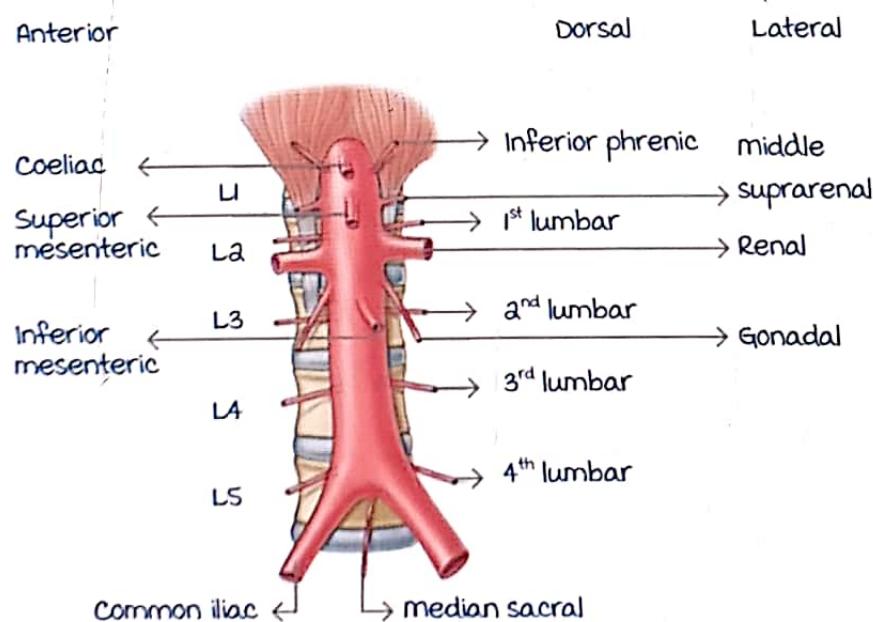
## Abdominal aorta and branches

00:00:07

The abdominal aorta is extending from T12 to L4.

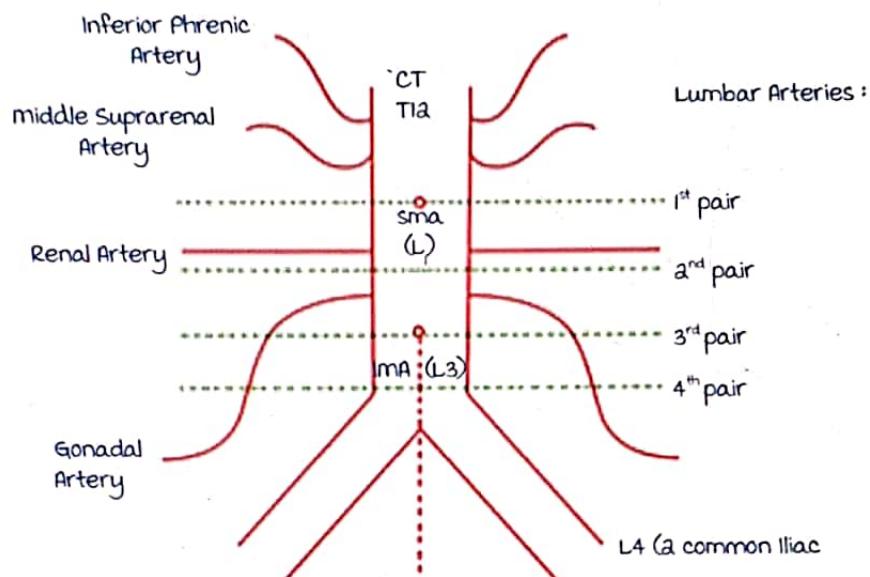
At the level of L4 it bifurcates into two common iliac arteries.

The aorta branches		
Ventral	Lateral	Dorsal
Celiac trunk - T12	inferior phrenic artery	lumbar arteries (four pairs)
Superior mesenteric artery - L1 (SMA)	middle suprarenal artery	median sacral artery
Inferior mesenteric artery - L3 (IMA)	renal artery	
	gonadal artery	



Active space

Lateral branches :



CT : Celiac Trunk

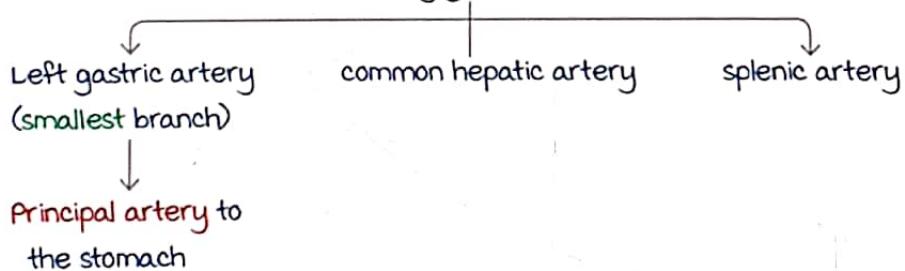
SMA : Superior mesenteric Artery

IMA : Inferior mesenteric Artery

### Celiac trunk

00:05:47

The celiac artery gives three branches



The common hepatic artery gives

right gastric artery and gastroduodenal artery

becomes proper hepatic artery

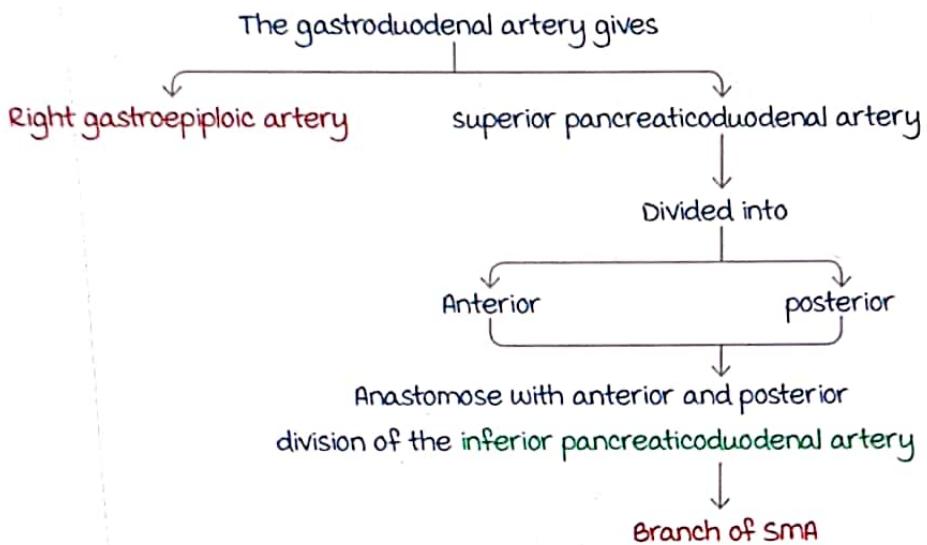
Right hepatic artery

Left hepatic artery

Gives cystic artery

Supplies gallbladder

The left gastric artery and right gastric artery anastomose along the lesser curvature of the stomach.

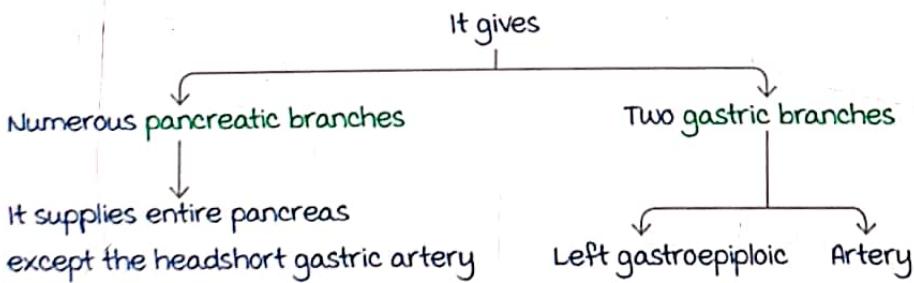


The superior pancreaticoduodenal artery supplies the head of pancreas.

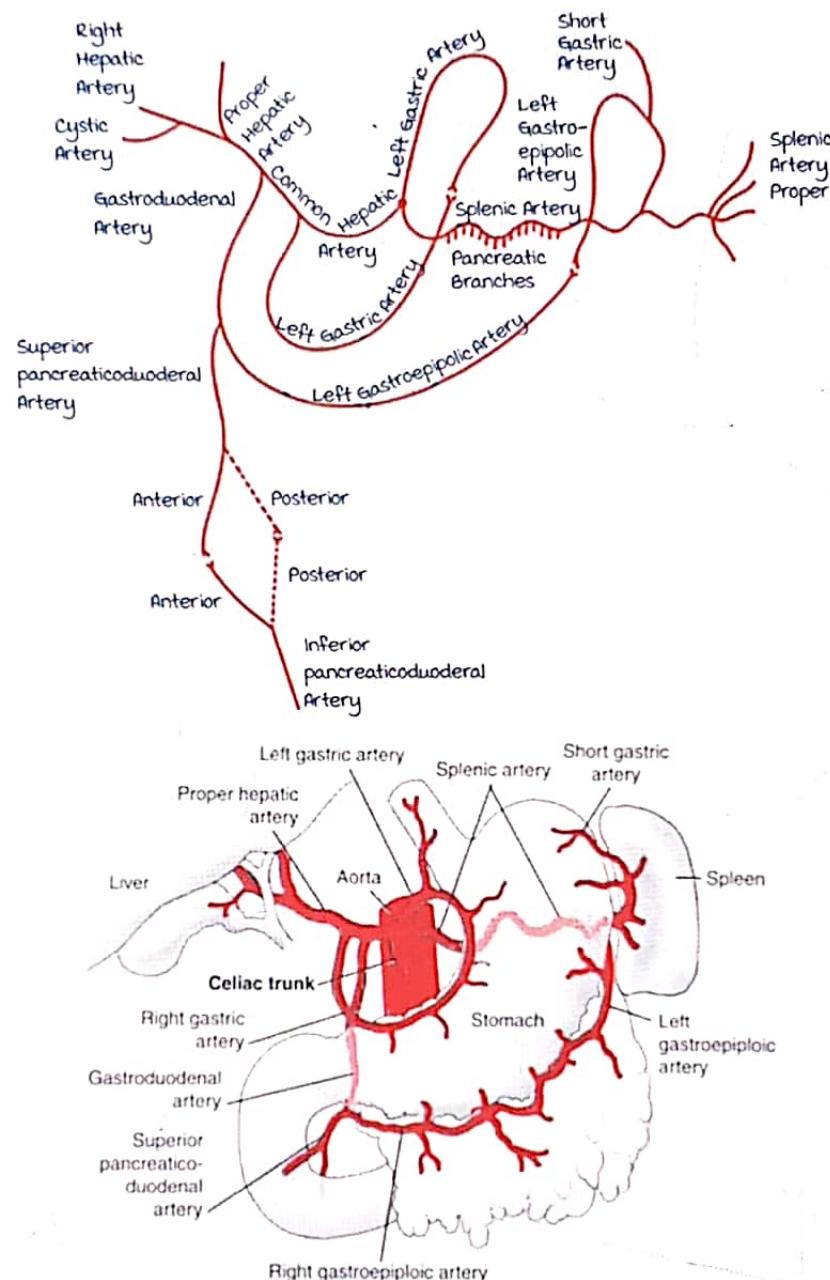
### Splenic artery

It is the tortuous artery.

It is situated in the upper border of pancreas.

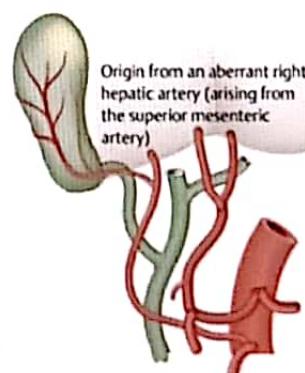


The splenic artery further divides into splenic artery proper (end artery) (Allms)



#### Clinical correlation :

**Aberrant right hepatic artery** arises from the superior mesenteric artery.

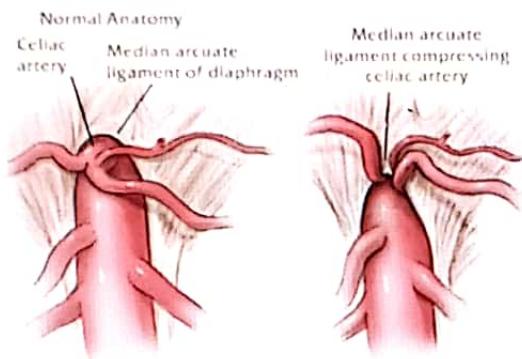


#### Dunbar syndrome

Normal - the celiac trunk arises at the level of T12

Just below the median arcuate ligament of diaphragm.

In Dunbar syndrome - the celiac trunk originates from higher level  
The median arcuate ligament compresses the celiac trunk.



## Superior mesenteric and inferior mesenteric artery

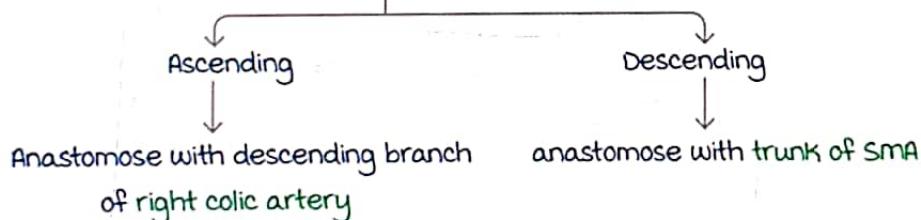
00:20:08

### Superior mesenteric artery

Convex side - numerous jejunal & ileal branches

Concave side :

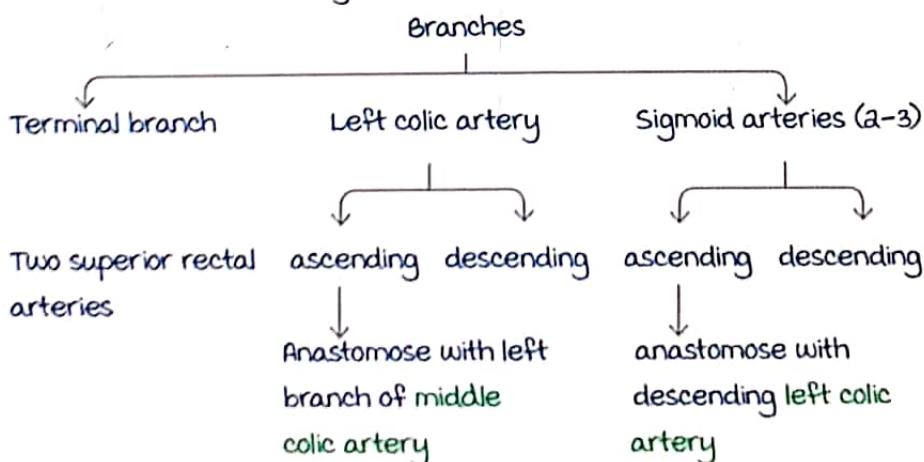
1. Inferior pancreaticoduodenal artery - divides into anterior and posterior
2. middle colic artery - divides into right and left
3. Right colic artery - divides into ascending and descending branches
4. Ileocolic artery - divides into



Branches of ileocolic - anterior caecal artery

- Posterior caecal artery
- Appendicular artery (end artery)
- Ileal artery

### Inferior mesenteric artery

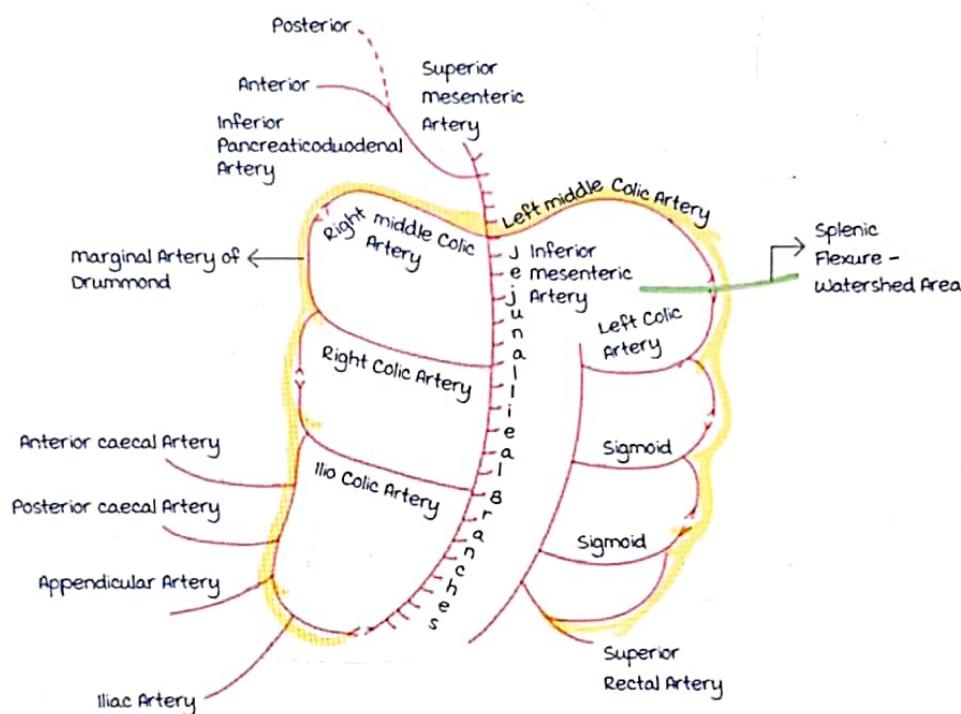


Active space

The colic vessels anastomose with each other and margins,

Forming arterial arcades around the peripheral margins of colon

Called marginal anastomosis (artery) of Drummond.



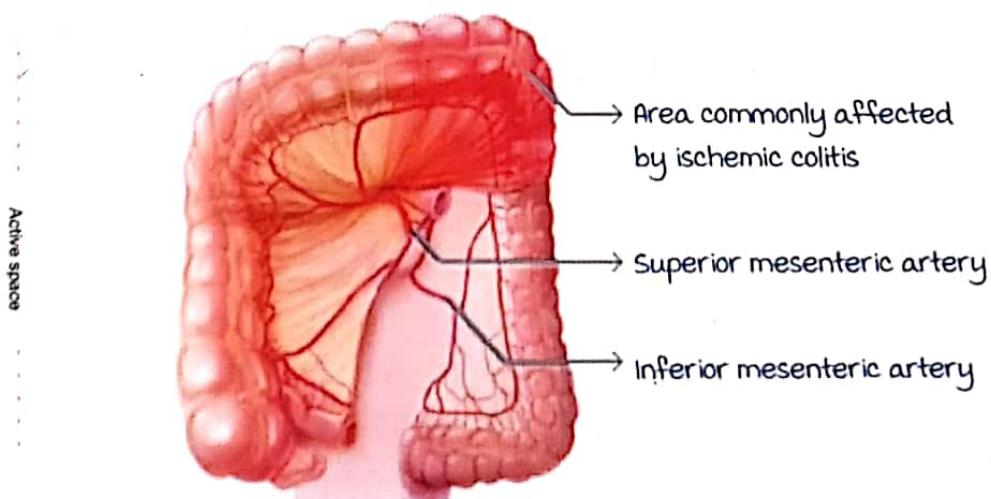
Watershed area:

**Splenic flexure** is the watershed area.

Above the splenic flexure is supplied by SMA.

Below the splenic flexure is supplied by IMA.

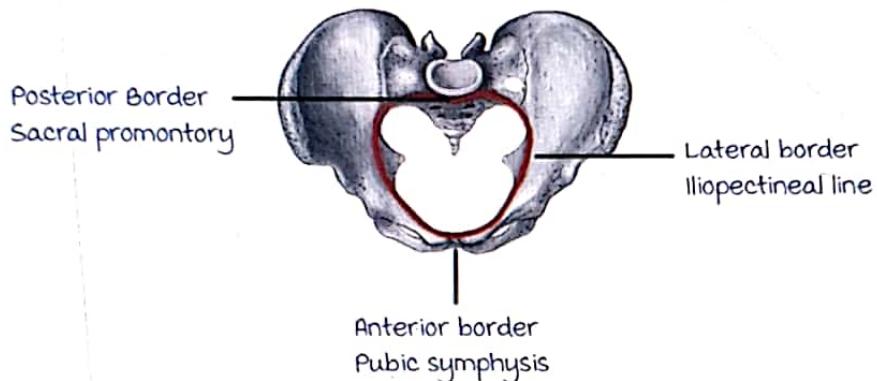
Ischemic colitis is mc seen in left colonic flexure called the Griffith



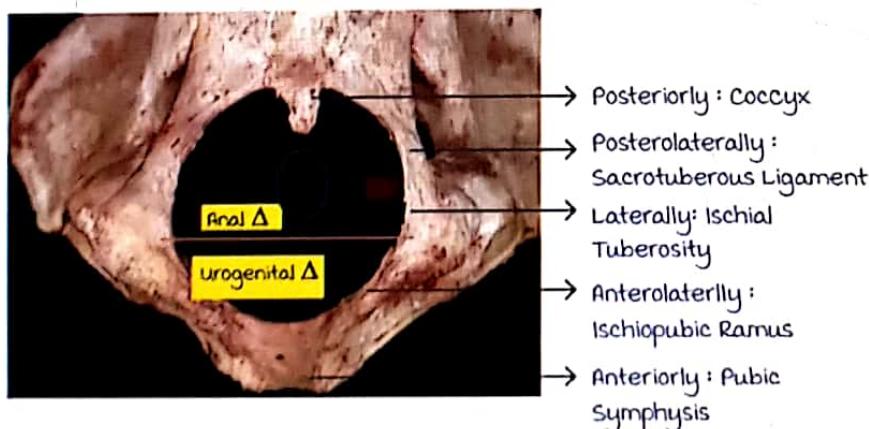
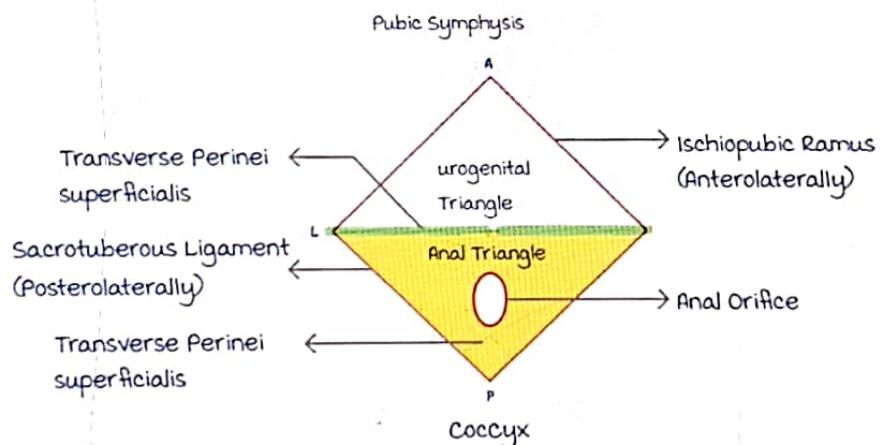
# PELVIS AND PERINEUM

## Boundaries of Pelvic inlet

00:00:03



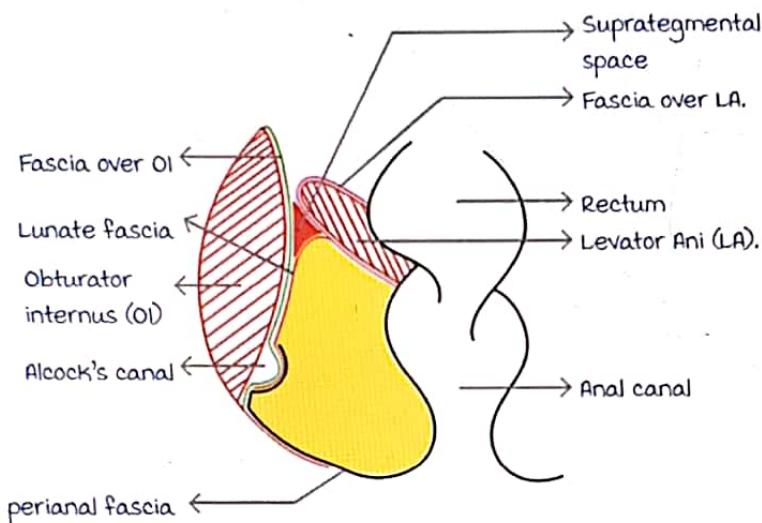
## Boundaries of Pelvic Outlet : (perineum)



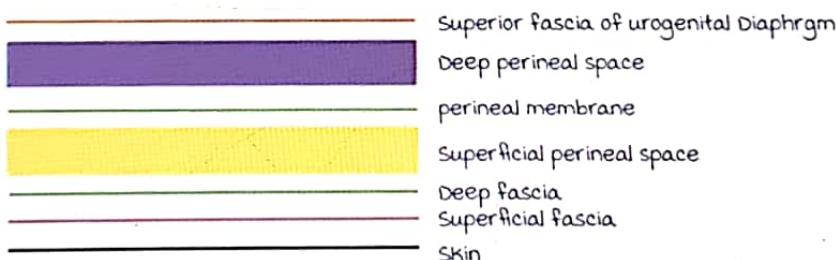
Active space

Ischioanal Space/ Ischiorectal fossa

00:04:50

**Boundaries :**

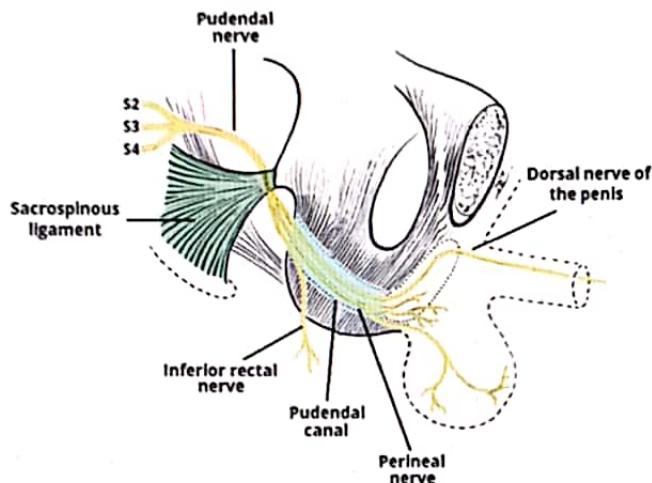
- Anteriorly: Transverse Perinei superficialis
- Posteriorly: Sacrotuberous ligament



- medially: Levator Ani muscle
- Laterally :
  - Obturator internus muscle
  - Fascia over obturator internus muscle
  - Alcock's canal

**Alcock's canal :**

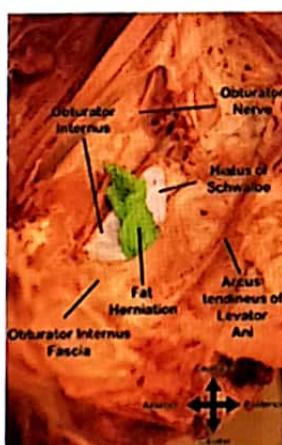
1. Other name is Pudendal canal
2. Lateral wall of Ischiorectal fossa
3. 2.5 cm above Ischial tuberosity
4. Formed by the splitting of the fascia over obturator internus, lunate, perineal fascia.



