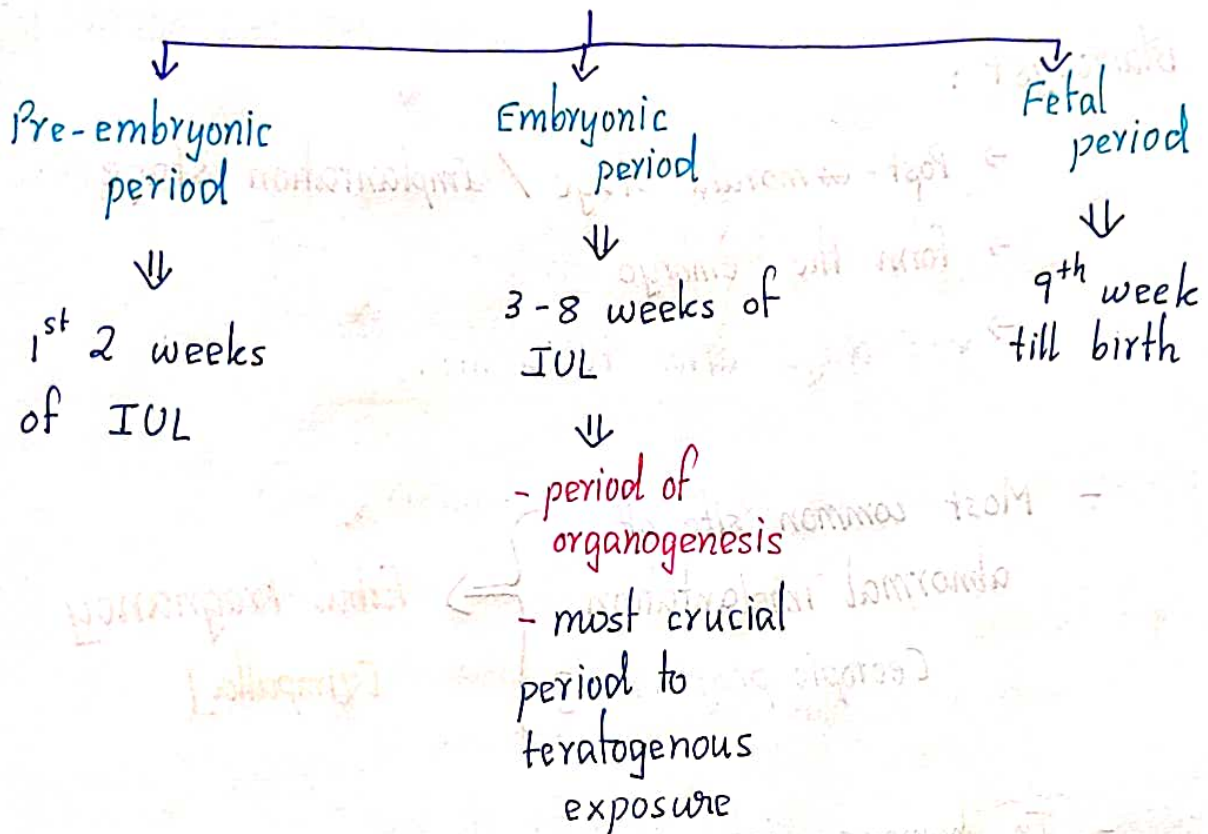


EMBRYOLOGY

3 phases of intrauterine [prenatal] life



Implantation:

- Complete embedding of blastocyst into uterine endometrium.
- Occurs 5-7 days after fertilisation
- usual site of implantation } → upper post. wall of body of uterus

Morula :

- 16 celled stage of embryo.
- 3-4 days after fertilisation.

Blastocyst :

- Post-~~to~~ morula stage / Implantation stage
- form the embryo
- 4-5 days after fertilisation.

- Most common site of abnormal implantation [ectopic pregnancy] } → Tubal Pregnancy [Ampulla]

- In humans, interstitial implantation occurs.

Fate of fertilisation [effects of fertilisation] :

- Completion of 2nd meiotic division [of 2^o oocyte] so that ovum is formed.
- Restoration of diploid [2n] chromosome in zygote.
- Initiation of cleavage [series of mitotic divisions]
- Determination of sex of individual.

spermatogenesis :

→ Formation of spermatozoa from spermatogonium.

Site: ⇒ **Seminiferous Tubules** of testis.

Total duration: ⇒ 70 - 75 days.

→ storage,
Gaining of motility,
Maturation of sperm

} occur in → **Epididymis**

→ Final maturation of sperms → Capacitation of sperms

↓
- ↑ ability of sperms to penetrate ovum.

- Last for about 7 hrs.

↓
♀ **genital tract**

↓
mainly in Uterine tubes
[UT > uterus]

Pathway of movement of sperms: [inside ♂]

Seminiferous tubules

→ straight tubules

→ Rete testis

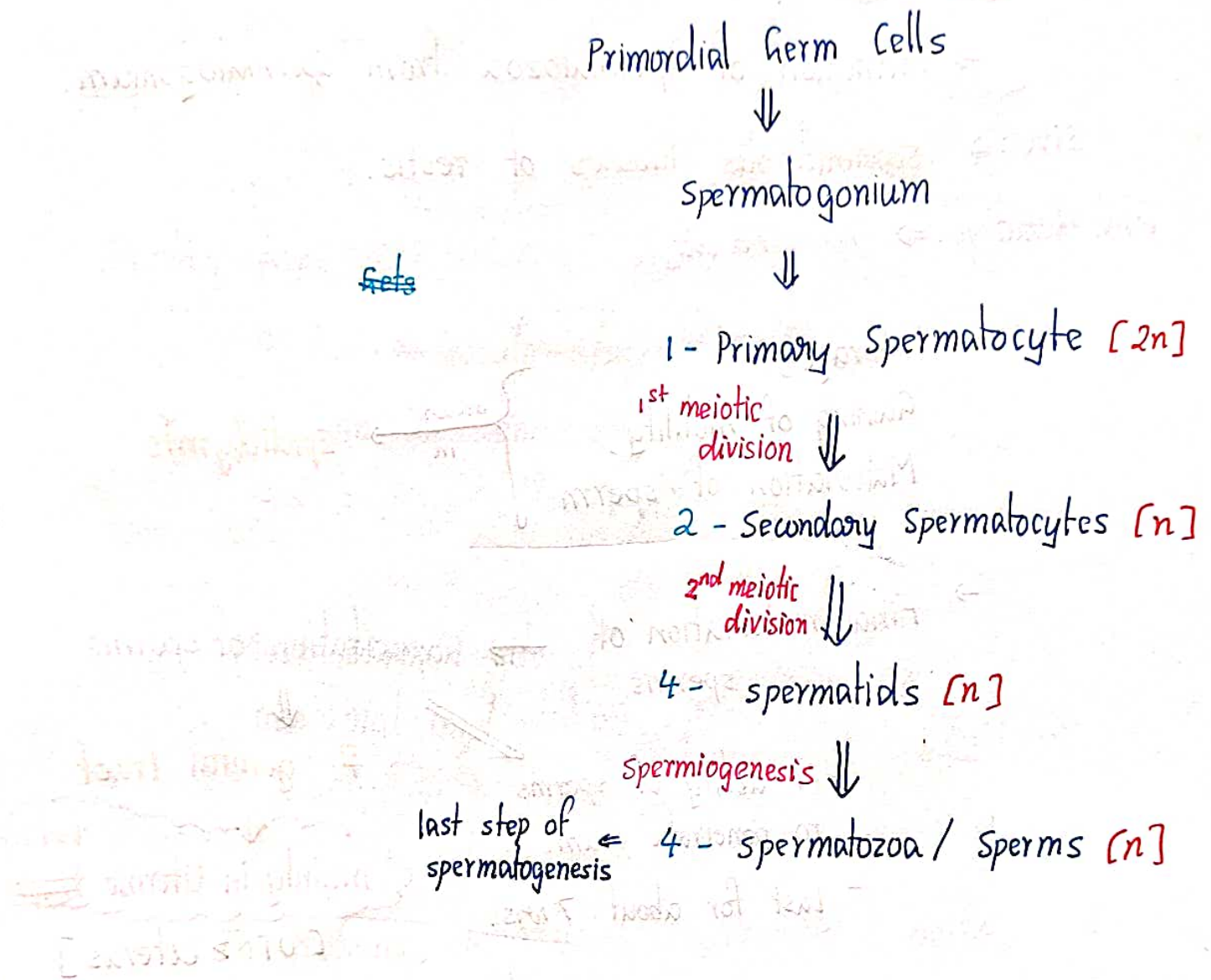
→ Efferent ductules

→ Epididymis

↓
♂ urethra ← Vas deferens

scrotal temp. → 2-3°C lower than body temp.
[for normal spermatogenesis]

Steps:



→ 1 1° spermatocyte → 4 sperms

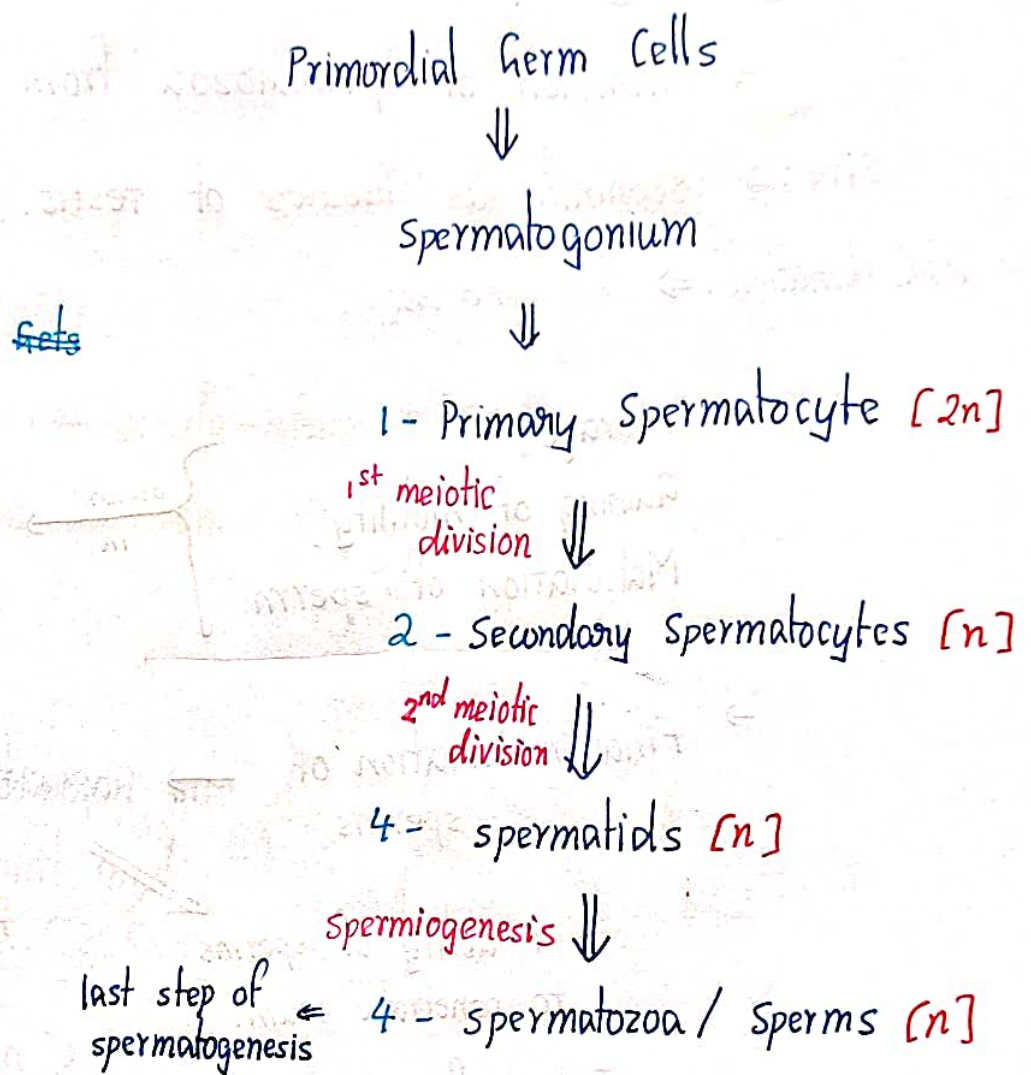
→ 1 1° oocyte → 1 ovum

→ Polar bodies formed → in oogenesis only

→ Meiosis occurs only in germ cells [Gonads]

Testis Ovary

Steps:



→ 1 1° spermatocyte → 4 sperms

→ 1 1° oocyte → 1 ovum

→ Polar bodies formed → in oogenesis only

→ Meiosis occurs only in germ cells [Gonads]

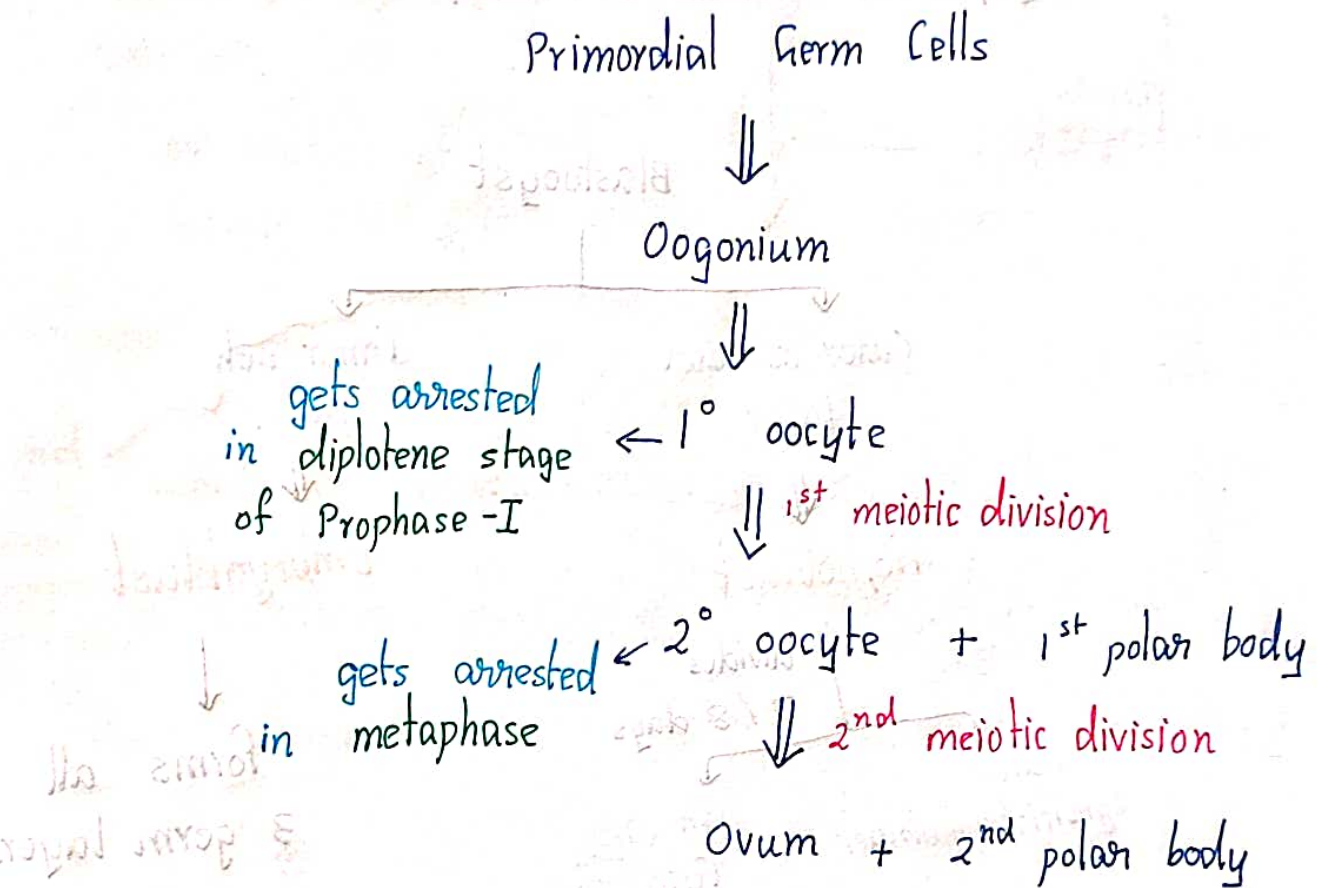
Testis Ovary

Oogenesis :

- formation of ovum from oogonium.

site : - **Ovarian Cortex**

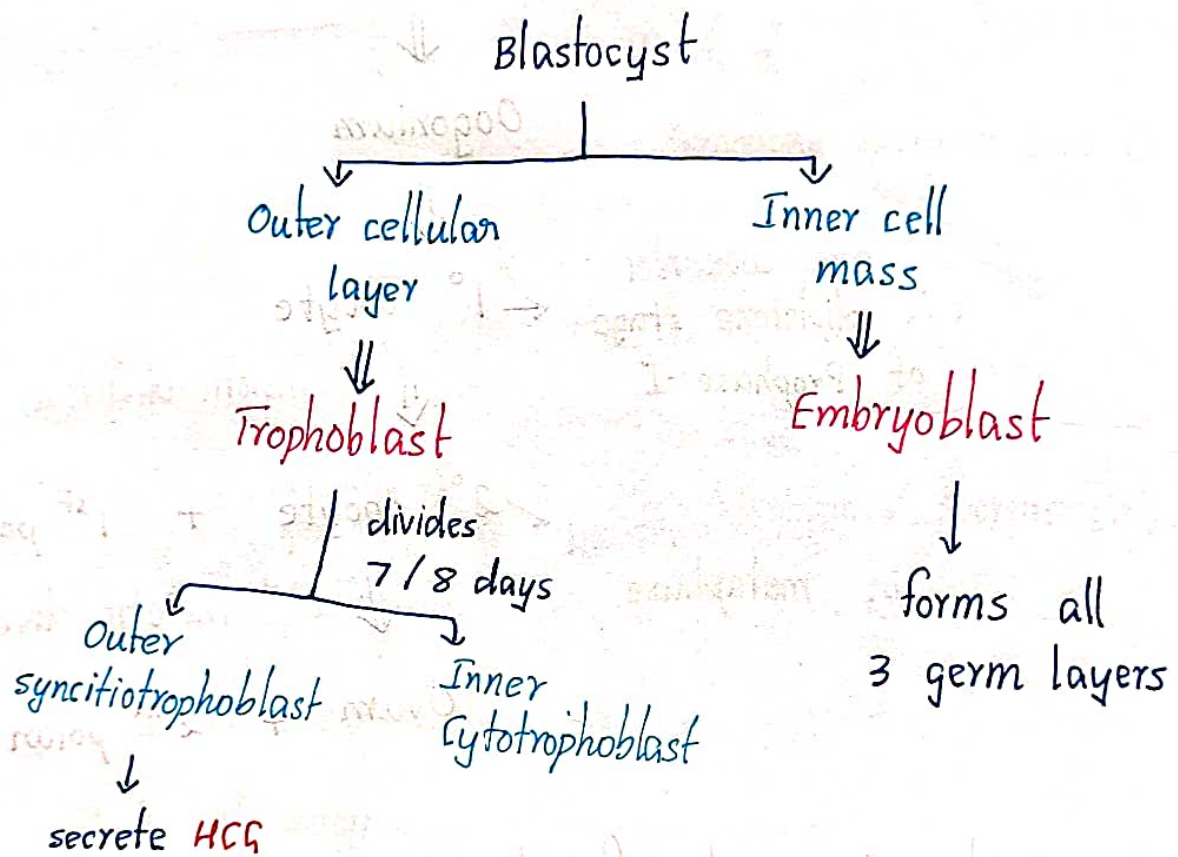
steps :



- The 1° oocyte formation occurs only before birth.
- They get arrested in diplotene stage.
- When they reach puberty, just before ovulation 2° oocyte is formed.
- This 2° oocyte gets arrested in Metaphase-II.
- Completion of 2nd meiotic division occurs soon after fertilisation. (i.e) immediately after sperm penetrates the ovum]

cleavage :

- Continuous mitotic divisions with very less duration of interphase.
- [Nuclear content & cell number increases.
cytoplasmic volume decreases.



→ Fertilised ovum enters Uterus in Morula stage.
↓
[uterine cavity]

Zona Pellucida :

- Membrane covering embryo till blastocyst stage.
- 2 functions:
 - Prevent polyspermy
 - Prevent ectopic pregnancy

2 fates of Corpus Luteum :

If No fertilisation



Corpus luteum
will last for 14 days



Then converts into
corpus albicans

Fertilisation occurred



C.L will last
for 3-4 months

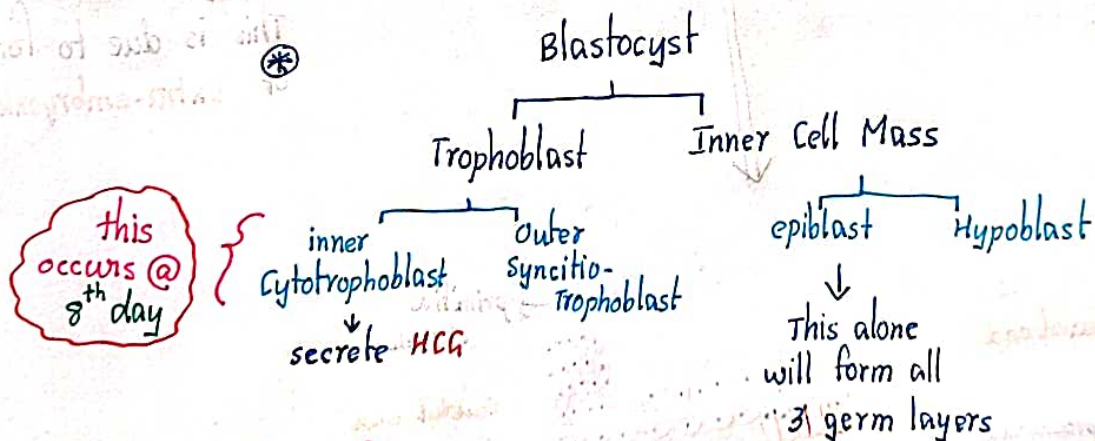


secrete
progesterone

2nd week of development :

→ Bilaminar Germ-disc formation.

Events occurring :

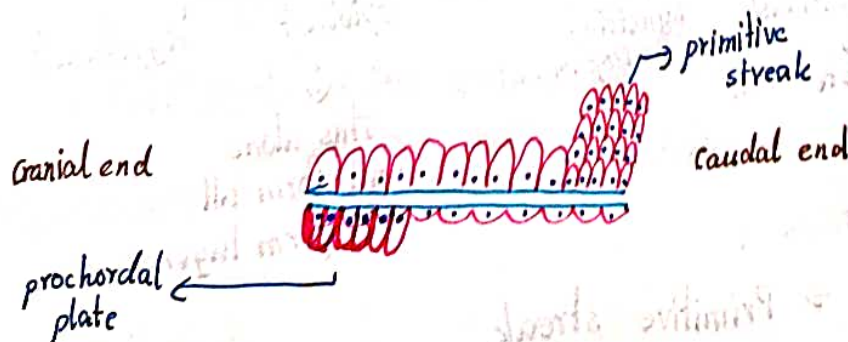
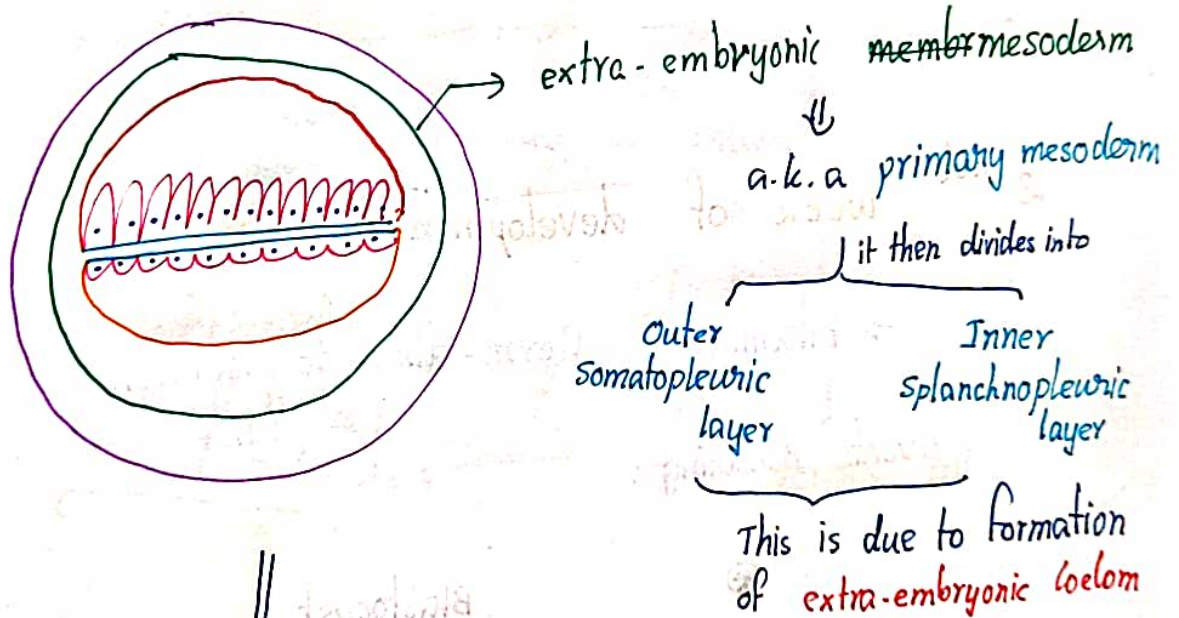
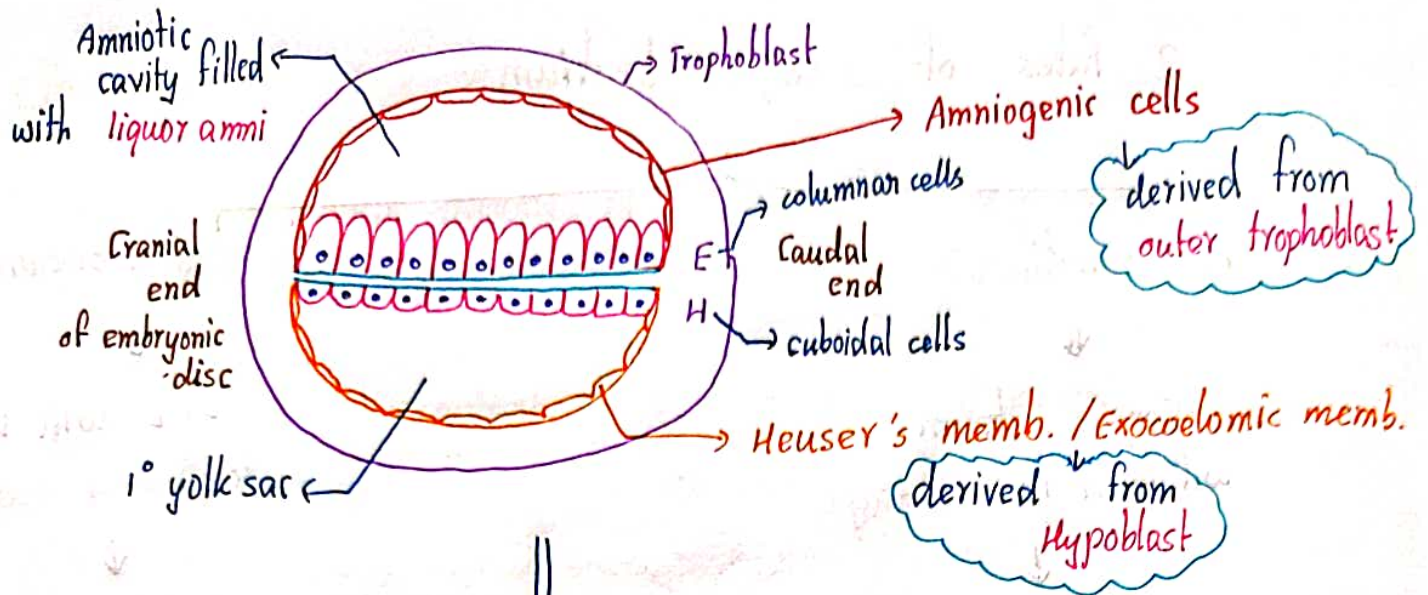


Epiblast forms :

- Primitive streak
- Amniotic cavity
- all 3 germ layers

Hypoblast forms :

- Prochordal Plate
- 1^o yolk sac
- Exocoelomic membrane / Heuser's memb.



