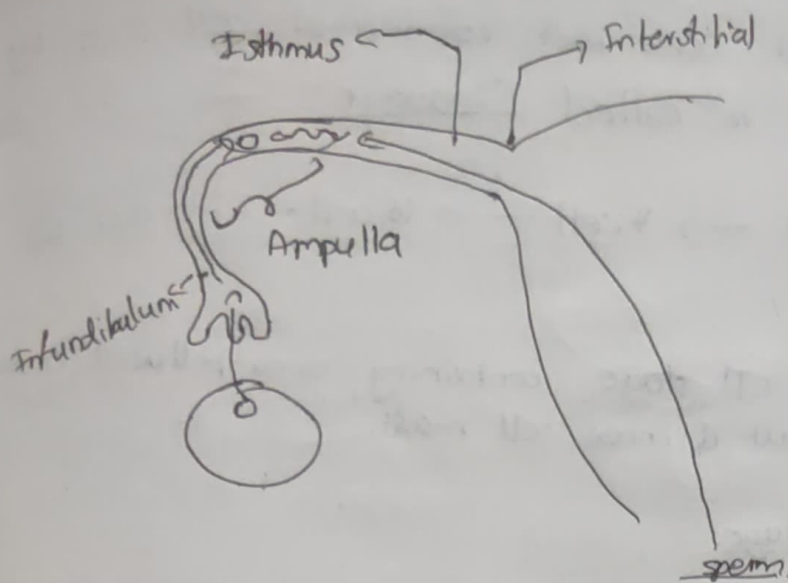
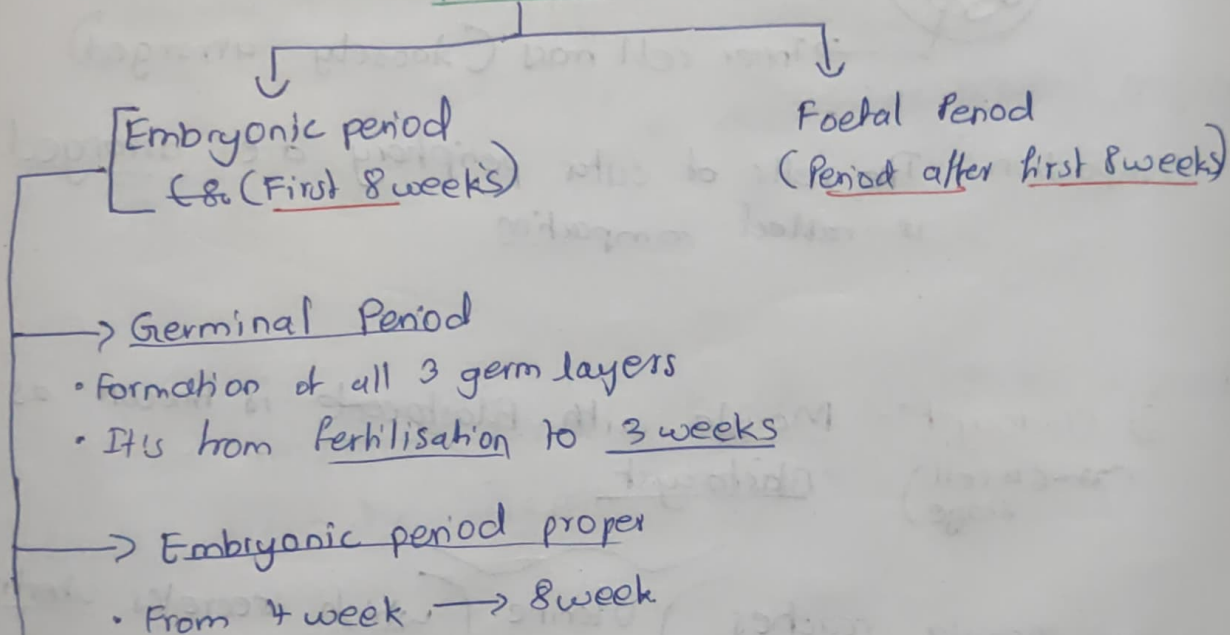