5. Extends from lesser sciatic foramen upto deep peroneal pouch
6. Contents of pudendal canal:
  - a. Pudendal nerve: gives two branches in the pudendal canal
    - i. Perineal nerve
    - ii. Dorsal nerve of penis
  - b. Internal pudendal artery
  - c. Internal pudendal vein
- Supraregional space: above lunate fascia.

#### Hiatus of Schwalbe :

- Gap between levator Ani muscle and obturator internus muscle



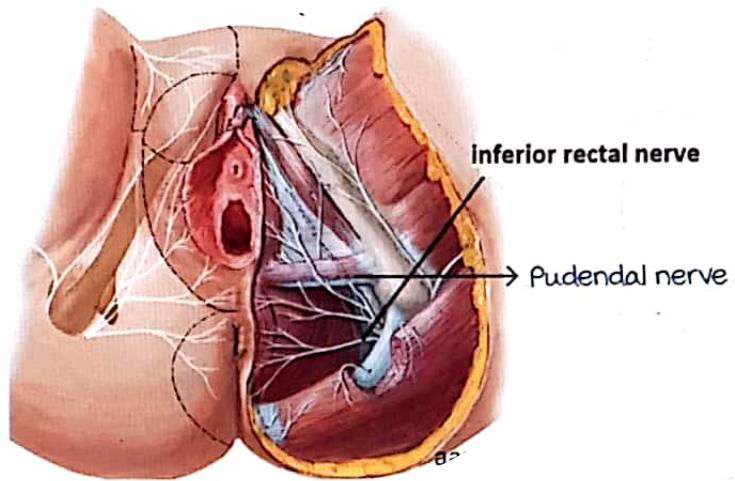
#### Contents :

1. Inferior rectal nerve/ inferior rectal artery
2. Pudendal nerve
3. Dorsal nerve of penis (in male)/ clitoris (in female)
4. Perineal nerve
5. Internal pudendal artery
6. Internal pudendal vein

Active

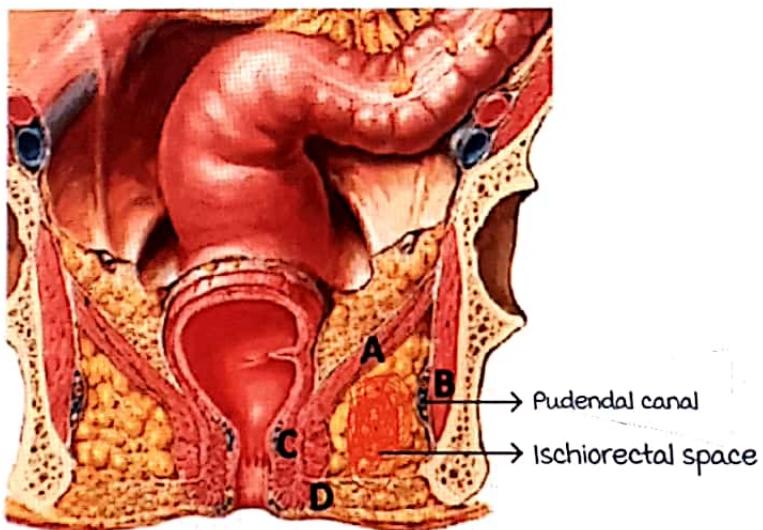
## 7. Posterior scrotal vessels/nerves

## 8. Fat



Note: Shape (horseshoe shaped)

Ischiorectal fossa communicates with other side behind the rectum and the anal canal



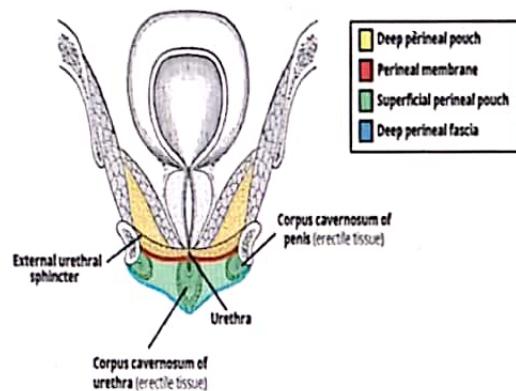
A. Levator ani muscle

B. Obturator internus

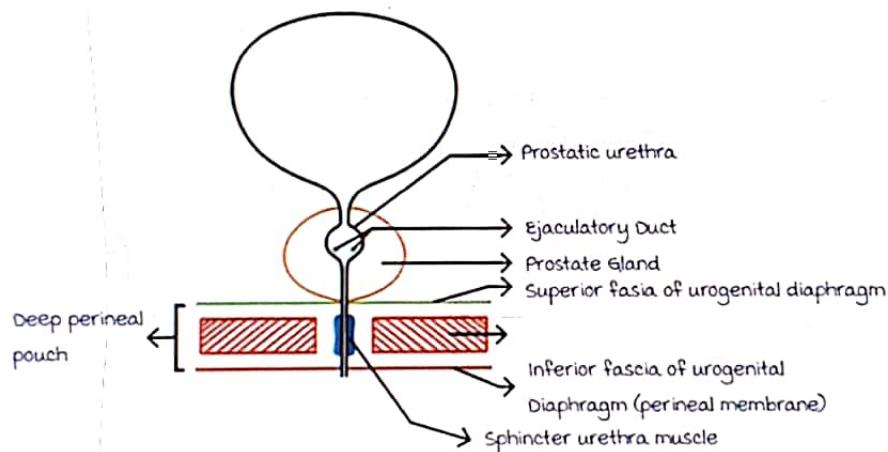
C. Internal anal sphincter

D. External anal sphincter

## Urogenital triangle

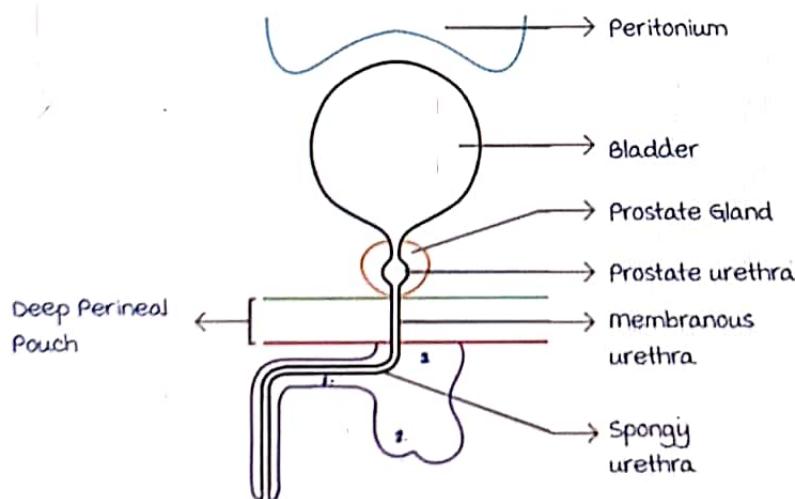


Layers :



Superficial perineal space communicates with anterior abdominal wall in front side

Deep perineal space :



- Sphincter urethra muscle:
  - Helps to hold the urine
  - Control micturition
  - Skeletal muscle
  - Nerve supply: Pudendal nerve
  - Damage to the external sphincter urethra result in incontinence of urine
- Internal urethral sphincter:
  - At bladder neck
  - Prevent retrograde ejaculation of semen
  - Smooth muscle
  - Nerve supply: autonomic
  - Damaged in TURP procedure (procedure for BPH)

MC complication of TURP: retrograde ejaculation of semen

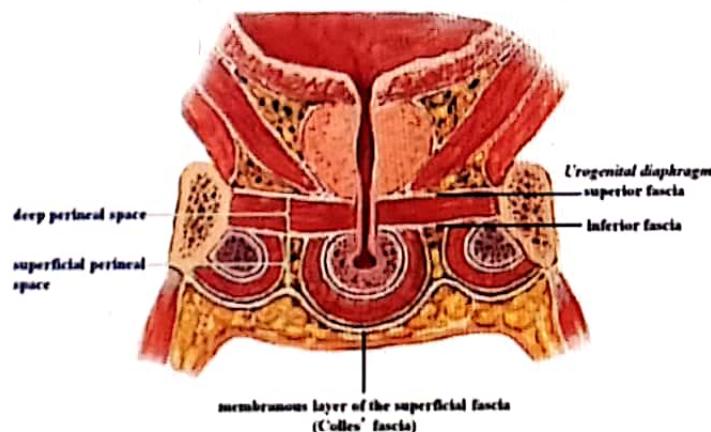
Internal urethral sphincter	External urethral sphincter
Smooth muscle	Skeletal muscle
ANS	Somatic
If damaged: retrograde ejaculation of semen	If damaged: incontinence of urine

### Urogenital Diaphragm [UGD]

00:37:00

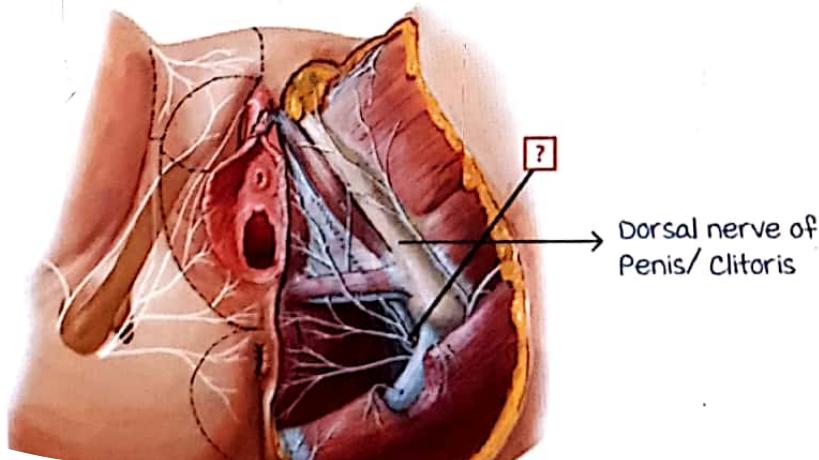
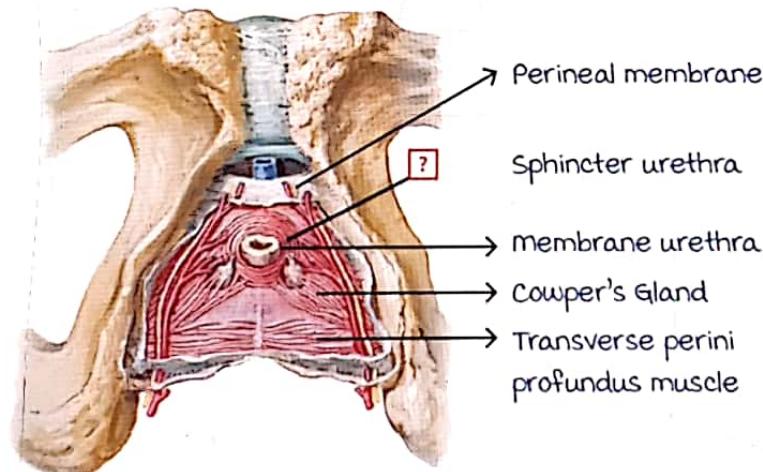
- Formed by muscles and fascia of deep pouch
- muscles :
  - Transverse perinei profundus
  - Sphincter urethra
- Fascia :
  - Superior fascia of UGD (above)
  - Perineal membrane (below)

Active space



- Contents :
- muscle :
  - Transverse perinei profundus
  - Sphincter urethra
- Nerve: Dorsal nerve of penis (in male)/clitoris (in female)
- Vessel: Internal pudendal artery (three terminal branches)
  - Dorsal artery of penis (in male)/clitoris (in female)
  - Artery to bulb of penis (in male)/clitoris (in female)
  - Deep artery of penis (in male)/clitoris (in female)
- Other contents :
  - a. male :
    - membranous urethra
    - bulbourethral glands (**Couper's gland**)
  - b. Female :
    - Vagina
    - Urethra

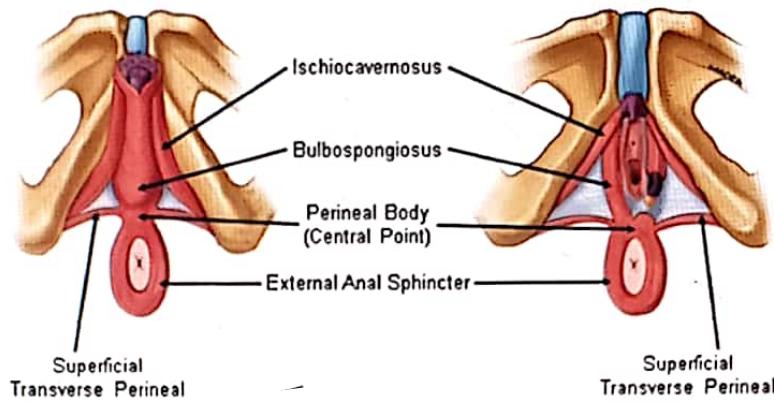
Male: Inferior view



Active space

Superficial perineal space

00:44:00

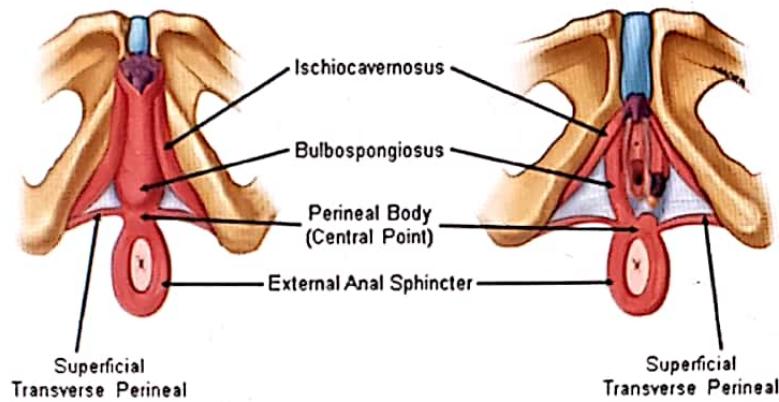


## Contents :

1. muscles :
  - a. Ischiocavernosus
  - b. Bulbospongiosus
  - c. Superficial transverse perineal [STP]
2. Artery :
  - a. Posterior scrotal vessel (male) / posterior labial vessel (fe male)
  - b. Internal pudendal artery and its terminal branches
3. Nerves:
  - a. Posterior scrotal nerve (male) / posterior labial nerve (fe male)
4. Other :
  - a. In males:
    - i. Spongy urethra
    - ii. Ducts of Cowper's gland
    - iii. Root of penis (crux of penis + bulb of penis)
  - b. In female:
    - i. Vagina
    - ii. Urethra
    - iii. Greater vestibular gland (Bartholin gland)

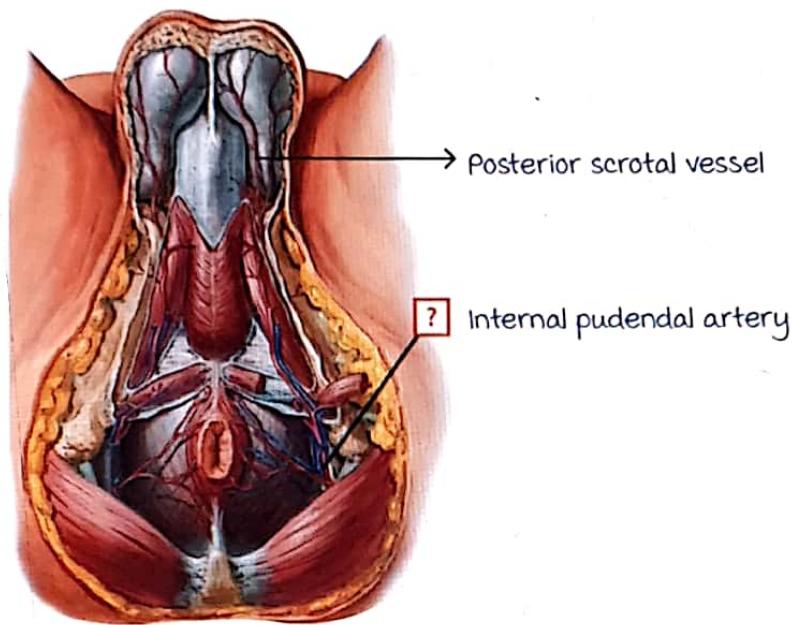
Superficial perineal space

00:44:00



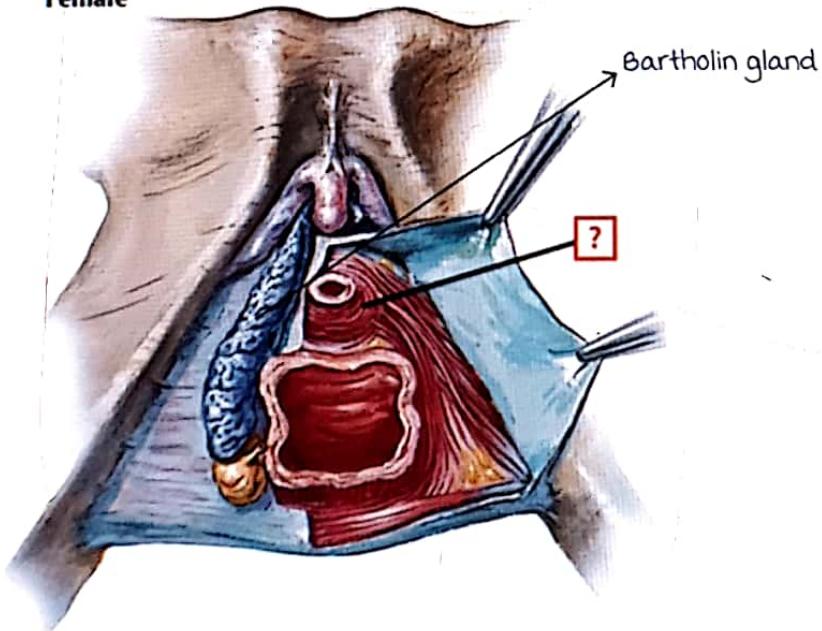
## Contents :

1. muscles :
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    - iii. Root of penis (crux of penis + bulb of penis)
  - b. In female:
    - i. Vagina
    - ii. Urethra
    - iii. Greater vestibular gland (Bartholin gland)



1. Bulbospongiosus
2. ischiocavernosus
3. Superficial transverse perineal

**Female**

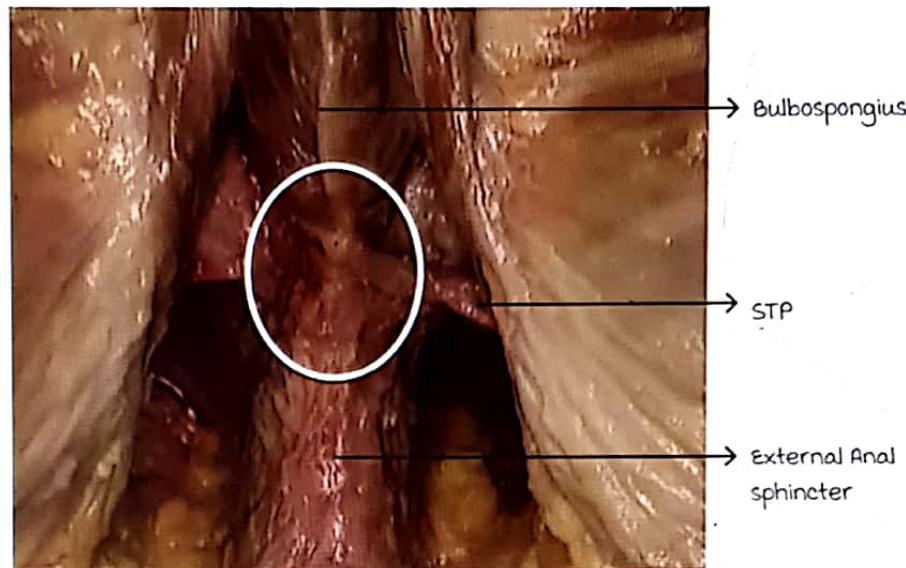


Active space

Bartholin duct opens into the posterolateral part of vagina  
(lateral wall > posterior wall)

## Deep perineal space

00:53:00



- Fibro muscular structure between urogenital orifice and anal orifice
- Support to the pelvic organs by receiving muscles in various stratum
- 3 stratum :
  - Superficial: Bulbospongiosus, STP, external anal sphincter
  - Intermediate: Transverse perinei profundus, deep part of external anal sphincter
  - Deep: pubococcygeus part of levator ani [LA] muscle
- Ischiocavernosus muscle is **not** meeting at the perineal body

## Urethral Rupture

00:59:00

Spongy urethral rupture :

Extravasation of urine :

1. Penis
2. Scrotum
3. Superficial perineal pouch
4. Anterior abdominal wall

No Extravasation to :

1. Thigh- due to fascia lata
2. Ischiorectal fossa- due to Colles fascia
3. Deep pouch- due to perineal membrane

membranous urethral rupture:

Extravasation of urine:

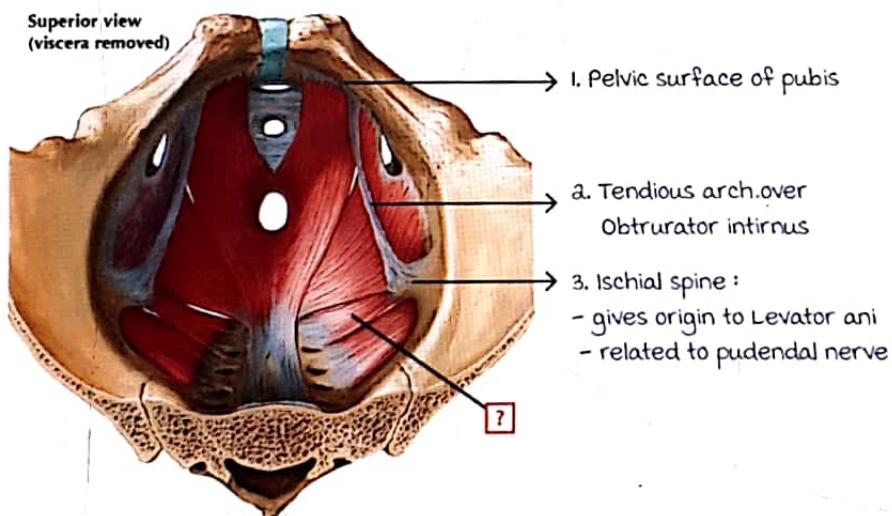
1. Deep peroneal pouch
2. Space of Retzius
  - If peroneal membrane ruptured then urine goes to superficial peroneal pouch
  - Only in the case of bladder rupture, the urine extravast to peritoneal cavity

Buck fascia:

- deep fascia of penis
- if intact, hematoma is confined only to shaft of penis

## Pelvic Diaphragm

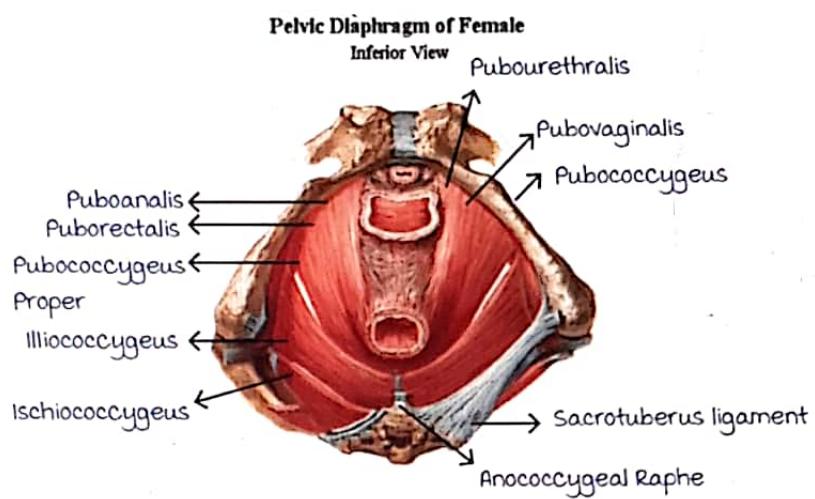
01:09:00



- muscular partition covering the pelvic outlet
- Two Components :
  - Levator ani muscle: Pubococcygeus + iliococcygeus
  - Ischiococcygeus muscle
- 1, 2, 3 give origin to levator ani muscle

Active space

## Subtypes of Pubococcygeus:



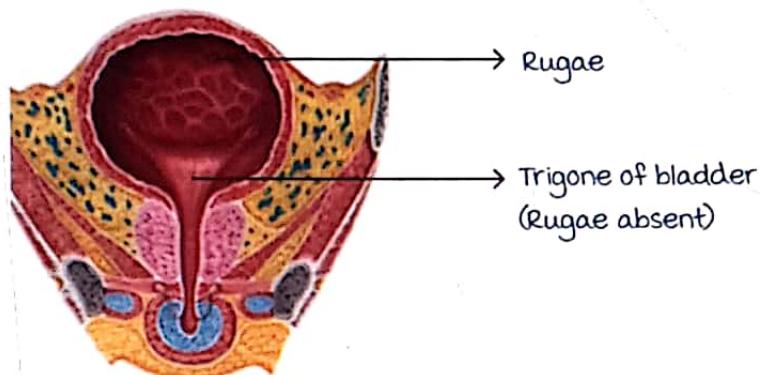
- Pubococcygeus proper inserted to coccyx and anococcygeal raphe
- Puborectalis behind rectum continues with opposite side and forms Puborectalis sling
- Puboanalis blends with anal canal
- Pubovaginalis inserted to perineal body, narrow the vaginal hiatus and prevent prolapse

In male: Puboprostaticus is present instead of pubo vaginalis

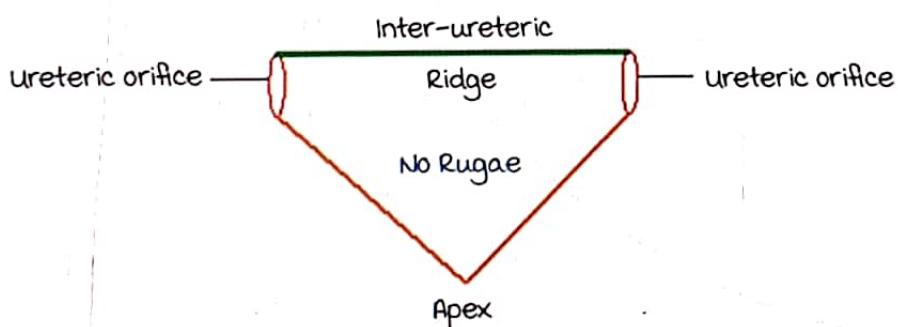
Nerve supply: S3, S4

## PROSTATIC URETHRA AND PROSTATE

### Anatomy of Bladder



- Bladder Trigone
  - Triangular area inside the bladder.
  - No rugae because submucosa is absent.
  - mucosa adherent to underlying detrusor muscle.
  - Bladder : Endodermal origin.
  - Trigone : mesodermal origin.