3rd week of development

- Trilaminar germ disc formation.

⊗ Gastrulation:

↳ another name of Trilaminar Germ disc formation.

↳ The process of formation of primitive streak & eventually formation of all 3 germ layers is known as gastrulation.

↳ 1st germ layer formed: endoderm

derived from
epiblast &
replaces hypoblast

↓
(after formed will
replace hypoblast)

↳ 2nd germ layer formed: intra-embryonic mesoderm

↳ the remaining cells of epiblast persist as } ectoderm.

⊗ Primitive streak:

→ **Formation:** proliferation of epiblast cells at the caudal end of embryonic disc.

↳ formed during 3rd week of development

→ formation of primitive streak is the 1st indicator/sign of gastrulation.

→ formation of primitive streak } 15th day
occurs on [beginning of 3rd week]

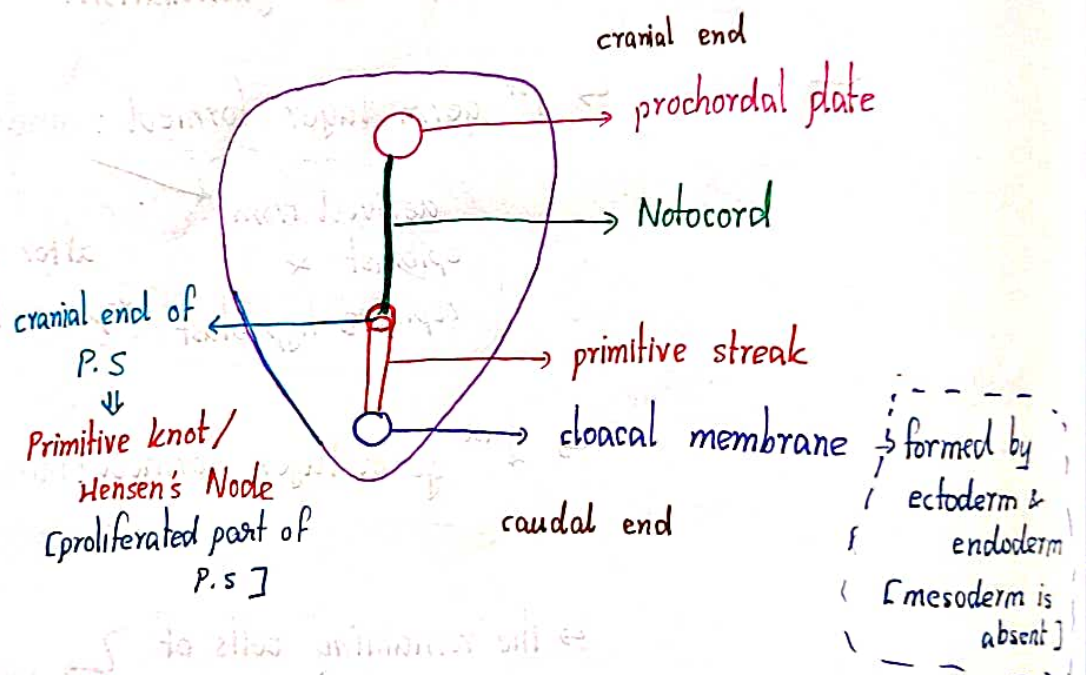
→ Functions / derivatives of P.S :

↳ P.S gives rise to 3 structures [SIN]

S - Septum Transversum

I - Intra-embryonic Mesoderm

N - Notocord



→ Fate of P.S :

↳ Normal P.S cells obliterate after forming all the 3 structures [SIN] in and around 4th week.

Sometimes abnormally, P.S cells persist

↓
will give rise to

Sacro-Coccygeal Teratoma

also can be due to persistence of Primordial Germ Cells

derived from ectoderm

most common tumor in New born

Notocord :

- a midline rod-like structure of embryonic disc.
- formed / derived from **Intra-embryonic mesoderm**.
- develops during 3rd week of development.

Formation :

↳ formed by proliferation of cells of cranial end of primitive streak. (i.e) **Primitive knot**.

Extent :

from Primitive knot / Cranial end of P.S
to Caudal end of prochordal plate

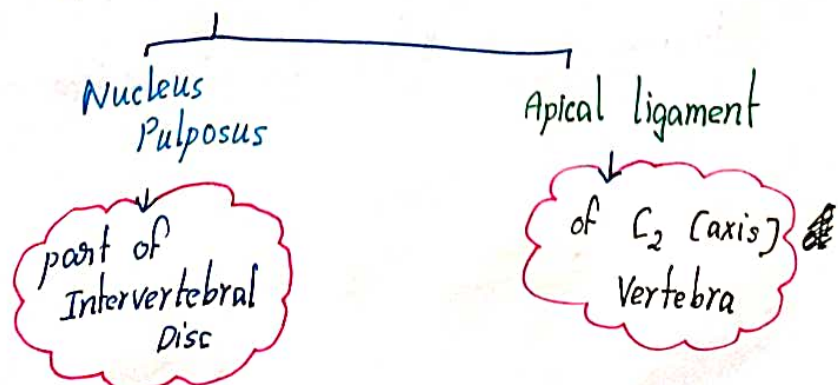
Functions :

- defines the axis of embryo.
- Induces ectoderm to form Neural plate. [forms future Neural Tube]

Fate :

- doesnot give rise to any midline structure in body.
[ex: Vertebral column]

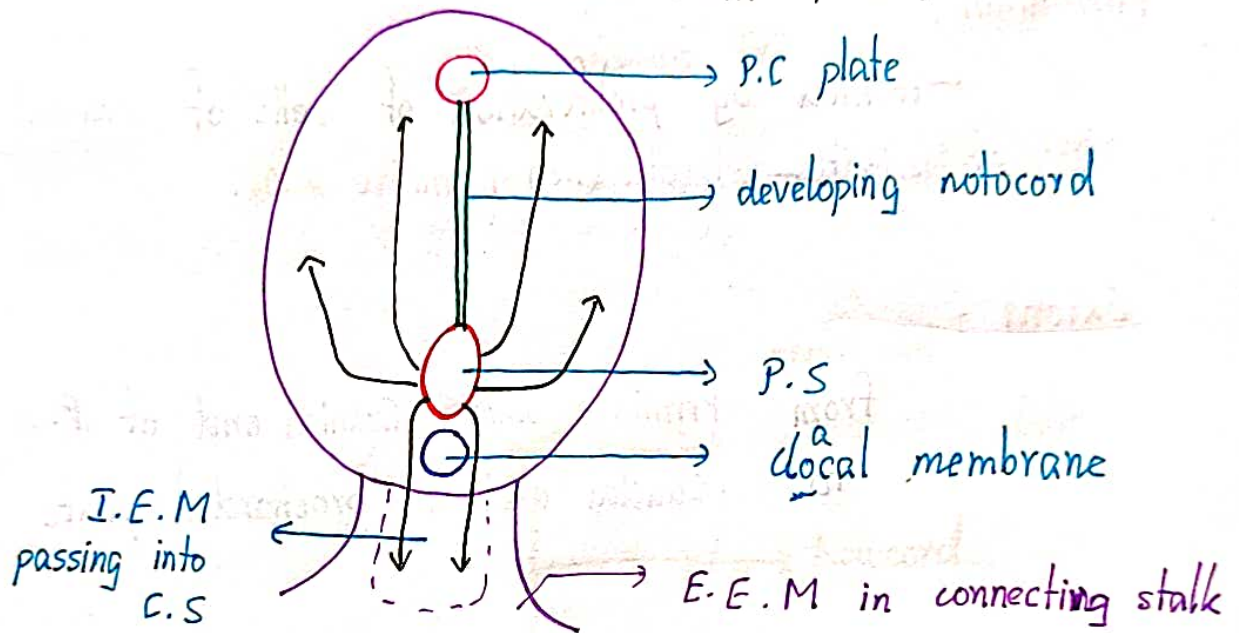
- 2 remnants of N.C in adults :



- Normally Notocordal cells disappear /obliterate completely [except the 2 remnants].

- Abnormally N.C persist & forms **chordoma**
↓
benign tumour

spread of IEM cells after formed from P.S :

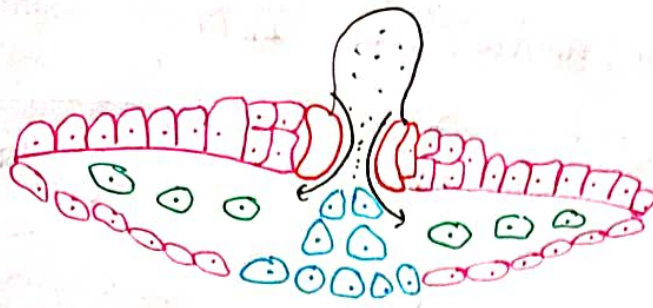


IEM spread throughout embryonic disc except.

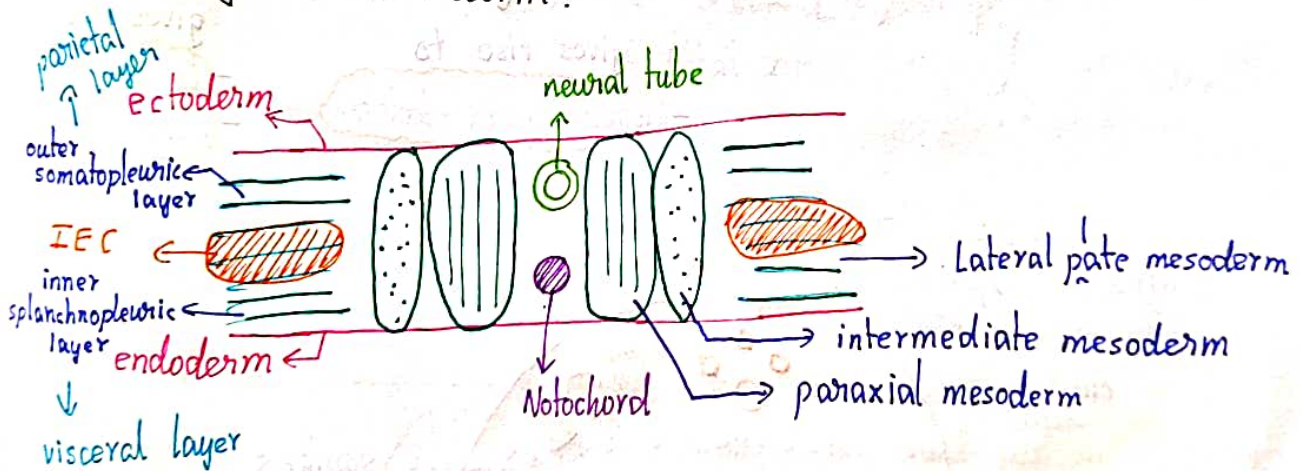
- Prechordal plate
- Notochord
- cloacal membrane

P.C.P & C.M $\Rightarrow$ made up of only **ectoderm & endoderm**
[no mesoderm]

forms
Buccopharyngeal membrane



Intraembryonic mesoderm:



Formation:

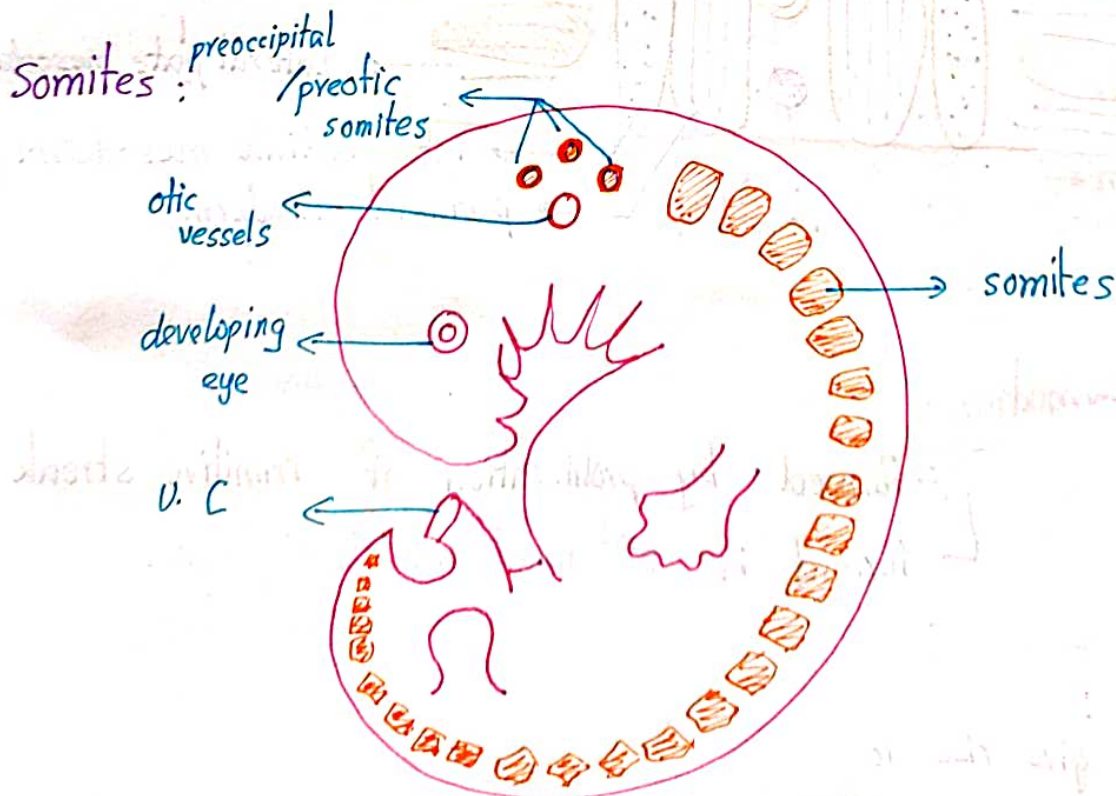
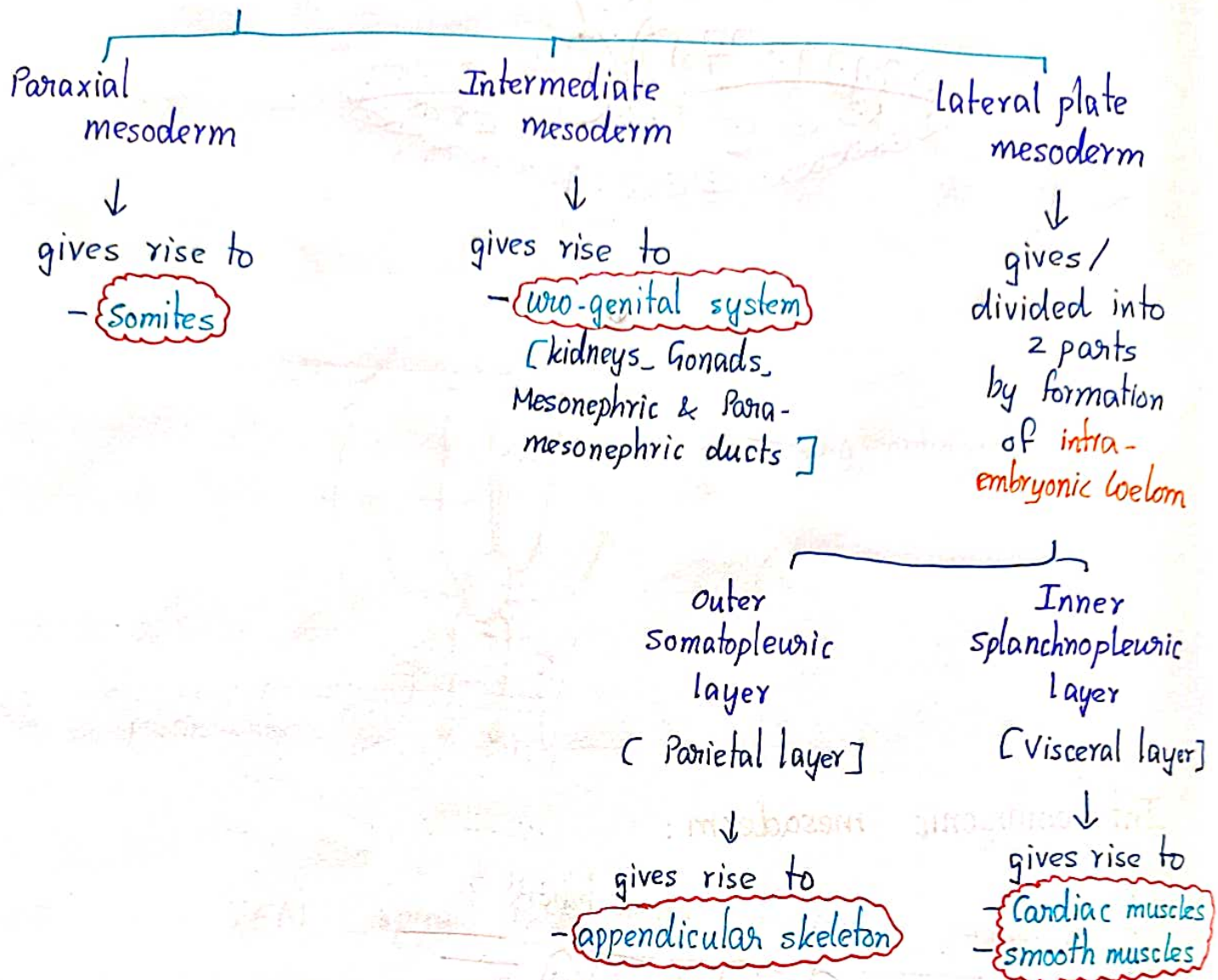
- ↳ formed by proliferation of Primitive streak cells.
- ↳ formed in 3rd week of development.

IEC:

give rise to

- Pleural Cavity
- Pericardial Cavity
- Peritoneal Cavity

3 subdivisions & derivatives of IEM :



- somites are cubical structures.
- Counting the somites $\Rightarrow$ approx. age of embryo can be found.

- somites are derived from **paraxial mesoderm** in cranio-caudal direction.

$\Downarrow$
(i.e) starts from occipital region

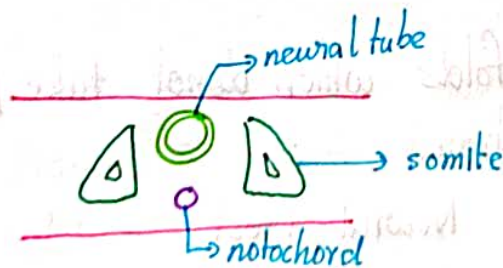
ends at sacrocoxygeal region

- 1st pair of somites appear on $\Rightarrow$ 20th day

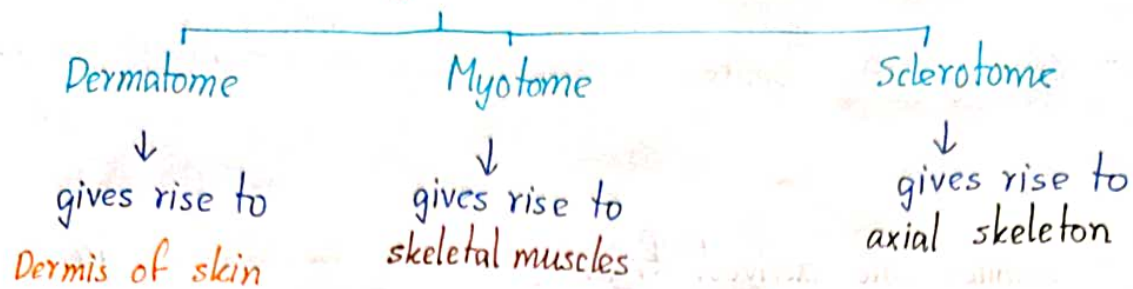
- after which, everyday 3-4 pairs of somites are formed.

- at the end of 5th week [35th day] $\left. \vphantom{\begin{matrix} \text{at the end of 5th week [35th day]} \end{matrix}} \right\} 42-44 \text{ pairs of somites}$
A total of

- somite period : 20th - 30th / 20th - 35th day



3 parts of somites



significance:

↳ by counting them, approx. age of embryo [in somite period] can be estimated.

- ⊗ pre-occipital somites ⇒ give rise to extraocular muscles.
- ⊗ occipital somites ⇒ give rise to tongue muscles [except palatoglossus]
- ⊗ cervical somites ⇒ gives rise to diaphragm [C₃ - C₅]

Neural crest cells:

Formation:

- Tips of neural folds which do not take part in neural tube formation.
- This forms the Neural Crest
- It is considered as 4th germ layer.
- forms major part of peripheral nervous system.
- derived from Neuroectoderm.