General Embryology



→ Entire length of human pregnancy is 40 week or 280 days

40 week



First Week of Development

Major events happening are:-

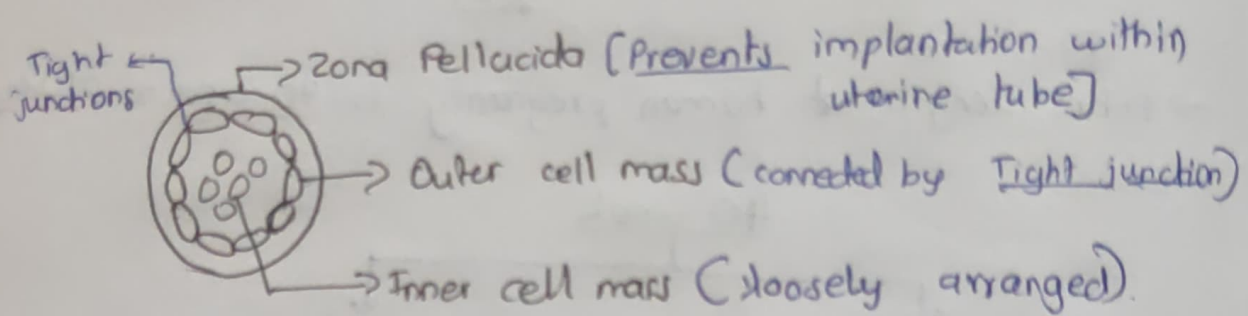
- 1) Cleavage
- 2) Morula
- 3) Blastocyst
- 4) Implantation.

1) Cleavage:- Is the process by which larger fertilized cell (zygote) will come back to normal cell size by mitotic division is called Cleavage.

1 cell $\rightarrow$ 2 cell $\rightarrow$ 4 cell $\rightarrow$ 16 cell $\rightarrow$ goes on

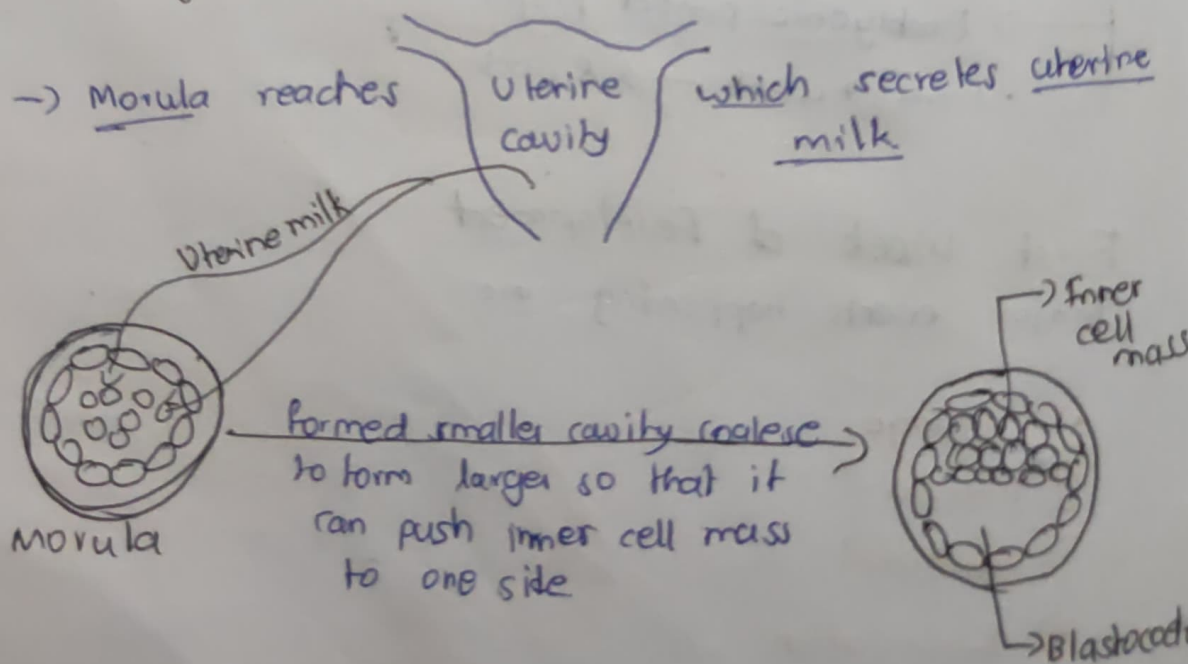
2) Morula:- 12-16 cell stage containing zona pellucida, outer cell mass & inner cell mass.