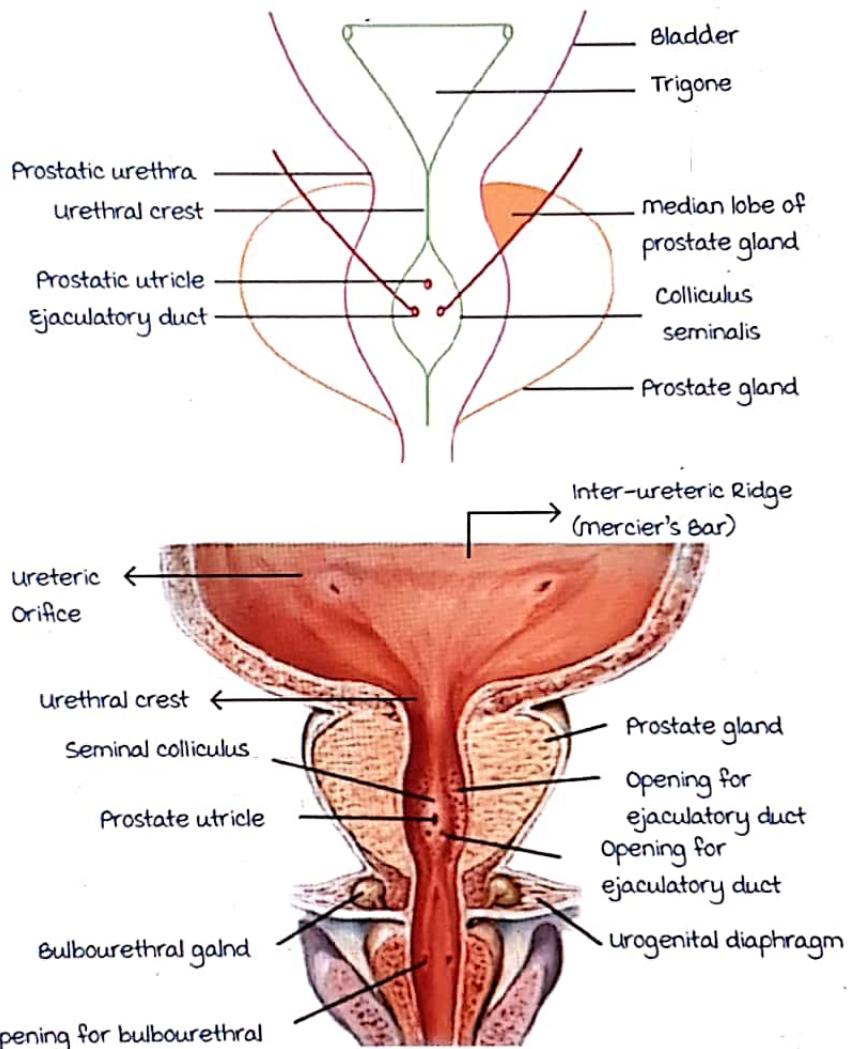
- urethral crest
  - Small elevation due to **trigone of bladder**. (AIIMS)
- Colliculus seminalis (Verumontanum)
  - urethral crest expands to form colliculus seminalis.

Has **3 openings** : (NEET)

- 2 Ejaculatory ducts
  - Each formed by Vas deferens + Seminal vesicle.

Derived from **mesonephric duct**.

- Prostatic utricle  
Forms a cul-de-sac.  
Remnant of paramesonephric duct in male.



### Anatomy of Prostate Gland

00:07:07

median lobe of Prostate gland

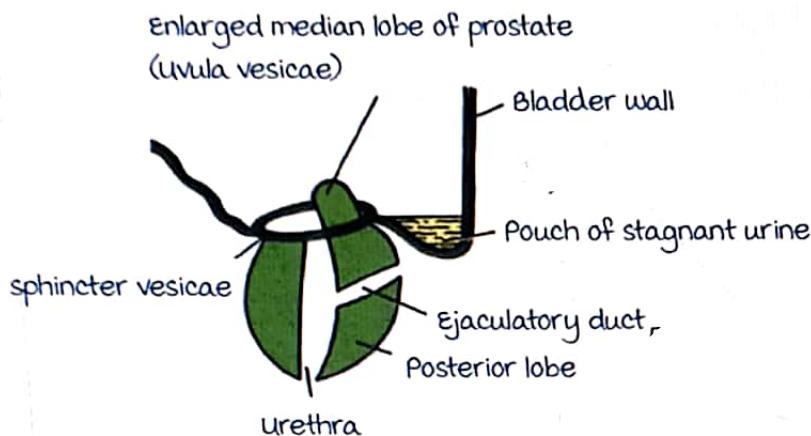
Boundaries :

- Anterior: Prostatic urethra.
- Posterior: Ejaculatory
- Base: Extends into bladder to form uvula vesicae.

Active slide

**Uvula Vesicae**

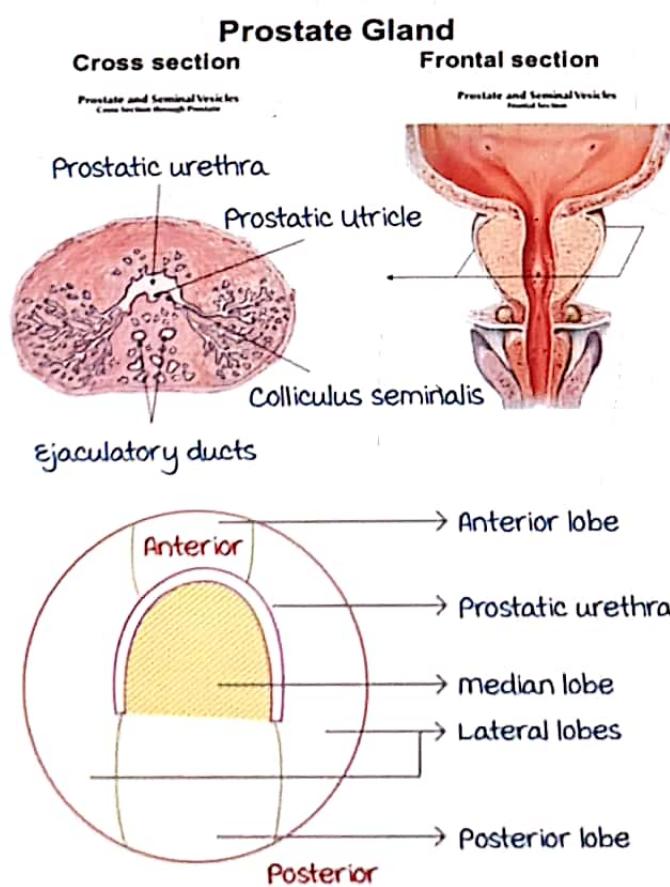
- Base of median lobe extends into bladder. (2019 NEET)
- Forms tongue like projection.
- Uvula vesicae enlarges in BPH – stagnation of urine.



## Lobes of the prostate gland

00:10:23

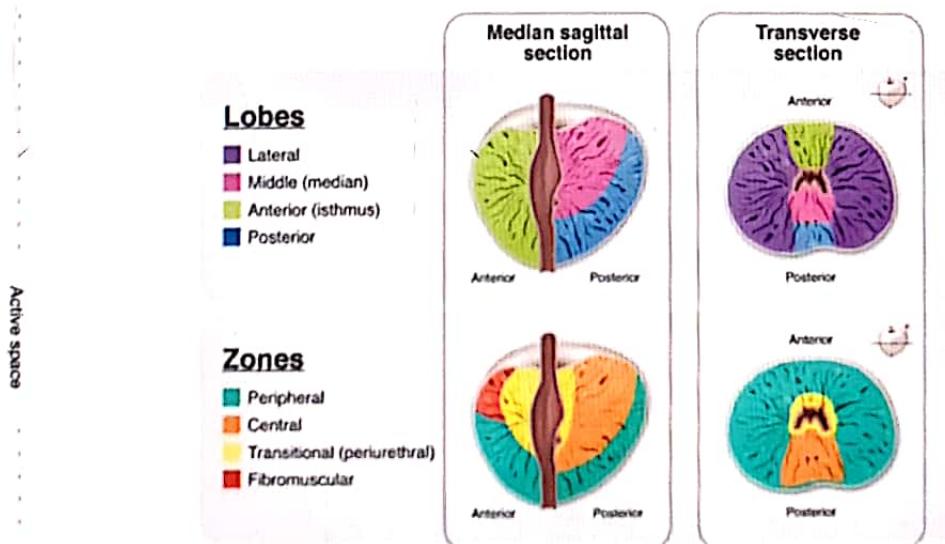
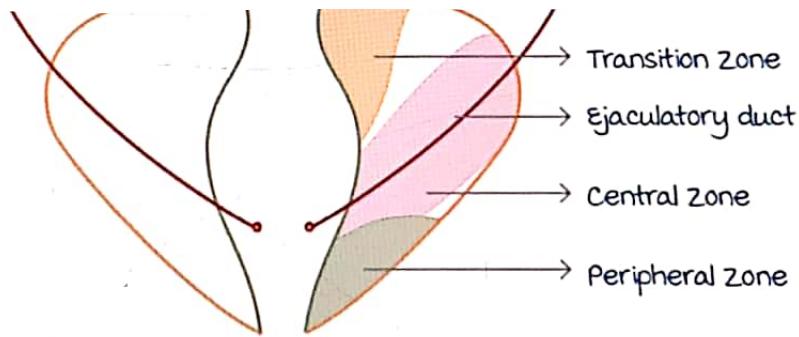
- median lobe  
Lies behind crescent shaped prostatic urethra.
- 2 Lateral lobes  
Lie on either side of prostatic urethra.
- Posterior lobe  
Both lateral lobes continue behind median lobe as posterior lobe.
- Anterior lobe  
Both lateral lobes continue in front of prostatic urethra as anterior lobe.  
*Does not contain any glandular part.*  
Thus, it is also known as Isthmus.



## Zones of Prostate Gland

00:13:12

- Transition zone:  
Surrounds proximal part of prostatic urethra.  
Benign Prostatic Hyperplasia (BPH) is more common in transition zone.
- Central Zone:  
Surrounds ejaculatory duct.  
Carcinoma (< 2%) is highly invasive – involves the ductal system (ejaculatory duct, seminal vesicle, vas deferens, epididymis).
- Peripheral Zone:  
Surrounds distal part of prostatic urethra.  
Carcinoma of prostate is most commonly seen in peripheral zone (80 – 85%).  
Asymptomatic initially.  
In advanced stages, it compresses the prostatic urethra, giving rise to obstructive symptoms.



## Blood Supply of Prostate Gland

00:13:12

Mnemonic: Mr. X, admitted as In-patient, is receiving IV.

Middle Rectal artery.

Internal Pudendal artery.

Inferior Vesicle artery.

Counterpart of prostate gland in females: Paraurethral glands of Skene.

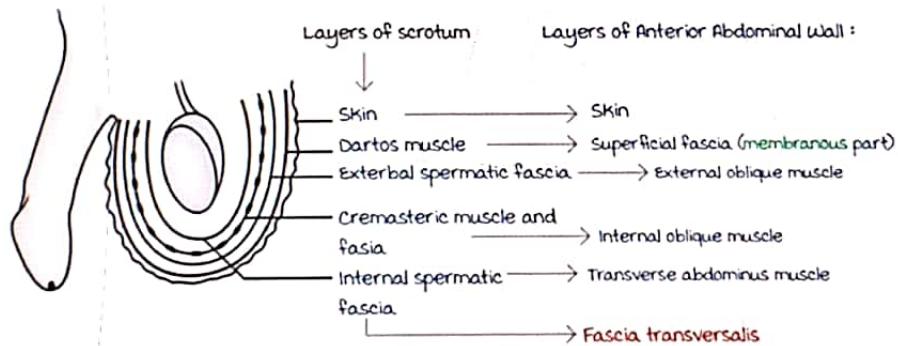
## Layers of Scrotum

00:25:15

Derived from layers of abdominal wall.

Dartos muscle is a subcutaneous muscle.

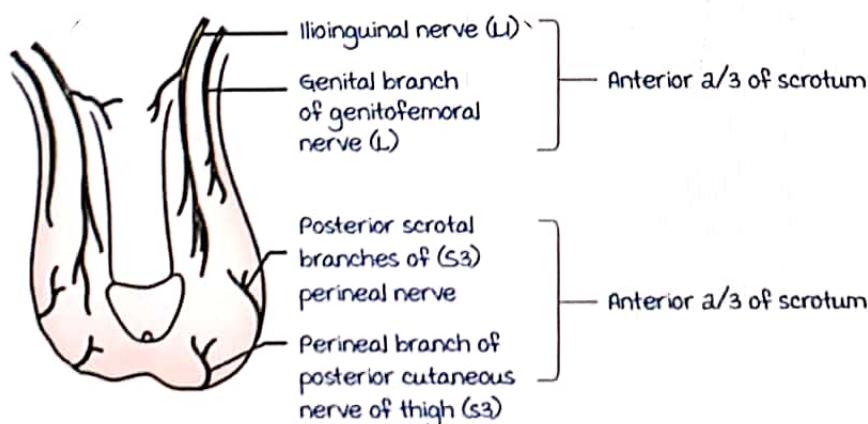
Transverse abdominis muscle does not contribute to the layers of scrotum.



**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

## Nerve Supply of Scrotum

00:22:33

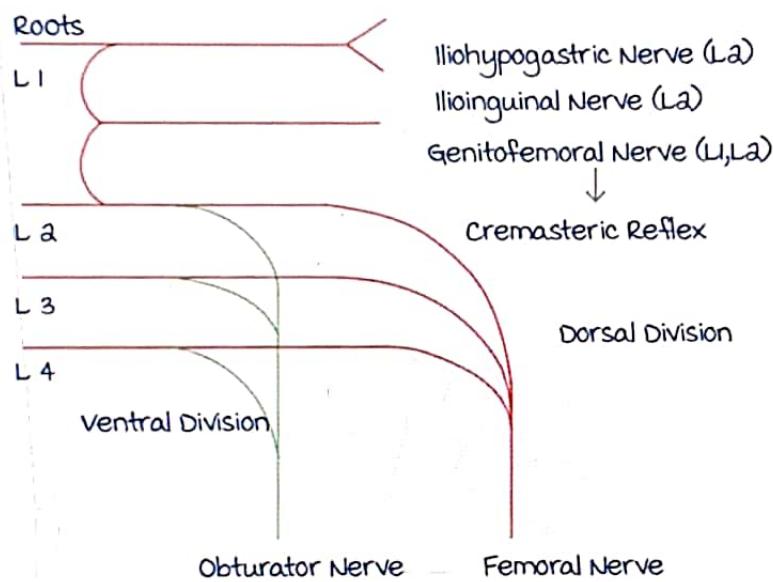


# LUMBAR PLEXUS AND CUTANEOUS INNERVATION

## Lumbar plexus

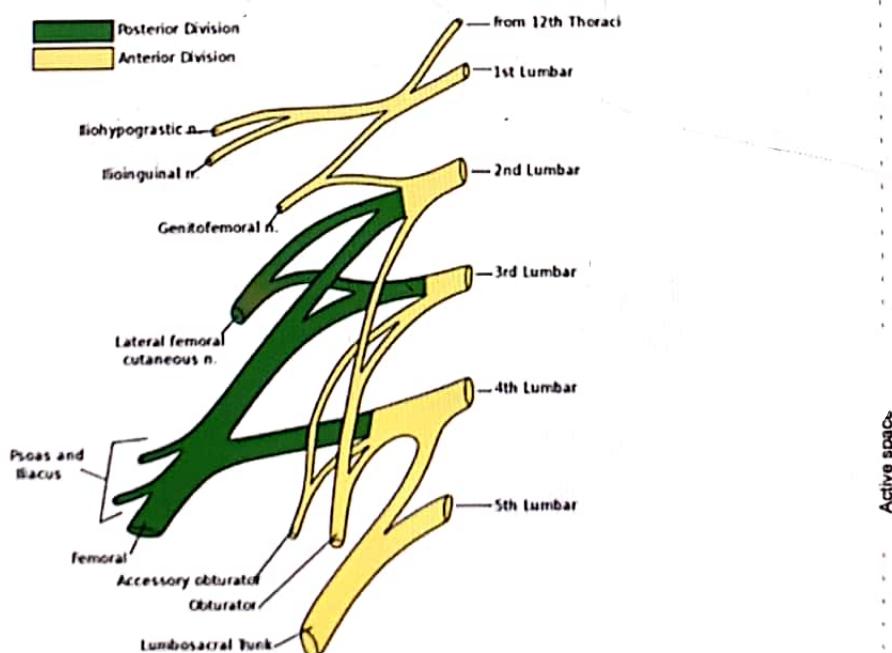
00:00:26

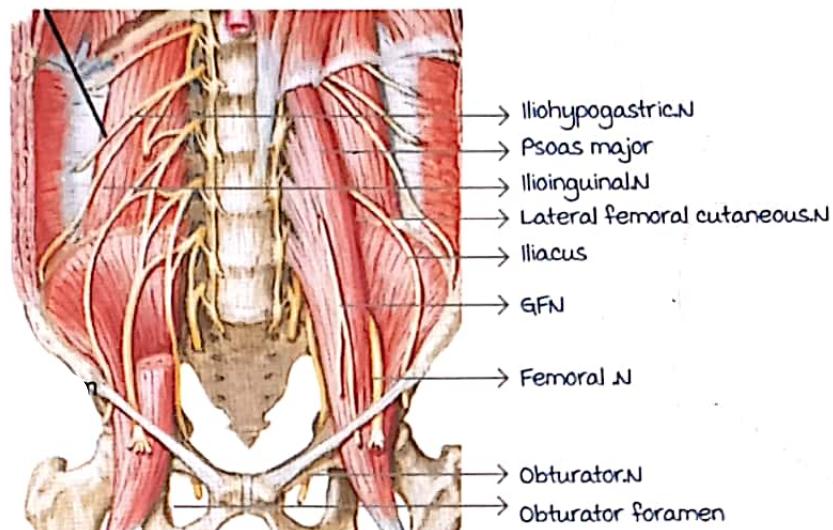
Lumbar plexus is formed by L1, L2, L3, L4.



L4 + L5 forms lumbosacral trunk that is involved in sacral plexus.

L4 is involved in both lumbar and sacral plexus - nervus furcalis (2018 JIPMER).





GFN (genitofemoral nerve)  
 ↓  
 The lateral femoral cutaneous nerve  
 ↓  
 Passes behind the inguinal ligament  
 ↓  
 Supplies the lateral aspect of the thigh

meralgia paresthesia - if the lateral femoral cutaneous nerve is irritated

↓  
 Causes loss of sensation over lateral aspect of the thigh.

Active space



## Cutaneous innervation of the lower limb

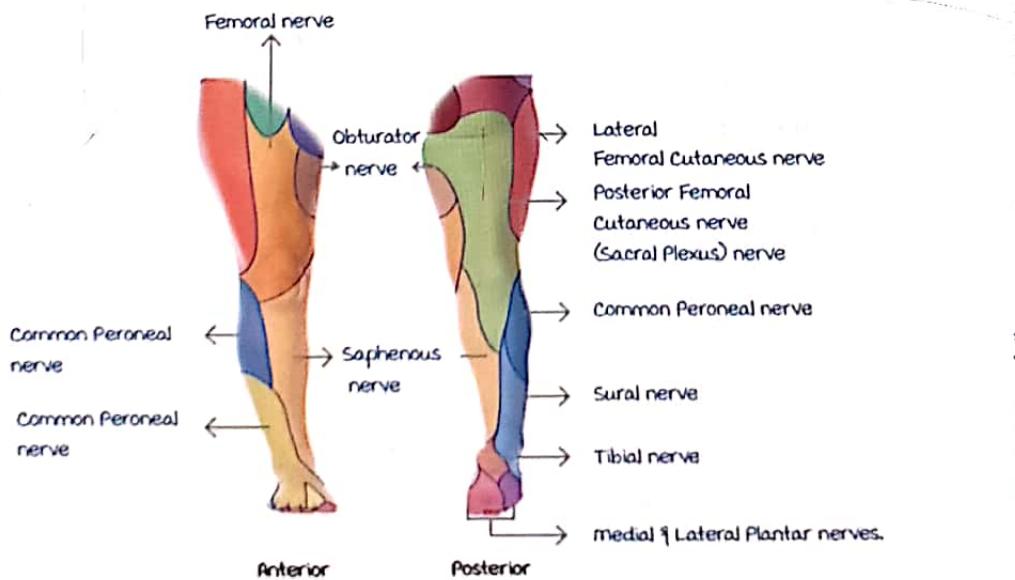
00:11:30

Thigh:

- Lateral aspect of the thigh - lateral femoral cutaneous nerve.
- Anterior aspect of the thigh - femoral nerve, medial aspect of the thigh - obturator nerve.
- major part of posterior thigh - posterior femoral cutaneous nerve (branch from sacral plexus).

Leg:

- medial aspect of the leg - saphenous nerve (branch of femoral nerve).
  - ↓  
It is the longest cutaneous nerve
- Lateral aspect of the leg - common peroneal nerve (CPN)
- Lower part of the lateral aspect of the leg - superficial peroneal nerve
  - ↓  
It supplies entire dorsum of the foot except 1st web space.
- The 1st web space is supplied by deep peroneal nerve
- The superficial and deep peroneal nerve are the branches of CPN
- Lateral aspect of the upper part of leg - CPN
- Lower part of the lateral aspect of leg - sural nerve
- The heel is supplied by tibial nerve.
- The sole is supplied by medial & lateral plantar nerve.



The posterior femoral cutaneous nerve supplies :

- Posterior aspect of the thigh
- Buttock region
- Scrotum
- upper part of popliteal fossa.

## FRONT OF THIGH AND ADDUCTOR COMPARTMENT

### Compartments of thigh

00:00:05

Flexor compartment – supplied by femoral nerve.

Extensor compartment – supplied by obturator nerve.

Adductor compartment – supplied by tibial component of sciatic nerve.

Pectenous muscle :

Hybrid muscle (present in two compartments).

Supplied by obturator nerve and femoral nerve.

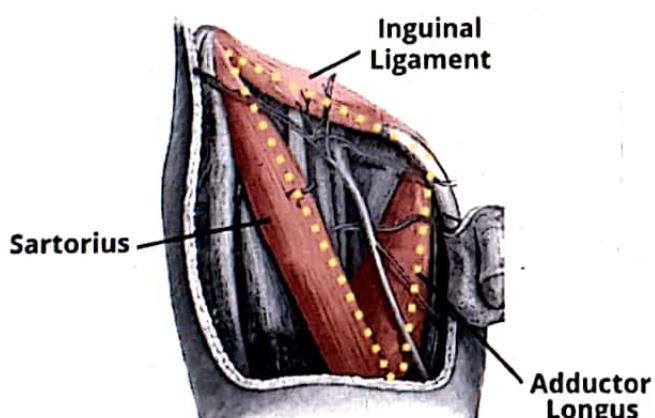
Adductor magnus muscle :

Hybrid muscle.

Supplied by obturator nerve and tibial component of sciatic nerve.

### Femoral triangle

00:03:45



Boundaries of femoral triangle :

medially – medial border of adductor longus.

Laterally – medial wall of sartorius muscle.

Base – inguinal ligament.

Active space

Contents of femoral triangle :

Femoral artery.

Femoral branch of genitofemoral nerve.

Femoral vein (with great saphenous vein).

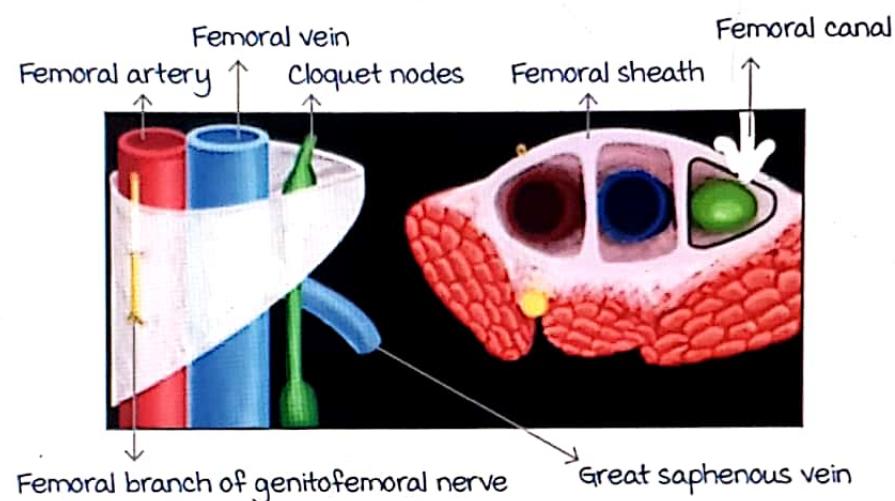
Femoral canal (containing Cloquet nodes – deep inguinal lymph nodes).

Femoral sheath :

Fascia over the proximal part of femoral vessel.

Anteriorly formed by – fascia transversalis.

Posteriorly formed by – fascia iliaca.