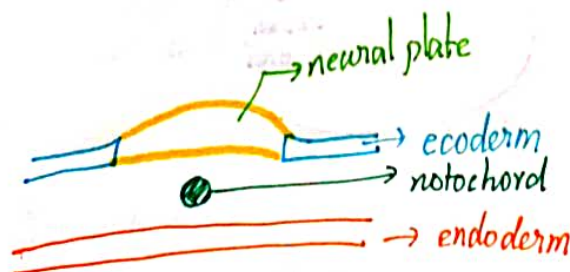
Derivatives :

- ↳ Ganglia of cranial (N) & spinal (N)
- ↳ Autonomic ganglia [symp. & parasymp. ganglia]
- ↳ Nerve Plexuses of GIT [Meisner's Plexus & Auerbach's Plexus]
 - submucosal Plexus
 - Myenteric Plexus [muscularis externa]
- ↳ Adrenal medulla [chromaffin cells]
- ↳ Parafoallicular ['c' cells] of thyroid gland.
- ↳ All neuroglial cells [except microglial cells]
- ↳ Arachnoid & Pia matter [Leptomeninges]
 - [dura mater → mesodermal]
- ↳ Conotrunkal septum of Heart
- ↳ Odontoblasts ⇒ give rise to dentine of teeth.
- ↳ Melanoblast

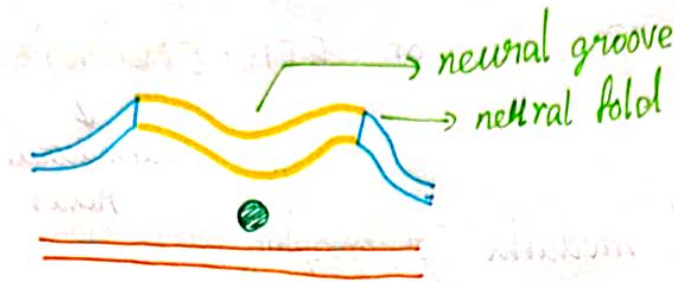
Neurulation :

- Process of nerve tube formation is known as neurulation.

step 1 : Notochord induces overlying ectoderm to form neural tube. plate. [sign of neurulation]



step 2 : Central part of neural plate gets depressed
 ↓
 Neural groove



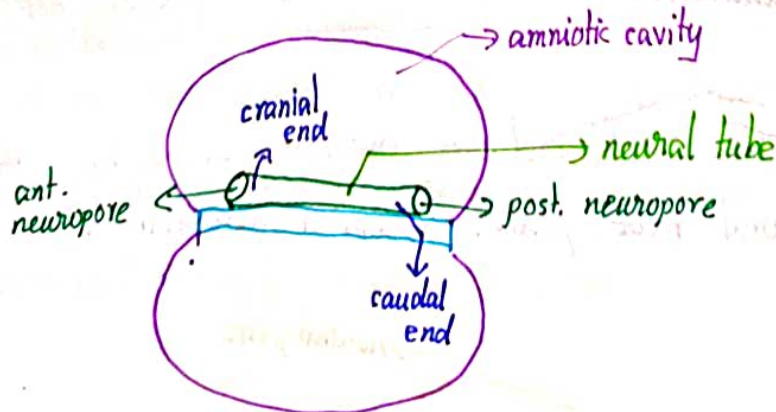
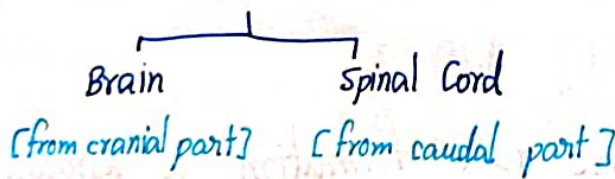
step 3 : Edges get elevated $\Rightarrow$ form neural fold [neural crest]



step 4 : Neural folds come closer $\Rightarrow$ fuse $\Rightarrow$ form neural tube



2 derivatives of neural tube:



Placenta :

- Discoid shaped organ.
- Feto-maternal organ.
- Organ of Respiration. [∵ during fetal life, lungs will be collapsed & non-function]

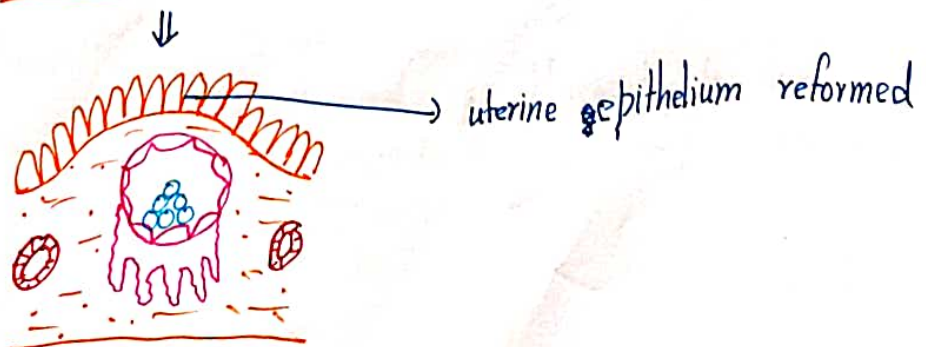
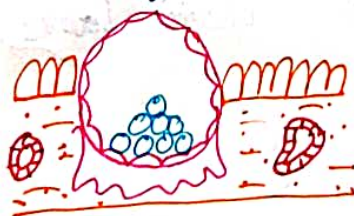
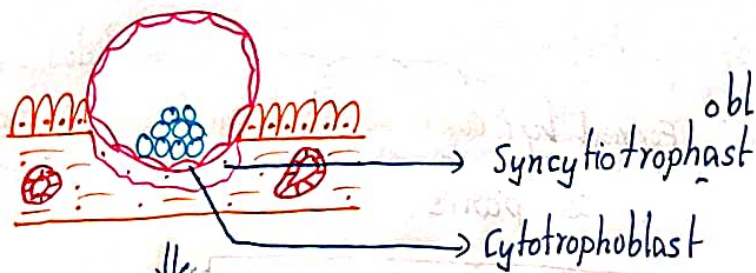
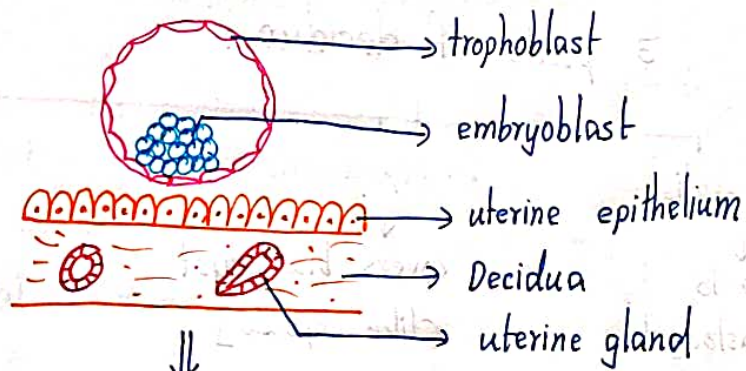
Formation :

Maternal part :

↳ Decidua Basalis

Fetal part :

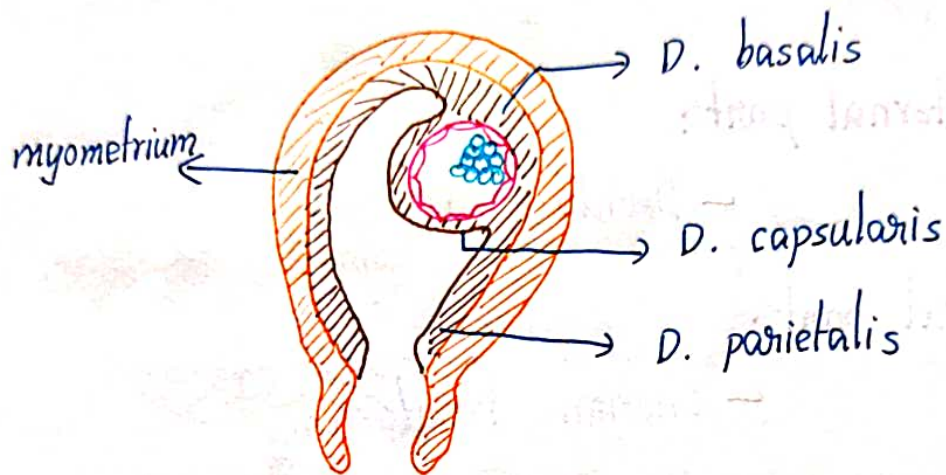
↳ chorion frondosum



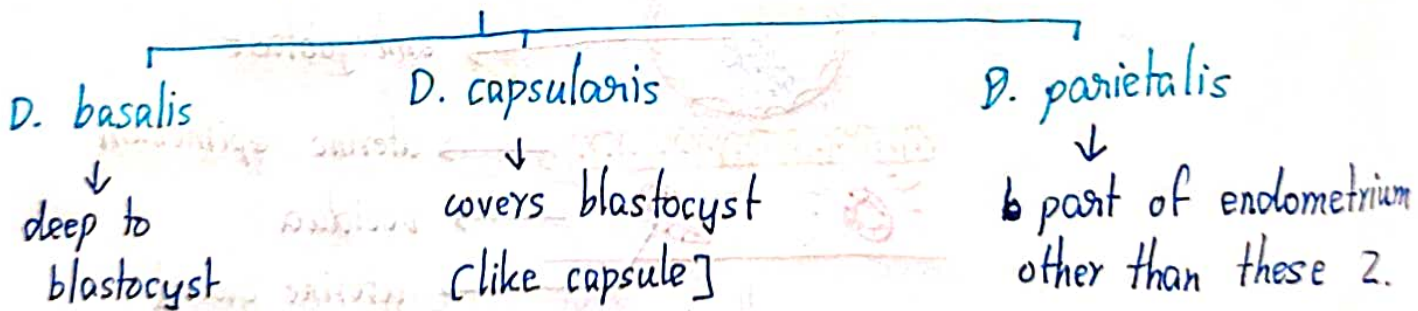
Decidua :

↳ Endometrium of uterus after implantation of blastocyst.

↳ Gravid endometrium is known as decidua.



3 parts of decidua :

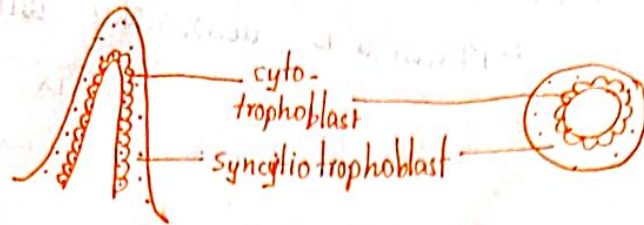


Chorion : Formed by outer somatopleuric layer of EEM & trophoblast union.
2 parts

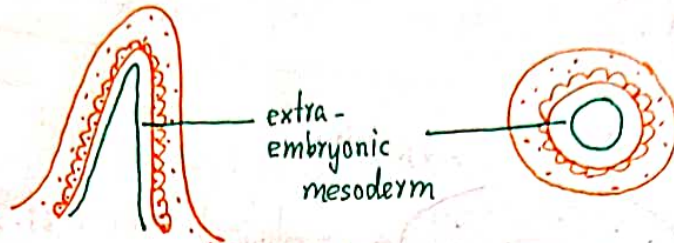
chorion frondosum chorion laeve

3 types of Chorionic Villi :

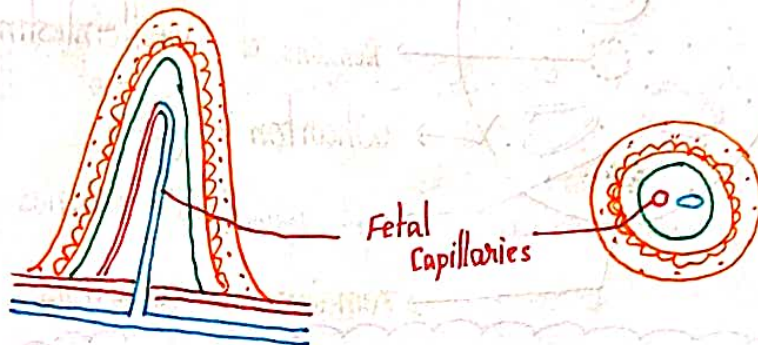
1° villus



2° villus



3° villus



2 surfaces of placenta :

Maternal Surf.

↓
Rough & contains
numerous cotyledons

Fetal Surf.

↓
- smooth & glistening
- Umbilical Cord is
attached to the centre
of this surf. [normally]

Anomalies of placenta :

⊗ Bidiscoidal / Bilobed Placenta :

↳ 2 disc shaped placenta instead of
1 disc shaped placenta.

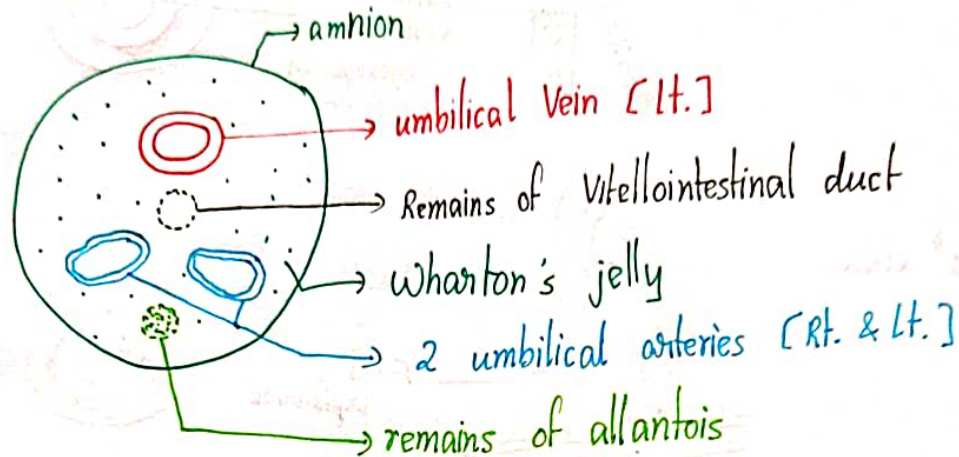
⊗ Marginal Placenta :

↳ Umbilical Cord is attached to the
periphery (margin) of fetal surf. of placenta.

* Placenta Previa:

↳ Placenta is abnormally attached to lower part of uterus / Cervix.

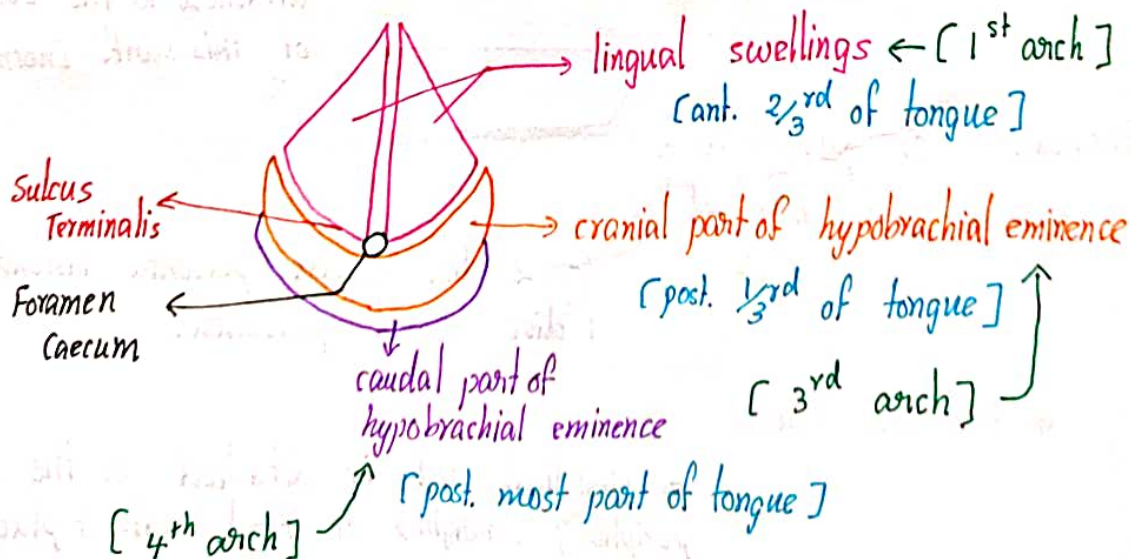
Umbilical Cord:



Wharton's jelly → Mucoid Connective Tissue

Anastomoses b/w 2 umbilical arteries ⇒ Hyrtl's anastomoses

Development of tongue:



pharyngeal
arches

Embryonic
structures

Part of Tongue
derived

1st arch

→ pair of lingual swellings
1 tuberculum impar

ant. $\frac{2}{3}$ rd
of tongue

3rd arch

→ cranial part of Hypobranchial
eminence

post. $\frac{1}{3}$ rd of
tongue

4th arch

→ caudal part of Hypobranchial
eminence

Epiglottis & *
post. most
part of tongue

All tongue muscles $\Rightarrow$ derived from Occipital Myotomes/
Somites

└ except palatoglossus [4th pharyngeal
arch]
└ supplies by Hypoglossal (N)

Development of thyroid:



ultimobranchial body [caudal pharyngeal
complex]

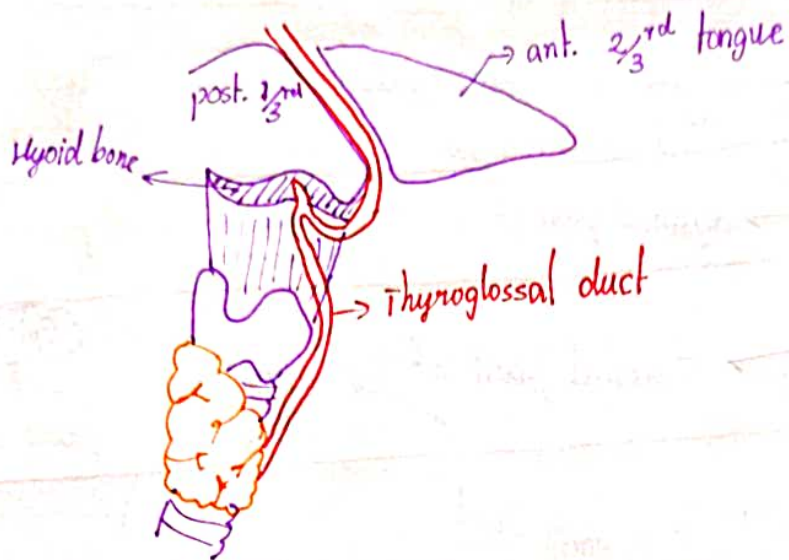
↓
developing thyroid
from Thyroglossal duct



→ remnant of thyroglossal duct

→ pyramidal lobe

→ isthmus



→ Thyroid diverticulum [Thyroglossal duct] is an outgrowth from the floor of primitive pharynx

→ Thyroid gland is endodermal in origin.

→ Thyroglossal duct runs downwards in front of hyoid & then below hyoid bone & finally reach in front of trachea.

↳ Here it enlarges to form bilobed thyroid gland.

→ After forming of Thyroid, usually entire Thyroglossal duct disappears.

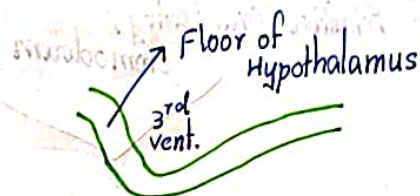
→ Abnormally, a part of thyroglossal duct may persist called Thyroglossal cyst.

most common site ⇒ subhyoid region
rupture leads to
Thyroglossal Fistula

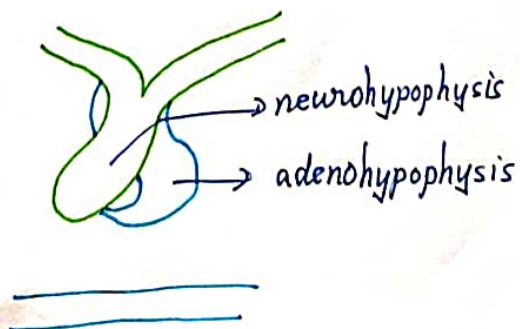
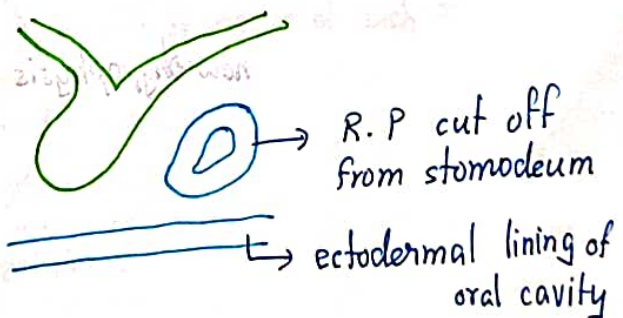
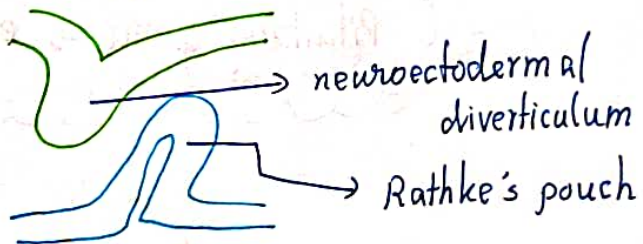
Parafollicular cells → derived from Neural Crest Cells & ultimobranchial body

Thyroid gland starts functioning by the end of } 12th week
[end of 3rd month]

Development of Pituitary Gland:



ectodermal lining of primitive oral cavity



2 parts of pituitary

Adenohypophysis [ant.]

Neurohypophysis [post.]

↓
develops from
Rathke's pouch

↓
develops from
Hypothalamus [floor]
← from Diencephalon

↓
ectodermal diverticulum
from Roof of Primitive Oral Cavity /
stomodeum

↓
It forms neuroectodermal
diverticulum

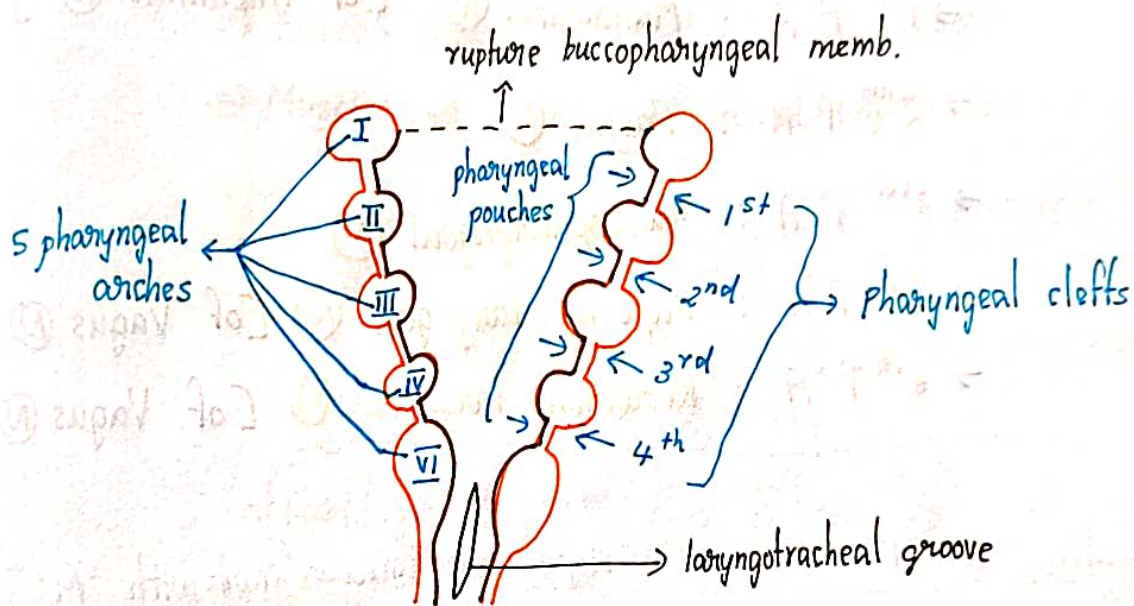
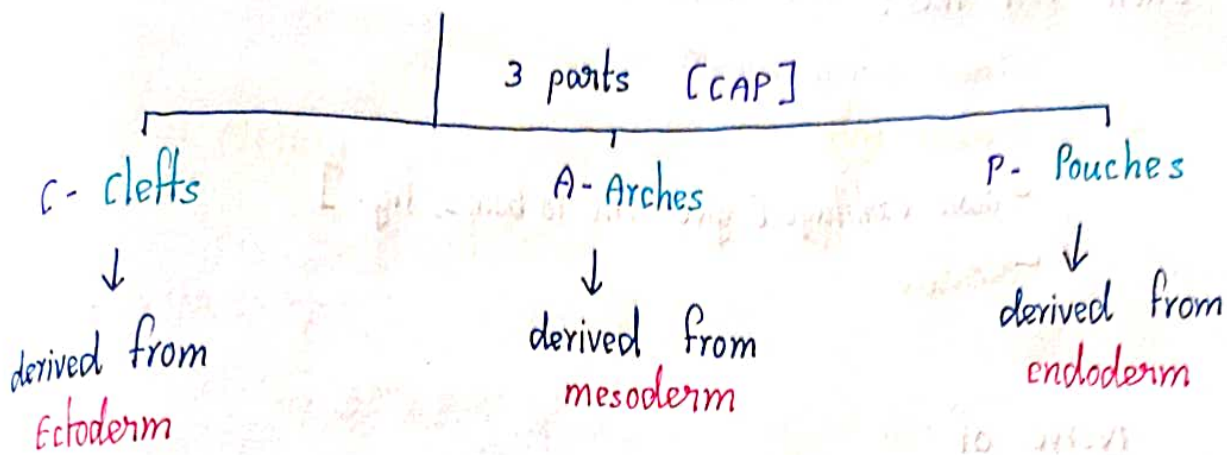
Both diverticulum fuse to form Pituitary Gland

Pituitary gland ⇒ ectodermal origin

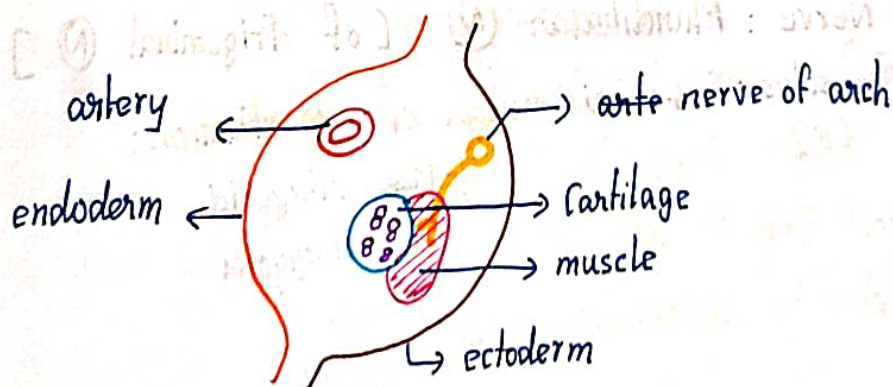
adenohypophysis {
 Pars Distalis
 Pars Intermedia
 Pars Tuberalis

neurohypophysis - Pars nervosa

pharyngeal / Branchial Apparatus :



Pharyngeal arches :



There are totally 5 pharyngeal arches.

5th P. A $\Rightarrow$ disappears [absent]

Each P.A has:

↳ own artery

↳ own **N**

↳ own cartilage [give rise to bones, lig.]

↳ muscles

Nerve of

→ 1st P.A : Mandibular **N** [of Trigeminal **N**]

→ 2nd P.A : Facial **N**

→ 3rd P.A : Glossopharyngeal **N**

→ 4th P.A : Superior laryngeal **N** [of Vagus **N**]

→ 6th P.A : Recurrent laryngeal **N** [of Vagus **N**]

Derivatives of 1st P.A : [Majority derivatives ⇒ start with 'M']

⇒ 1st P.A is a.k.a Mandibular arch.