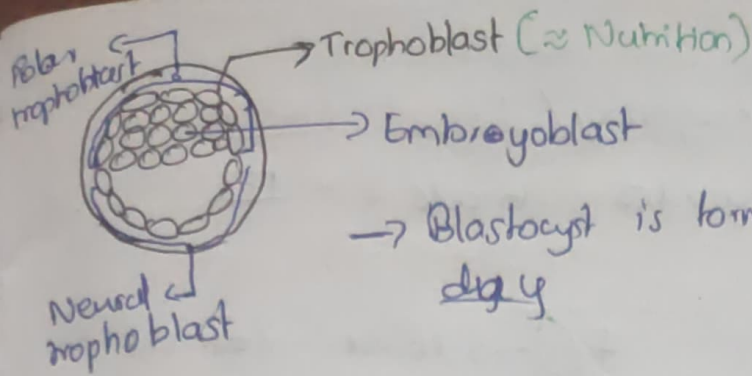
12-16 cell stage



compaction:- The cells of outer periphery are arranged. is called compaction.

3) Blastocyst:- Morula with Blastocoel is known as Blastocyst (32-64 cell stage)

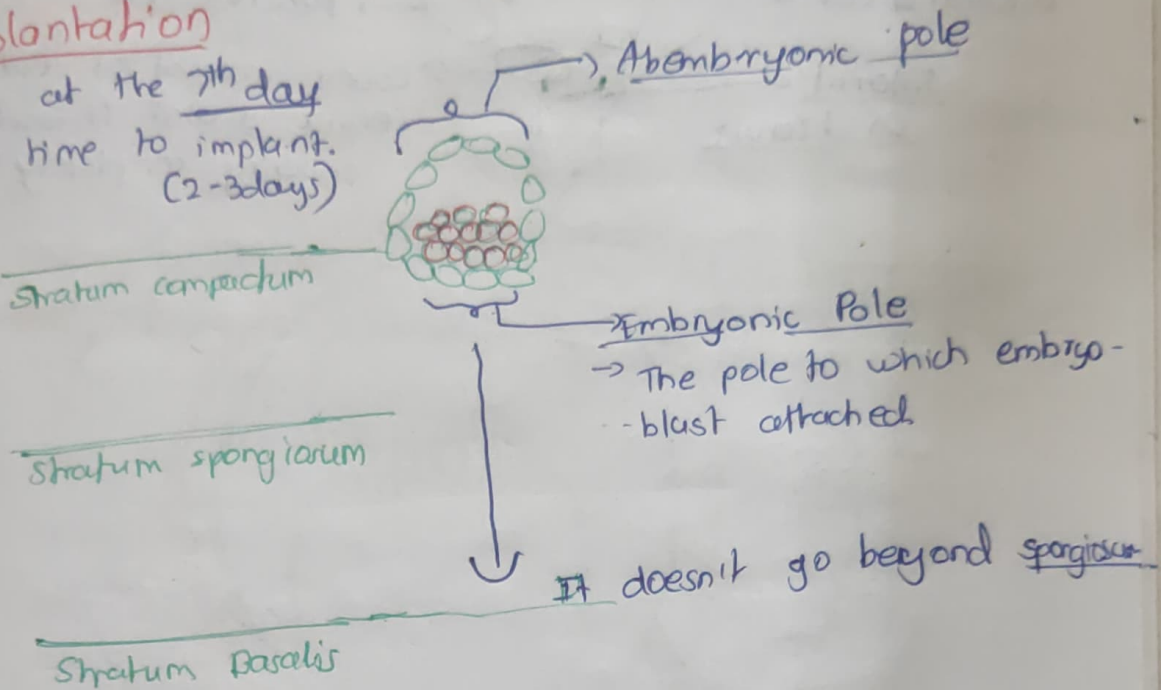




→ Blastocyst is formed roughly about 5th day

4) Implantation

→ Starts at the 7th day
takes time to implant.
(2-3 days)