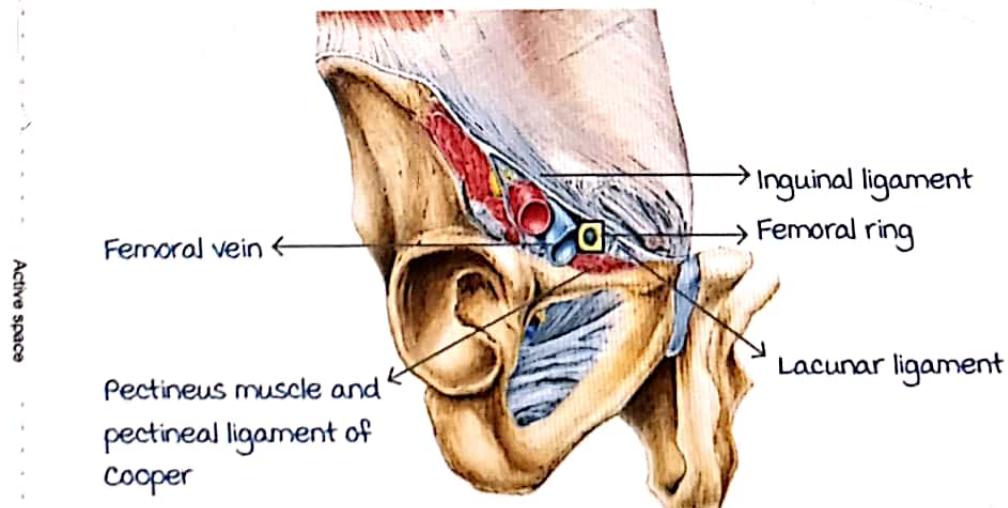
Femoral ring :

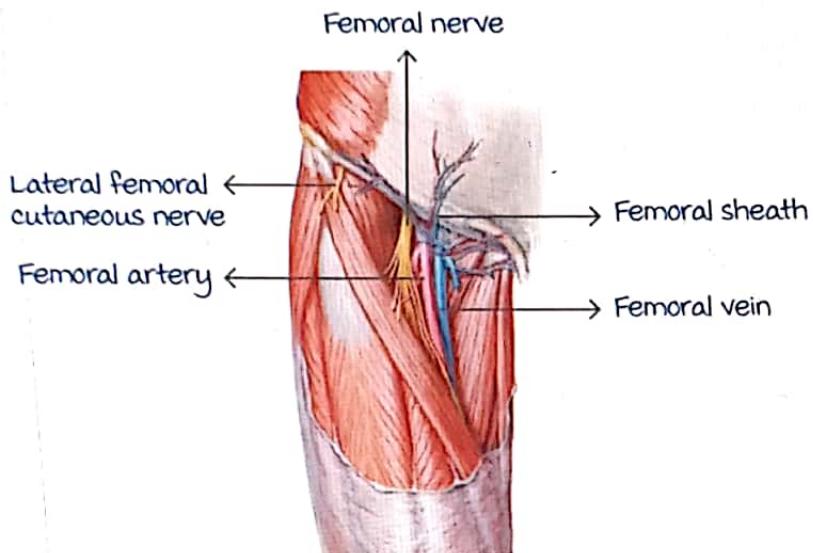
Anterior boundary – inguinal ligament.

Posterior boundary – pecten muscle and pecten ligament of Cooper.

medial boundary – lacunar ligament.

Lateral boundary – femoral vein.





Femoral nerve is **not** a content of femoral sheath, it is situated lateral to the femoral sheath.

### Floor of femoral triangle

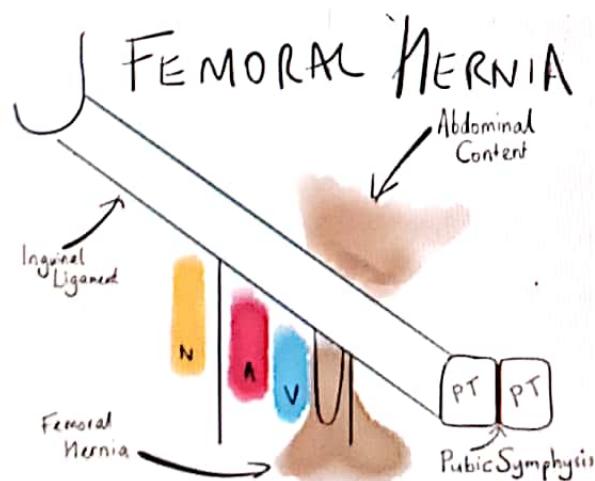
00:14:55

- From med. To lat. Side
- 1. Adductor longus
- 2. Pectenius
- 3. Psoas major
- 4. Iliacus



Landmark for femoral hernia.

Femoral hernia - Below and lateral to the pubic tubercle.



Active space

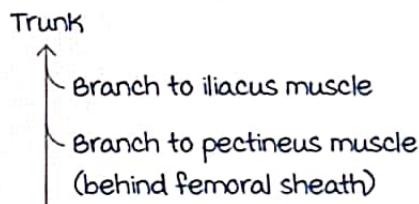
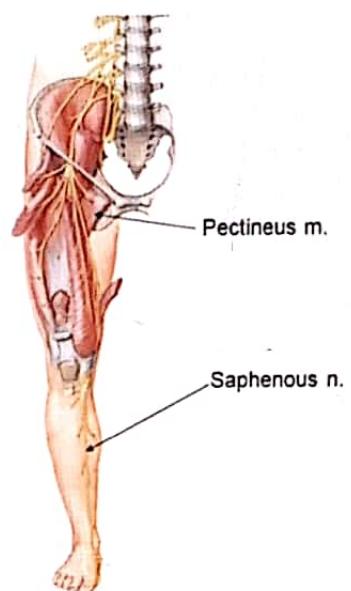
## Femoral nerve

00:16:51

It's a mixed nerve.

**Root value** - dorsal division of L2, L3, L4.

**Not** a content of femoral sheath.



- 2 cutaneous branches : medial femoral cutaneous nerve. Intermediate femoral cutaneous nerve. and,
- 1 motor branch to sartorius muscle.

Anterior and the posterior division of femoral nerve is divided by lateral circumflex femoral artery.

- 1 cutaneous branch : Saphenous nerve. and,
- 1 motor branch to quadriceps femoris muscle.

## Obturator nerve

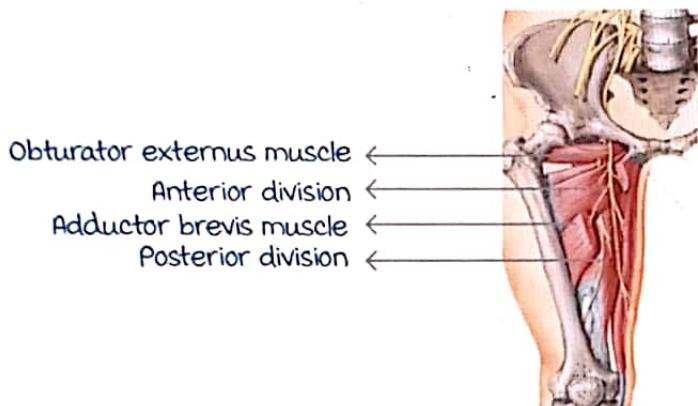
00:22:29

Active space

It's a mixed nerve.

**Root value** - ventral division of L2, L3, L4.

Divided into anterior and posterior divisions.



Anterior division of obturator nerve :

Course - Passes anterior to obturator externus and adductor brevis muscles.

Supplies - Pectenius, gracilis, adductor longus and adductor brevis muscles.

Close to obturator foramen it provides supply to hip joint and femoral artery.

Has 4 types of branches - muscular, articular, vascular and cutaneous.

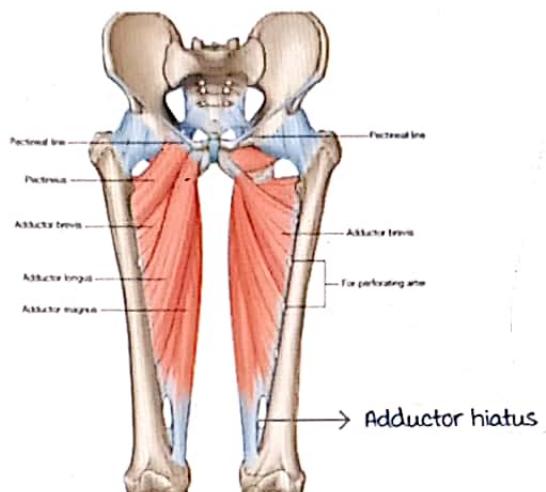
Fate - at the lower border of adductor magnus muscle, it joins with saphenous nerve and medial femoral cutaneous nerve to form **sub-sartorial plexus** and supplies medial aspect of thigh.

Posterior division of obturator nerve :

Course - Passes posterior to obturator externus and adductor brevis muscles.

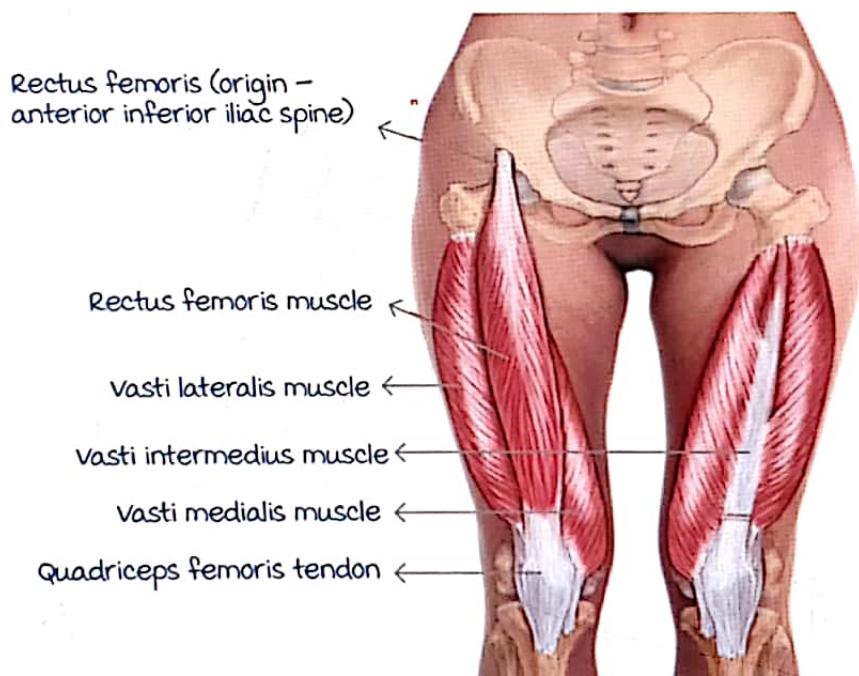
Supplies - adductor magnus, obturator externus, and adductor brevis (if not supplied by anterior division).

Has 3 types of branches - muscular, articular and vascular.



## Quadriceps femoris

00:31:12



**Rectus femoris muscle :**

Origin - anterior inferior iliac spine.

Action - flexion of hip, extension of knee.

**Vasti muscles (v.lateralis, v.intermedius, v.medialis):**

Origin - femur.

Action - knee extension, **no action at hip joint**.

Active space

**Quadriceps femoris tendon :**

Formed by 3 vasti muscles + rectus femoris muscle joining at the patella.

Action - extension of knee joint (**locking of knee joint**).

## Sartorius muscle (tailor's muscle)

00:37:08

Origin – anterior superior iliac spine.

Course –

Forms lateral wall of femoral triangle



Roof of adductor canal



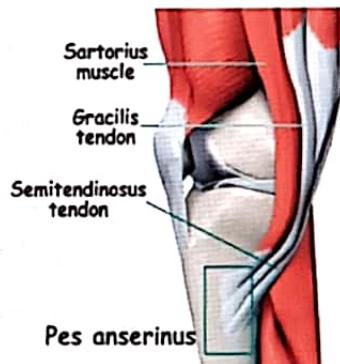
medial side of the knee



Attaches to medial surface of tibia forming pes anserinus



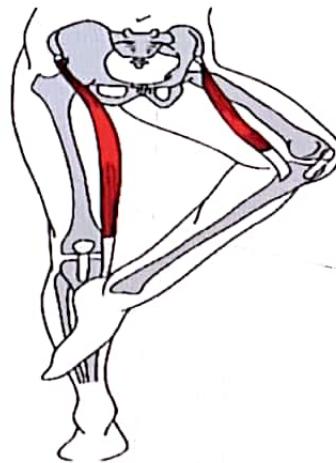
Pes anserinus – formed by sartorius muscle + gracilis tendon + semitendinosus tendon.



Action –

At level of hip joint – flexion of hip, adduction, and lateral rotation.

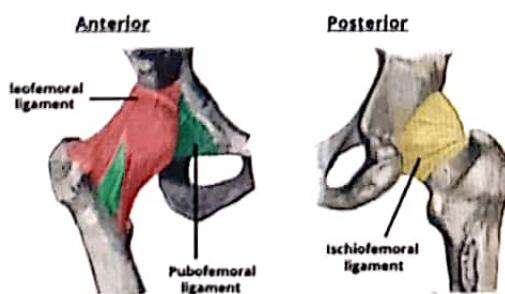
At level of knee joint – medial rotation and flexion.



## Ligaments of hip joint

00:42:31

Active space



**Ileofemoral ligament**

Also Known as **ligament of Bigelow**.

Origin – anterior inferior iliac spine.

Shape – inverted 'Y' shaped.

Insertion/attachment – intertrochanteric line.

Function – prevents hyperextension of hip joint.

**Ischiofemoral ligament**

Location – posterior part of capsule.

Function – assists ileofemoral ligament in its action.

**Pubofemoral ligament**

Origin – pubic crest and superior ramus of pubis.

Insertion/attachment – blends with the capsule.

Function – prevents hyperabduction.

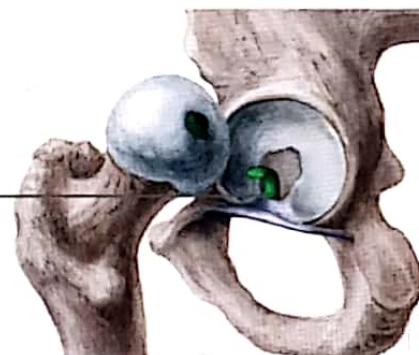
**Ligament of head of femur**

Function – **doesn't** gives support

to the hip joint.

- Conveying of blood vessels.

Ligament of head of femur ←

**Adductor canal**

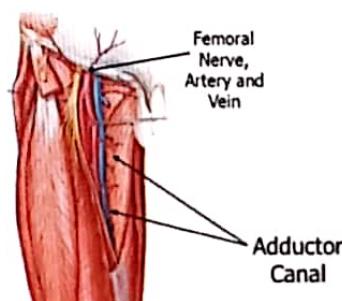
00:47:49

**Boundaries:**

**Roof** – sartorius muscle.

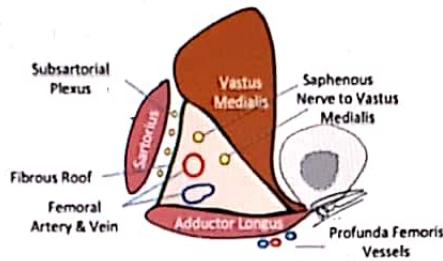
**Posterioromedially** – adductor longus and adductor magnus muscles.

**Anterolaterally** – vastus medialis muscle.



Contents :

- Femoral artery.
- Femoral vein.
- Nerve to vastus medialis.
- Saphenous nerve.



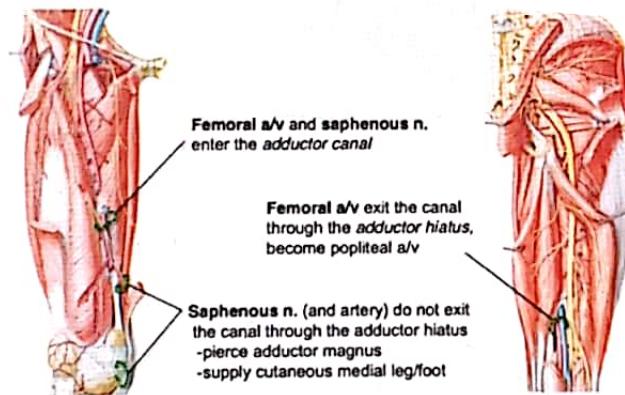
**NOTE :** femoral vein is situated **behind** the femoral artery in the adductor canal.

### Adductor hiatus

00:51:44

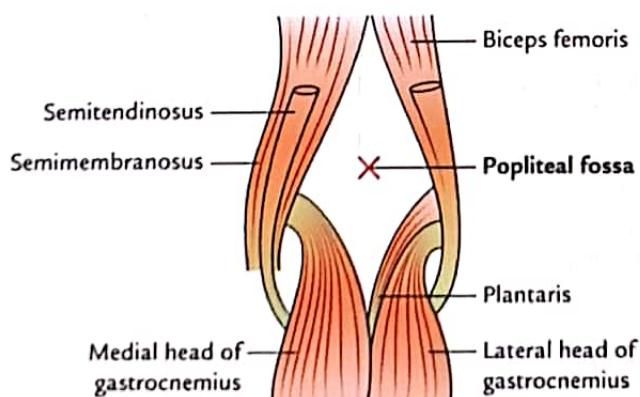
Adductor hiatus is present in the tendon of adductor magnus muscle.

Structures passing through adductor hiatus – femoral artery and vein, and posterior division of obturator nerve.



### Popliteal fossa

00:53:35



Active space

Boundaries :

Superomedially – semitendinosus and semimembranosus muscles.

Superolaterally - biceps femoris muscle.

Inferomedially - medial head of gastrocnemius muscle.

Inferolaterally - plantaris and lateral head of gastrocnemius muscle.

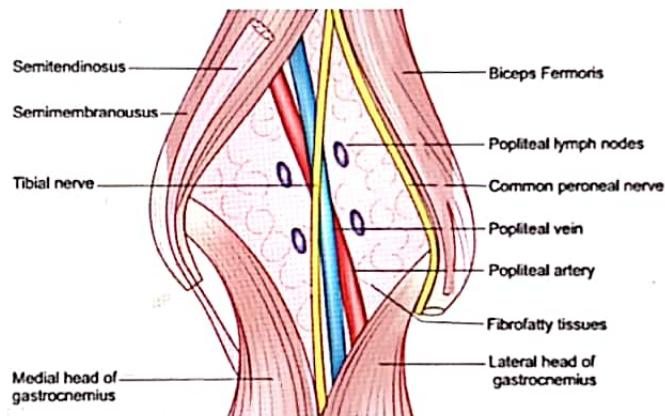
Arrangement of structures in popliteal fossa (medial to lateral):

In the proximal part

Popliteal artery → Popliteal vein → Tibial nerve

In the distal part

Tibial nerve → Popliteal vein → Popliteal artery



Contents of popliteal fossa:

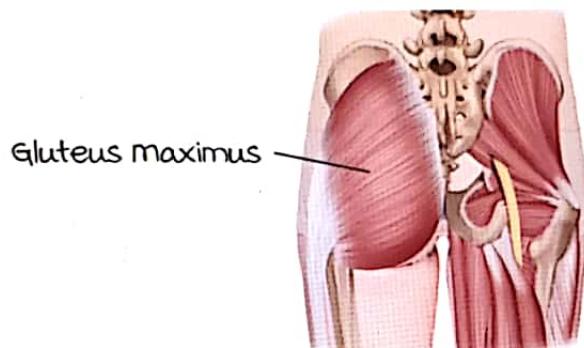
- Popliteal artery.
- Popliteal vein.
- Small saphenous vein.
- Tibial nerve.
- Common peroneal nerve.
- Popliteal nodes.
- medial and lateral sural cutaneous nerves.
- Posterior division of obturator nerve.
- Fat.

# GLUTEAL REGION & HAMSTRING MUSCLES

## Muscles

00:00:11

Gluteus maximus :



Origin :

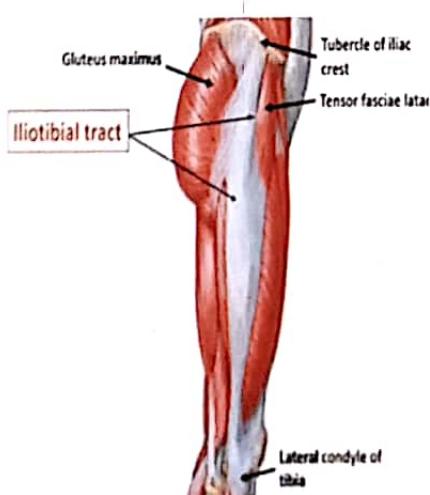
- Ilium Bone
- Sacrum
- Coccyx
- Sacrotuberous Ligament

Insertion :

- $\frac{1}{4}$  attached to gluteal tuberosity (3rd trochanter of the femur)
- $\frac{3}{4}$  to iliotibial tract

Iliotibial Tract :

- modification of deep fascia of thigh
- Gives attachment to two muscles (one in front and one in back)
- Gluteus maximus in back (supplied by inferior gluteal nerve)
- Tensor fasciae latae in front (supplied by superior gluteal nerve)

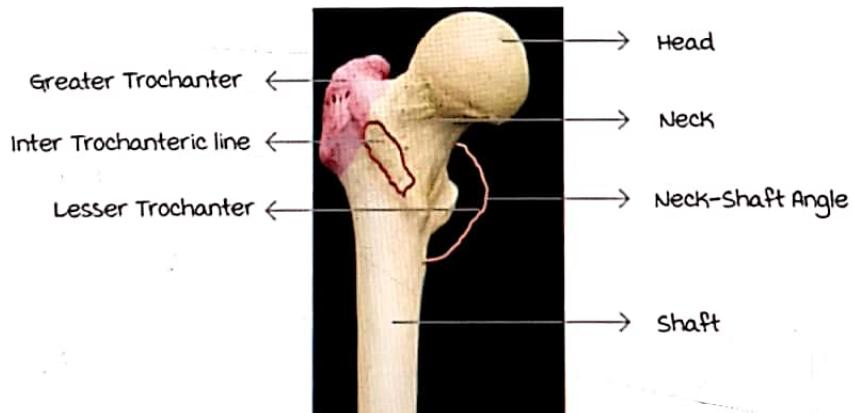
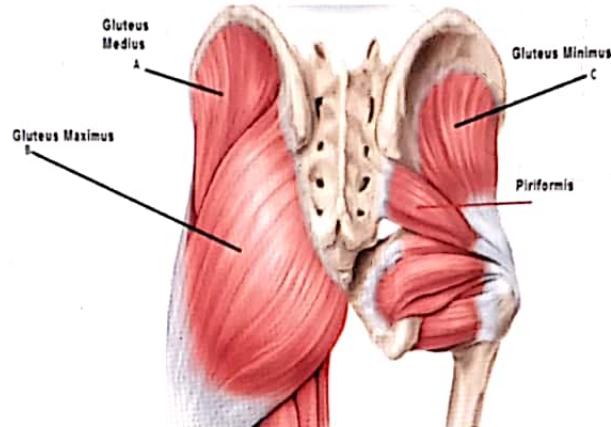


Active space

**Actions :**

- 1) Extension of hip.
- 2) Lateral rotation of the hip (prime lateral rotation)

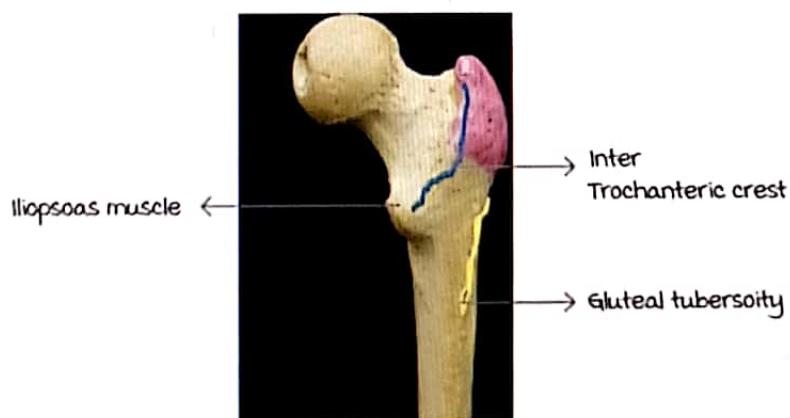
**Gluteus medius and Gluteus minimus :**



**Neck shaft angle :**

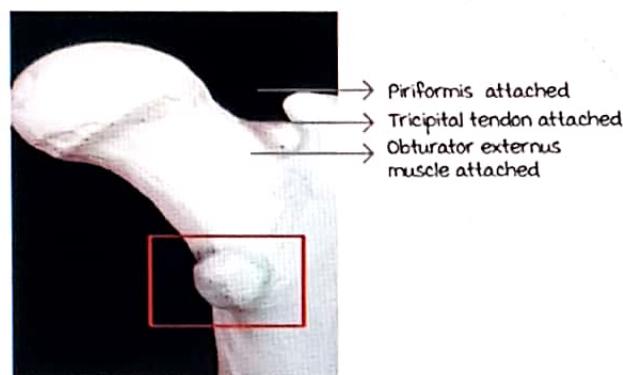
- In adults :  $125^\circ$
- In children :  $160^\circ$

Active space



- Anterior surface of Greater Trochanter : Gluteus minimus
- Lateral surface of Greater Trochanter : Gluteus medius

Posterior view :



Tricipital tendon :

- Gemellus superior
- Obturator internus
- Gemellus inferior

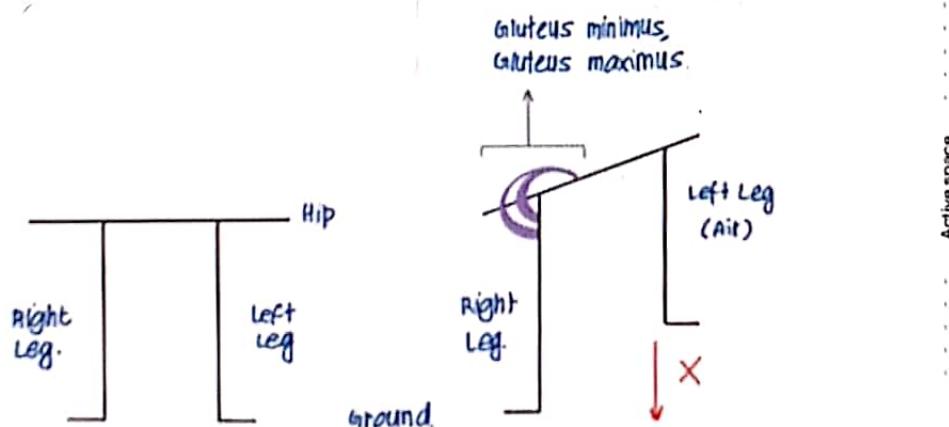
Nerve supply :

- Both muscles supplied by superior gluteal nerve
- Superior gluteal nerve supplies 3 muscles :
  - a) Gluteus medius
  - b) Gluteus minimus
  - c) Tensor fascia lata

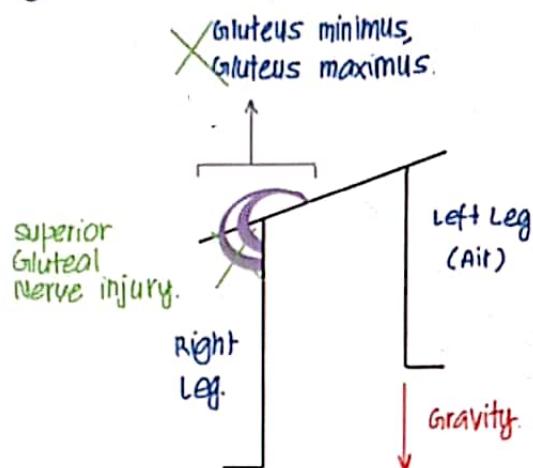
**Warning:** Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

Action :

- medial rotation and Abduction of the hip
- Stabilize the hip joint by acting from below (prevent sinking of the pelvis on the unsupported side)



## Trendelenberg Sign :



Sinking of the pelvis on unsupported side when patient is standing in the paralysed side

Case: A 20 yr. old male with pelvis sinking on the right side and Trendelenberg sign positive. Which is the sound side?