⇒ Nerve : Mandibular **N** [of Trigeminal **N**]

⇒ Muscles : → 4 main muscles of mastication:
[8]

↳ Med. Pterygoid
↳ Lat. Pterygoid
↳ Masseter
↳ Temporalis

→ MATT :

M - mylohyoid

A - Ant. belly of Digastric

T - Tensor tympani

T - Tensor Palati

⇒ Cartilage of 1st P.A : ~~the~~ Meckel's Cartilage

⇒ Bones : - Maxilla, Mandible,
- Malleus, Incus

⇒ ligaments : → spheno-mandibular lig.
→ Ant. lig. of malleus

⇒ Artery : **Maxillary artery**

Derivatives of 2nd P.A :

⇒ 2nd P.A is a.k.a **Hyoid arch**.

⇒ Nerve : **Facial (N)**

⇒ Muscles : → muscles of facial expression

→ 2 'P's' → Post. belly of digastric
→ Platysma

→ 2 'S's' → stapedius
→ stylohyoid

⇒ Cartilage of 2nd P.A : **Reichert's cartilage**

⇒ Bones & ligaments : 5 'S's'

- stapes
- styloid process of Temporal bone
- stylohyoid lig.
- smaller [lesser] Horns
- superior part of body of Hyoid

⇒ Artery : - **Hyoid artery**
- **stapedial artery** } significant mainly during fetal life.

Derivatives of 3rd P.A :

⇒ Nerve : **Glossopharyngeal (N)**

⇒ Muscles : **Stylopharyngeus muscle**

⇒ Bones :
- Greater Horns
- Inf. part of body of Hyoid

⇒ Arteries : **3 carotid art. [CCA, ICA, ECA]**

°° 3rd P.A is a.k.a **carotid arch.**

Derivatives of

→ a.k.a **Pulmonary arch**

4th P.A

6th P.A

⇒ Nerve : **sup. laryngeal (N)**
[of Vagus (N)]

recurrent laryngeal (N)
[of Vagus (N)]

⇒ Muscles : → all muscles of pharynx
[except **stylopharyngeus**]

→ all muscles of soft palate
[except **Tensor Palati**]

→ **Cricothyroid**

→ all intrinsic muscles of larynx
[except **cricothyroid**]

⇒ Cartilages : All cartilages of larynx are derived from cartilages of 4th & 6th P.A [except : **Epiglottis**]

← caudal part of
hyobranchial eminence

⇒ Arteries : { Rt. side: **Rt. Subclavian art.**
Lt. side: **Arch of aorta**

→ Rt. Lt. } → **Rt. & Lt. pulmonary Ar.**

Ductus Arteriosus
[Lt. side]

Pharyngeal Pouches: [Endodermal]

Derivatives of

* 1st P.P :

→ Tubo-tympanic recess : { Eustachian tube
Tympanic cavity
Tympanic antrum/
Mastoid antrum.

* 2nd P.P :

→ Ventral part of P.P ⇒ Palatine tonsils/
Tonsillar fossa

* 3rd P.P : [Th Ird]

↓
Thymus → pair of Inf. Parathyroid Glands

* 4th P.P :

→ Sup. parathyroid Glands

→ Ultimobranchial body → parafollicular / C cells
of thyroid gland

Pharyngeal Clefts :

→ Only 1st cleft gives rise to definitive structure

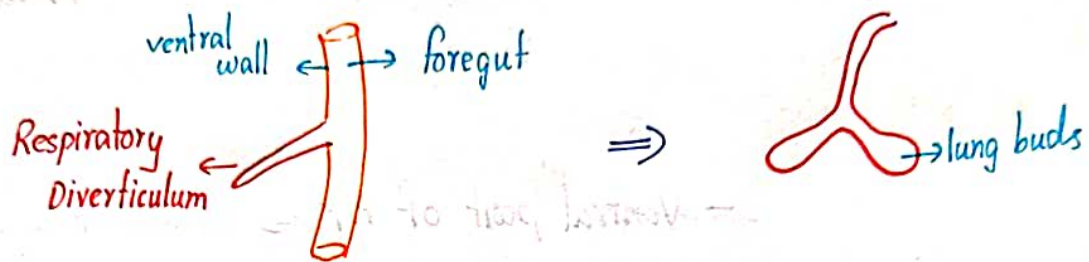
[External Auditory Meatus]

→ Other 3 clefts will disappear.

Development of Respiratory System:

→ Respiratory System is **Endodermal** in origin.

→ Respiratory Diverticulum arises from **ventral wall** of **foregut**.



→ R. D grows downwards & divides into 2 lung buds / Bronchial buds.

→ Proximal part of R.P forms ⇒ **Larynx & Trachea**

→ 2 Lung buds of R.P forms ⇒

↓
form 2 primary bronchi

↓ divides to

secondary bronchi [**lobar bronchi**]

↓ divides to

tertiary bronchi [**segmental bronchi**]

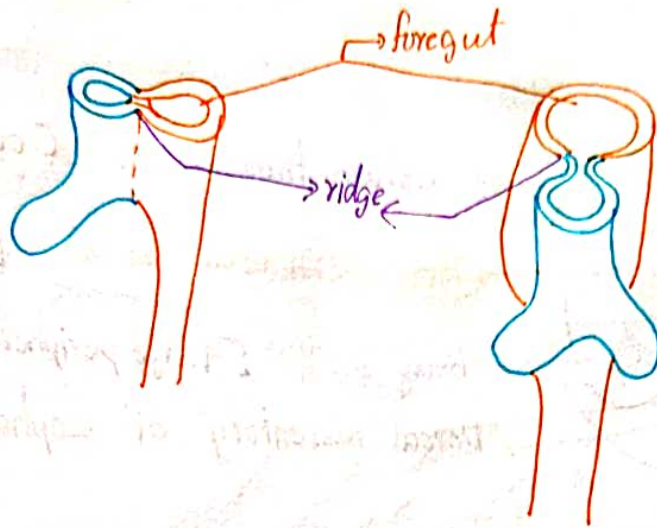
↓ further divisions & sub-divisions

Terminal bronchioles, Respiratory bronchioles

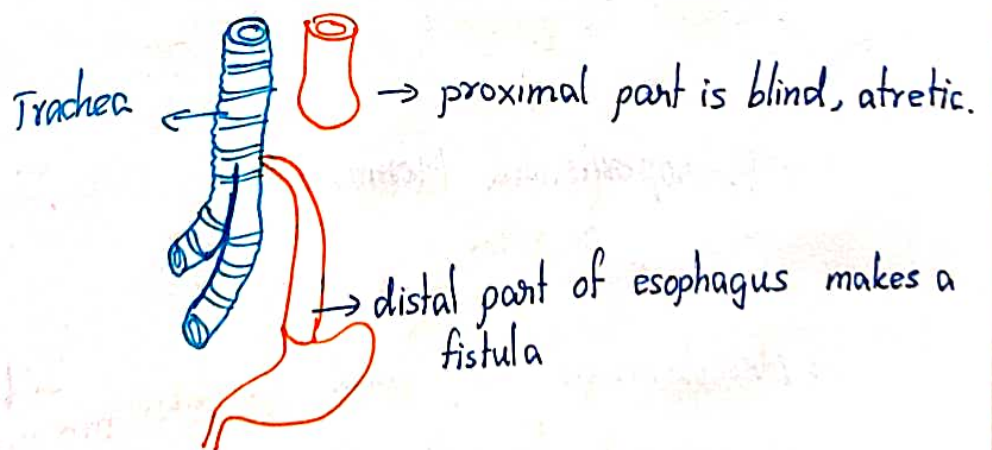
Alveolar sac, Alveoli

Cartilages, Smooth muscles,
Connective tissue components } → derived from **splanchnopleuric mesoderm**

Tracheo-esophageal fistula:

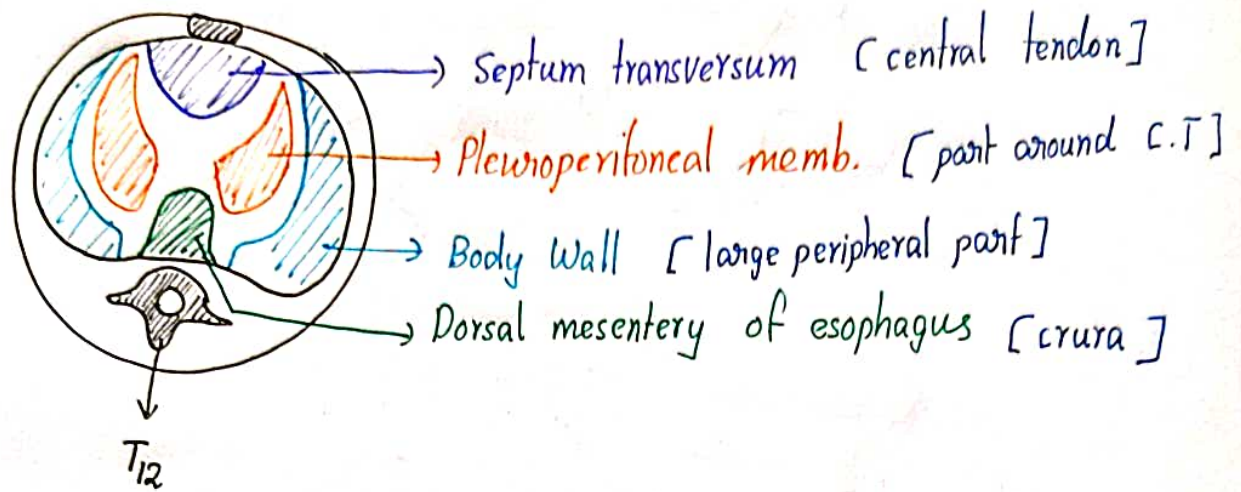


- Abnormal communication b/w trachea & esophagus.
- due to defective development of tracheo-esophageal septum.
- TEF is associated with esophageal atresia.
- Most common type of TEF is



→ This can be suspected by immediate vomiting of anything taken in [milk] by the neonate.

Development of diaphragm:



Diaphragm is **mesodermal origin**.

Embryonic Structure

→ Septum Transversum

→ Pleuroperitoneal Memb.

→ Mesoderm of body wall

→ Dorsal mesentery of oesophagus

→ Cervical myotomes / [C₃ - C₅] Somites

Part of Diaphragm formed

- Central tendon of diaphragm.

- small peripheral part around the central tendon.

- large peripheral part of diaphragm.

- Crura [Rt. & Lt. crus]

- muscular part of diaphragm.

Congenital Diaphragmatic Hernia:

Most common cause: defective development of Pleuroperitoneal memb.

CDH is more common on left side, Post. lat. aspect.

most common CDH ← Bochdalek Hernia

This hernia will cause accumulation of abdominal contents into thorax

↓
This will collapse / compress the lung

↓
Pulmonary Hypoplasia
[Mainly Lt. lung]

↓
This will cause death of fetus.

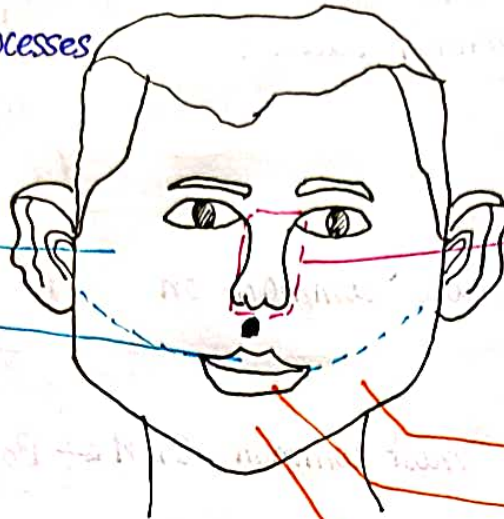
Morgagni Hernia:

↳ occurs through foramen of morgagni into Rt. ant. side / direction.

Development of Face :

* Maxillary processes

1. Upper part of cheek
2. lat. part of upper lip

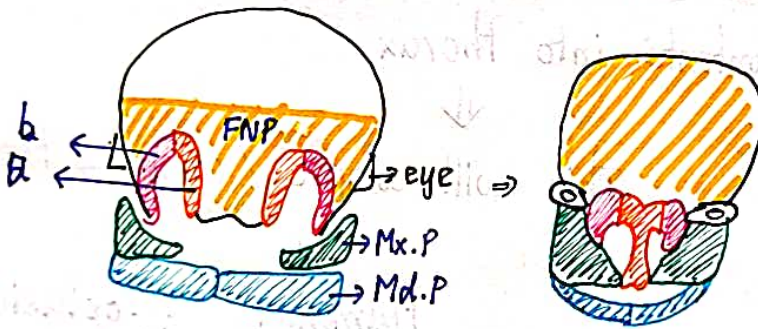


* Fronto-nasal Process

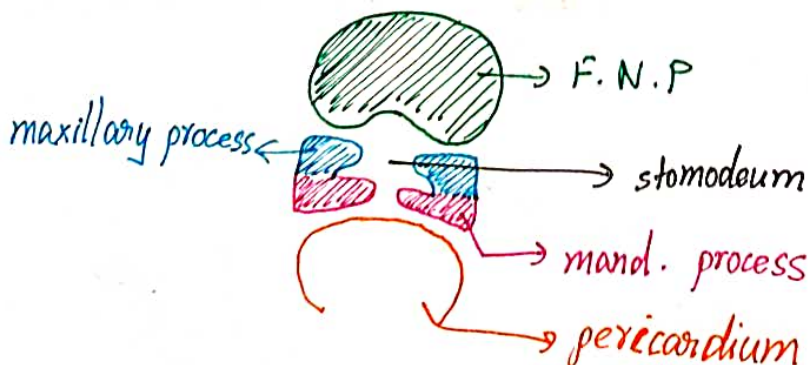
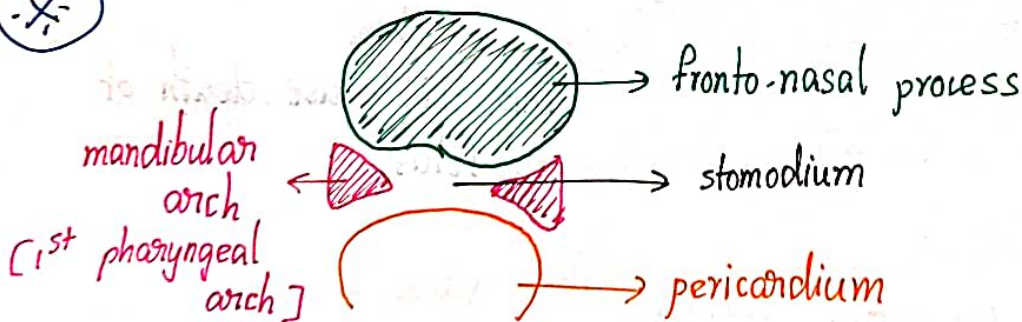
1. Forehead.
2. Ext. nose, nasal cavity, nasal septum
3. Philtrum of Up. Lip

1. Lower part of cheek
2. entire lower lip
3. chin / mentum

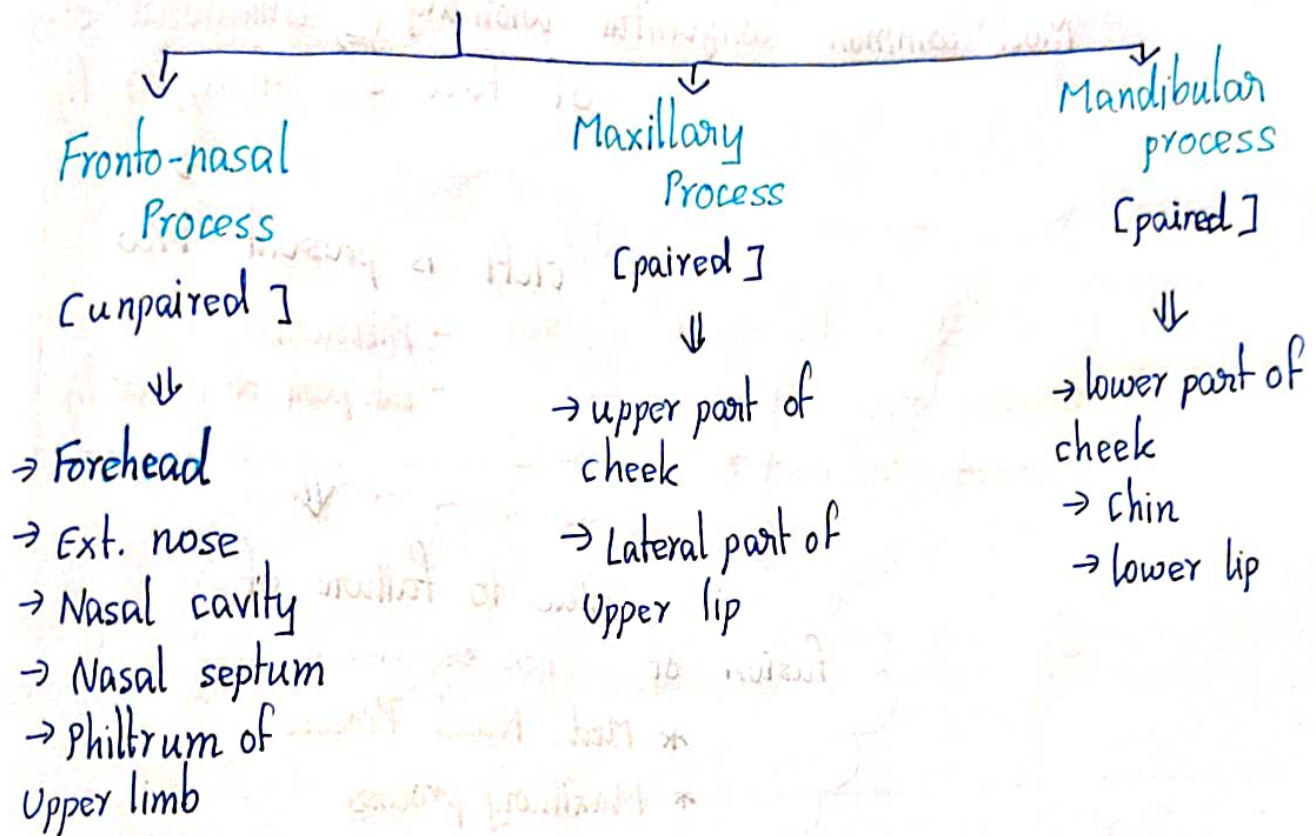
* Mandibular process



- a → med. nasal process
b → lat. " "



Face develops from
5 processes around the stomodeum



Derivatives :

Upper lip :

- ⊗ Philtrum : from medial nasal processes [FNP]
- ⊗ Lat. part : from Maxillary processes

Lower lip : from mandibular process

Cheek :

- ⊗ Upper part : Maxillary process
- ⊗ Lower part : Mandibular process

Congenital anomalies of face:

Most common congenital anomaly of face } unilateral cleft of upper lip

cleft is present b/w

- Philtrum
- lat. part of upper lip

due to failure of fusion of [on one side]

- * Med. Nasal Process
- * Maxillary process

Midline Cleft of Upper lip:

cleft present at middle of philtrum:

due to failure of fusion the 2 med. nasal processes.

Cleft of lower lip:

cleft present at midline from lower lip.

due to failure of fusion of the 2 mandibular processes

oblique facial cleft:

↳ The cleft is present b/w

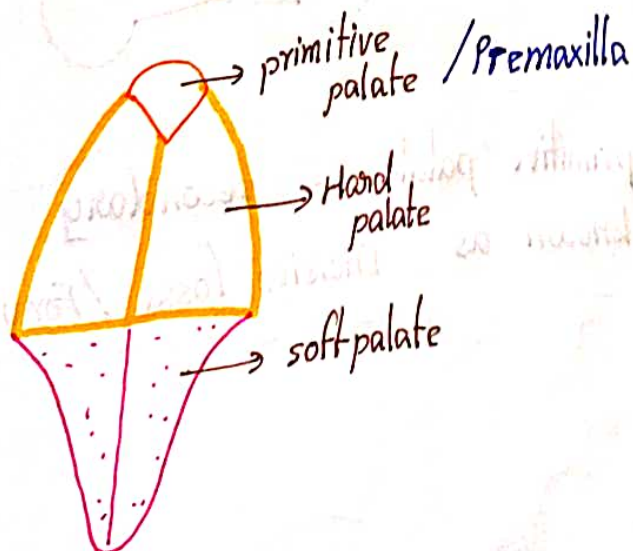
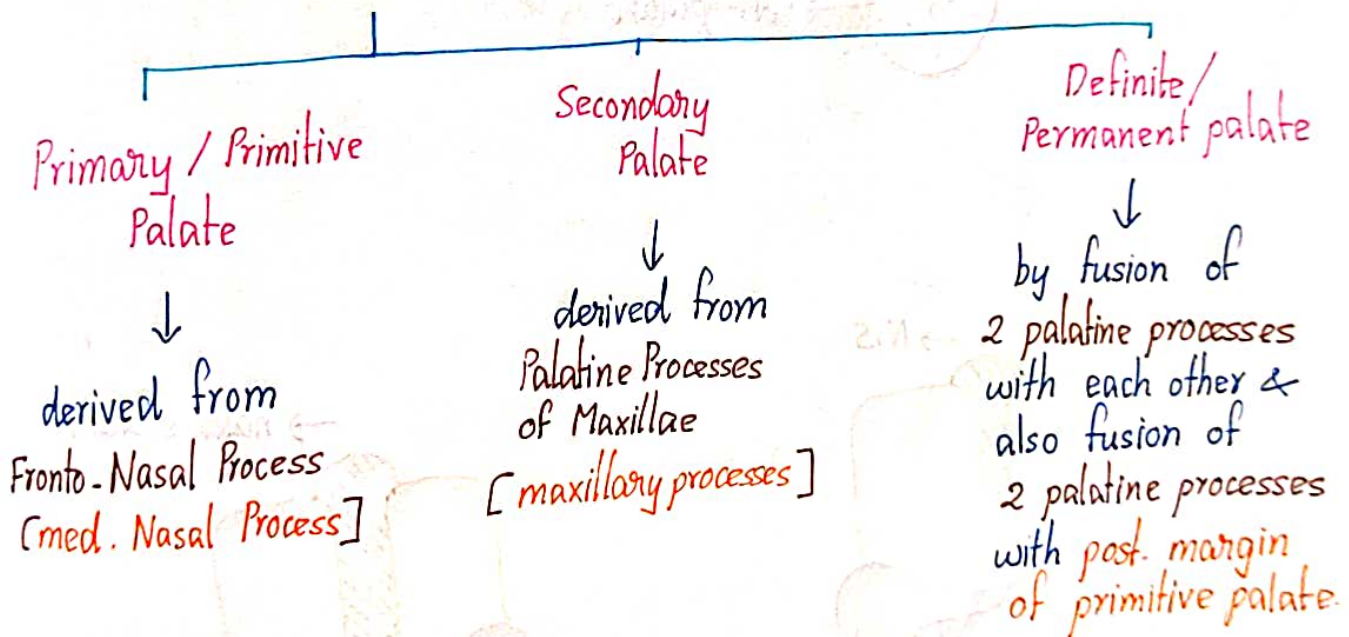
- lat. part of nose &
- upper part of cheek

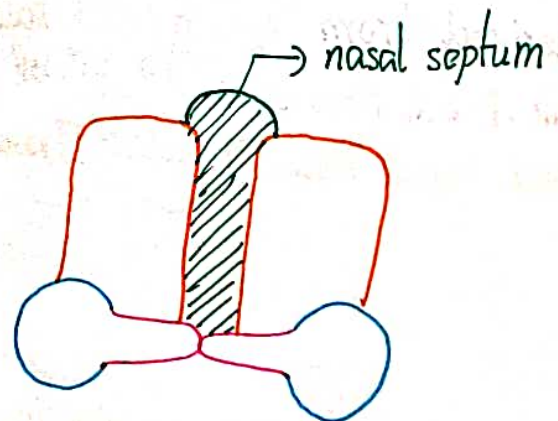
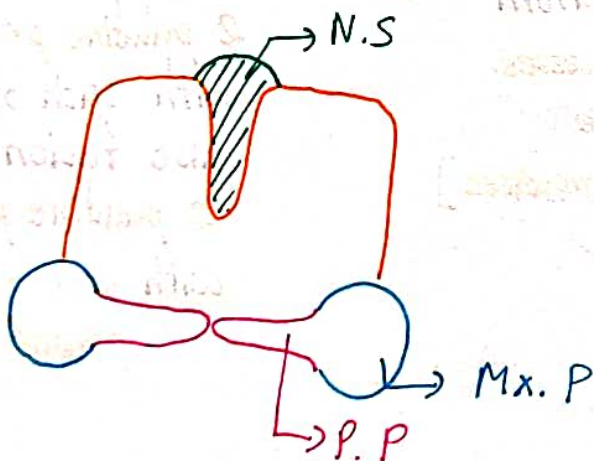
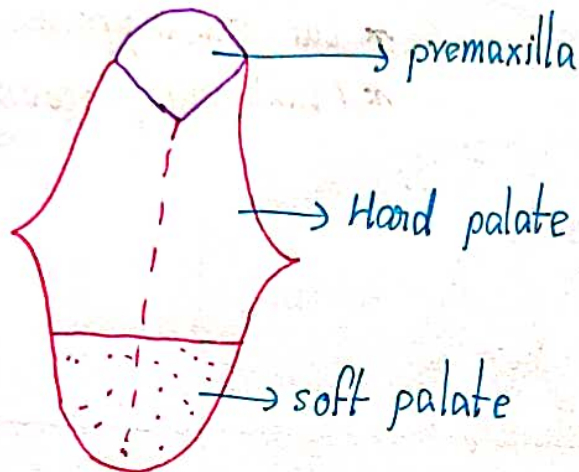
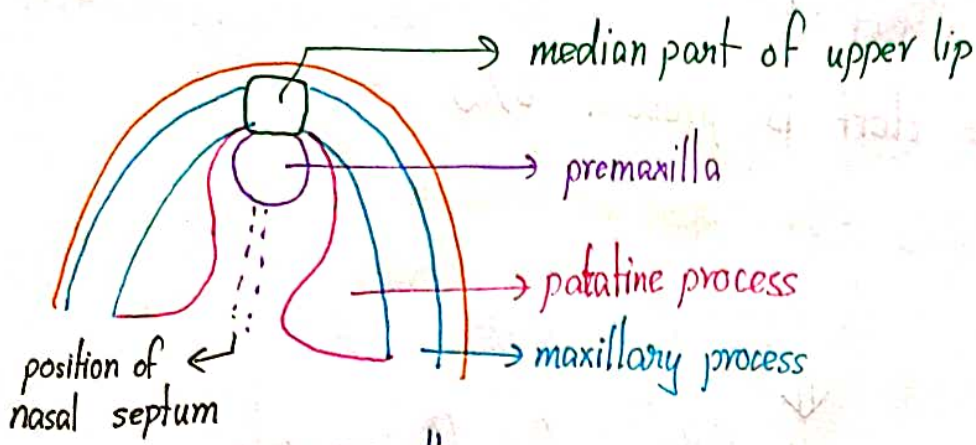


due to failure of fusion of

- * Lat. nasal process
- * Maxillary process

Development of palate:





Junction b/w primitive palate & secondary palate in adult is known as Incisive fossa / Foramen.

cleft Palate :

⊗ Bilateral Complete C.P :

failure of fusion of

- P.P with each other
- P.P with premaxilla [Both]



⊗ Unilateral Complete C.P

failure of fusion of

- P.P with each other
- P.P with P.M [one side]



Embryology of CVS :

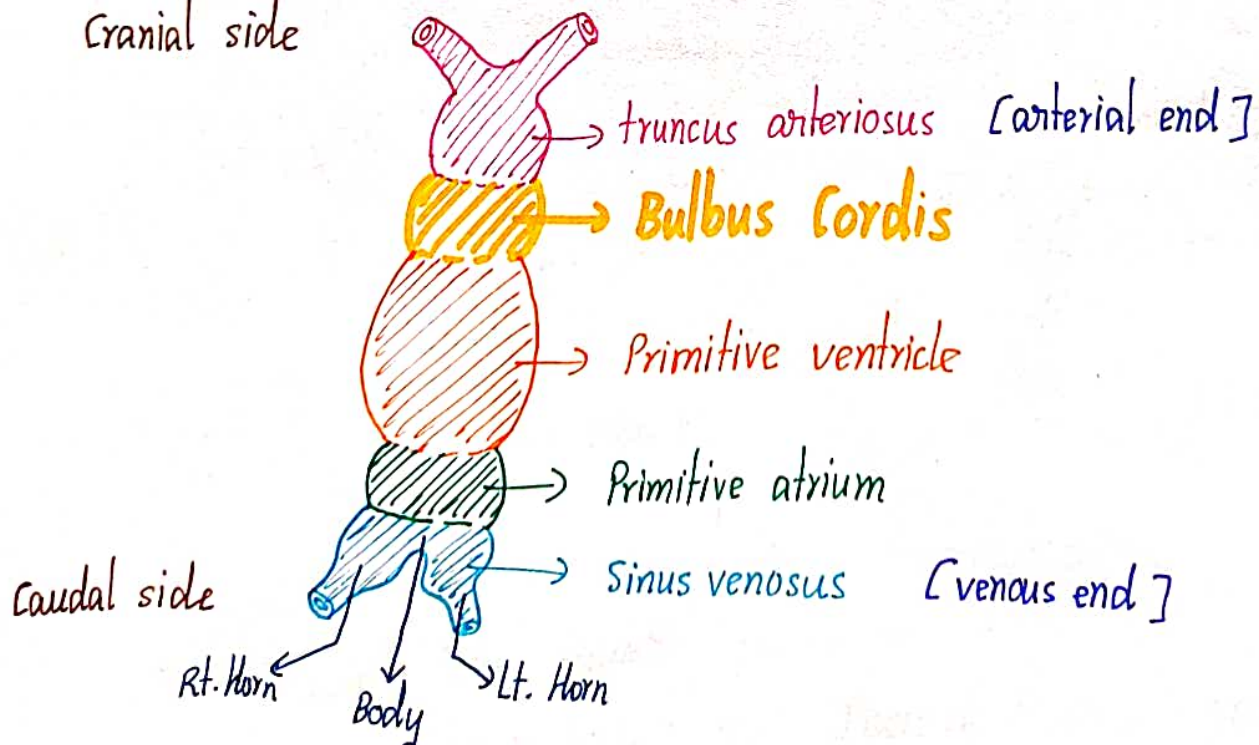
- 1st system in our body to start functioning.
- Heart starts beating from 21st / 22nd day [end of 3rd week]

- Heart, Vessels, Blood cells & lymphatics $\Rightarrow$ Mesodermal origin

Cardiogenic area : located in / Part of Splanchnopleuric layer of L.P.M [Cranial to Prochordal plate / Cranial to Buccopharyngeal memb.]

Heart tube :

Cranial side



derivatives of Heart tube part [in adults] :

* Truncus arteriosus:

- Asc. aorta
- Pulmonary trunk

* Bulbus cordis:

- outflow part of both ventricles [smooth part]
- rough part of Rt. ventricle

* Primitive Ventricle:

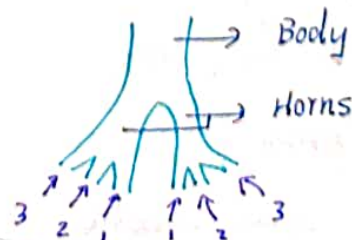
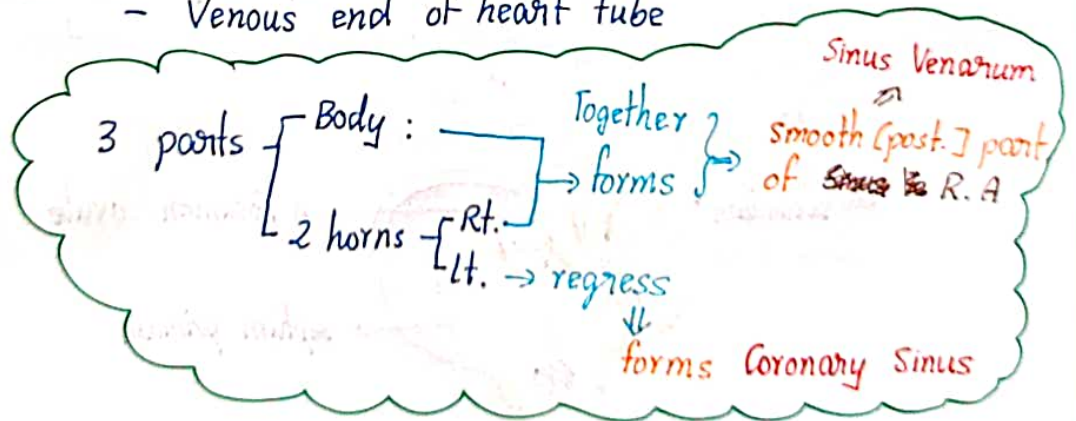
- rough part of Lt. ventricle

* Primitive atrium:

- Rough part of both atria

* Sinus venosus:

- Caudalmost part of Heart tube
- Venous end of heart tube



Each Horn
will receive
3 veins

- ① Vitelline Vein
- ② Umbilical Veins
- ③ Common Cardiac Vein

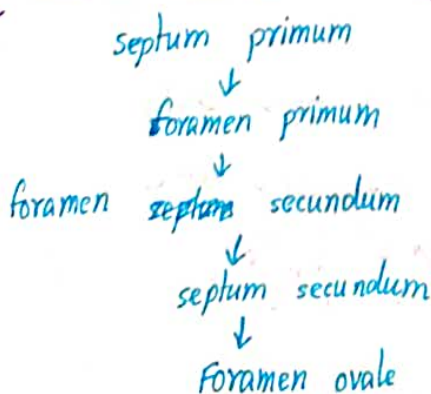
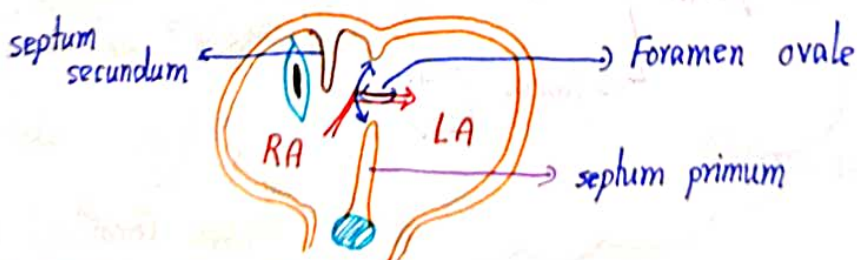
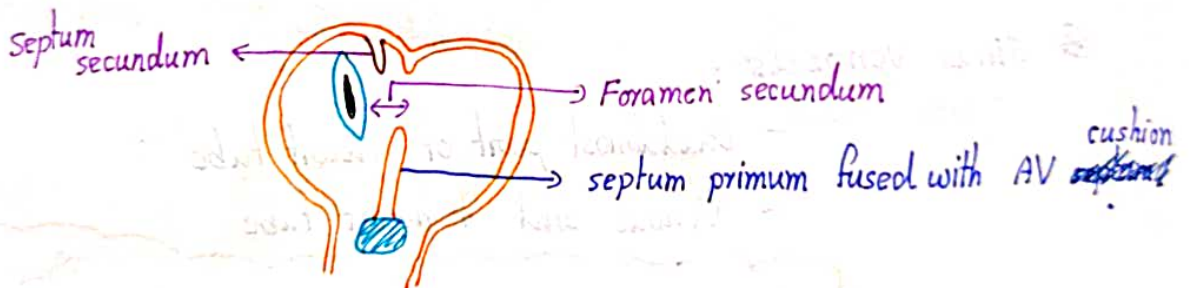
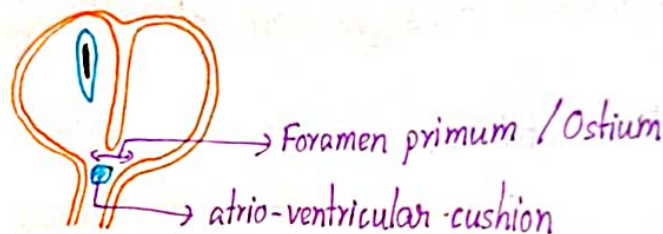
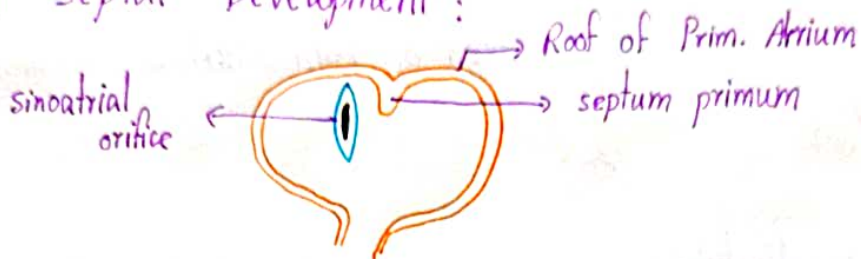
Rt. C.C.V $\Rightarrow$ forms SVC

V.V $\Rightarrow$ disappear

Rt. V.V $\Rightarrow$ forms part of IVC

Lt. side veins $\Rightarrow$ insignificant

Interatrial Septal Development:



Steps in IAS development:

⊗ Formation of Septum primum:

↓
grows downward from roof of primitive atrium [towards AV cushion]

⊗ Formation of foramen primum / ostium:

↓
opening b/w septum primum & AV cushion.

⊗ Formation of Foramen Secundum:

↓
opening formed by breakdown of upper part of septum primum, while S.P fuses with AV cushion /

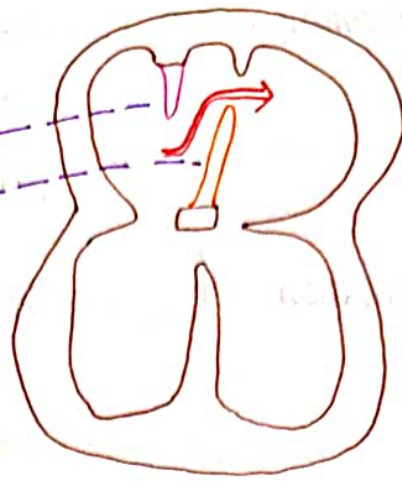
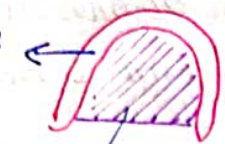
⊗ Formation of Septum Secundum:

↓
arises & grows downwards from roof of primitive atrium

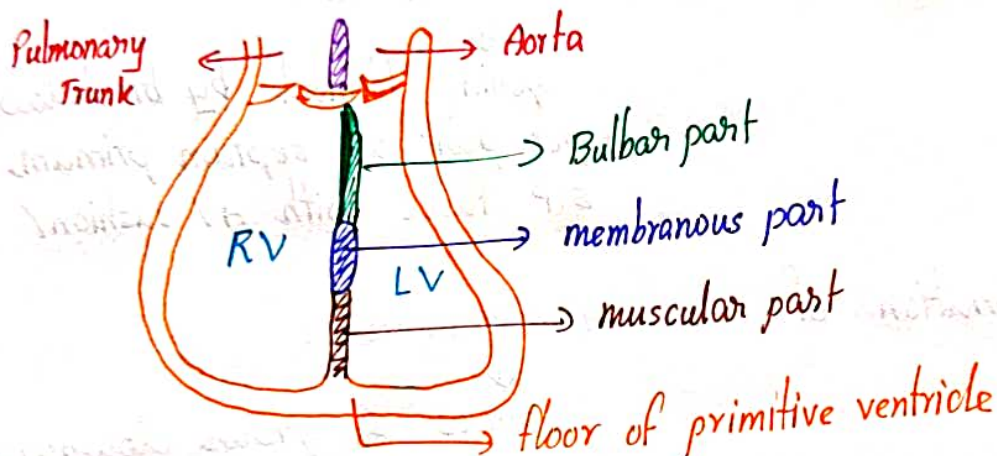
⊗ Formation of Foramen ovale:

↓
b/w S.S & S.P there is an oblique passage formed called F.O through which blood moves from R.A → L.A.

limbus
fossa ovalis
fossa ovalis



Interventricular Septum development:



3 parts of IVS:

⊛ Bulbar part:

from Rt. & Lt. Bulbar Ridges

⊛ Membranous part:

from A.V. Cushion

⊛ Muscular part:

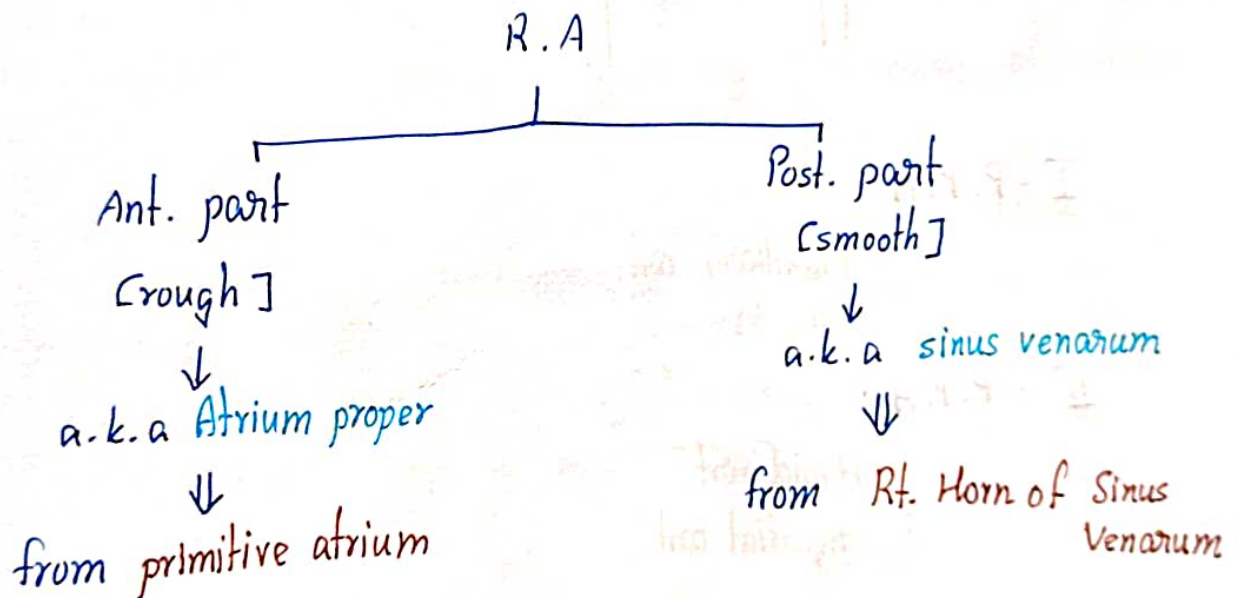
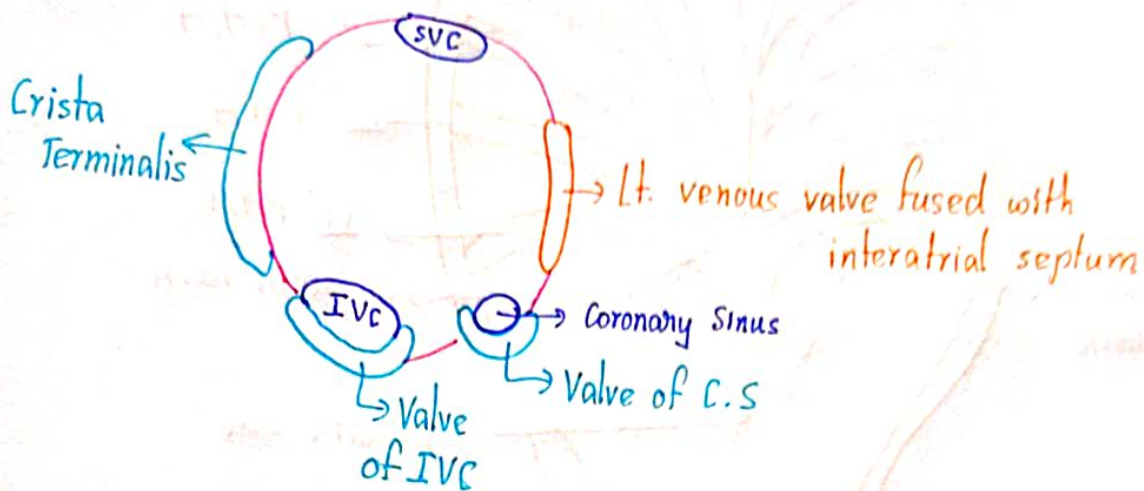
from floor of primitive ventricle [Myocardium]

Applied:

Ventricular septal Defect: [Most common defect of Heart]

↳ mostly affects membranous part.

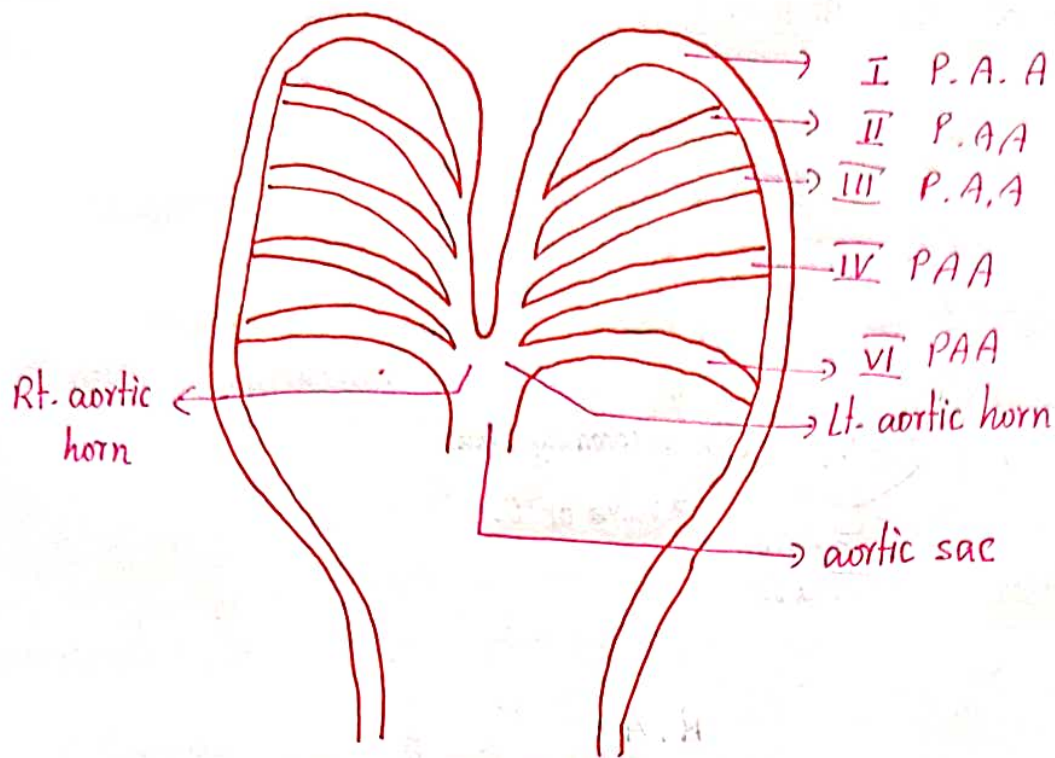
Development of Rt. atrium :



Crista Terminalis
IVC valve
CS valve } develop from Rt. Venous Valve

Fossa ovalis → remnant of septum primum
Limbus fossa ovalis → " " septum secundum

Pharyngeal Arch Arteries:



I - P.P.A :

↳ Maxillary art.

II - P.P.A :

↳ Hyoid art.

↳ Stapedial art.

III - P.P.A :

↳ CCA

↳ ICA

↳ ECA

IV - P.P.A :

↳ Rt. → Rt. SCA

↳ Lt. → part of arch of aorta

VI - P.P.A :

↳ Rt. → Rt. Pul. ar.

↳ Lt. → Lt. Pul. ar.

↳ Ductus ar.

Development of arch of aorta:

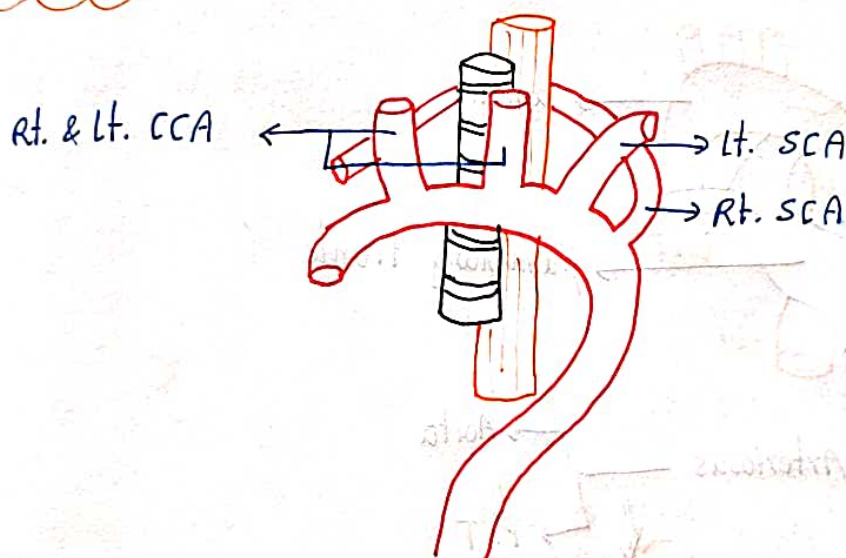
4 sources:

- aortic sac
- Lt. Horn of aortic sac
- Lt. 4th P.A. art.
- Lt. Dorsal aorta

Dysphagia Lusoria:

Due to abnormal origin of **Rt. SCA**, it passes **behind esophagus**, compressing it causing dysphagia.

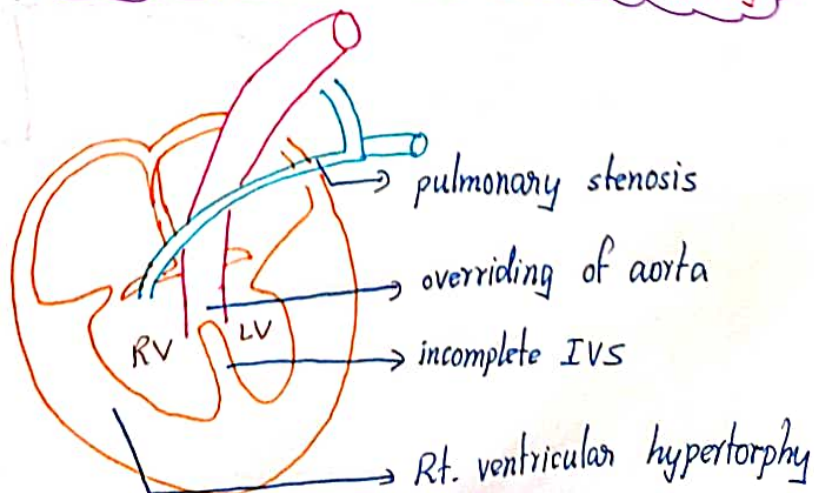
retro-esophageal



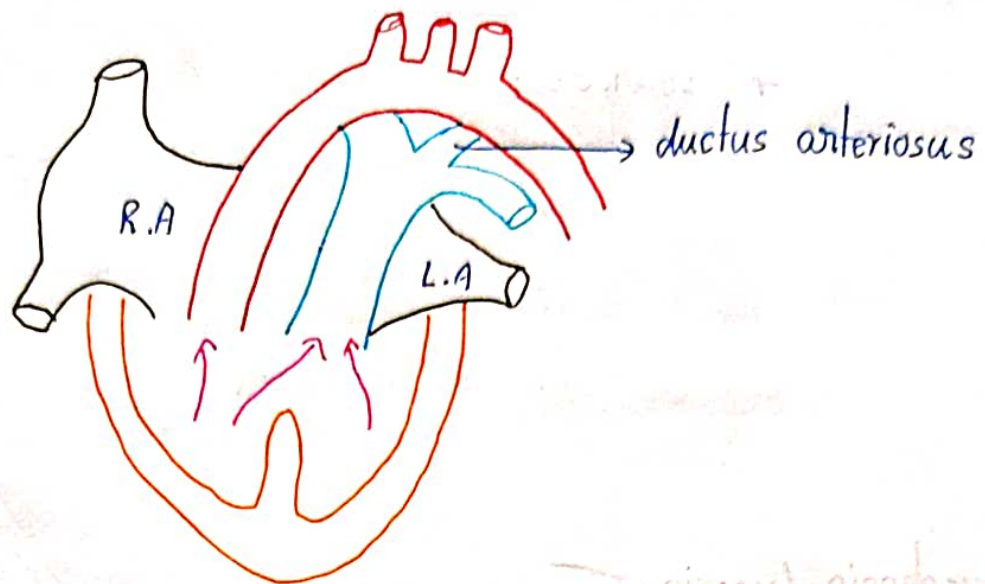
Fallot's tetralogy: → Most common congenital cyanotic cardiac anomaly.