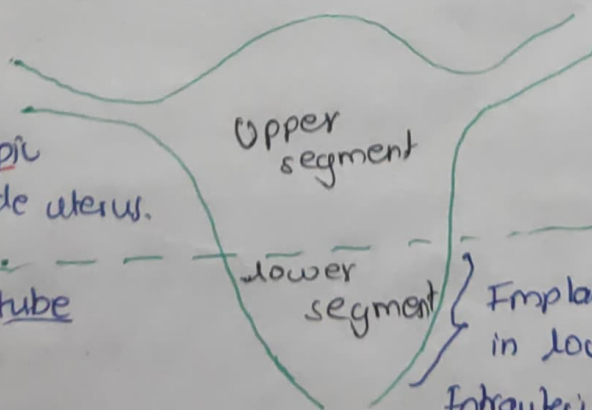


→ To get implanted zona pellucida should be removed.
It is done by trypsin like enzymes

Site of Implantation

Extrauterine Ectopic pregnancy:- outside uterus.

→ Site in
Salpingian tube
Abdomen
Ovary



→ Implantation
anywhere in
upper segment
Normal Implantation

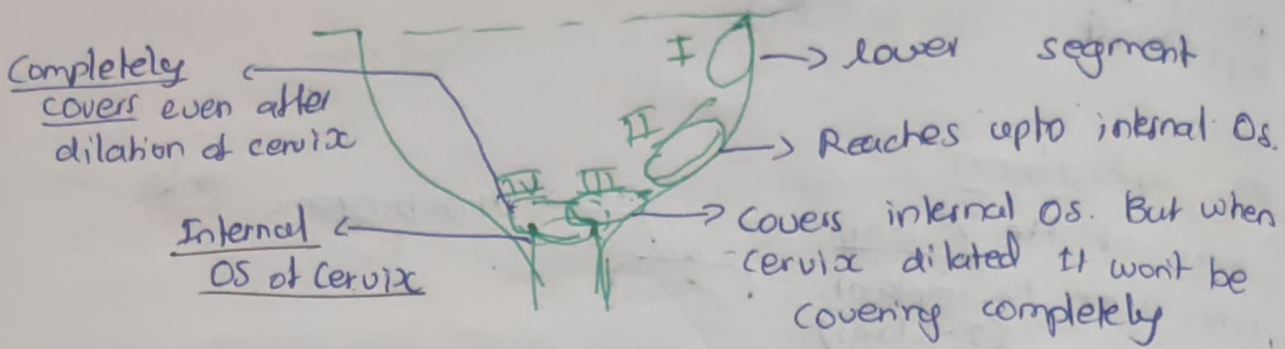
Implantation anywhere
in lower segment.
Intrauterine Ectopic Pregnancy

Ectopic Pregnancy:- Other Implantation in other than upper segment of uterine cavity called Ectopic Pregnancy.