Ans : Right side (Rt side unsupported, Lt side paralyzed, Gluteus medius and minimus affected, Superior gluteal nerve affected)

muscles attached to the greater trochanter:

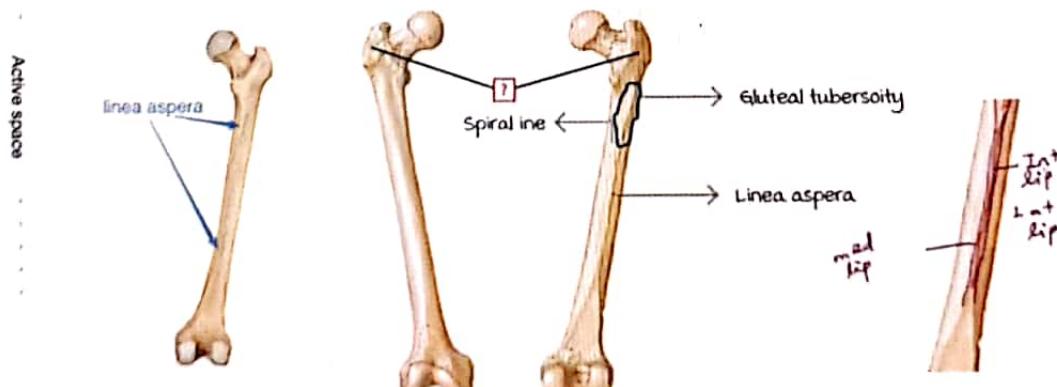
- Gluteus medius
- Gluteus minimus
- Obturator externus
- Tricipital tendon :
  1. Gemellus superior
  2. Obturator internus
  3. Gemellus inferior
- Piriformis muscle

muscles attached to the lesser trochanter :

- Iliopsoas muscle

### Linea aspera

00:19:50



Spiral line :

- Continuation of medial lip
- Gives attachment to pectenous muscle

Lips :

vastus medialis attached medial to medial lip

a. medial lip :

- Gives attachment to medial intermuscular septum
- adductor brevis and adductor longus + adductor magnus

b. Intermediate lip :

- Gives attachment to posterior intermuscular septum
- short head of biceps femoris muscle

c. Lateral lip :

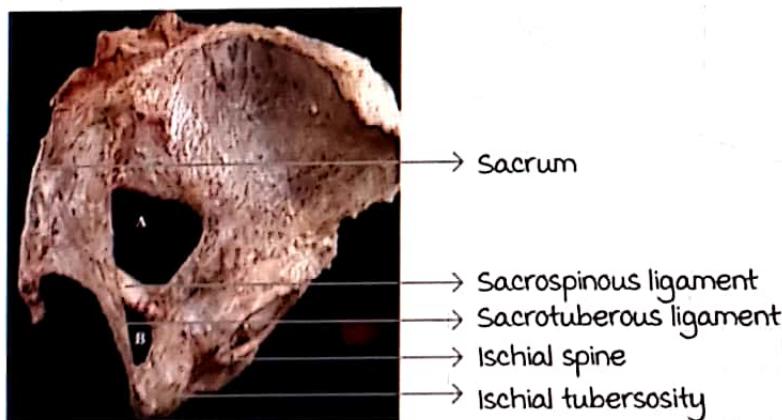
- Gives attachment to lateral intermuscular septum
- Vasti lateralis attached lateral to lateral lip

Sequential arrangement of structures in the linea aspera :

vasti medialis → medial intermuscular septum → Adductor brevis/longus → Adductor magnus → posterior intermuscular septum → short head of biceps femoris → lateral intermuscular septum → vasti lateralis.

## Other muscles in gluteal region

00:27:30



Active space

A : Greater sciatic foramen

B : Lesser sciatic foramen

Structures passing through greater sciatic foramen : Piriformis muscle

Piriformis muscle : Key muscle

- Above piriformis : Superior gluteal artery and superior gluteal nerve

- Below piriformis :
  1. Inferior gluteal artery and nerve
  2. Sciatic nerve
  3. Posterior femoral cutaneous nerve
  4. Nerve to quadratus femoris
  5. Nerve to obturator internus
  6. Internal pudendal vessel
  7. Pudendal nerve

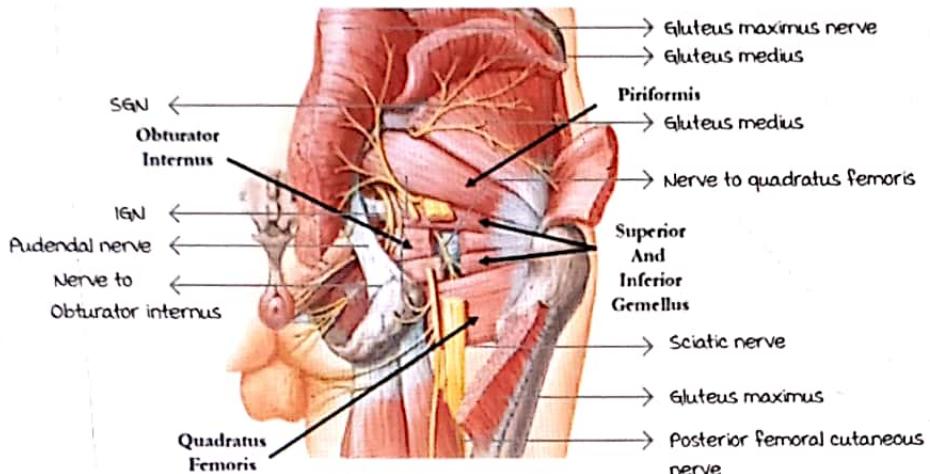


Piriformis

Structures passing through lesser sciatic foramen :

- Tendon of obturator internus muscle
- PIN structure :
  1. Pudendal nerve
  2. Internal Pudendal vessel
  3. Nerve to obturator internus

Obturator  
Internus



Superior gluteal nerve [SGN] : dorsal division of L4 L5 S1

Inferior gluteal nerve [IGN] : dorsal division of L5 S1 S2

Sciatic nerve :

- Tibial component: ventral division of L4 L5 S1 S2 S3
- Common Peroneal component :dorsal division of L4 L5 S1 S2

Posterior femoral cutaneous nerve: dorsal division of S1 S2 and ventral division of S2 S3

Nerve to quadratus femoris :

- I. Quadratus femoris
- II. Inferior gemellus

Nerve to obturator internus :

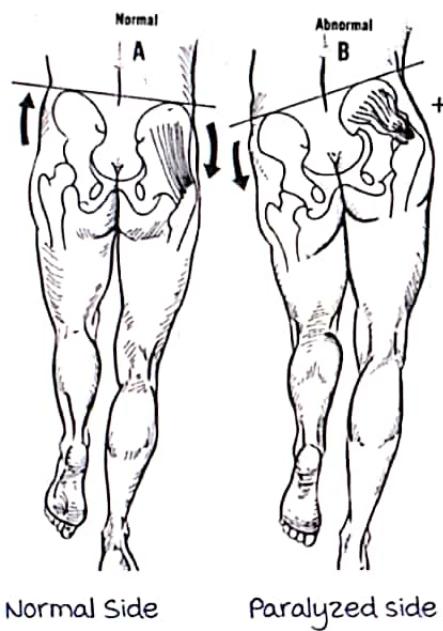
- I. Obturator internus
- II. Superior gemellus

- Piriformis supplied by fibers from S1 S2 (Sacral Plexus)

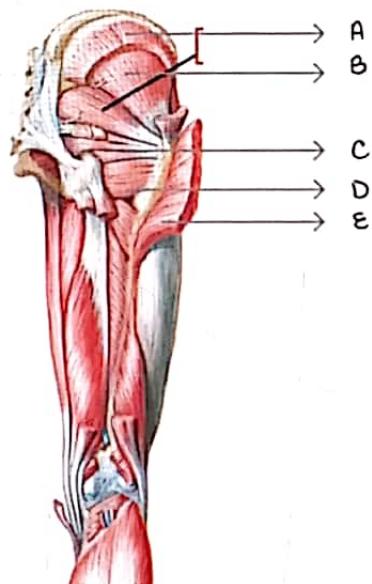
Lateral rotators of the Hip joint :

- Gluteus maximus
- Piriformis
- Superior gemellus
- Inferior gemellus
- Obturator externus
- Obturator internus
- Quadratus femoris
- Sartorius muscle

## Trendelenberg Sign :



## Image based question :



- A Gluteus maximus  
B Gluteus medius  
C Gluteus minimus  
D Tricipital tendon  
E Quadratus femoris muscle

Active space

Cadaveric Images :



Gluteus maximus



Gluteus medius

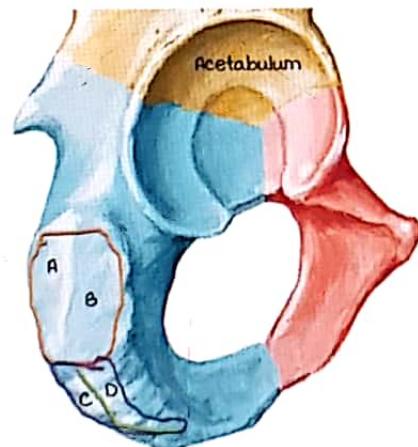
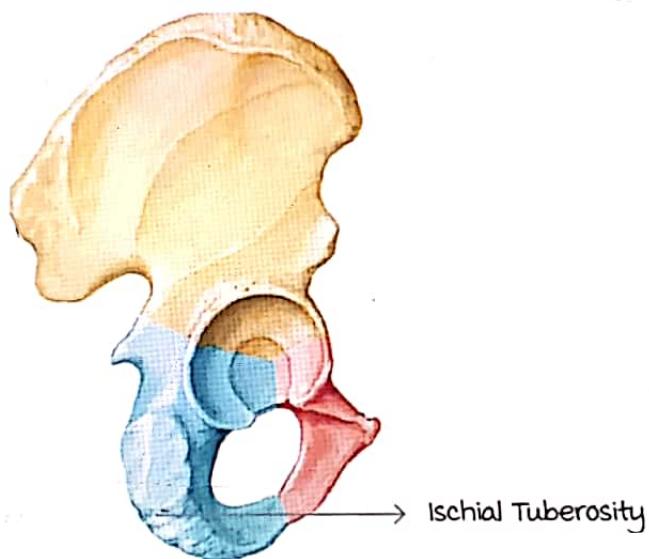


Active space

## Hamstring muscles

00:47:50

- Origin : Ischial tuberosity
- Insertion : Bones of leg (Tibia/fibula)
- Action :
  - They cross the hip behind : hip extension
  - They cross the knee behind : knee flexion
- Nerve supply : Tibial component of sciatic nerve



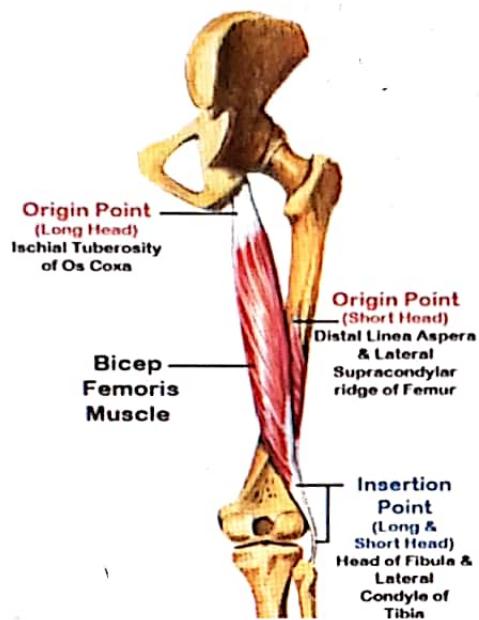
A : (upper lateral) - semimembranosus

B : (Lower medial) - semitendinosus and long head of biceps femoris muscle

C : (Lateral part) - Hamstring part of adductor magnus is attached

D : (medial part) - **no** muscles attached, Sacrotuberous ligament attached

### Biceps femoris :



Long head of Biceps femoris is a Hamstring muscle

Short head [supplied by common peroneal component of sciatic nerve] is **not** a Hamstring muscle (because of origin from femur)

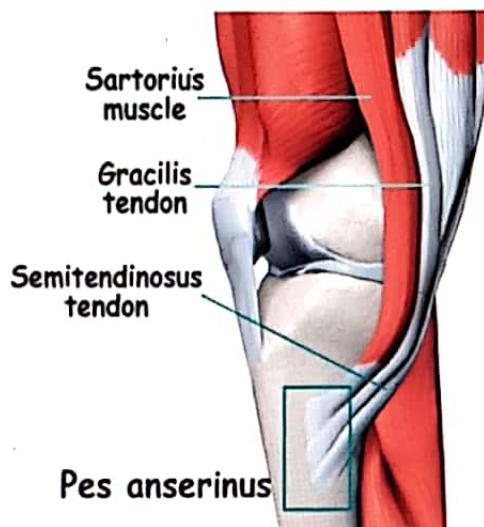
### Semitendinosus muscle :



- Two parts :
  - Fleshy : proximal
  - Tendon : distal

Active space

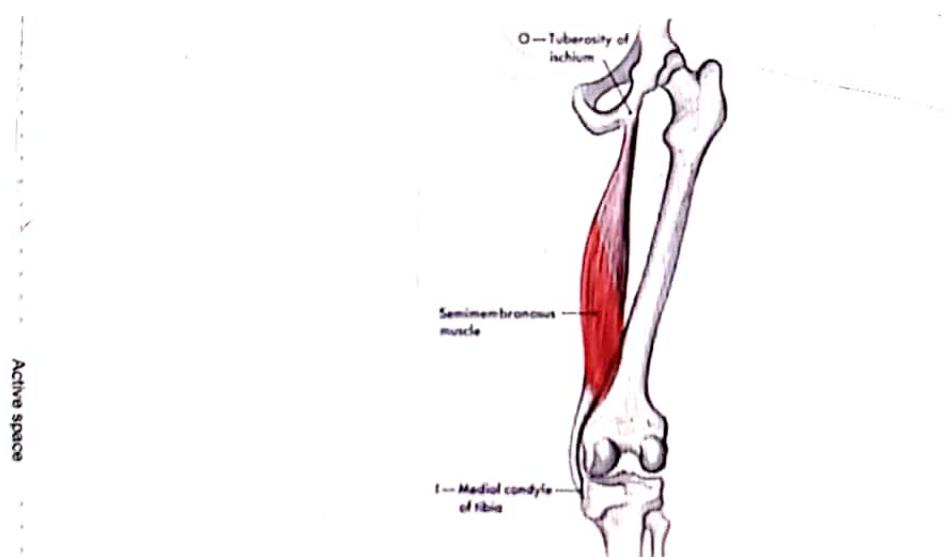
## Pes anserinus :



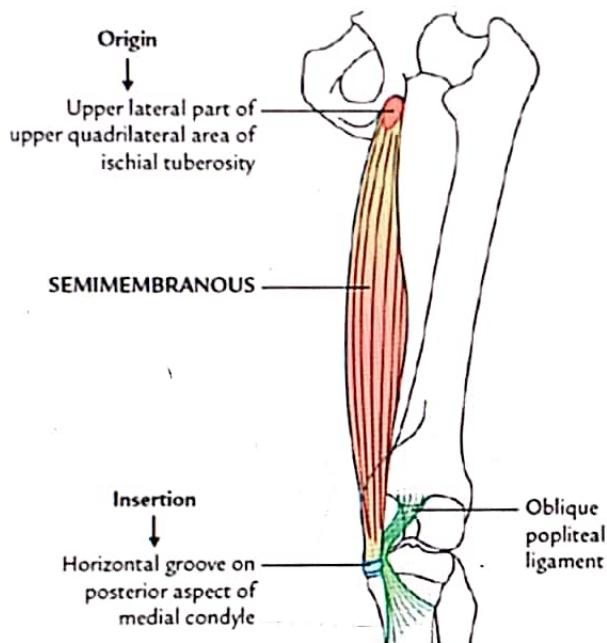
## Guy ropes muscles :

- Origin : hip bone
- Insertion : Tibia
- Act as a rope and tie the hip bone to the tibia
- 3 muscles :
  - Sartorius
  - Gracilis
  - Semitendinosus

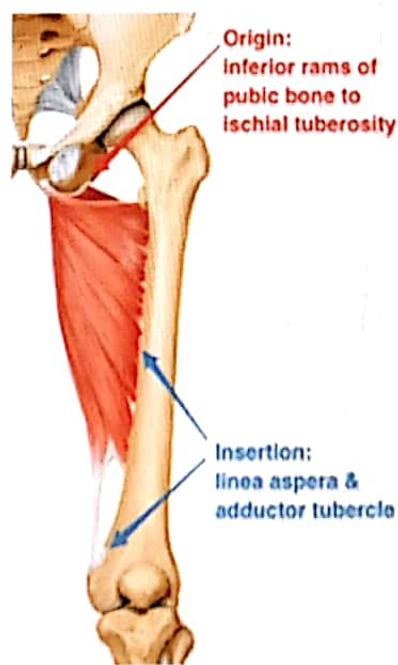
## Semimembranosus muscle :



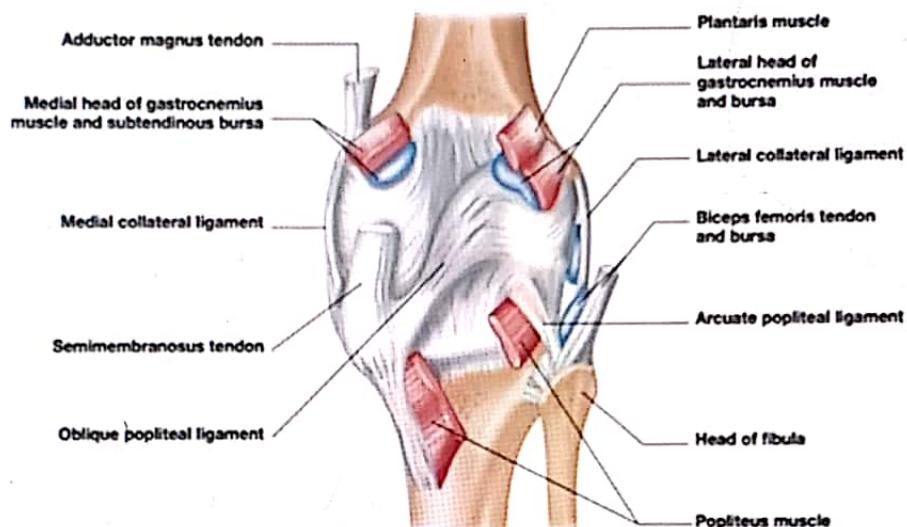
- Two parts :
  - Fleshy : distal
  - membrane : proximal
- Oblique popliteal ligament: derived from the semimembranosus muscle



Adductor magnus muscle :



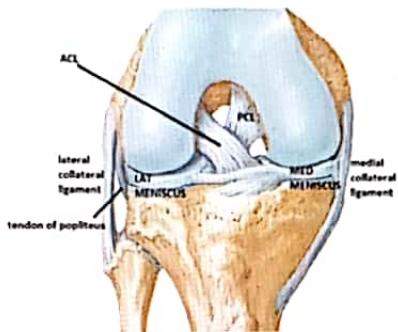
All hamstrings have to be attached to tibia/fibula but this muscle despite being attached to femur is a hamstring muscle : medial collateral ligament (primitive insertion of adductor magnus muscle) attaches to the tibia.



# KNEE JOINT

## Ligaments

00:00:04



### 1) medial Collateral Ligament :

- Primitive insertion of Adductor magnus
- Attached to medial meniscus
- Prevents medial displacement of femur and tibia

**unhappy/Terrible Triad :** Severe blow on the lateral aspect on knee joint, when patient planted his sole firmly on the ground.



- Tear of medial collateral ligament
- Tear of medial meniscus
- Tear of Anterior Cruciate Ligament [ACL]

### 2) Lateral Collateral Ligament :

- Also Known as Fibular collateral ligament [FCL]
- Primitive origin of peroneus longus muscle
- Tendon of Popliteus - between Lateral meniscus and FCL

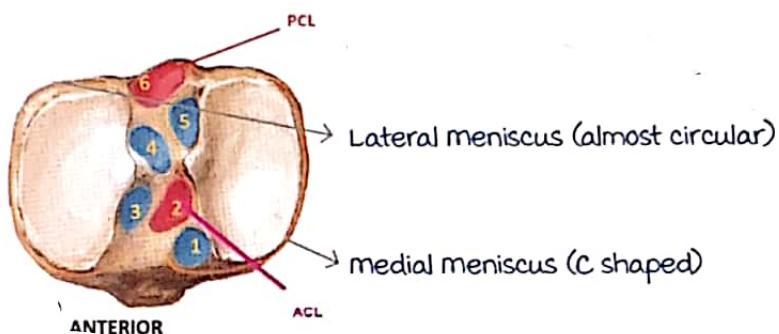
Active space

## Applied:

- Tendon of Popliteus pulls lateral meniscus during knee injury.
- mc affected meniscus in knee injury - medial meniscus (fixed to the capsule)

Intercondylar Area

00:09:04



Tibia inter condylar area attachment - Intercondylar area intervenes between two articulating surfaces, it provides attachment to following structures from anterior to posterior

Brendon McCULLUM

From anterior to posterior

1. MEDIAL MENISCUS - ANTERIOR END
2. CRUCIATE LIGAMENT - ANTERIOR
3. LATERAL MENISCUS - ANTERIOR END
4. LATERAL MENISCUS - POSTERIOR END
5. MEDIAL MENISCUS - POSTERIOR END
6. CRUCIATE LIGAMENT - POSTERIOR

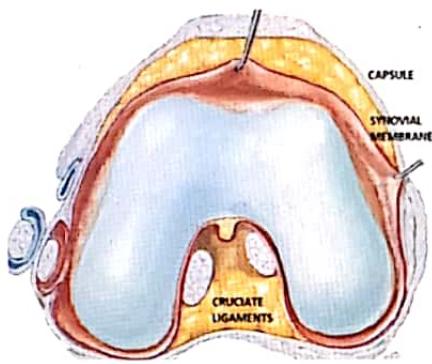
Active space

	medial meniscus	Lateral meniscus
Shape	C shaped	Almost circular
Attached to	medial collateral Ligament	Tendon of Popliteus
In Knee Injury	mc affected (fixed to the surrounding capsule)	Pulled by Popliteus tendon

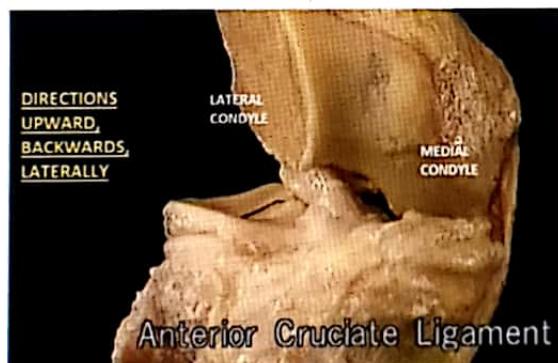
## Cruciate Ligament

00:09:04

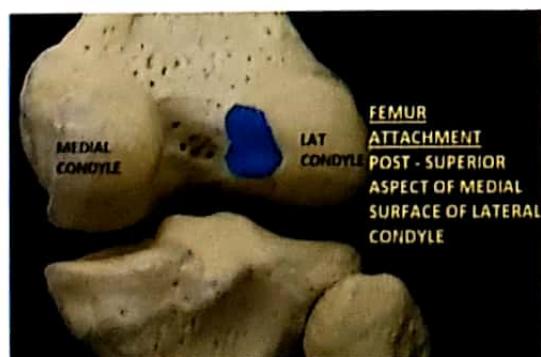
- ACL/PCL
- Intra Capsular
- Extra Synovial



ACL :



- Tibial attachment : Anterior part of the Intercondylar area of the tibia.
- Direction : upward, backward, and laterally.

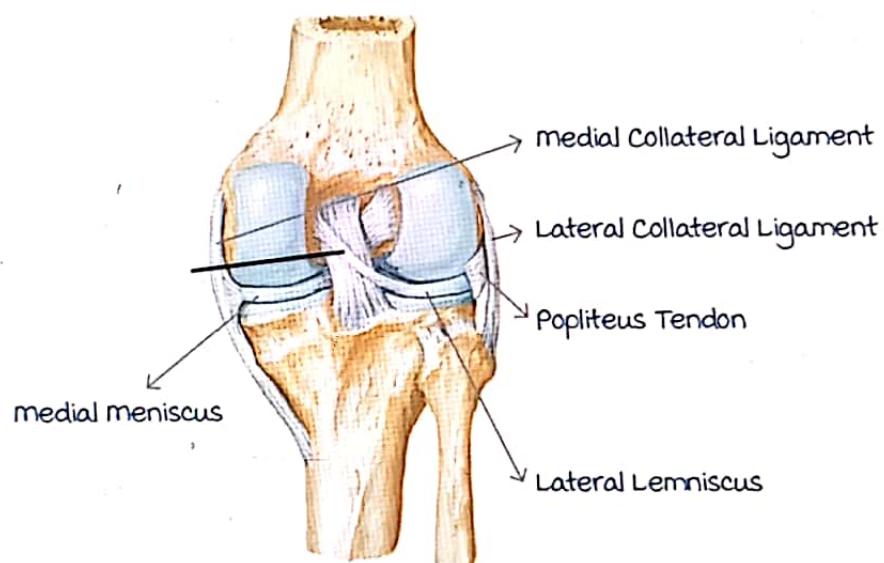


- ACL is attached on the posterosuperior aspect of medial surface of lateral condyle.
- Function : prevent anterior displacement of tibia and posterior displacement of femur
- Taut : during extension of knee joint

PCL : exact opposite of ACL.