4 components:

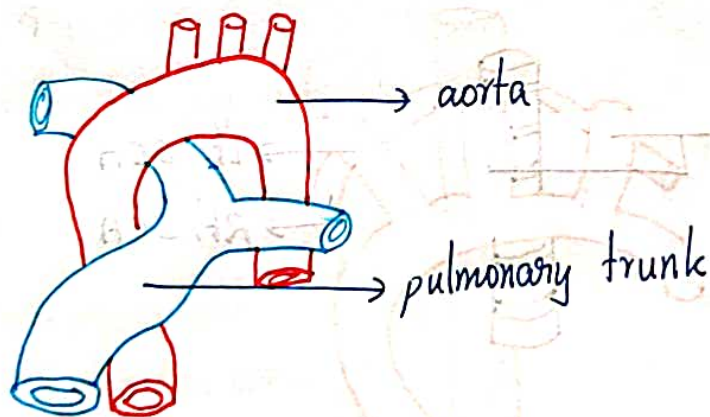
- Pulmonary stenosis
- Over-riding of aorta
- Ventricular Septal Defect
- Rt. ventricular hypertrophy.



Transposition of Great arteries :



normal
position of
Aorta &
P.T



due to formation of Aortico-pulmonary Septum/
spiral septum / Conotruncal septum

derived from Neural
Crest Cells

Congenital anomalies due to spiral septum:

⊗ Absence of spiral septum:

failure of its development causes inability of T.A to divide into A.A & P.T.



Persistent / Patent Trunkus Arteriosus

⊗ Spiral septum forms but is not spiral:

This causes



Transposition of Great arteries

⊗ Ant. displacement of spiral septum:

This will cause unequal division of A.A & P.T (i.e)

A.A ⇒ very broad

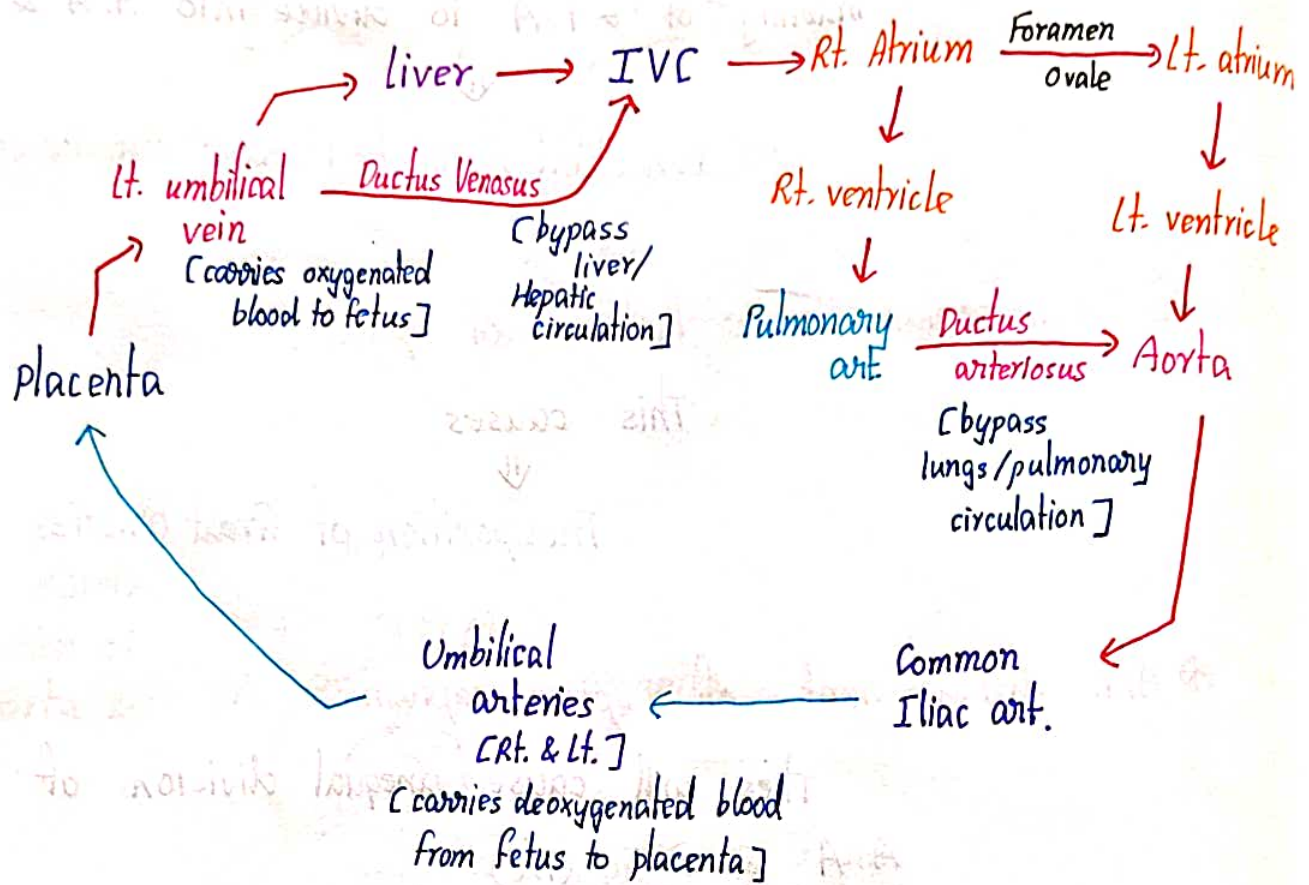
P.T ⇒ very narrow

This is known as (a component of) Fallot's tetralogy

Fetal Circulation:

→ Fetal lungs are non-functional [collapsed state].

→ Placenta is the organ of respiration in fetus.



Changes in F.C after birth:

→ Umbilical arteries: { Proximal part: persist as **Superior Vesical Ar.**
Distal part: **obliterate** ⇒ **Medial Umbilical lig.s.**

→ Lt. umbilical vein: **obliterate** to form **ligamentum Teres Hepatis.**

→ Ductus venosus: **obliterate** to form **ligamentum venosum**

→ Ductus arteriosus: " " " **ligamentum arteriosum**

→ Foramen ovale: gets **closed** [due to approximation of **septum primum** & **septum secundum**] & form **fossa ovalis.**

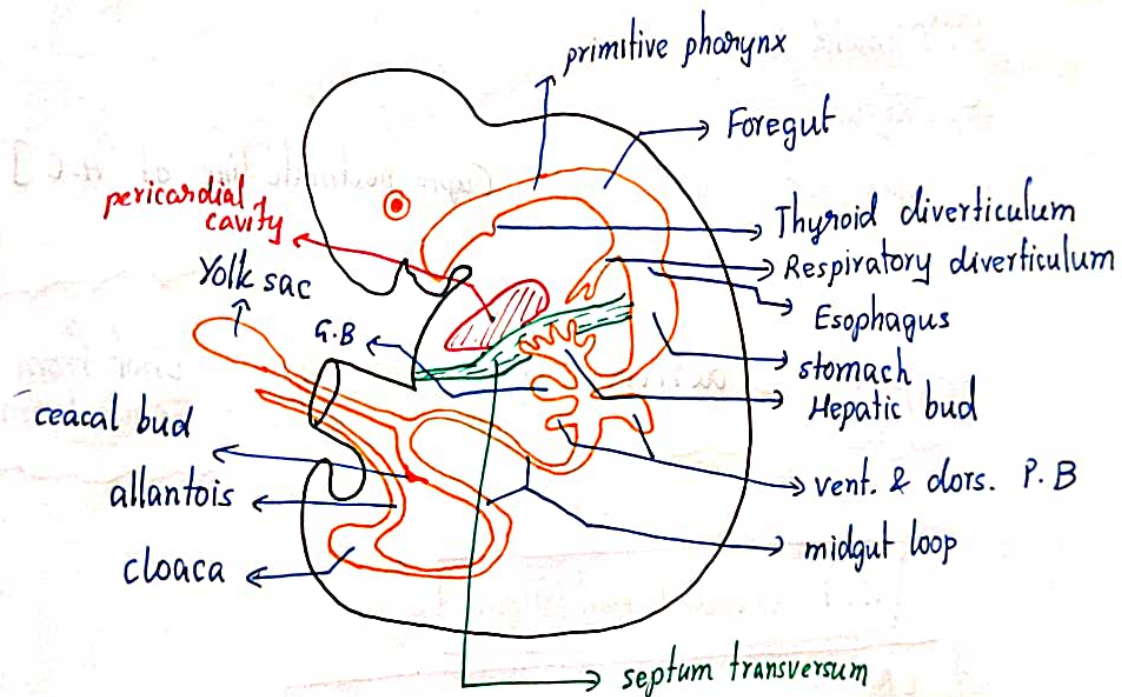
Axis artery of Upper limb : derived from 7th cervical intersegmental ar.

↓
give rise to SCA

Axis artery of Lower limb : derived from 5th lumbar intersegment ar.

↓
give rise to Ext.
Iliac Ar.

Development of GIT :



Foregut :

- floor of mouth
- Tongue
- Pharynx
- Thyroid
- Esophagus
- stomach
- Upper half of duodenum (upto opening of CBD)
- liver
- pancreas
- pharyngeal pouch

Midgut :

- ↳ lower half of duodenum
- ↳ Jejunum
- ↳ Ileum
- ↳ Caecum & Appendix
- ↳ Asc. colon
- ↳ Prox. $\frac{2}{3}$ rd of Transverse Colon

Hindgut :

- ↳ Distal $\frac{1}{3}$ rd of T.C
- ↳ Desc. Colon
- ↳ Sigmoid Colon
- ↳ Rectum
- ↳ Upper part of anal canal [upto pectinate line of A.C]

spleen $\Rightarrow$ derived from **mesoderm** [not from endoderm]

GIT $\Rightarrow$ **endodermal** origin

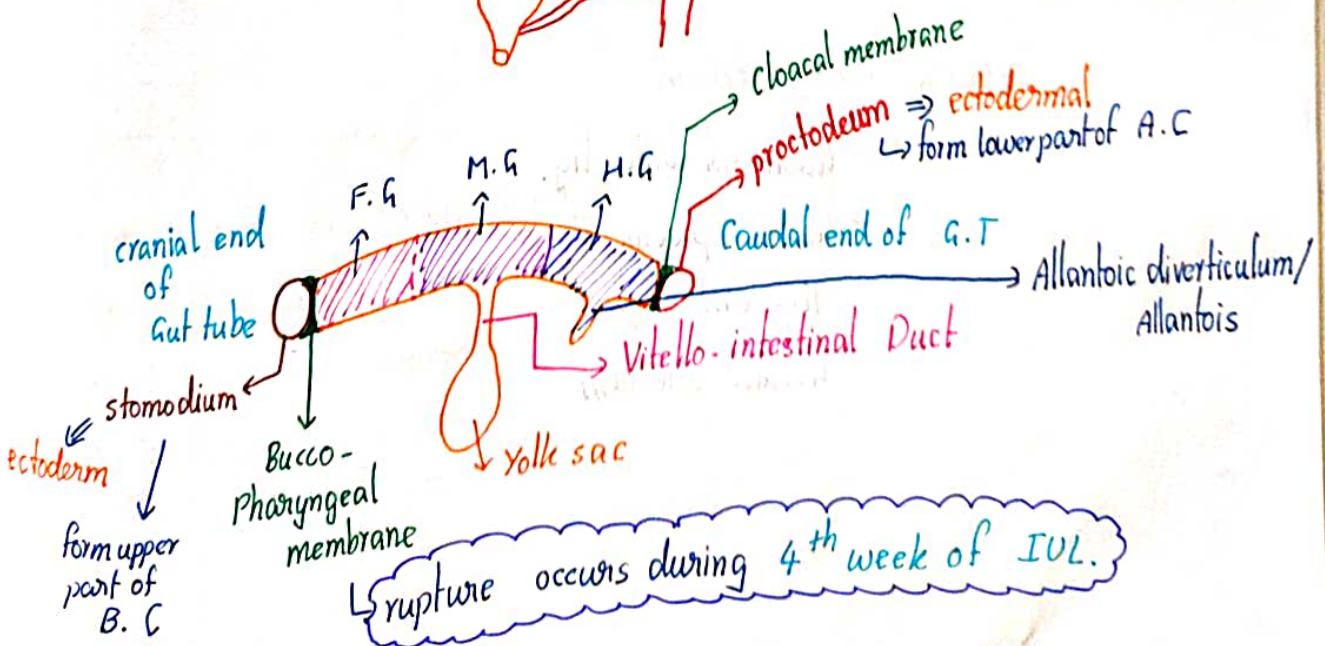
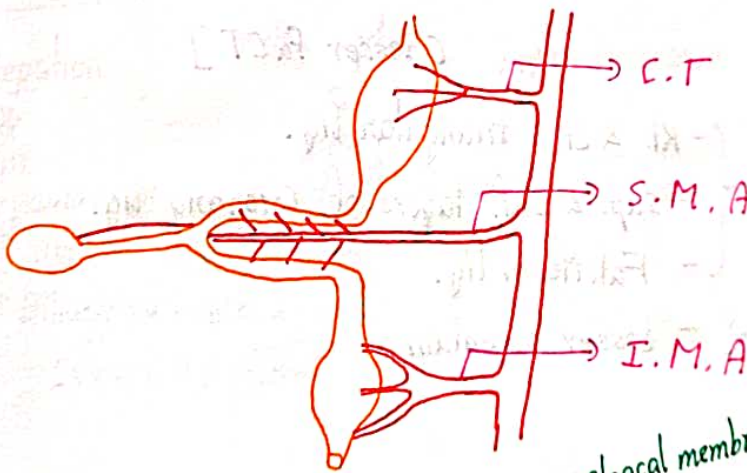
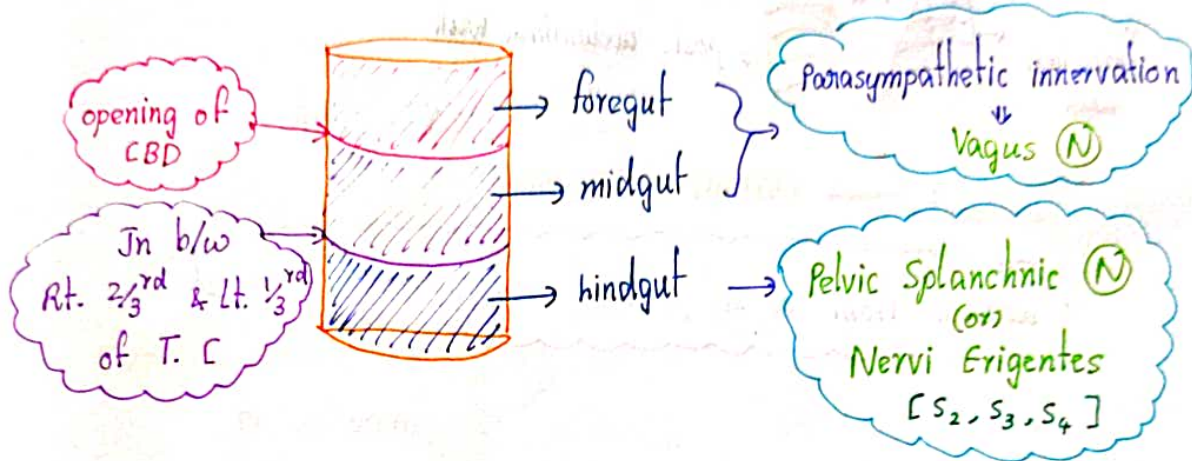
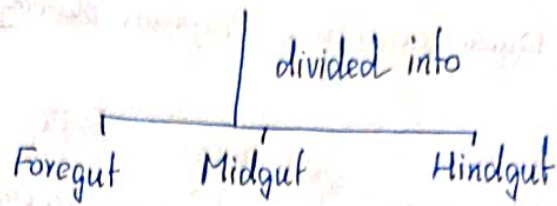
Nervous System $\Rightarrow$ **ectodermal**

CVS $\Rightarrow$ **mesodermal**

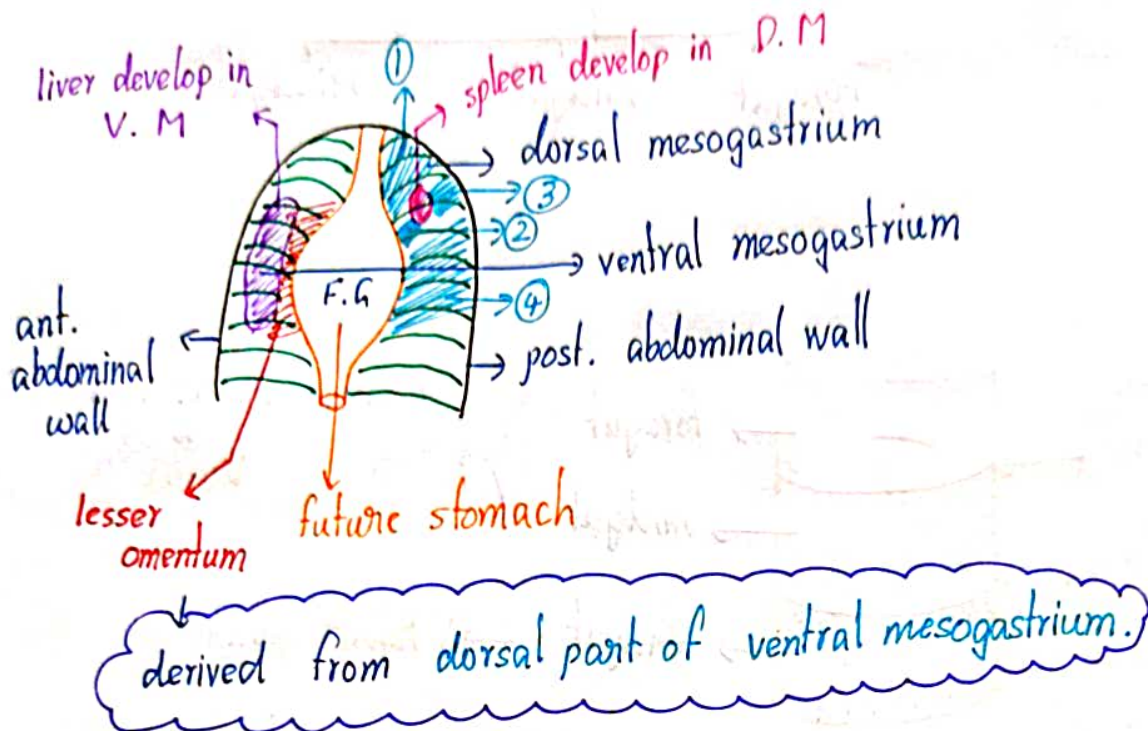
Resp. Sys. $\Rightarrow$ **endodermal**

Genital & Urinary Sys. $\Rightarrow$ **mesodermal**

Yolk sac gives rise to Gut Tube $\Rightarrow$ endodermal



Bucco-pharyngeal membrane rupture during 4th week.
 Cloacal membrane rupture during 7th/8th week



Derivatives of

⊗ Ventral mesogastrium: [lesser FaCT]

derived from Ventral part {

- Rt. & Lt. triangular lig.
- sup. & Inf. layers of coronary lig.
- Falciform lig.

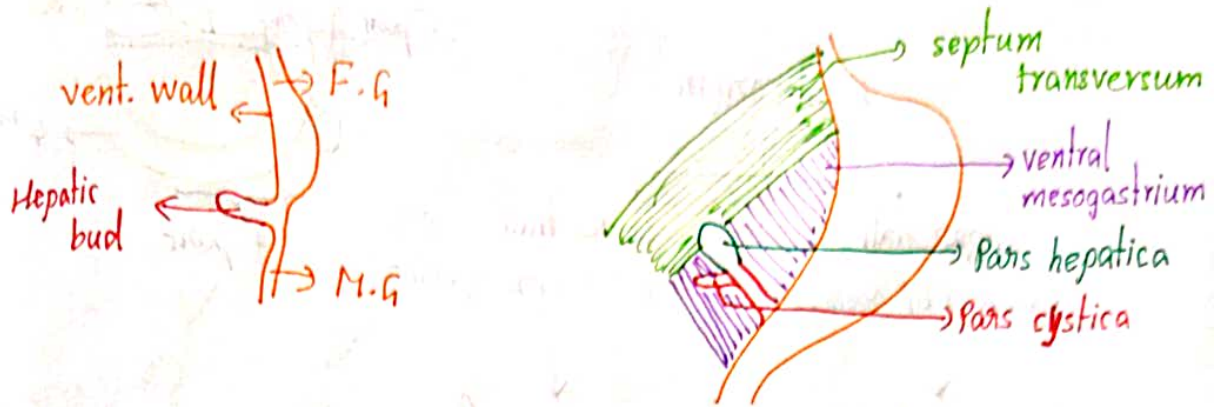
derived from dorsal part {

- Lesser omentum

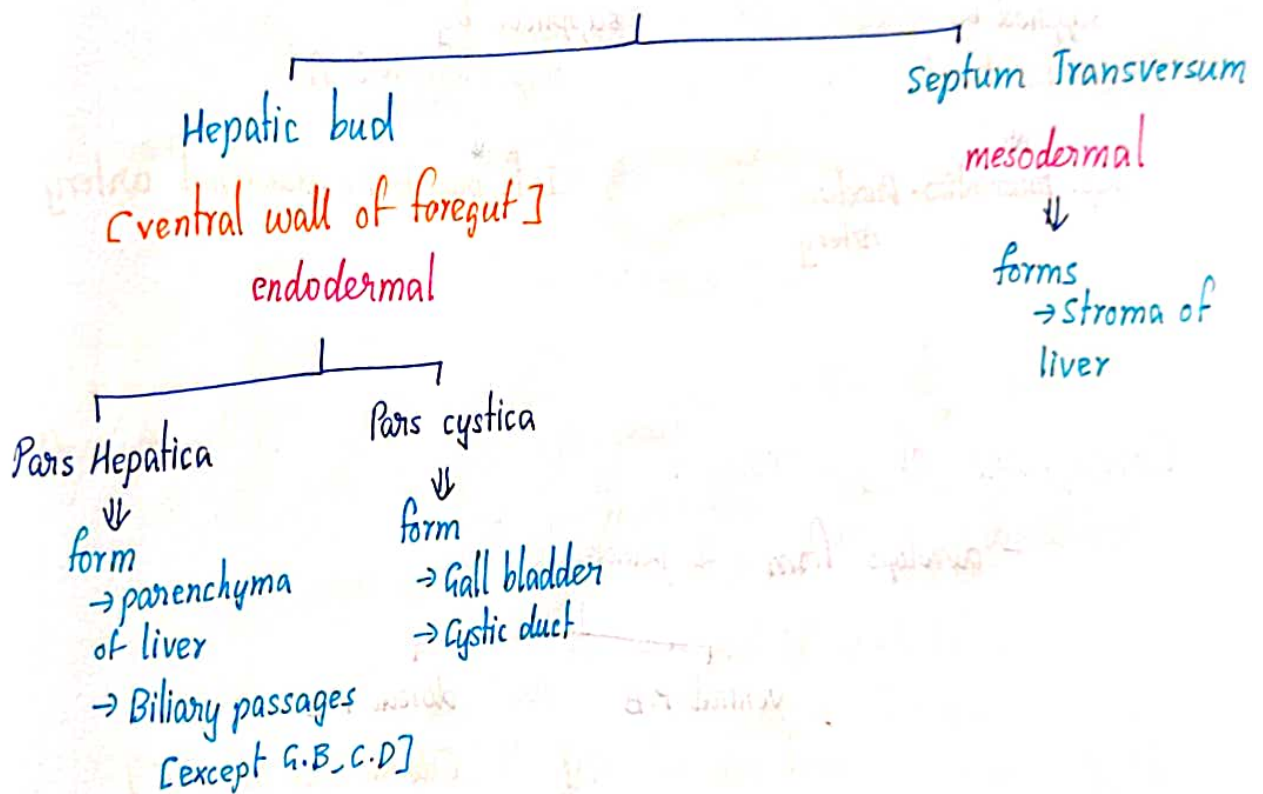
⊗ Dorsal mesogastrium:

- 1 - Gastro-phrenic lig.
- 2 - Gastro-splenic lig.
- 3 - Splenorenal lig.
- 4 - Greater omentum

Development of liver:



liver develops from 2 sources



- * Kupffer cells → hepatic macrophages
- * Microglia → CNS macrophages
- * Dust cells → alveolar "
- * Osteoclast → bone "
- ↳ osteolytic in nature

Development of duodenum :

- Dual origin

upper half
[above CBD opening]

↓
derived from
foregut

↓
supplied by
coeliac trunk

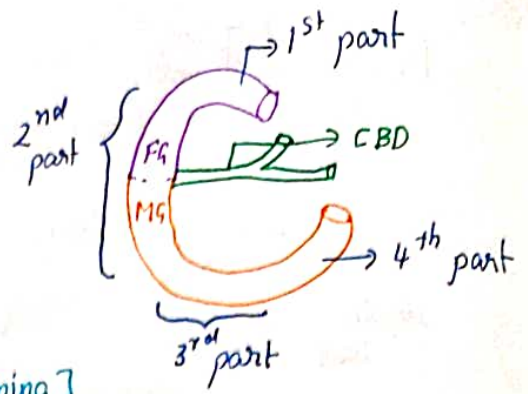
↓
Sup. Pancreatico-Duodenal Artery

lower half
[below CBD opening]

↓
derived from
midgut

↓
supplied by
Sup. Mesenteric Ar.