~~Intrauterine~~

Intrauterine Ectopic Pregnancy / Placenta previa

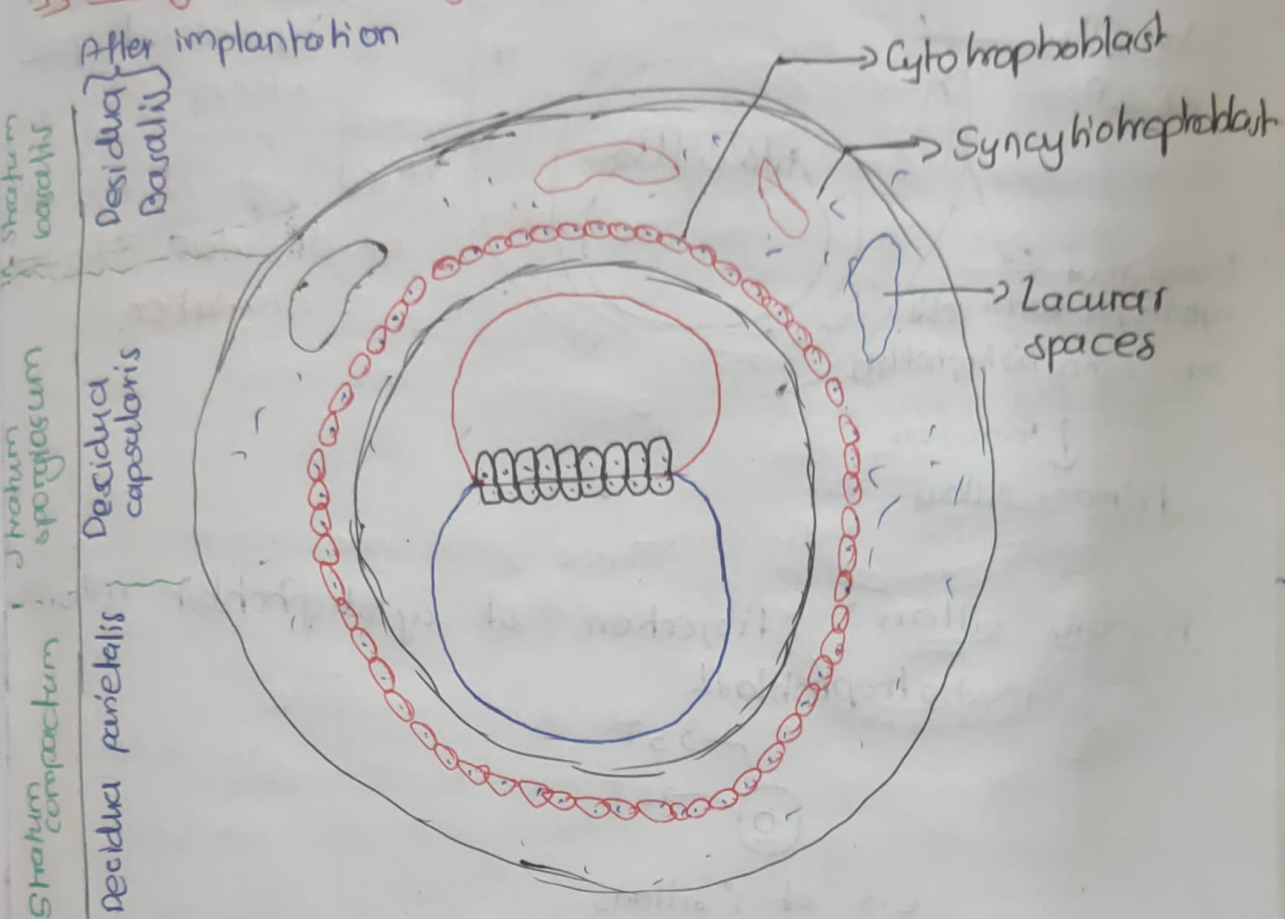
→ It has four grades. Grade I - IV



(Rule 4 2) 2nd WEEK of Development

1. Changes happening for Trophoblast
2. Changes happening for Embryoblast.

1] Changes Happening for Trophoblast



Uterine lining

→ Fibrin plug (formed at end of 12th day)