### Menisco femoral Ligament

00:23:17



- Posterior part of the lateral lemniscus attached to the medial condyle of femur.
- Two parts :
  - Ant- anterior to PCL (Ligament of Humphrey)
  - Post- posterior to PCL (Ligament of Wrisberg)

coronary Ligament :

- Tibio meniscal Ligament
- Coming from medial- lateral meniscus to peripheral margins of Tibia.

## COMPARTMENTS OF THE LEG

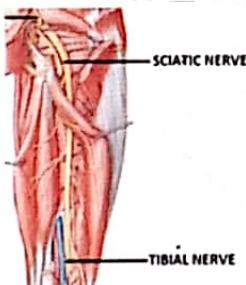
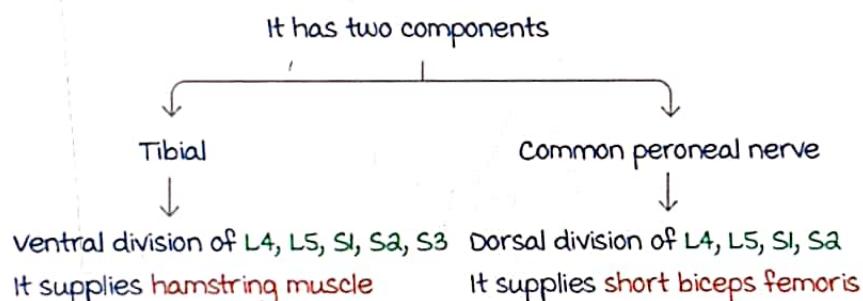
There are three compartments of the leg:

1. Flexor compartment
2. Extensor compartment
3. Peroneal compartment

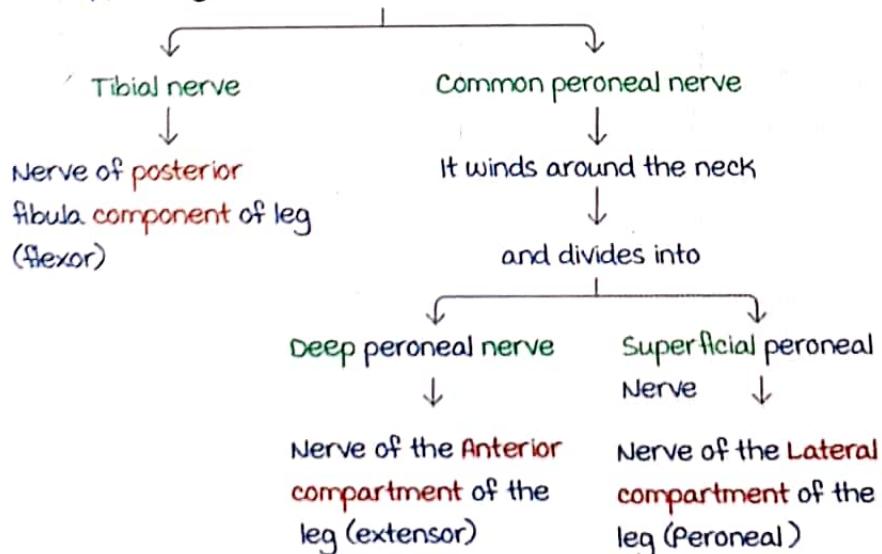
### Sciatic nerve

00:00:13

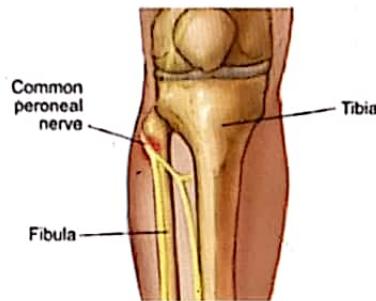
It is a branch of the sacral plexus.



At the upper angle of popliteal fossa, the sciatic nerve divides into

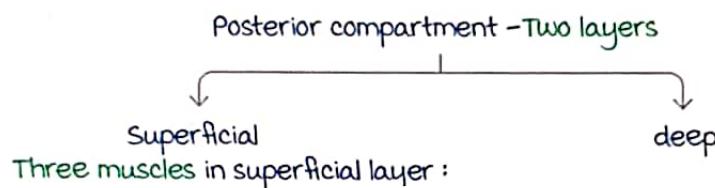


Active space



### Superficial-Posterior compartment of leg

00:03:25



- Two heads of gastrocnemius
- Soleus
- Plantaris

Note :

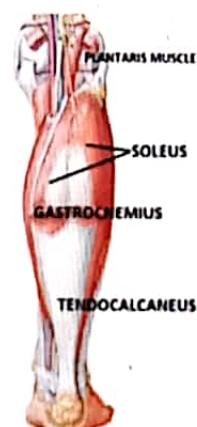
The neurovascular structures are absent in the superficial posterior compartment of leg (2018 Allms).

Two heads of gastrocnemius and soleus join together to form triceps surae.

The triceps surae forms the tendo calcaneus or Achilles tendon.

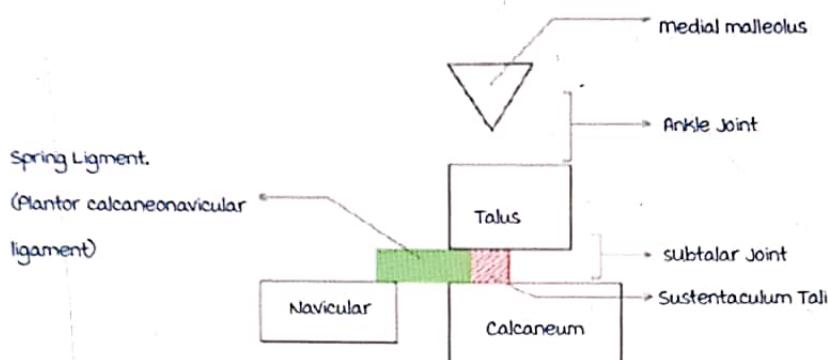
The Achilles tendon crosses the ankle joint behind and is responsible for the plantar flexion.

The plantaris muscle is not a part of triceps surae. It is a small muscle and its tendon attaches to tendo calcaneus.



## Ankle joint

00:08:17



The ankle joint is formed by **three bones**: tibia, fibula and talus.

The subtalar joint is present below the talus.

The calcaneus bone has a small projection on the medial side called the **sustentaculum tali**.

A ligament from the sustentaculum tali to the navicular bone called the **spring ligament** or **plantar calcaneonavicular ligament**.

## Deltoid ligament

00:11:31

It is a strong ligament and strengthens the ankle joint on the **medial side**. (2019 JIPMER).

It is present on the medial side of ankle joint.

All the components of the deltoid ligament are attached to **tibia - medial malleolus**.

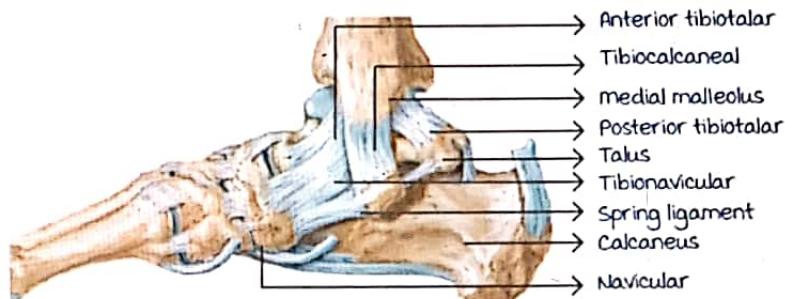
The components are : (Allms)

1. Tibionavicular - blends with the spring ligament
2. Tibiocalcaneal - attached to sustentaculum tali
3. Anterior tibiotalar
4. Posterior tibiotalar

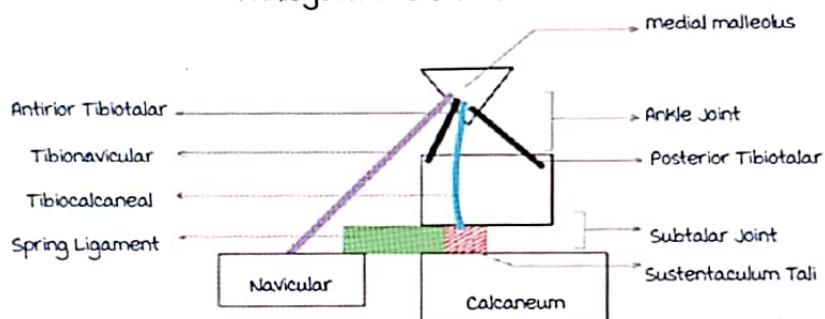
The deltoid ligament is attached to :

1. medial malleolus (tibia)
2. Navicular bone
3. Spring ligament
4. Sustentaculum tali
5. Talus

movements of ankle joint - plantarflexion and dorsiflexion.  
movements of the subtalar joint - inversion and eversion.



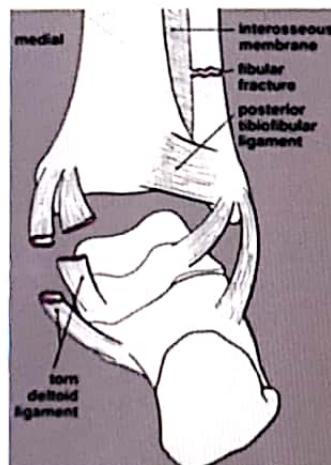
Ankle joint-medial view



#### Clinical correlation

##### Pott fracture

The fibula is fractured above the intact distal tibiofibular syndesmosis, the deltoid ligament is ruptured, and the talus is subluxed laterally.



Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

Ankle joint- lateral view

00:21:56

Ankle joint is strengthened laterally by three ligaments :

1. Anterior talofibular
2. Posterior talofibular
3. Calcaneo fibular



Ankle joint- lateral view

The commonly affected ligament during inversion sprain is anterior talofibular.

Ligaments in the ankle joint

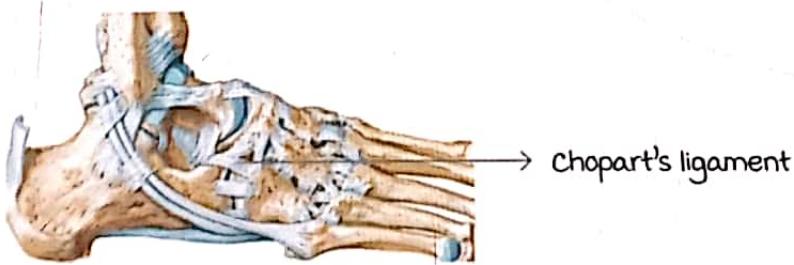
Chopart's ligament

It is a ligament of calcaneocuboid joint.

It is Y shaped

The stem is attached to the calcaneus bone.

It has two components : calcaneonavicular and calcaneocuboid.



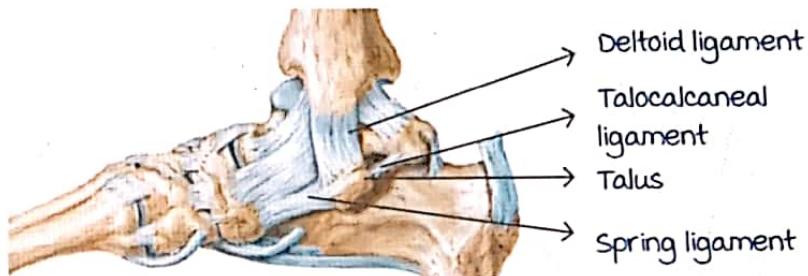
Sustentaculum tali

It is a projection on the medial side of the calcaneus bone.

The flexor hallucis longus tendon passes through the groove below it.

There are three ligaments attached :

1. Deltoid ligament
2. Spring ligament
3. Talocalcaneal ligament

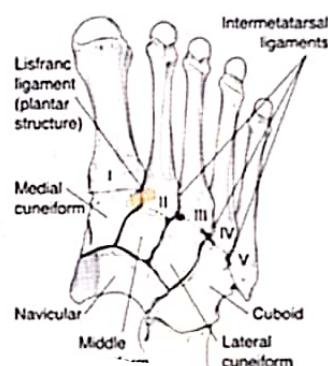


### Tarso metatarsal joint ligament

It is the **strongest ligament**.

A/K/A **lisfranc ligament**.

It extends from the medial cuneiform to the 2nd metatarsal bone.



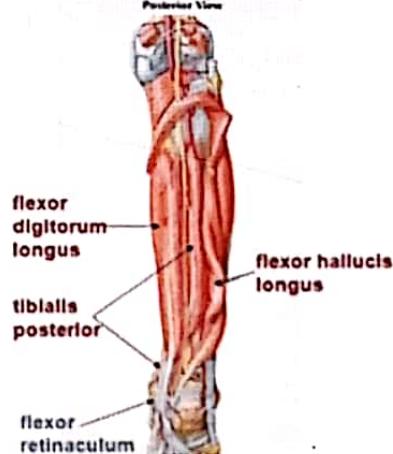
### Deep-posterior compartment of leg

00:35:40

There are **four muscles**:

1. Flexor hallucis longus
2. Popliteus
3. Tibialis posterior
4. Flexor digitorum longus

**Muscles of Leg (Deep Dissection)**



### Popliteus muscle

Origin - lateral femoral condyle

Tendon - **intracapsular**

Insertion - posterior surface of tibia

Nerve - **tibial nerve**

Action - it crosses the knee joint behind

Flexion of knee

Initiates the unlocking

Locking and unlocking of knee joint:

**Locking:**

The femur rotates internally/medially over the tibia.

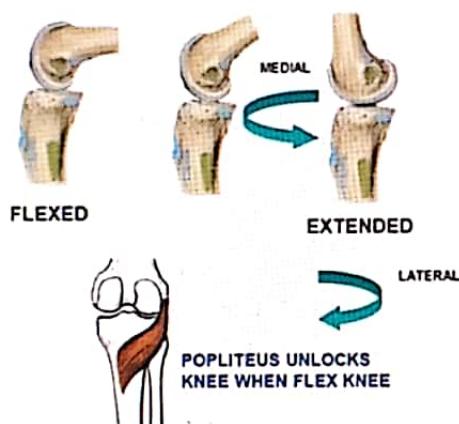
Quadriceps femoris muscle helps in locking the knee joint.

**Unlocking:**

The femur rotates laterally/externally over the tibia.

Popliteal muscle helps in unlocking the knee joint.

femur rotates medially during last 30 degrees of extension, due to shape of condyles



### Other muscles in deep-posterior compartment of leg

00:35:40

**Flexor hallucis longus**

Action- crosses the ankle joint behind

plantar flexion of ankle joint

Flexion of great toe.

**Flexor digitorum longus**

Action- crosses the ankle joint behind

plantar flexion of ankle joint

Flexion of lateral four toes.

**Tibialis posterior**

Action- crosses the ankle joint behind

plantar flexion of ankle joint

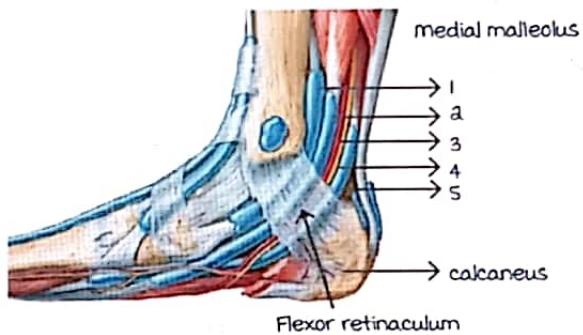
Inversion.

**Flexor retinaculum**

It extends from the medial malleolus to the calcaneum.

The structures passing through the flexor retinaculum (from medial to lateral)

1. Tibialis posterior
2. Flexor digitorum longus (FDL)
3. Posterior tibial artery
4. Tibial nerve
5. Flexor hallucis longus (FHL)



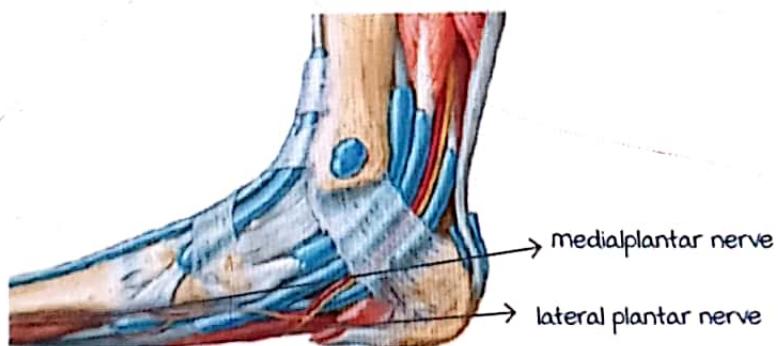
Tibial nerve is the nerve affected in the tarsal tunnel syndrome.

Tibial nerve after passing below the flexor retinaculum

Enters the sole and divides into

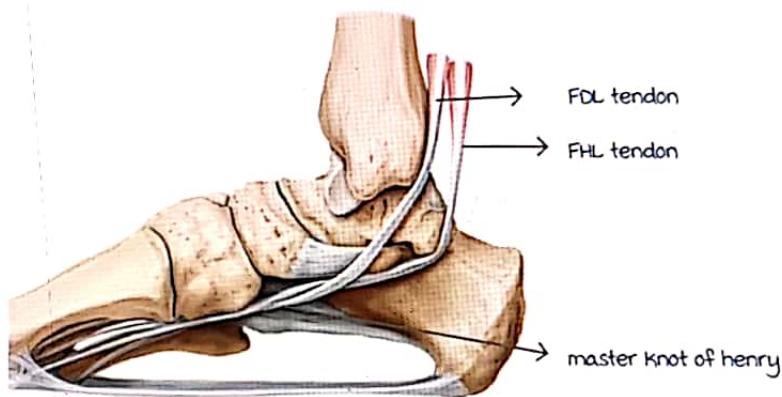
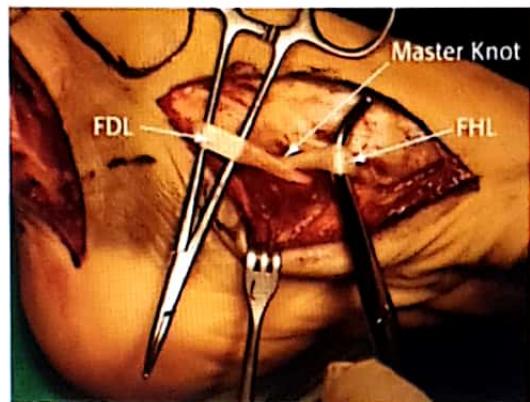
medial and lateral plantar nerve

motor and sensory supply to the sole



The FDL tendon and FHL tendon cross over the navicular bone, called the master knot of henry.

The synovial sheath of these tendons, if inflamed may get enlarged and compresses the medial plantar nerve.



## Inversion and eversion movement

00:44:38

It occurs at **three joints**:

- Subtalar joint
- Talocalcaneonavicular joint
- Transverse talar joint

**Inversion**

It is the **medial turning of the sole**.

It is done by - **tibialis posterior**

**Tibialis anterior**

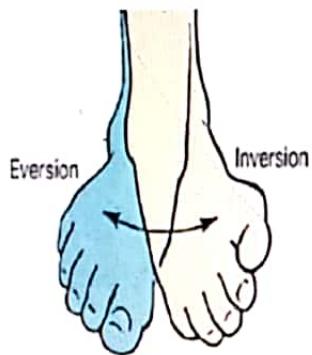
**Eversion**

It is the **lateral turning of the sole**.

It is done by - **peroneus longus**

**Peroneus brevis**

Active space



### Anterior compartment of leg

00:49:19

It is also known as the extensor compartment of leg.

The **deep peroneal nerve** (branch of the common peroneal nerve) is the nerve of the anterior compartment.

The muscles are :

1. Tibialis anterior

Action-crosses the ankle joint in front  
dorsiflexion of ankle joint.  
Inversion.

2. Extensor digitorum longus

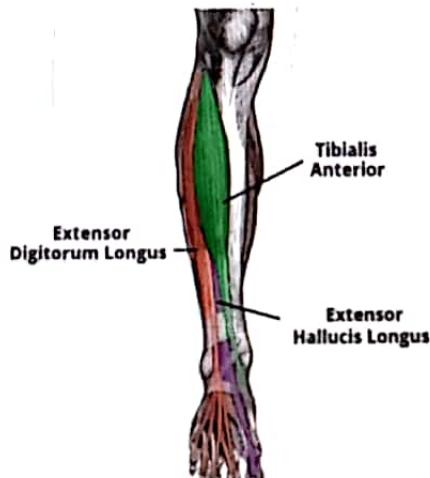
Action-crosses the ankle joint in front  
dorsiflexion of ankle joint.  
Extension of **lateral four toes**.

3. Extensor hallucis longus

Action-crosses the ankle joint in front  
dorsiflexion of ankle joint.  
Extension of **great toe**.

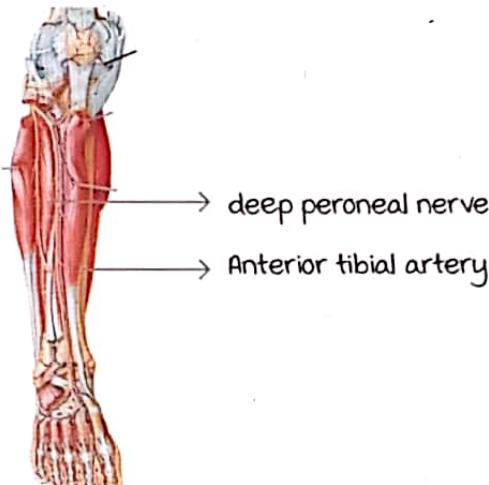
4. Peroneus tertius.

Action assists in eversion.

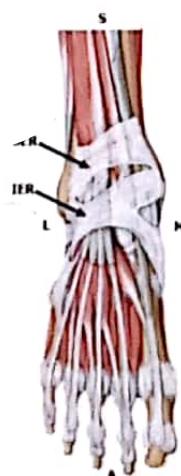
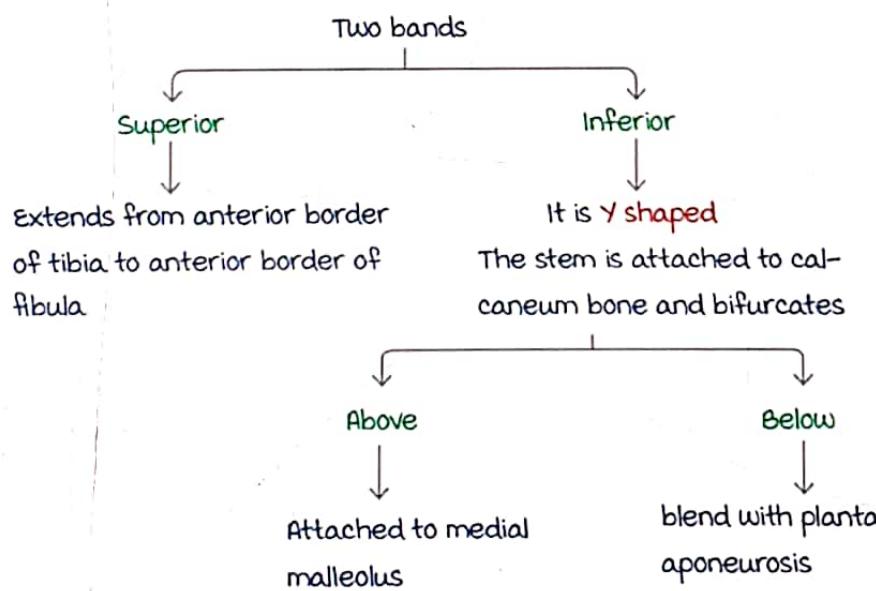


Clinical correlation :

Injury of deep peroneal nerve causes foot drop - dorsiflexion is not possible (2019 NEET)



Extensor retinaculum



Active space

## Lateral compartment of leg

00:56:09

A/K/A peroneal compartment of leg.

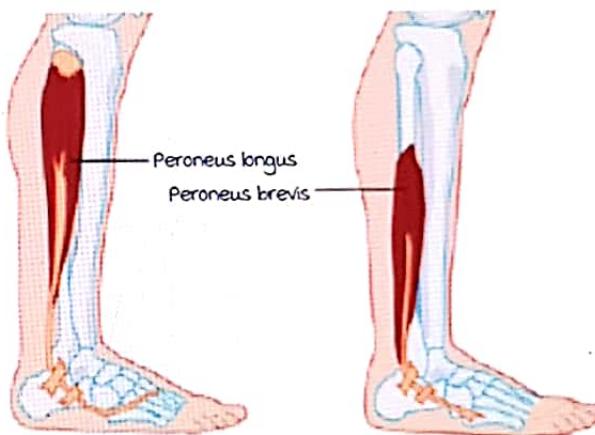
Nerve - superficial peroneal nerve.

There are two muscles

Peroneus longus

Peroneus brevis

Action of these two muscles - eversion of the subtalar joint.



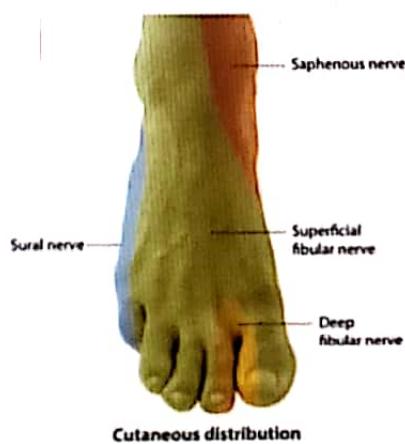
Cutaneous innervation of the dorsum of foot

The entire dorsum is supplied by **superficial peroneal nerve**, except 1<sup>st</sup> web space.

The lateral most aspect of the foot is supplied by the **sural nerve**.