↓
Inf. pancreatico-duodenal artery



Development of pancreas :

- develops from 2 pancreatic buds

ventral P.B

[vent. wall of F.G]

↓
~~smaller~~ smaller

forms → lower part of head
→ **Uncinate process**

dorsal P.B

[dorsal wall of F.G]

↓
larger

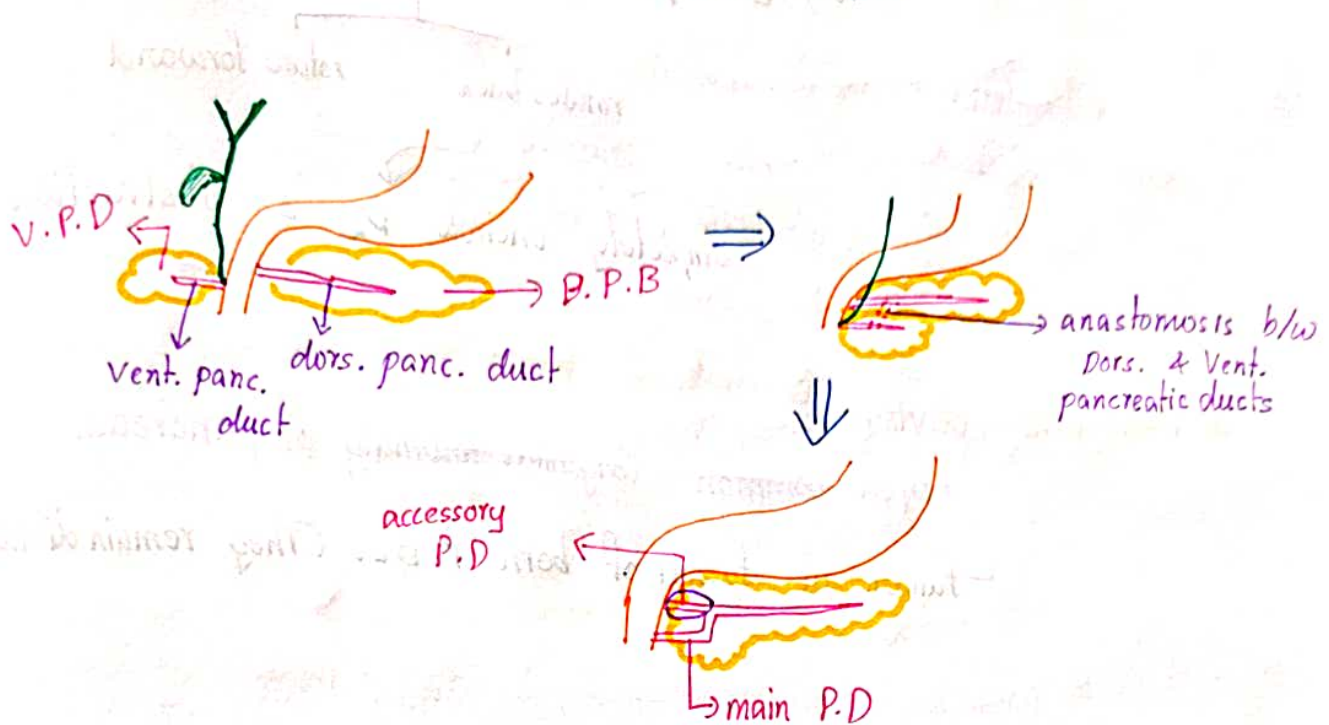
forms → major part of pancreas

[upper part of head,
Neck, Body, Tail]

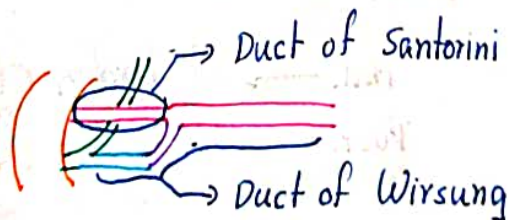
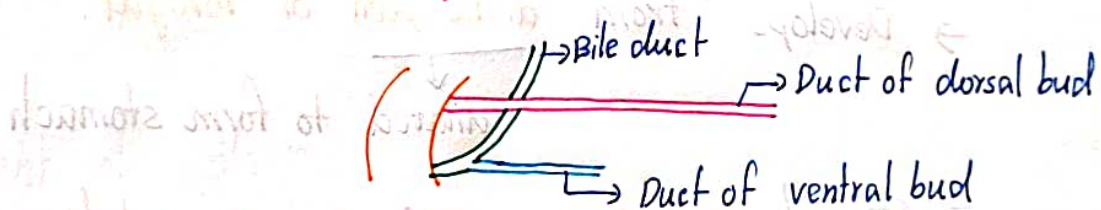


During rotation of duodenum, [upper half]

Vent. Pancreatic Bud comes to lie just below the Dorsal Pancreatic Bud.



Development of ducts of pancreas:



Main Pancreatic Duct : Ventral P.D & distal part of Dorsal P.D
 " : Proximal part of Dorsal P.D
 Accessory " : Ventral P.D

Congenital anomalies of pancreas:

⊗ Annular pancreas:

↳ V.P.B splits into 2 parts

rotates back rotate forward

completely encircle D_2 & obstruction of D_2

⊗ Pancreatic divisum:

→ most common Congenital anomaly of pancreas.

↳ failure of fusion of both P.Bs. [They remain divided]

Development of stomach:

→ Develops from distal part of foregut.

↓
dilated to form stomach

→ stomach undergoes 90° clockwise rotation.

→ Initially stomach has Ant. & post borders,
after rotation

Ant. → Rt. border [lesser curvature]

Post. → Lt. border [Greater curvature]

Septum Transversum:

- Derived from lateral plate mesoderm [LEM]
- Derivatives of S.T:
 - ⊗ Central tendon of diaphragm
 - ⊗ Stroma of liver
 - ⊗ Fibrous pericardium
 - ⊗ Ventral mesogastrium & its derivatives
 - [lesser omentum,
Falciform lig.,
Coronary lig.,
Triangular lig.]

before folding of embryo.
↓
Septum Transversum

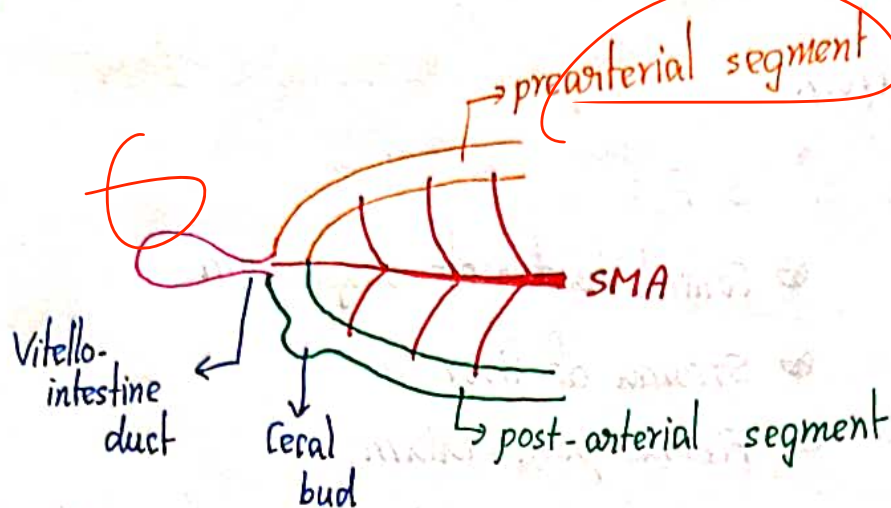
Development of spleen:

- Derived from mesoderm
- Develops in dorsal mesogastrium.
- Formed by union of numerous mesenchymal masses [lobules].
- Most common site of accessory spleen ⇒ Hilum of spleen
- Spleen projects into greater sac.
- Notches of spleen:
 - ↳ along sup. border of spleen
 - ↳ indicate lobular development of spleen.
 - ↳ indicate site of fusion of lobules.

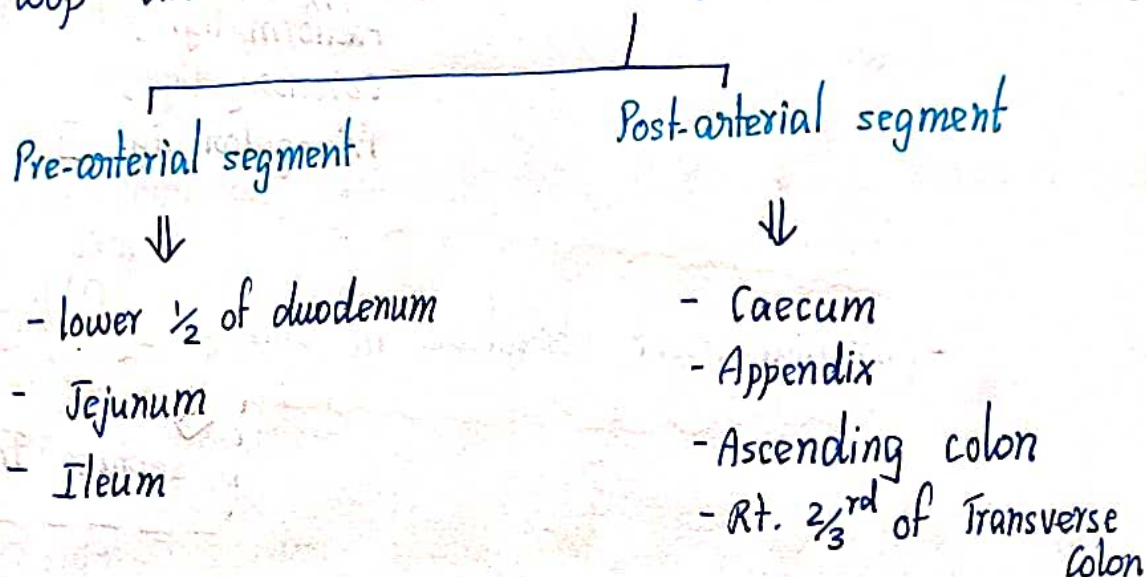
Kehr's sign:

↳ referred pain to lt. shoulder.

Midgut rotation: / Rotation of midgut loop:



Midgut loop divided into 2 loops segments [by SMA]

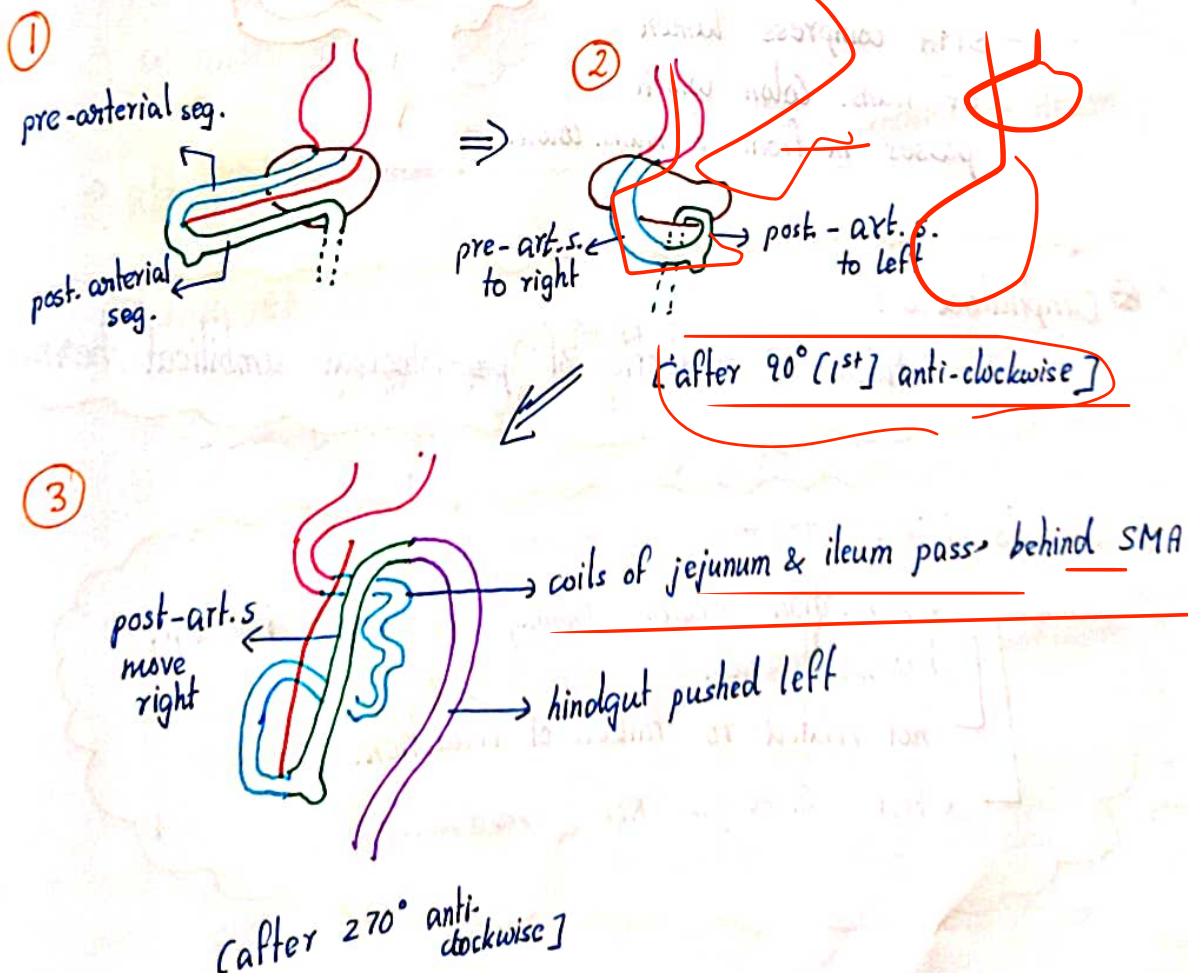
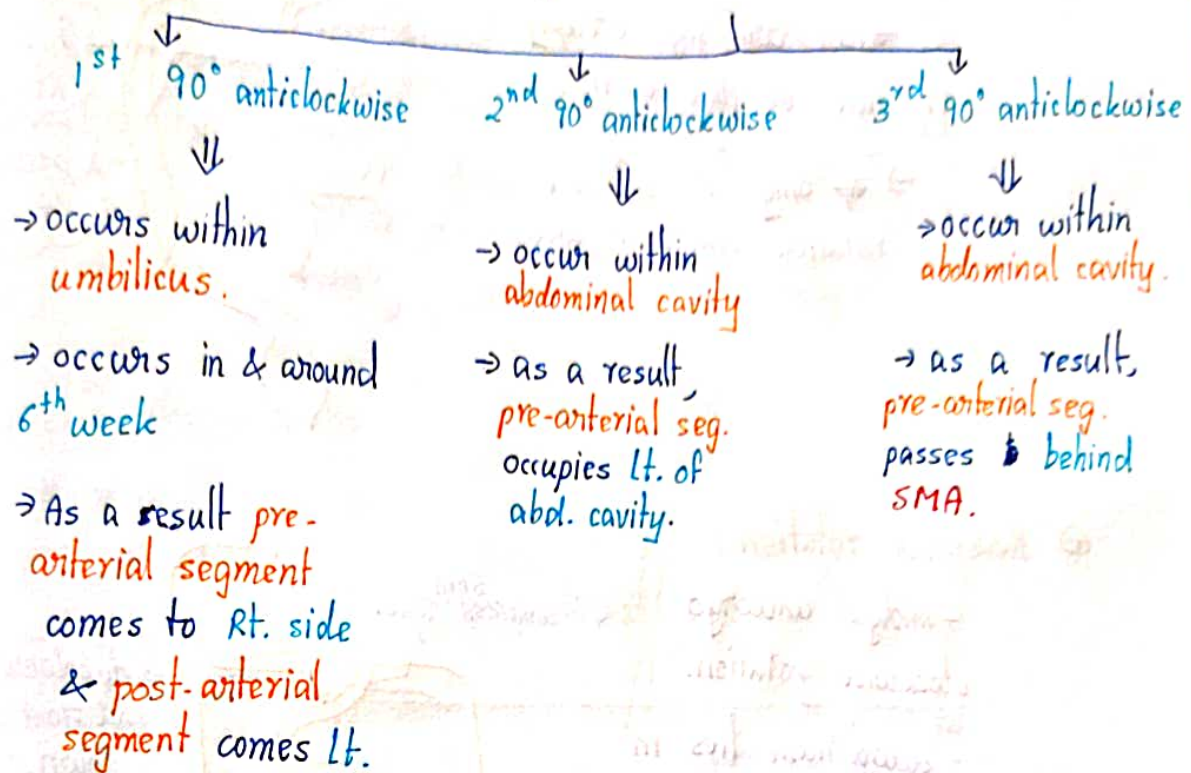


Physiological Umbilical Herniation:

- Occurs during 6th week of IUL.
- It occurs because of failure of accommodation of rapidly enlarging / elongating midgut loop by the abdominal cavity of embryo.
 - ↳ mainly pre-arterial segment
- Reduction of hernia occurs by around 10th week of IUL. [return of intestine back into abd. cavity]

3 stages of midgut rotation:

Totally midgut undergoes 270° counter-clockwise.

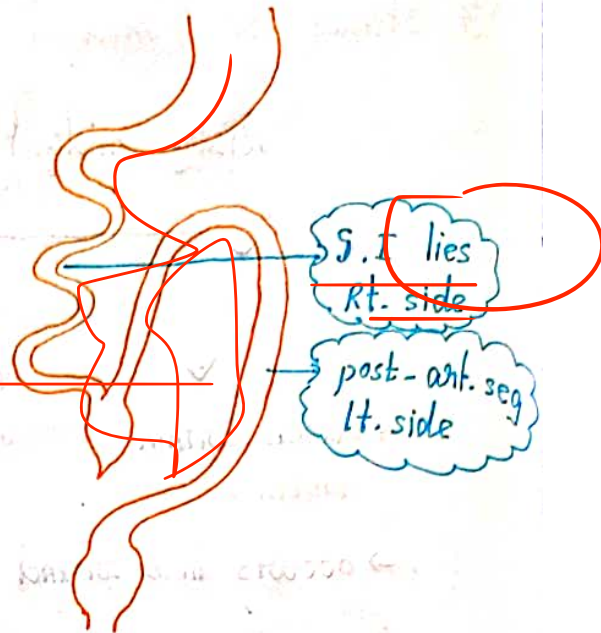


Midgut rotation anomalies:

⊗ Non-rotation of midgut:

→ Post-art. seg. occupy
lt. side of Abd. cavity.

→ only 1st 90° A.C
rotation will take place

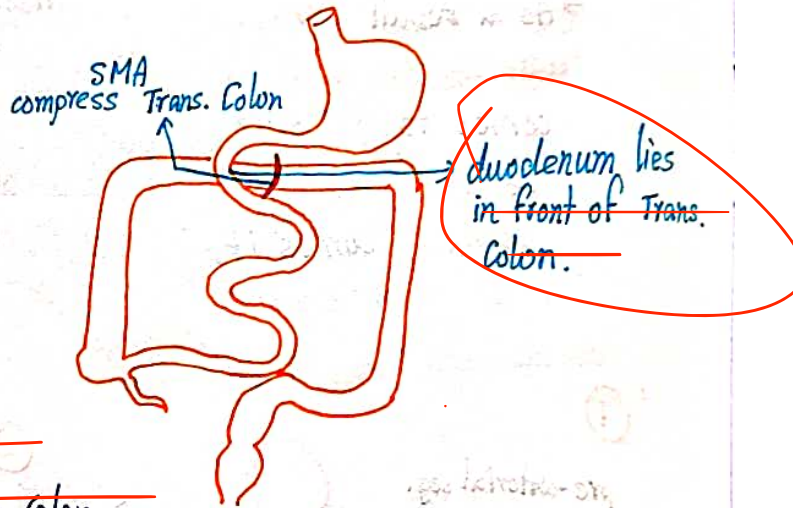


⊗ Reversed rotation:

- midgut undergo
clockwise rotation.

- duodenum lies in
front of Trans. colon.

- SMA compress lumen
of Trans. Colon which
passes in front of Trans. Colon.



⊗ Omphalocele:

↳ failure of reduction of physiological umbilical hernia.

⊗ Gastroschisis:

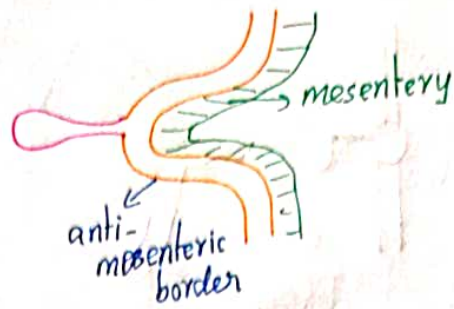
↳ herniation occurs through a defect in ant.
abdominal wall.

↳ not related to failure of reduction.

↳ defect will be just Rt. to midline.

Vitello - Intestinal Duct:

→ narrow diverticulum through which Yolk sac communicates with Gut tube [midgut]
↳ Ileum



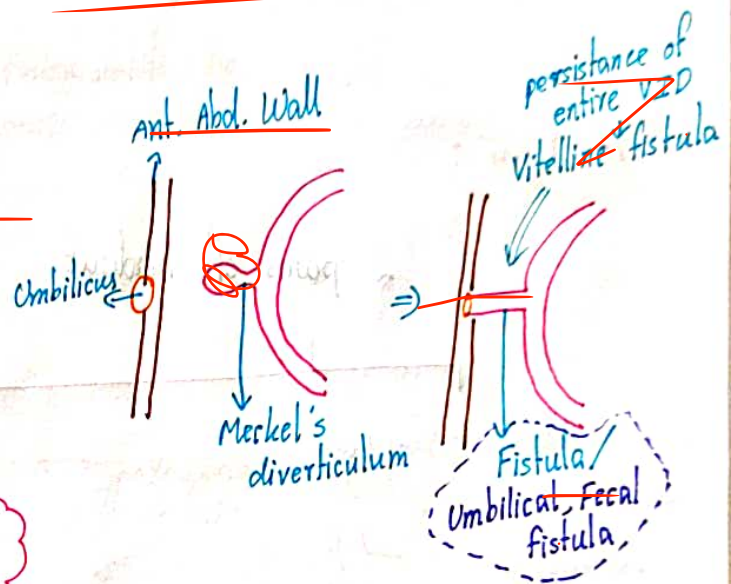
→ VID normally, disappears completely.

Meckel's diverticulum:

→ Proximal persistent part of VID.

→ It is a True diverticulum. [∵ it contains all 4 layers of GIT]

→ Most common congenital anomaly of GIT.



→ attached to/arise from anti-mesenteric border of ileum.

→ Rule of '2' :

↳ frequency of M.D : 2% of individuals.

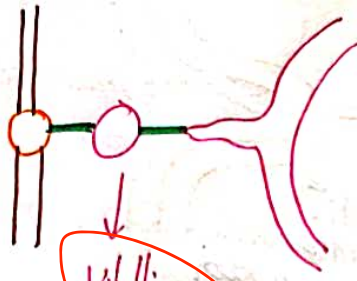
↳ length of M.D : 2 inches [5cm]

↳ location " " : 2 feet proximal to ileo-caecal jn.

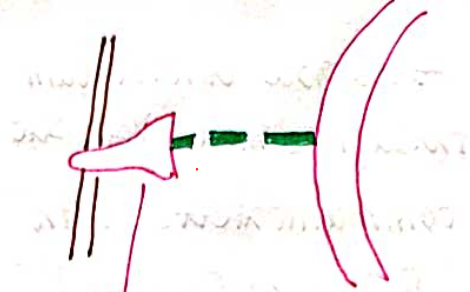
↳ only 2% of M.D cases are symptomatic (i.e) they are mostly asymptomatic.