↓
Replaced by lining of endometrial ~~lining~~ lining

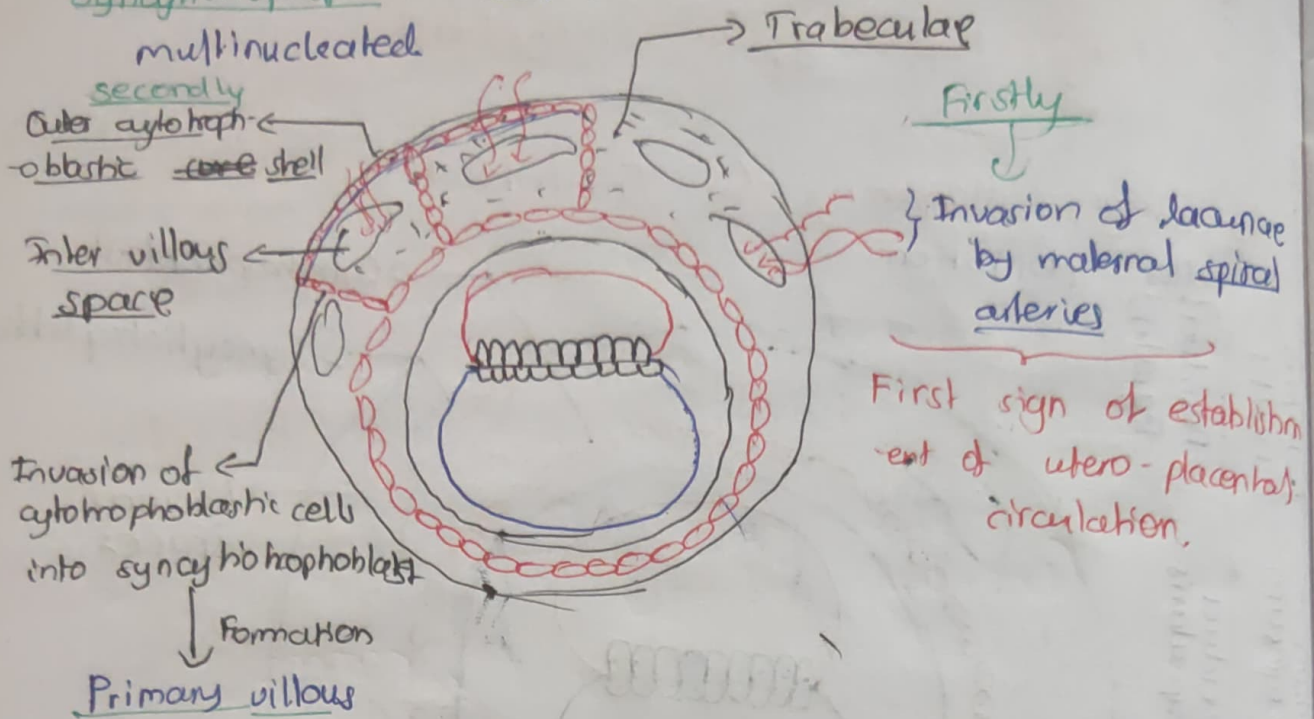
→ Trophoblast get differentiated into 2 layer (Rule of 2)

- Cytotrophoblast (inner)
- Syncytiotrophoblast (outer)

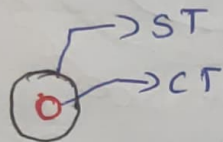
→ Embryonic pole has more development compared to Abembryonic pole

Cytotrophoblast: Mono nucleated cells with well differentiated cell membrane

Syncytiotrophoblast: Cell membranes dissolved its called multinucleated



Primary villi: - Projection of cytotrophoblast into syncytiotrophoblast.