The **saphenous nerve** (branch of femoral nerve)

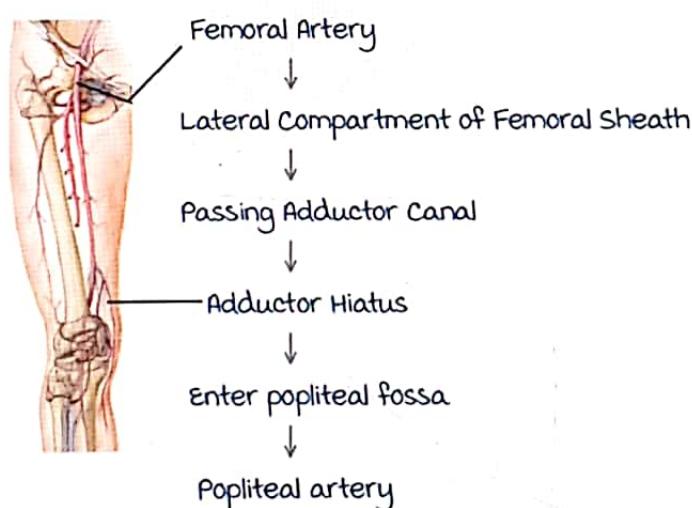
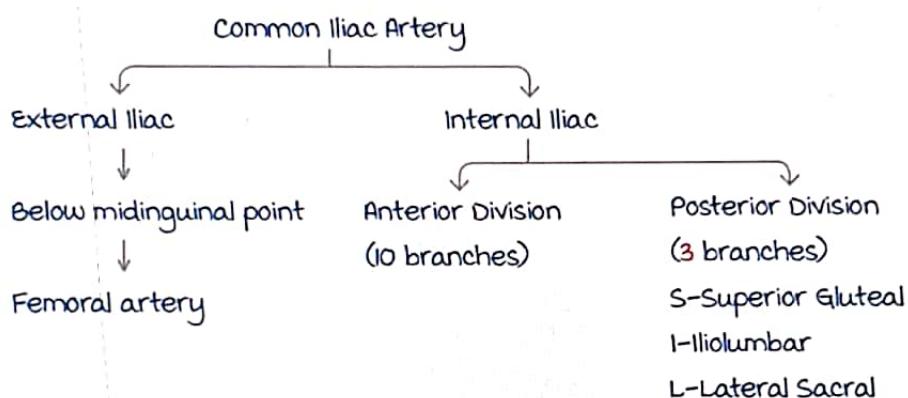
supplies the medial aspect of the leg up to the ball of the great toe. It is the **longest cutaneous nerve**.



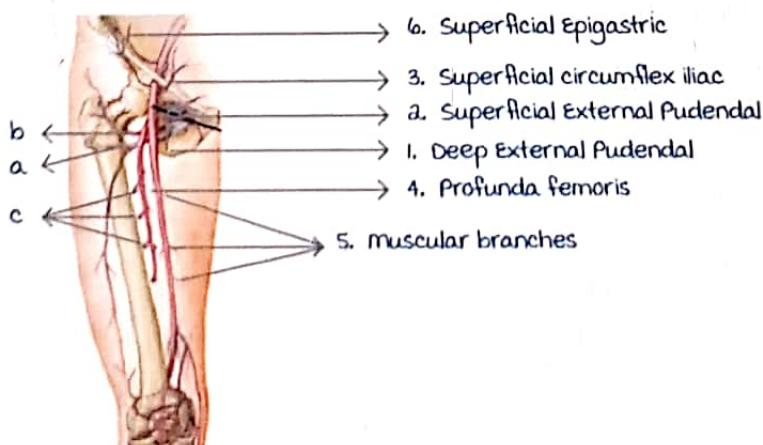
# BLOOD SUPPLY, ARCHES AND SOLE OF FOOT

## Blood Supply of Lower Limb

00:00:03



Branches of Femoral artery :



Active space

### Branches of Profunda femoris :

- Lateral circumflex femoral: divides the femoral nerve into anterior and posterior division.
- medial circumflex femoral
- Perforating branches : 4 in number
  - $2^{\text{nd}}$  perforating artery : Nutrient branch to femur bone

### Blood supply of femoral head :

- medial circumflex femoral > Lateral circumflex femoral  
↓  
Give Lateral Epiphyseal artery → major supply to the head.
- medial epiphyseal : derived from foveolar artery → supplies minor portions of head.
- Lateral epiphyseal > medial epiphyseal artery
- medial circumflex > Lateral epiphyseal artery

## Anastomosis

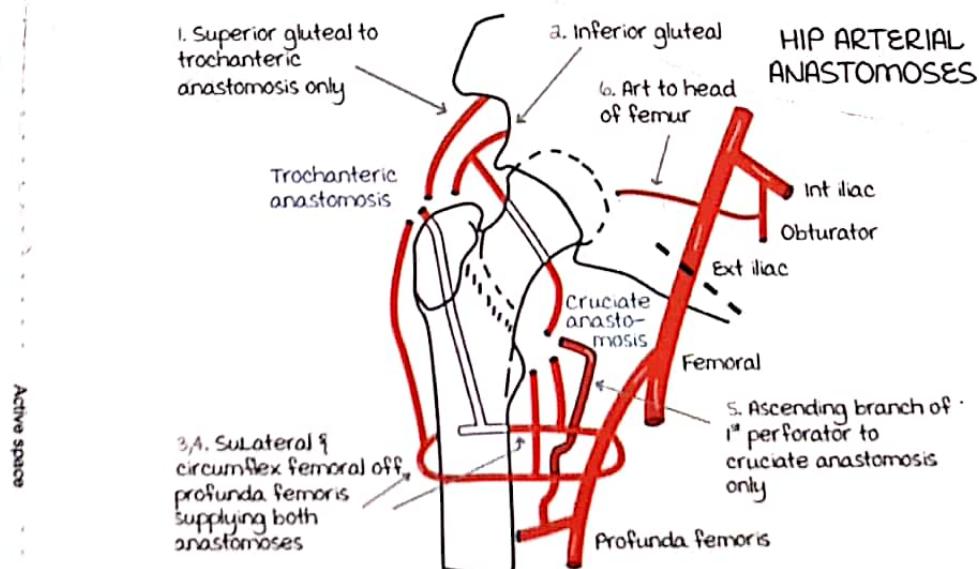
00:11:23

Anastomosis between internal iliac and external iliac artery.

### Two Types :

- Trochanteric
- Cruciate

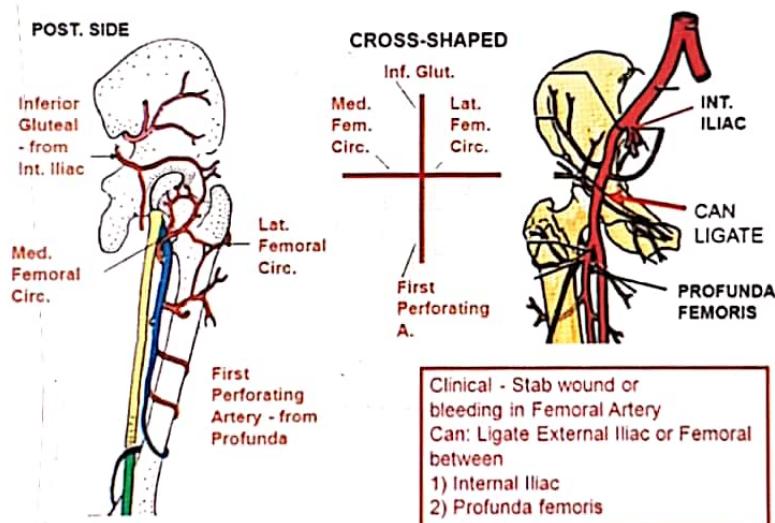
### Trochanteric :



Four arteries taking part in the trochanteric anastomosis :

1. Superior gluteal : branch of posterior division of internal iliac
2. Inferior gluteal : branch of anterior division of internal iliac
3. Lateral femoral circumflex : branch of Profunda femoris [branch of femoral artery (continuation of external iliac artery)]
4. medial femoral circumflex : branch of Profunda femoris [branch of femoral artery (continuation of external iliac artery)]

#### CLINICAL: CRUCIATE ANASTOMOSIS



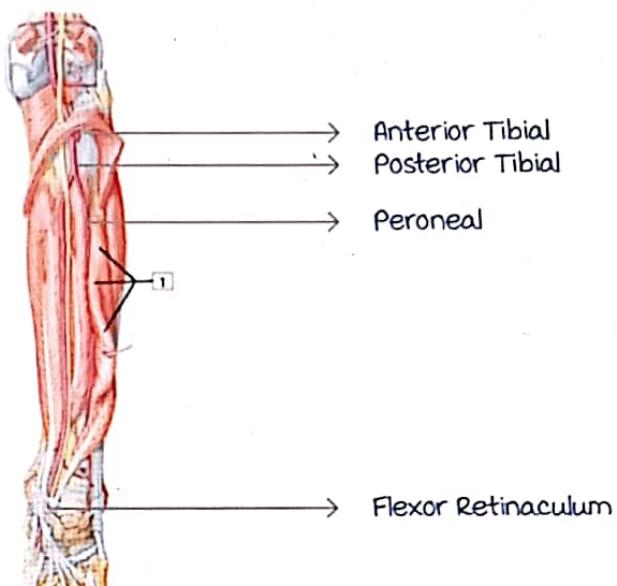
Arteries taking part in the cruciate anastomosis :

1. Inferior gluteal : branch of anterior division of internal iliac
2. First perforating : branch of Profunda femoris [branch of femoral artery (continuation of external iliac artery)]
3. Lateral femoral circumflex : branch of Profunda femoris [branch of femoral artery (continuation of external iliac artery)]
4. medial femoral circumflex: branch of Profunda femoris [branch of femoral artery (continuation of external iliac artery)]

Superior gluteal artery is **not** involved in cruciate anastomosis.

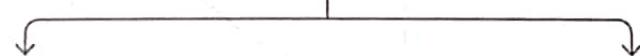
Blood Supply of Lower Limb continued

00:14:35



Popliteal artery divides into :

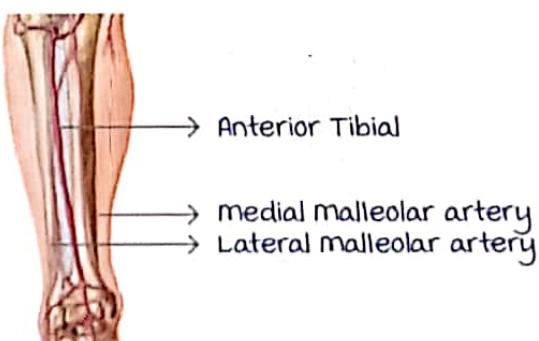
- Anterior Tibial (anterior compartment of leg)
- Posterior Tibial (posterior compartment of leg) :
  1. Gives nutrient artery branch to Tibia
  2. Peroneal artery (lateral compartment of leg)
- Passes below flexor retinaculum in sole to give branches



Lateral Plantar artery

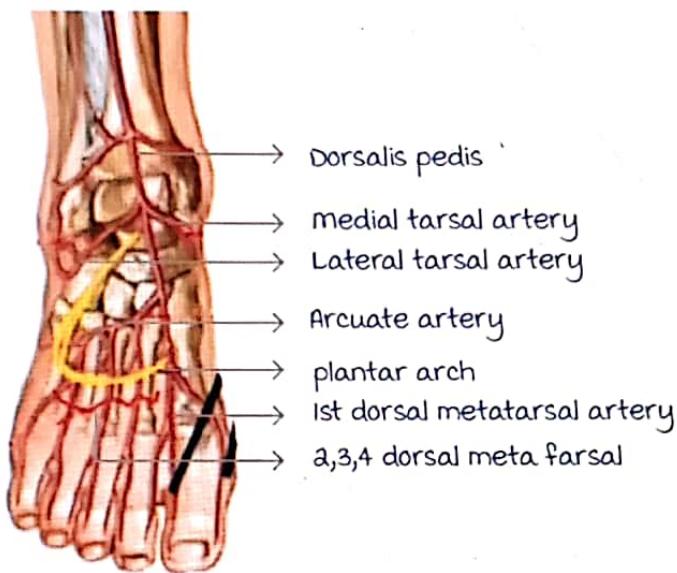
medial Plantar artery

Anterior Tibial artery :



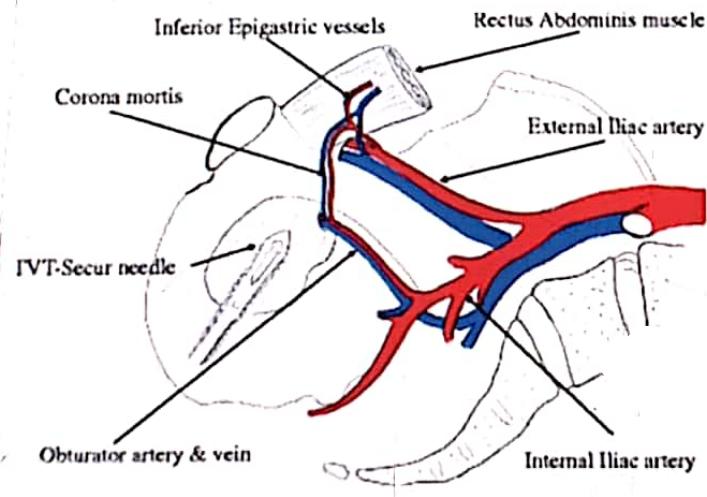
- Gives medial and lateral malleolar artery
- Continues as Dorsalis pedis artery

Dorsalis pedis artery :



Dorsalis pedis artery passes in triangular interval between heads of 1<sup>st</sup> dorsal interosseous muscles and enter the sole. In sole anastomose with lateral plantar artery and in turn completes plantar arch.

Corona mortis : very difficult to identify.

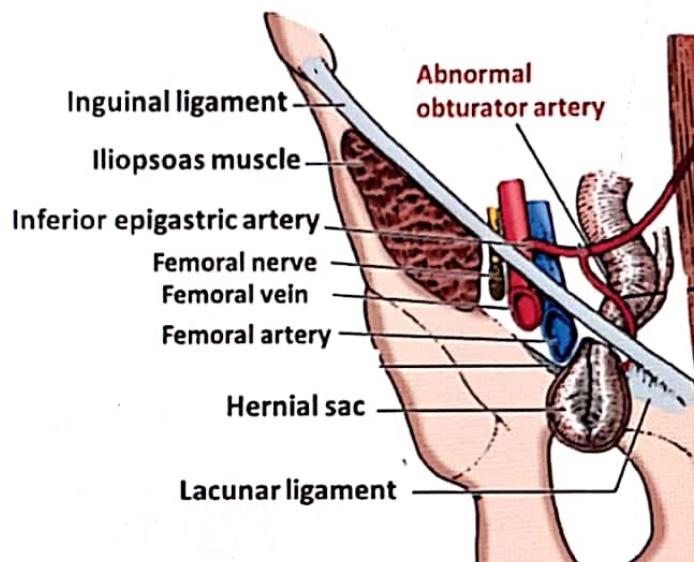


Anastomosis between :

- 1) Pubic branch of inferior epigastric artery: branch of external iliac artery
- 2) Pubic branch of obturator artery: branch of anterior division of internal iliac artery

Active space

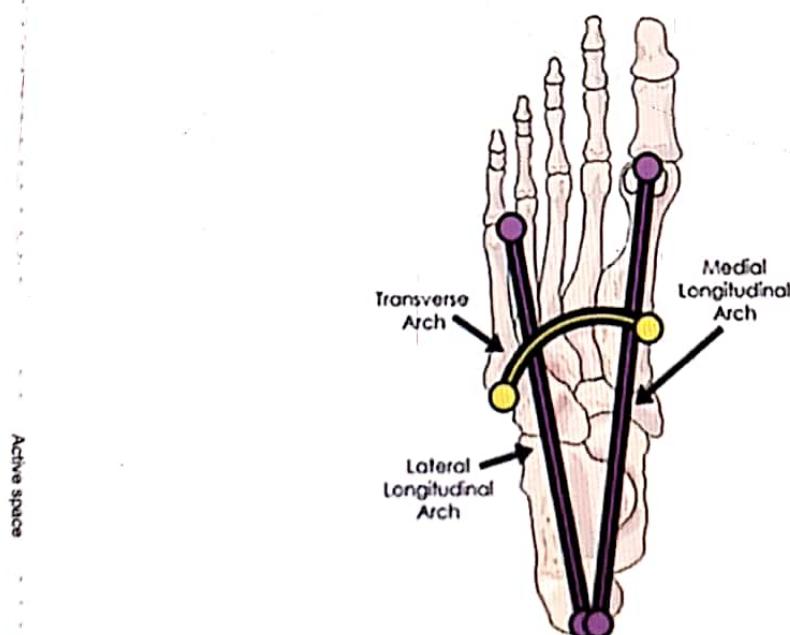
## Abnormal Obturator artery :



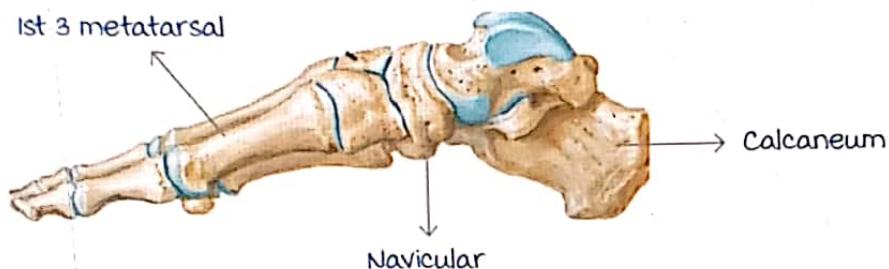
- Pubic branch of internal iliac artery replacing the obturator artery.
- Very close to Lacunar ligament (medial boundary of femoral ring)

Arches of foot

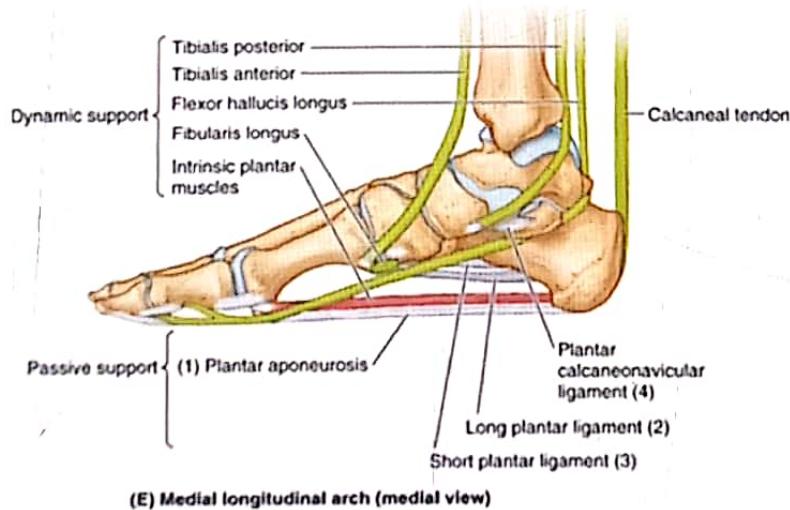
00:24:45



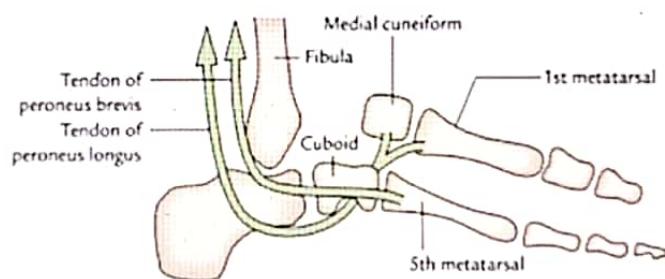
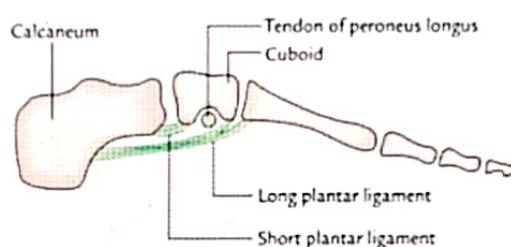
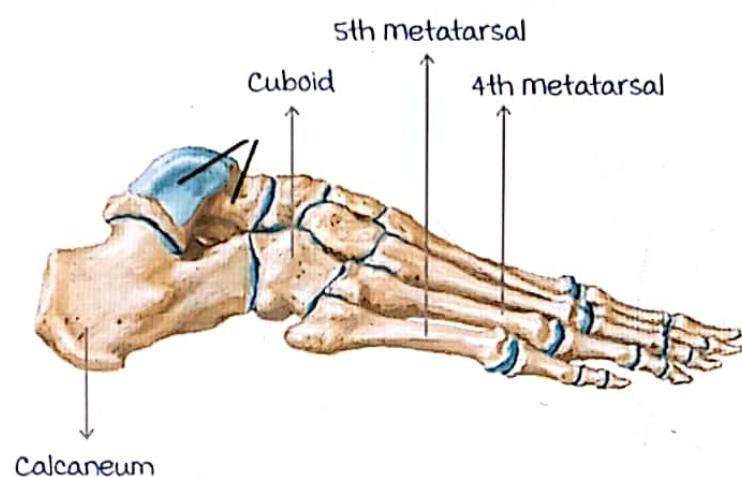
medial Longitudinal Arch :



- Summit of the arch : Talus bone
- Joint of the arch : Talocalcaneo Navicular Joint (ball and socket joint)
- Ligament support : Spring ligament
- Sling support : by tendons of :
  1. Tibialis posterior
  2. Tibialis anterior
  3. Flexor hallucis longus
  4. Flexor digitorum longus



- Joint of the arch: Calcaneo cuboid joint (saddle joint)
- Ligament support: Short and long plantar ligament
- Sling support: by tendons of peroneus longus and brevis

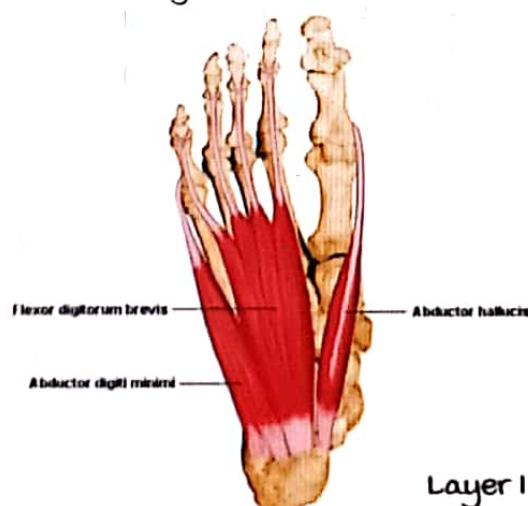


## Layers of Sole

00:30:55

- Nerve supply by : medial and lateral plantar nerve
- 4 layers :
- 1) Layer I : Abductor layer

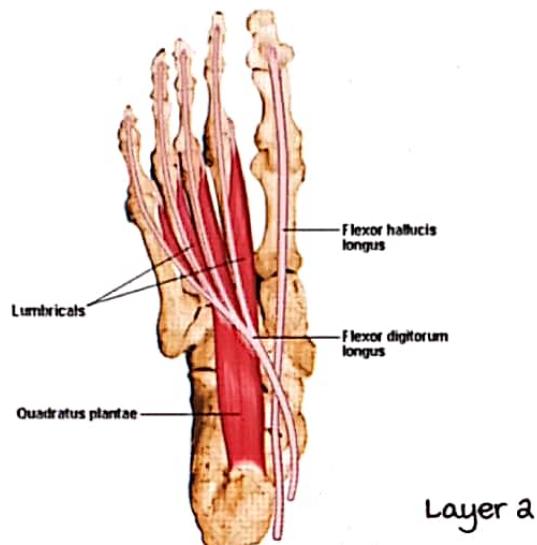
Active space



## Nerve Supply:

- Abductor hallucis and Flexor digitorum brevis supplied by medial plantar nerve.

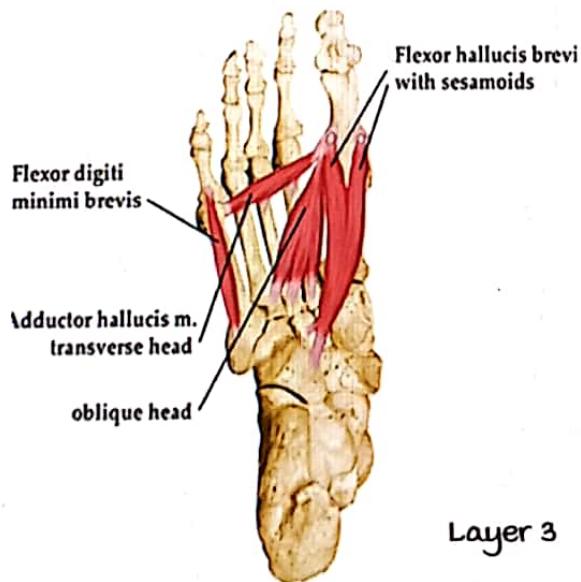
2) Layer 2 : (2 tendons and 2 muscles)



## Nerve Supply:

- 1st Lumbral by medial plantar nerve

3) Layer 3 : flexor layer

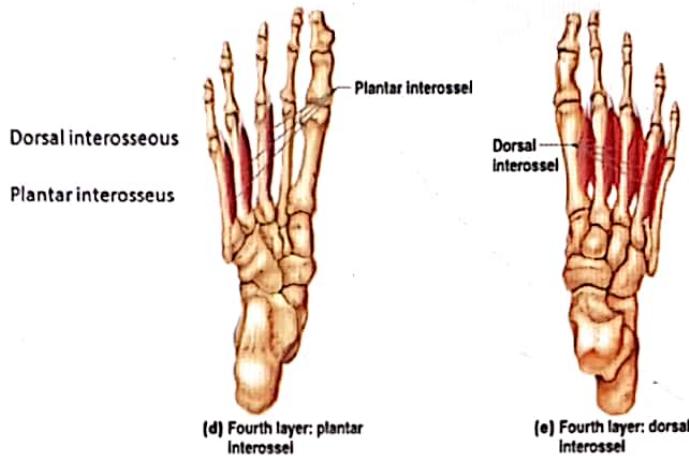


Active space

## Nerve Supply:

- Flexor hallucis brevis by medial plantar nerve

## 4) Layer 4 :



- Dorsal Interosseus : 4 in number (Bipinnate)
- Plantar Interosseus : 3 in number (Unipinnate)
- Supplied by the Lateral Plantar nerve.

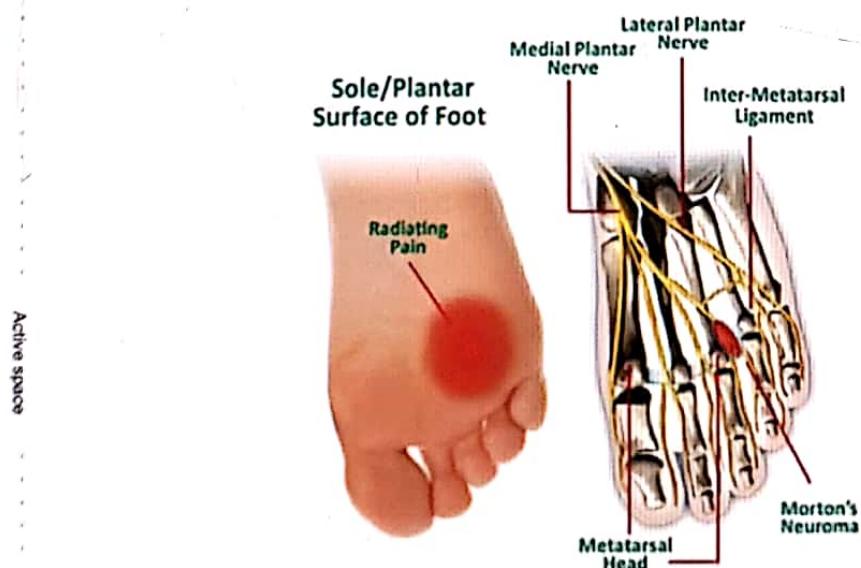
muscles supplied by medial Plantar nerve :

- L - 1st Lumbrical  
 A - Abductor hallucis  
 A - Flexor digitorum brevis  
 F - Flexor hallucis brevis

Rest all muscle in the sole are supplied by the Lateral Plantar nerve.