↳ 2 ectopic tissues :
↳ Gastric tissue [most common]
↳ Pancreatic tissue

↳ 2 symptoms :
↳ cause bleeding
↳ cause intestinal obstruction



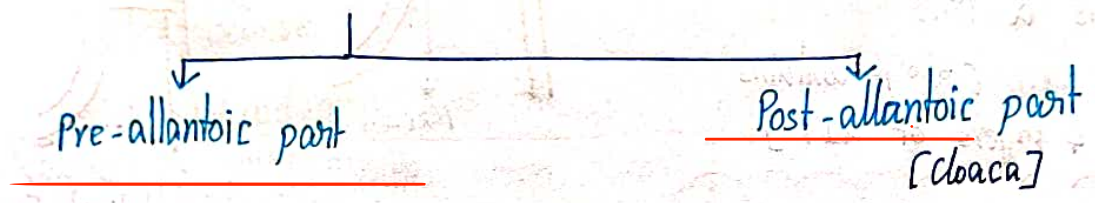
Vitelline Cyst
[middle part of VID persist]



Vitelline sinus
[distal part of VID persist]

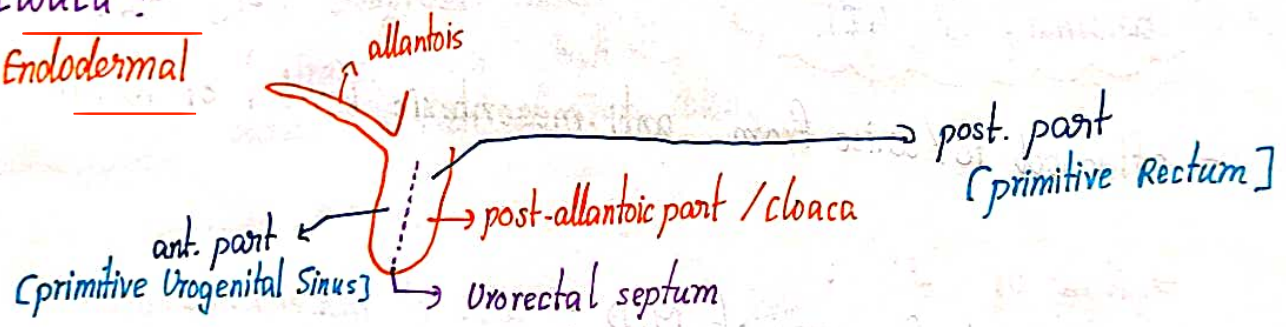
Hindgut :

2 parts of hindgut

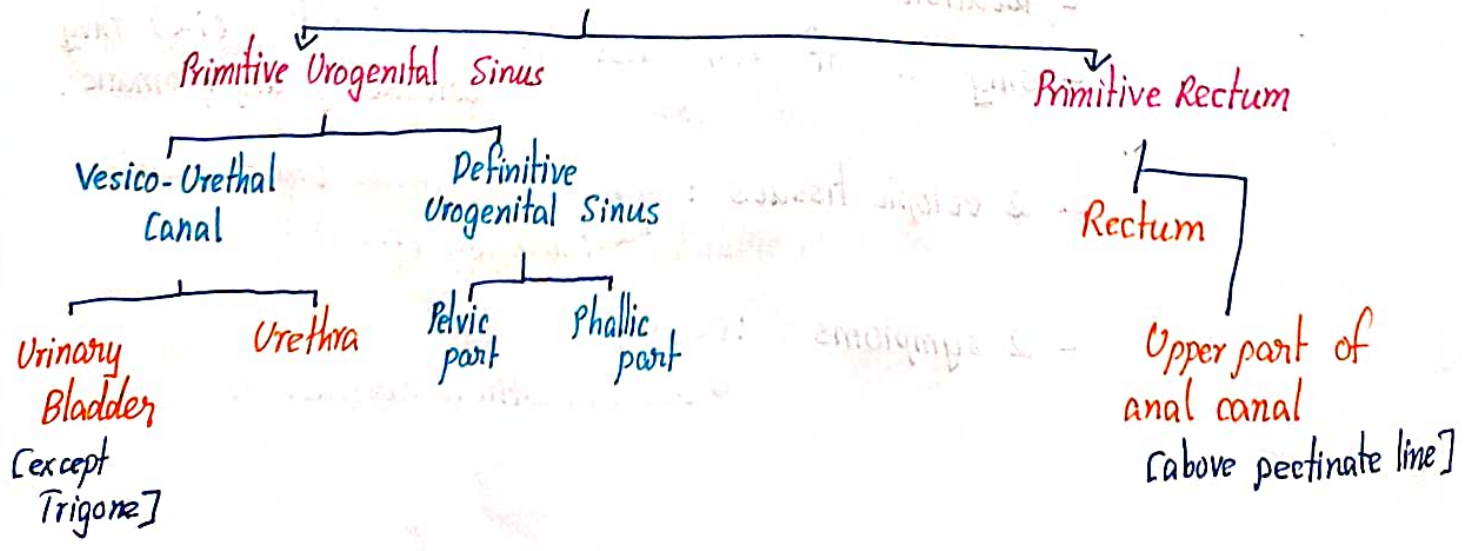


Cloaca :

- Endodermal



2 divisions of cloaca by Urorectal Septum.



Development of Urinary Bladder:

→ Major part of U.B : from Vesico-Urethral Canal.

[from primitive UGS → cloaca]
[endodermal]

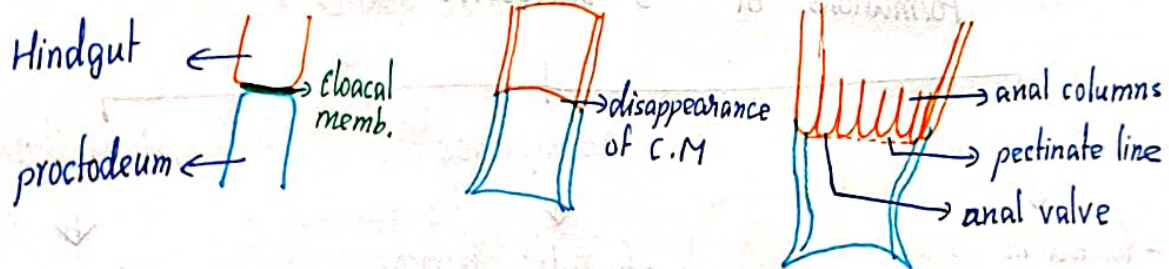
→ Trigone of U.B : from Mesonephric duct [caudal part]

[mesodermal]

↳ intermediate mesod.

→ Apex of U.B Median Umbilical lig. → Umbilicus

Development of Anal Canal:



→ Pectinate line ⇒ represent site of cloacal membrane [Anal memb.]

- Upper part of anal canal: Hindgut [cloaca]

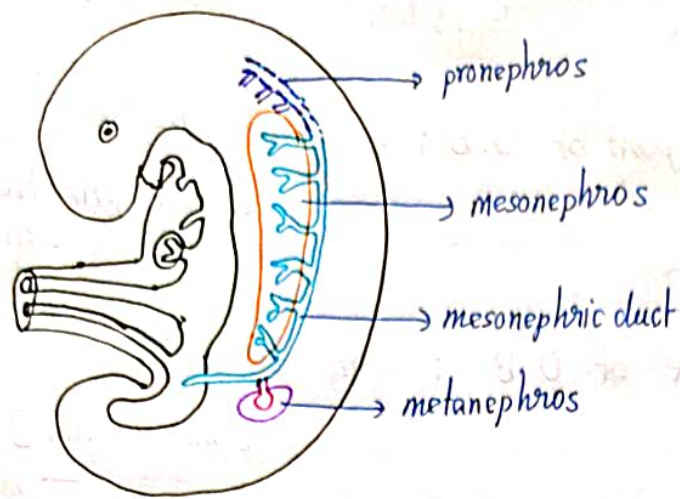
- lower part of anal canal: Proctodeum

- both parts of A.C are separated by anal membrane [part of cloacal memb.]

ruptures by 7th/8th week of IUL.

cloacal membrane: both ectoderm & endoderm.

Development of ^{Urinary} Urogenital System :



- develop from intermediate mesoderm, mesoderm (U.B. urethra)
↳ kidney - ureter

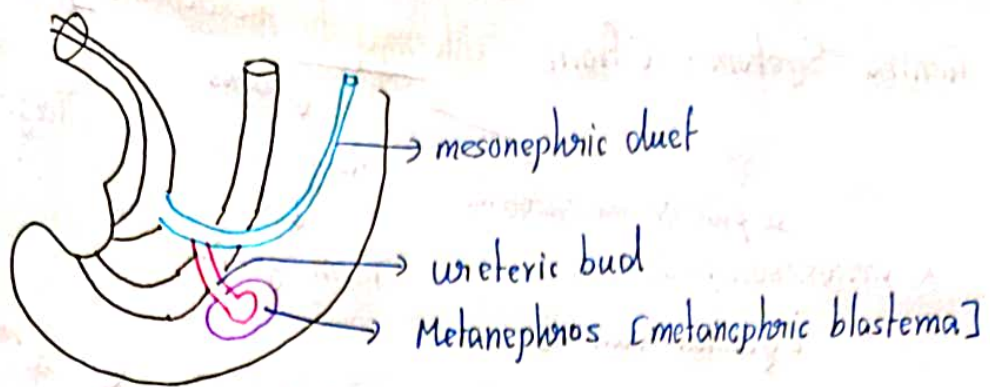
Development of kidney :

Formations of 3 successive kidneys

Pronephros	Mesonephros	metanephros
↓	↓	↓
- formed in cervical region of embryo	- formed in thoraco-lumbar region of embryo	- in sacral/pelvic region
- formed during beginning of 4 th week	- formed during end of 4 th week	- formed during beginning of 3 rd month
- It is entirely non-functional.	- It is temporarily functional.	- It is the permanent kidney.

Definitive kidney → develop in pelvic region [Metanephros]

Sources	metanephros : form excretory part of kidney } - Glomerulus - B.C - PCT - DCT - Henle's loop
	[mesonephric duct] : form collecting part of kidney } - collecting duct - minor & major calyces - Pelvis - Ureter



Ascent of kidney:

after formation of kidney in pelvic region, both ascend to reach lumbar region.

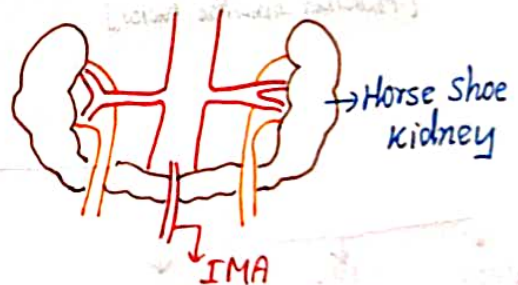
Congenital anomalies:

⊗ Pelvic kidney:

- kidney retained in pelvic region [failure of ascent]

⊗ Horse Shoe kidney:

- lower poles of both kidneys fuse with each other.



- Ascent is arrested by **IMA**.

- **most common Congenital Renal Anomaly.**

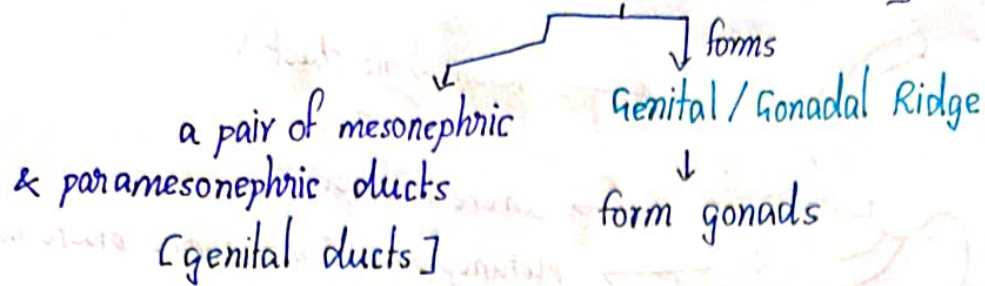
⊗ Polycystic kidney:

- numerous cysts on surface of kidney.

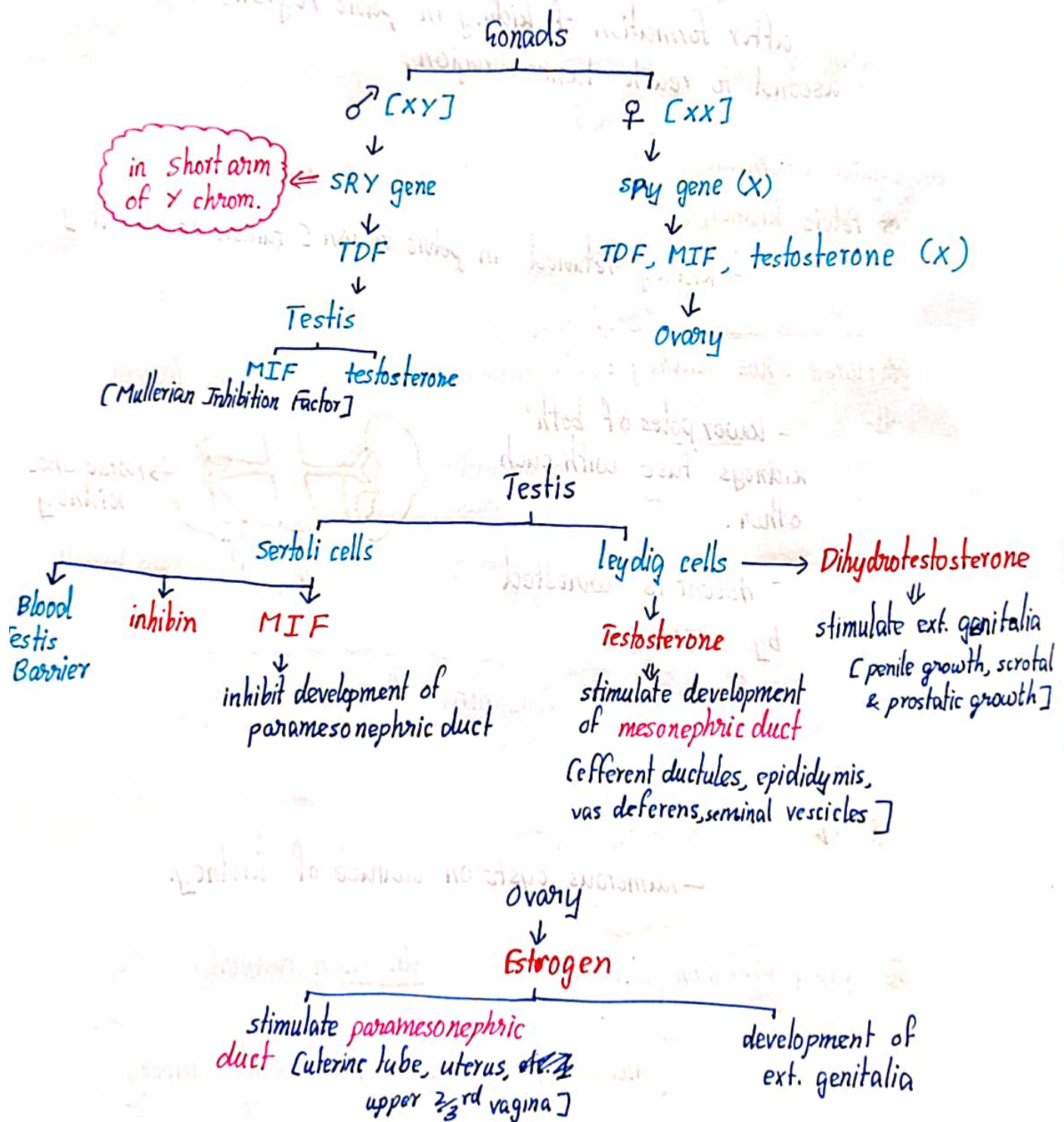
⊗ **Most common congenital Renal Vascular Anomaly**

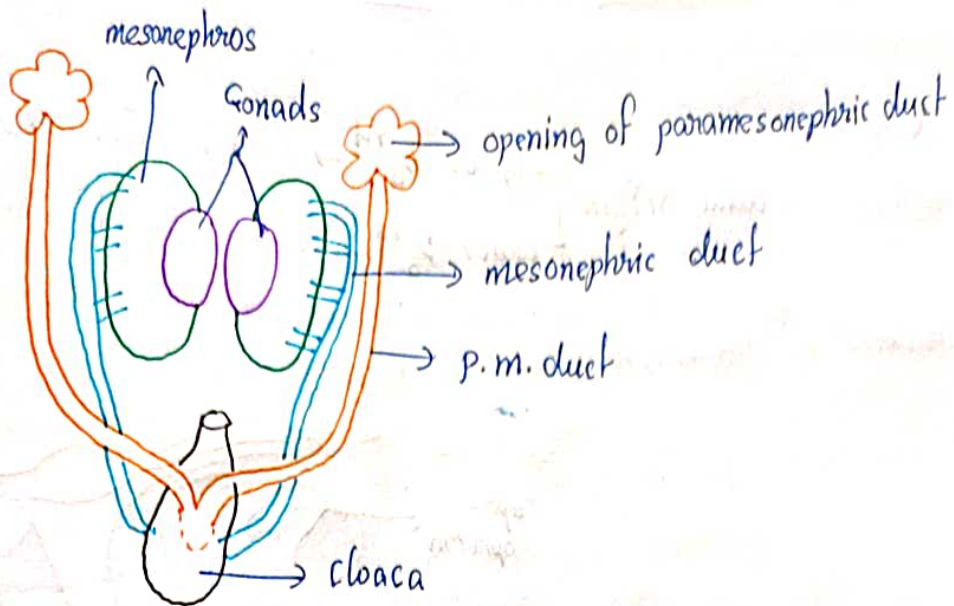
↓
Accessory / Supernumerary Renal artery

Genital System: [from **Intermediate mesoderm**]



Primordial Germ Cells: → invade genital ridge @ 6th week of IUL.
↳ derived from **epiblast** [Ectoderm]





Gonads → genital ridges

Scrotum, labia majora → genital swelling

Penis, clitoris → genital tubercles

main genital duct:

♂ ⇒ mesonephric / Wolffian ducts

♀ ⇒ paramesonephric / Mullerian ducts.

Derivatives of mesonephric ducts: PUT A DEEP SEMEN

U → ureteric bud [collecting part of kidney]

T → Trigone

A → Appendix of epididymis

D → Ductus deferens / Vas deferens

E → Epididymis

E → Ejaculatory duct

SEMEN → Seminal Vesicles

Derivatives of paramesonephric duct [in ♀]:

→ Fallopian tube [from unfused / upper part of P.M.D.]

→ Uterus [from fused / lower part of P.M.D.]

→ Upper $\frac{2}{3}$ rd of vagina [lower part of vagina]

Mullerian agenesis:

→ absence / agenesis of P.M.D.

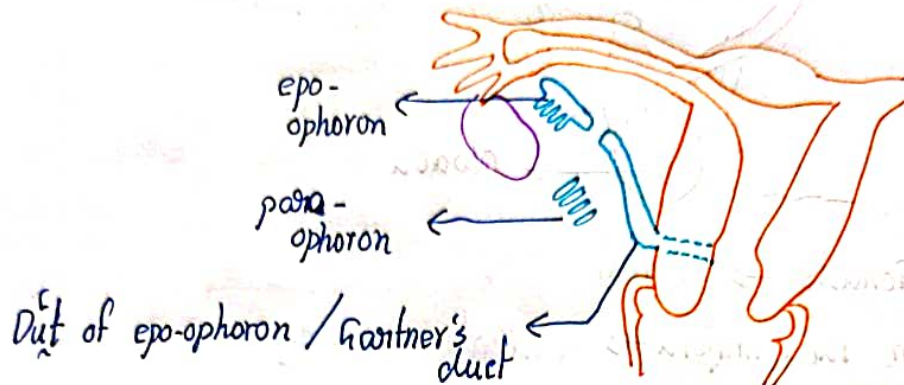
→ °° absence of F.T, Uterus, upper $\frac{2}{3}$ rd vagina.

→ [Ovary present.]

Vagina:

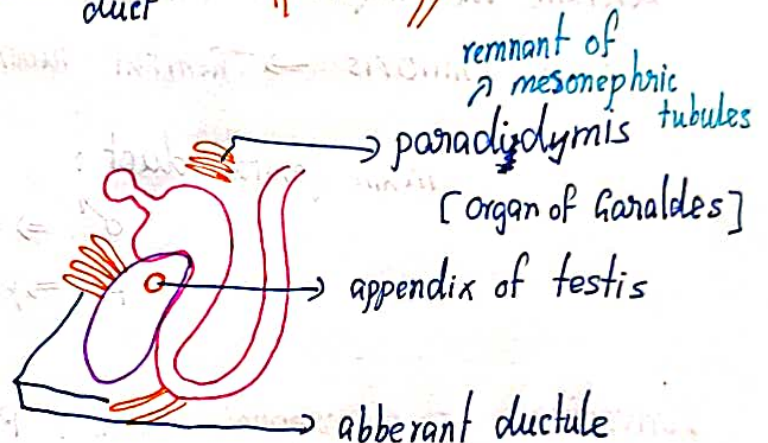
- dual origin $\left\{ \begin{array}{l} \text{Upper } \frac{2}{3}^{\text{rd}} \rightarrow \text{P.M.D [mesodermal]} \\ \text{Lower } \frac{1}{3}^{\text{rd}} \rightarrow \text{Primitive Urogenital Sinus [endodermal]} \end{array} \right.$

Remnants of mesonephric duct in ♀:



Remnants of P.M.D in ♂:

- Appendix of testis
- Prostatic utricle



Descent of Testis:

- Testis develops in lumbar region [Post. abd. wall] of embryo
- After development [during 2nd month] testis descend to scrotum. [just before birth]
- Factor responsible:

- Gubernaculum Testis: - fibromuscular band
 - ↳ attached to lower/caudal pole
- Processus Vaginalis: - Peritoneal fold - help for testis descent.
- Increased Intra-Abd. Pressure & Temp.
- ♂ sex hormones [esp. Testosterone]

→ Duration:

- ⊗ 3rd month → Iliac fossa
- ⊗ 4th - 6th month → Deep Inguinal Ring
- ⊗ 7th month → Passes through Inguinal Canal
- ⊗ 8th month → Sup. Inguinal Ring
- ⊗ just before birth → lower part of scrotum

Cryptorchidism:

Failure of descent of testis to scrotum bottom.

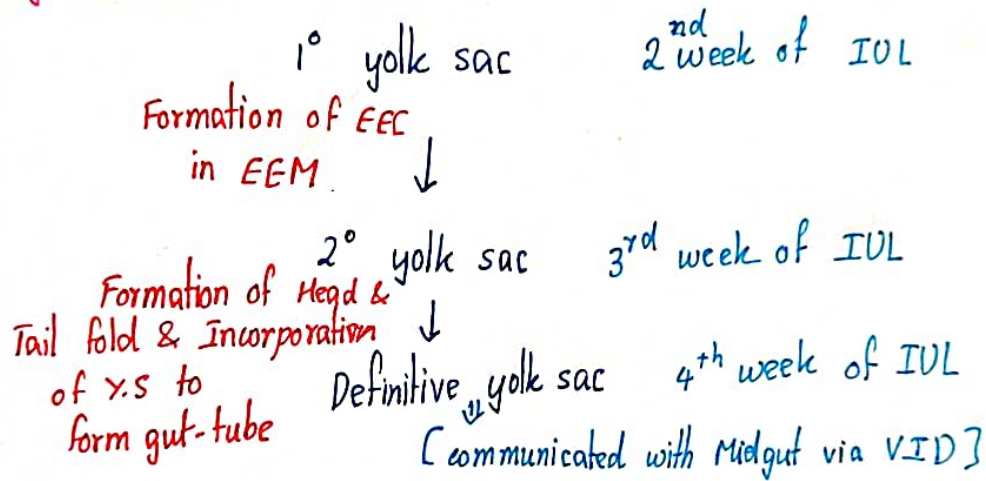
Complications:

- S - Sterility
- I - Injury to testis [more chance]
- T - Testicular tumor [seminoma]

Yolk Sac:

- One of the fetal membranes.

Stages:



Graffian follicle:

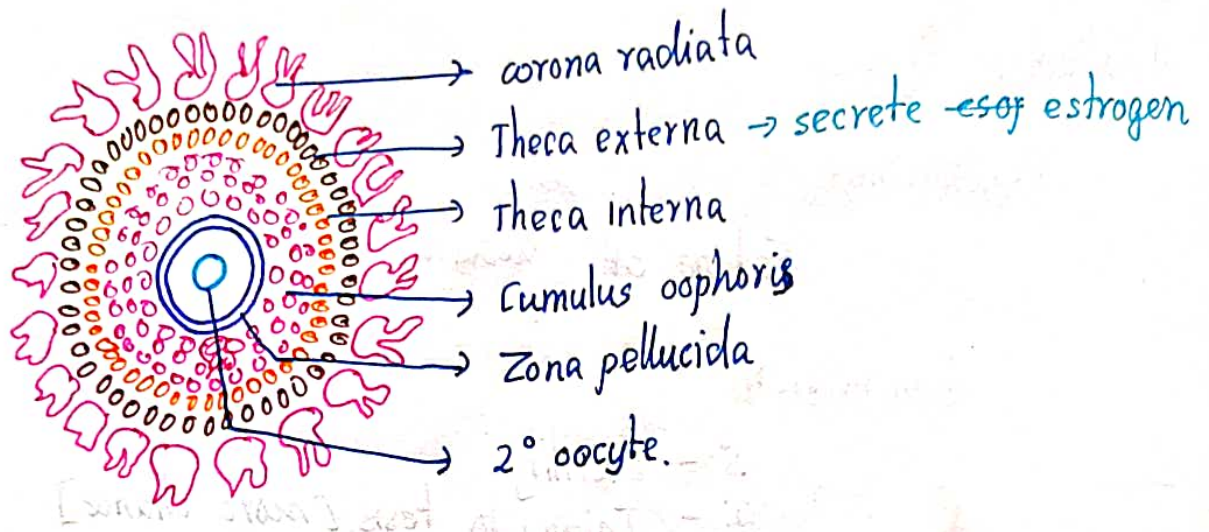
→ one of the tertiary follicles reach maximum size.

↓
Graffian follicle [largest mature follicle]

↓
remaining all will atrophy

→ G.F reaches the periphery of ovarian cortex.

→ The layer of cells surrounding 2° oocyte is Granosa Radiata.



→ After LH surge, ovulation occurs.

→ After ovulation, GF → gets converted into corpus luteum.