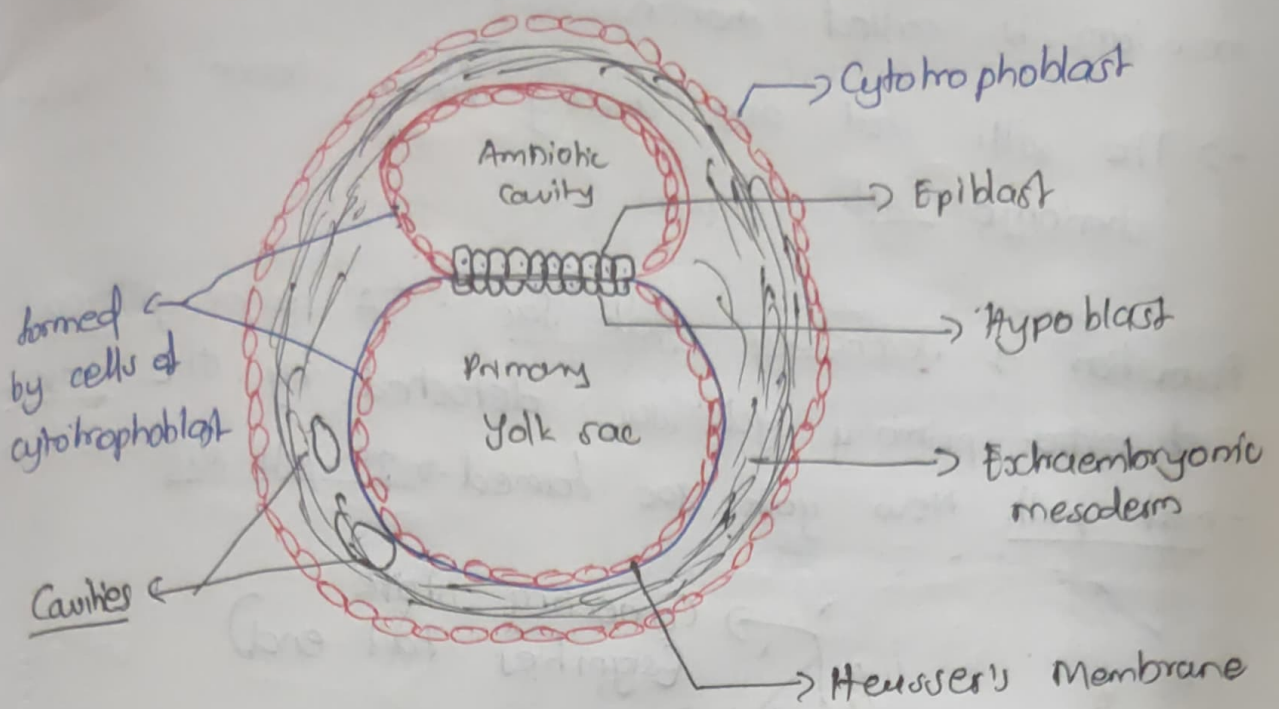
C.S. of 1° villous

→ As embryo starts developing faster needs more nutrition
 ⇒ Lacunar spaces filled by the spiral arteries and diffusion of nutrition to the embryo.

2] Change happening for embryoblast

→ detaches from trophoblast forms two layers

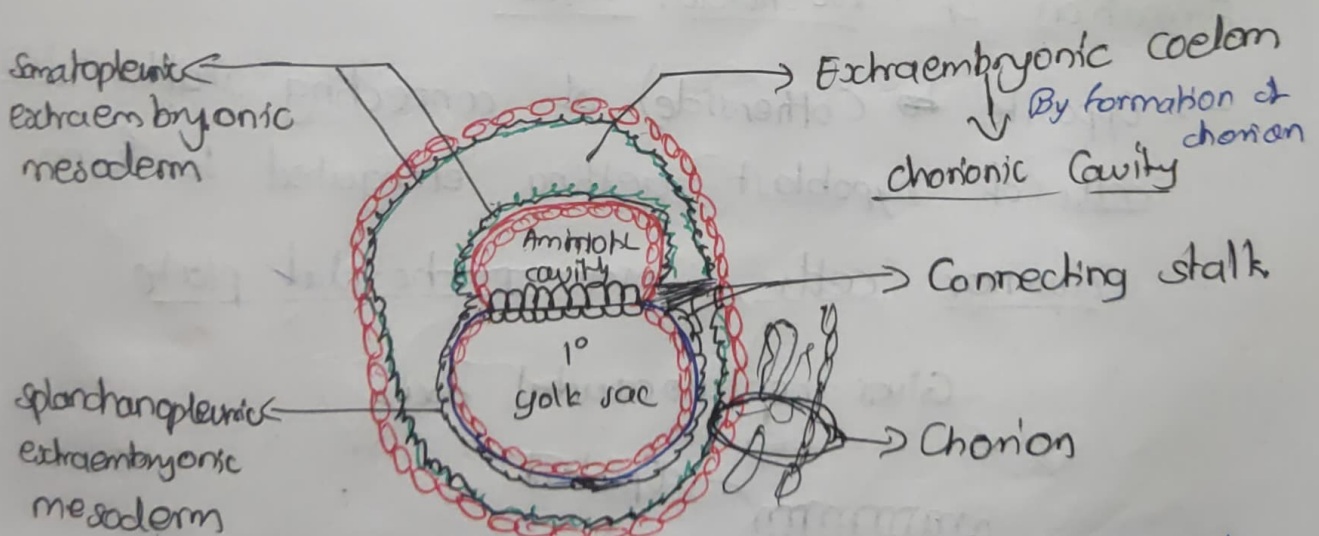
(Primitive ectoderm) • Epiblast: - Columnar cells in upper part
 (Primitive endoderm) • Hypoblast: - lower cuboidal cells



Extraembryonic Mesoderm - Tissue mass formed between Amniotic cavity, yolk sac & cytotrophoblast layer.