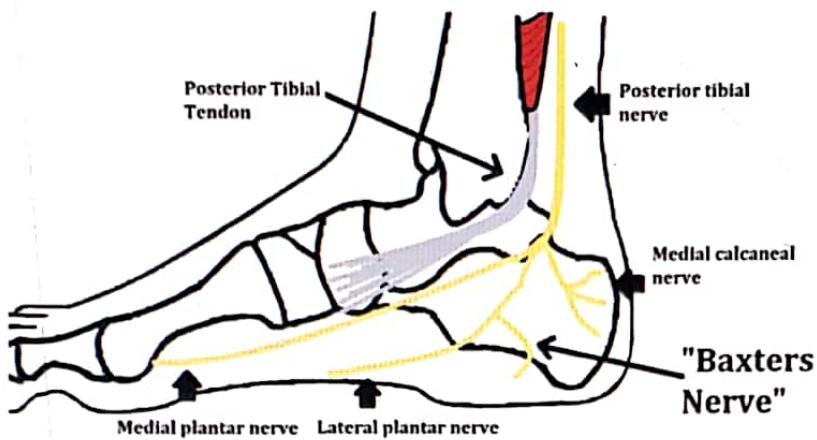
morton's Neuroma :

- most common entrapment disorder
- medial Plantar nerve affected (3rd common branch affected)



Baxter's Neuropathy :

Due to Baxter's Nerve (Inferior calcaneal branch of Lateral plantar nerve)



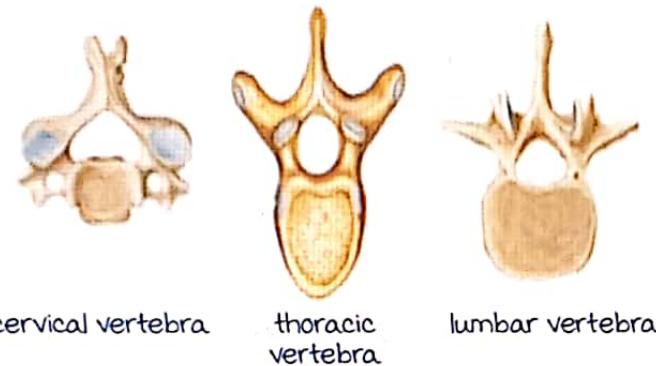
Active space

# BACK

## Vertebra

00:00:11

30 vertebrae ( cervical=7, thoracic = 12, lumbar=5, sacral=4, coccyx=1 )



Different features of vertebrae

Feature	Cervical	Thoracic	Lumbar
Body	Small/circular	Heart shaped	massive / Bean shaped
Vertebral canal	Triangular	Circular	Triangular
Identifying Feature	Foramen transversarium (FT)	Costal demifacet present	No FT/No costal demifacet
Superior art. facet	upwards and backward	upward, backward & laterally	medially
Spine	Bifid	Inclining downward	Backwards

Vertebral artery passes through the foramen transversarium [2017 Allms]

## Curvatures of vertebral column, C1 & C2 vertebra

00:12:07

Active space

Primary curvatures - Before birth - Thoracic & sacral - Kyphosis [concave anteriorly]

Secondary curvatures - After birth - Cervical & Lumbar - Lordosis  
[concave posteriorly]

C1 Vertebra.

Atlas - no body.

Transverse ligament connects the 2 lateral masses.

Groove for vertebral artery.

## C2 vertebra

Axis

Dens +

Atlas and axis are connected by atlantoaxial joint - Pivot joint.

Transverse ligament maintains the atlantoaxial joint. [JIPMER]

Side to side movement of head - atlantoaxial joint. [2019 NEET]

## Cranio axial ligaments

00:24:12

1. Cruciate ligament : consists of transverse ligament & longitudinal ligament.

Superior longitudinal ligament - Dens to occiput bone.

Inferior longitudinal ligament - Dens to axis.

2. Apical ligament of dens - Dens to occiput bone.

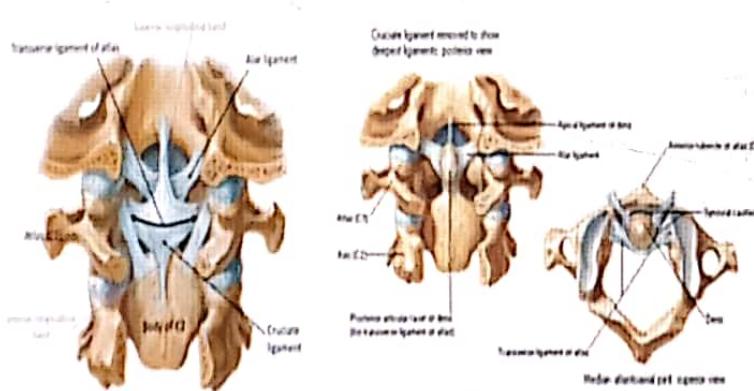
3. Alar ligament of dens - Dens to occiput condyles.

4. Posterior longitudinal ligament - Continuation of tectorial membrane

Ligaments passing through foramen magnum :

1. membrana Tectoria

2. Apical ligament of dens.



Active spaces

3. Superior longitudinal band

Atlanto occipital joint :

Ellipsoid joint &gt; condylar.

'Yes' movement - Flexion &amp; extension of neck.

## Triangles of the back

00:30:10

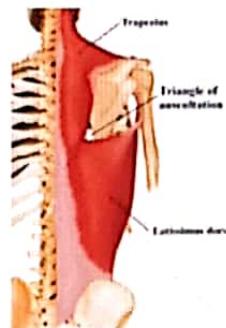
Triangle of auscultation:

Boundaries:

medial - Lateral border of trapezius.

Lateral - medial border of scapula.

Below - Latissimus dorsi.



Importance- Apex of lower lobe of lung, cardiac orifice.

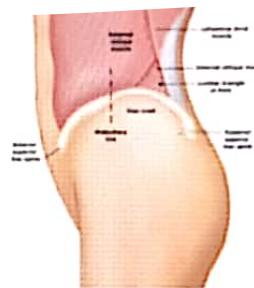
Lumbar triangle of Petit.

Boundaries:

In front - External oblique.

Behind - Latissimus dorsi.

Below - Iliac crest.



Importance- Site of internal hernia.

Latissimus dorsi forms the boundary of both the triangles.

## Spinal segments

00:33:30

	Vertebra	Nerves
Cervical	7	8
Thoracic	12	12
Lumbar	5	5
Sacrum	5	5
Coccyx	1	1

Total= 31 pairs

Spinal nerves upto C7- pass above the corresponding vertebra.

After that, they pass below the corresponding vertebra.

Warning: Not all points are covered in the notes, especially conceptual explanations. Please use the notes in conjunction with marrow masterclasses.

Active space

### Spinal segment :

Part of the spinal cord to which the spinal nerves are attached.

Vertebra	Spinal segment
Cervical	Add +1
T1-T5	Add +2
T6-T9	Add +3
T10	L1,L2
T11	L3,L4
T12	L5
L1	Sacral & coccygeal

### Lumbar puncture

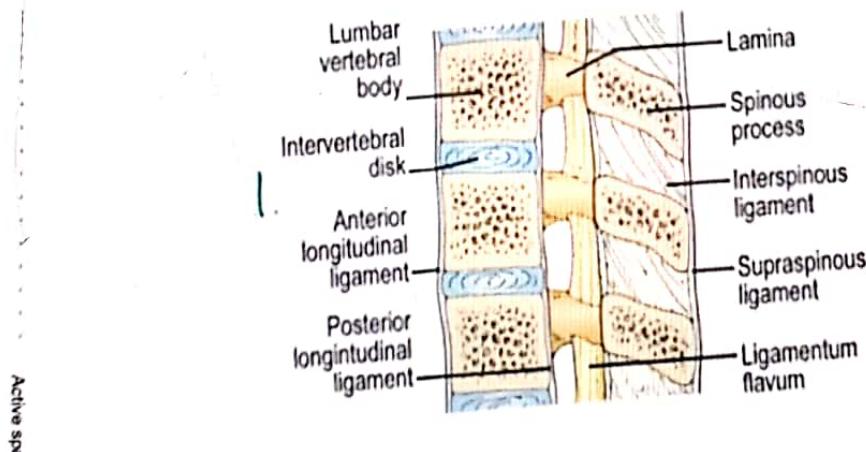
00:43:15

Done at the level of L4-L5 (Level - highest point of iliac crest)

Can also be done at L3-L4.

Structures pierced during lumbar puncture:

1. Supraspinous ligament.
2. Interspinous ligament.
3. Ligamentum flavum - Feeling of giving way or popping sensation
4. Dura - may also have popping sensation or feeling of giving way
5. Arachnoid mater.



# GENERAL ANATOMY

## Types of bones

00:01:18

### 1) Long bones

two ends [Epiphyses] + one shaft

- **medullary cavity**

- Ossified by **cartilage**

Eg: humerus, radius, fibula

miniature long bones

- Only **one epiphysis**

Eg: metacarpal.

modified long bones

- Horizontally placed

No **medullary cavity**

Ossifies by **membrane**

Eg: clavicle

### 2) Short bones

Named according to their **shapes**

Eg: Carpal bones, Tarsal bones ( Trapezium, cuboid)

### 3) Flat Bones

**Protective** in function.

Eg: Bones of thoracic cage and cranial vault.

### 4) Irregular bones

Eg: Hip bone

### 5) Pneumatic bones

**Air filled** cavities

maxillary , Frontal, Ethmoid, Sphenoid sinus bones, mastoid

(Temporal bone)

### 6) Sesamoid bones

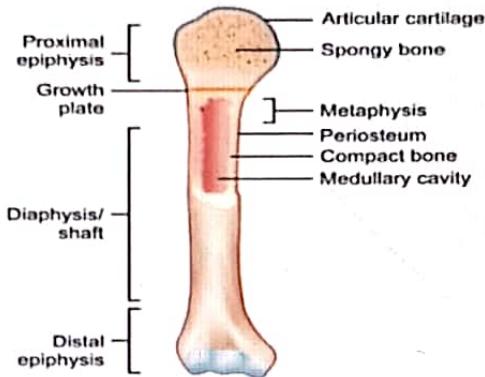
Bones are formed in **tendons**:

Patella- Quadriceps femoris.

Pisiform - Flexor carpi ulnaris.

Riders bone- Adductor longus

Active space

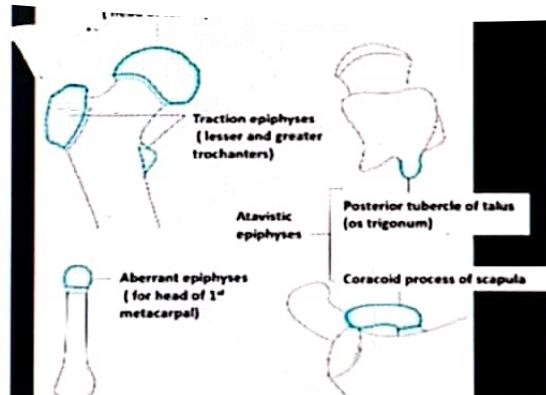


Fabella bone - Lateral head of gastrocnemius

metaphysis:

Epiphyseal end of diaphysis.

Highly vascular.



## Types of Epiphyses and Nutrient artery

00:08:36

Types of Epiphyses:

### 1) Pressure Epiphyses

Joint formation

Transmit weight

Active notes

### 2) Traction Epiphyses

Not involved in joint formation

Formed due to pull of muscles.

Eg: Lesser and greater trochanters.

### 3) Atavistic Epiphyses

Phylogenetically independent.

Fused to surrounding bones mainly for nutrition.

Eg: Coracoid process of scapula

Posterior tubercle of talus (os trigonum)

### 4) Aberrant epiphyses

Not usually present.

Eg: Head of 1st metacarpal bone

Base of remaining metacarpal bones.

Nutrient artery

Supplies:

medullary cavity

inner 2/3rd of cortex

metaphysis

Direction of nutrient artery:

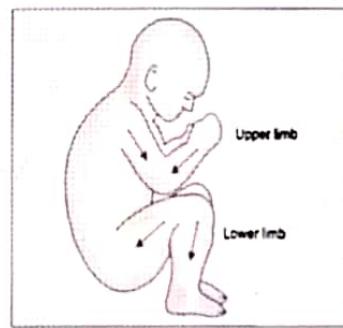
Mnemonic:

'To the elbow I go, from the knee I flee'

Growing end in upper limb:

upper part of Humerus.

Lower part of Radius and ulna



Growing end in lower limb:

Lower end of femur.

Upper end of tibia and fibula.

List of nutrient arteries:

Humerus - Profunda brachii artery

Radius, Ulna - Anterior interosseous artery

Femur - Profunda femoral artery

Tibia - Posterior tibial artery

Fibula - Peroneal artery (branch of : posterior tibial artery)

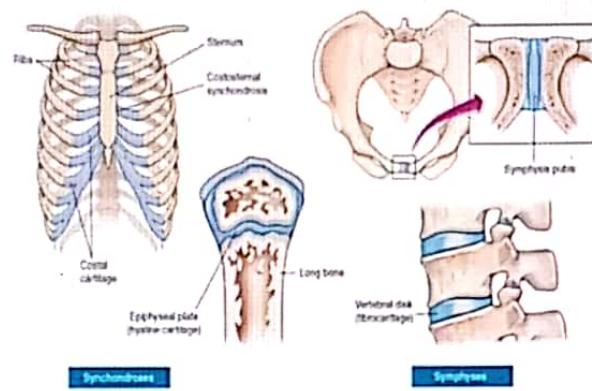
## Types of Joints

00:14:40

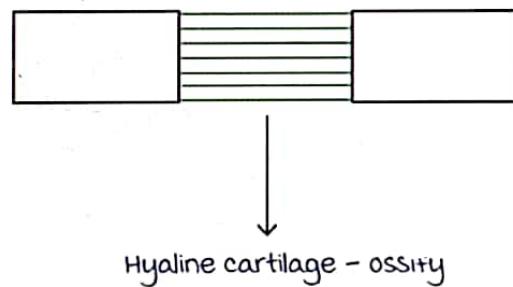
### 1) Cartilaginous joint

Primary cartilaginous joint: Synchondroses

Secondary cartilaginous joint: Symphyses



#### Primary cartilaginous joint:

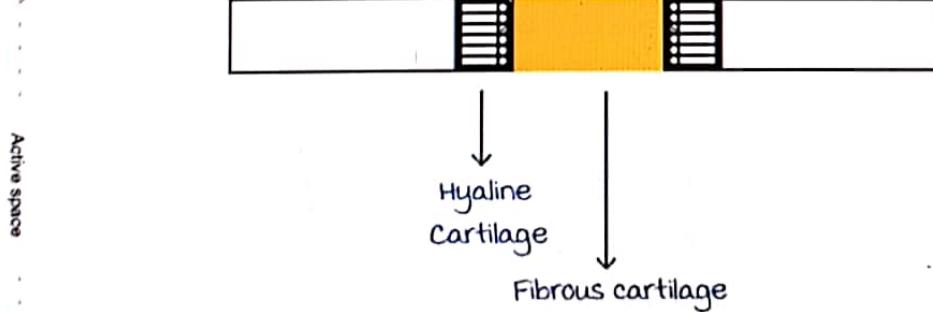


Primary cartilaginous joints are temporary joints

Eg: 1) Joint between epiphysis and diaphysis.

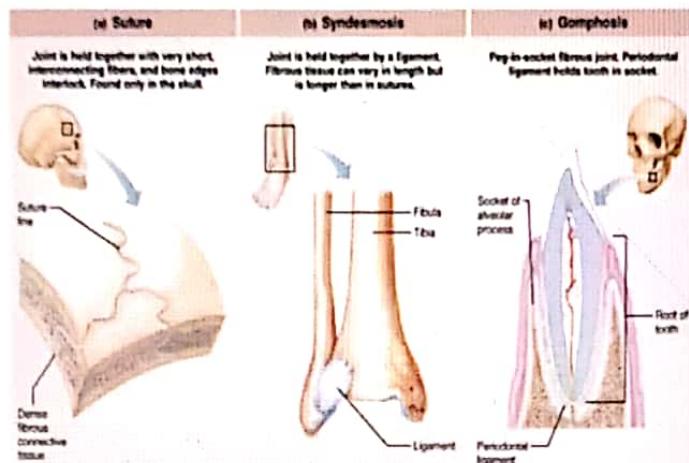
2) Costochondral joints

#### Secondary cartilaginous joint



Secondary cartilaginous joints are permanent

Eg: All midline joints like pubic symphysis, symphysis menti, manubriosternal joint etc

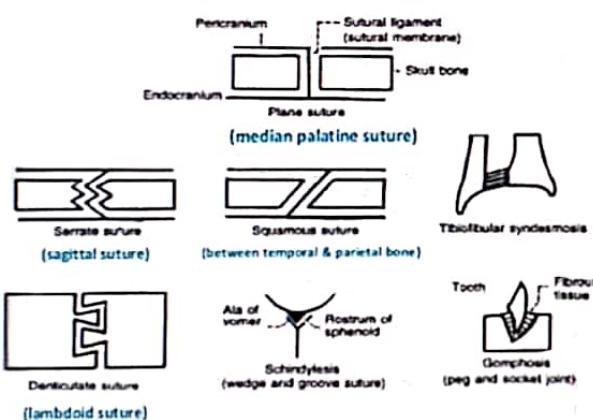


a) Fibrous joint

(a) Suture

Types of sutures :

### TYPES OF SUTURES



Plane suture : median palatine suture

Serrate suture : Sagittal suture

Squamous suture : Between temporal and parietal bone

Denticulate suture : Lambdoid suture

Schindyisis : Wedge and groove suture

Special type of suture

Between **Ala of vomer** and **Rostrum of sphenoid**



Active space

(b) **Syndesmosis**

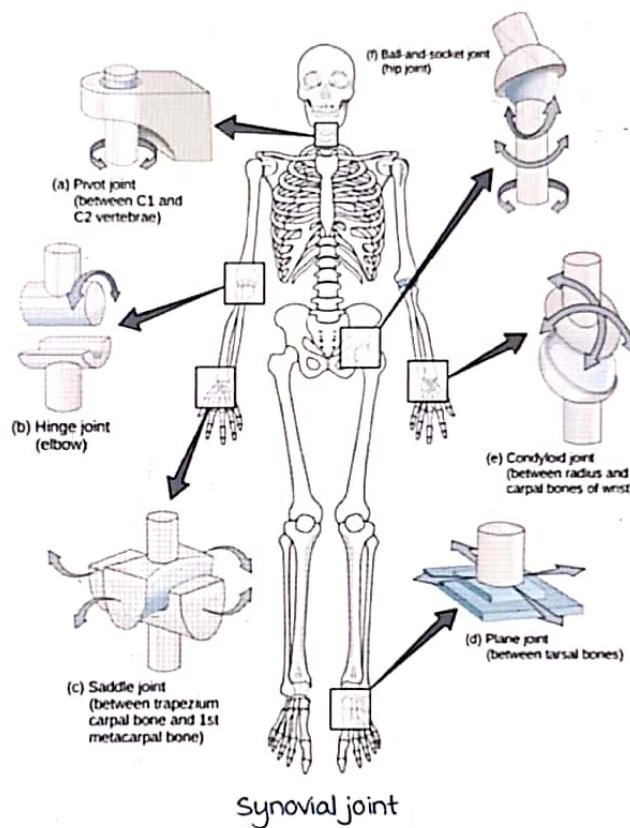
Inferior tibia-fibular joint

(c) **Gomphosis**

Periodontal ligament

**Other types of joints**

00:21:43

**Types:**

**Plane :** Inter carpal joints  
 Inter tarsal joints  
 Chondro sternal joints  
 costovertebral joints  
 Facet joint (zygapophyseal joints)

**Hinge :** Flexion and Extension  
 Eg : Elbow joint  
 Ankle joint  
 Interphalangeal joint

**Pivot :** Rotation  
 Eg : Atlanto-axial joint  
 Radio-ulnar joint

**Condyloid :** Condyles in head  
 Eg : Temporo-mandibular joint  
 Knee joint

**Ellipsoid** : Elliptical condyles

Eg : Wrist joint

Knuckle joint

Atlanto occipital joint

**Saddle** : Reciprocally convexo-concave

Eg : 1<sup>st</sup> carpo metacarpal joint

Sterno-clavicular joint

Malleus-incus joint

Calcalcaneo-cuboid joint

**Ball and socket** : multi-axial

Eg : Hip joint

Shoulder joint

Incus-stapes joint

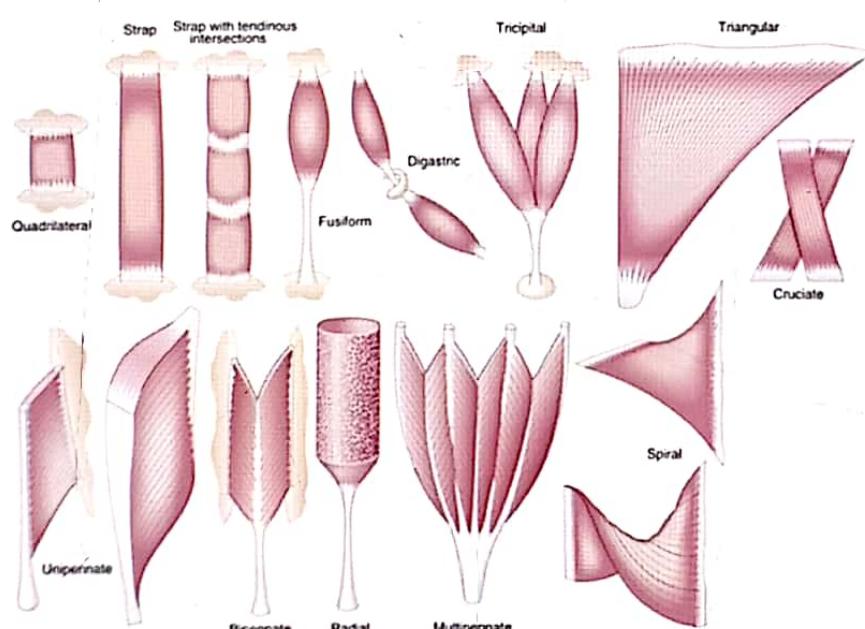
Talo-calcaneo navicular joint.

## Muscles

00:28:05

Origin : Fixed

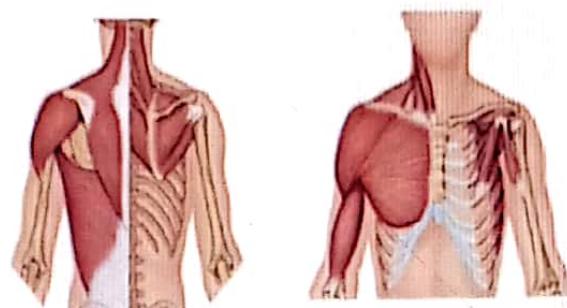
Insertion : movable



**muscle shapes :**

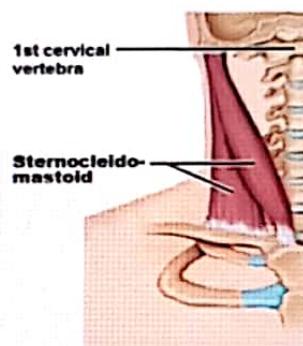
- Quadrilateral : Pronator quadratus  
Thyrohyoid
- Strap : Infrahyoid
- Strap with tendinous intersections : Rectus abdominis
- Fusiform : Biceps  
Digastric
- Spiral/ twisted fasciculi : Trapezius  
Latissimus dorsi

Active space

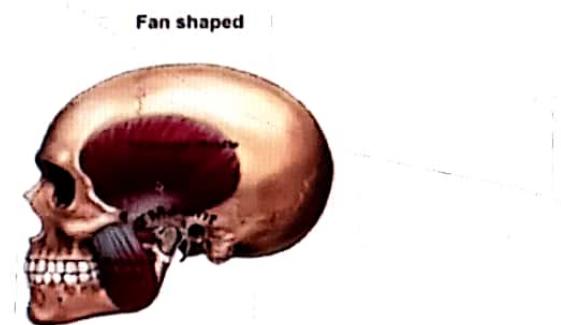


Pectoralis major

Cruciate fasciculi : Sternocleidomastoid



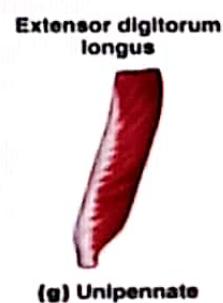
masseter

Convergent Fasciculus : Temporalis  
(broad origin)

Fan shaped

Unipennate : Extensor digitorum longus  
Flexor pollicis longus  
Palmar interosseous  
Lumbricals 1, 2

Active space



(g) Unipennate

**Bipennate:** Rectus femoris  
 Flexor Hallucis Longus  
 Peroneus Longus  
 Dorsal interosseous  
 Lumbricals 3, 4



(f) Bipennate

**Multipennate:** Deltoid  
 Tibialis anterior  
 Subscapularis



(g) Multipennate

**Hybrid muscles:**

2 nerve supplies.

Digastric: Anterior - nerve to mylohyoid  
 Posterior - Facial nerve

Levator scapulae: C3-C4

Dorsal scapular nerve

Subscapularis: upper and lower scapular nerve

Brachialis: musculocutaneous nerve  
 Radial nerve

FDP: Anterior interosseous nerve

Ulnar nerve

FPB: median nerve  
 Ulnar nerve

Pectoralis major: medial and lateral pectoral nerve.

Adductor magnus: Obturator nerve  
 Tibial component of sciatic nerve

Pectenius: Femoral nerve

Obturator nerve

Biceps Femoris: Tibial component  
 Common peroneal nerve component

} Sciatic nerve

Active space