→ like the formation of lacunar spaces, cavities formed between extraembryonic mesoderm.

→ These cavities coalesced to form a larger cavity.



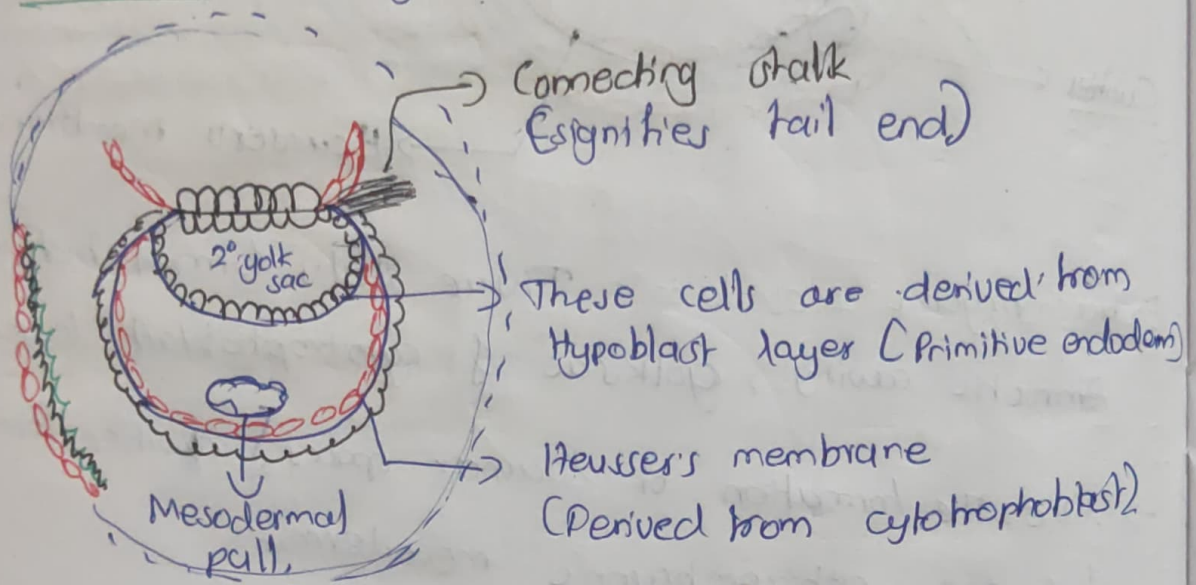
→ Extraembryonic - mesoderm is again differentiated into 2 different layers (rule 4 & 2)

- Somatopleuric extraembryonic mesoderm
- Splanchnopleuric extraembryonic mesoderm

Chorion :- The whole trophoblast (syncytiot cyto) & splanchnopleuric somatopleuric extraembryonic mesoderm is called chorion.

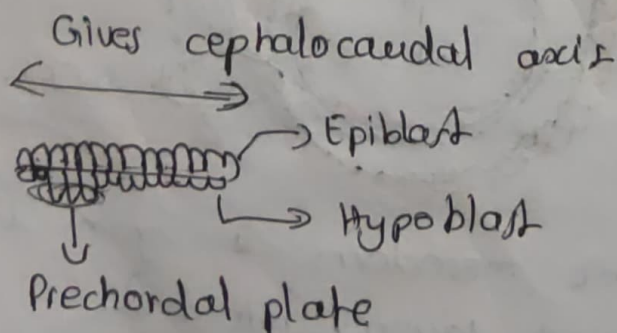
→ The villi that are arising from chorion is called chorionic villi.

Formation of Secondary Yolk Sac :- A major portion of ~~extra~~ primary yolk sac detached by the mesoderm - pull. New yolk sac formed → 2° yolk sac



Formation of Prechordal Plate

→ Opposite to (other side) of connecting stalk, columnar cells of hypoblast getting elongated to form prechordal plate



Rule of 2 in 2nd week. Imp

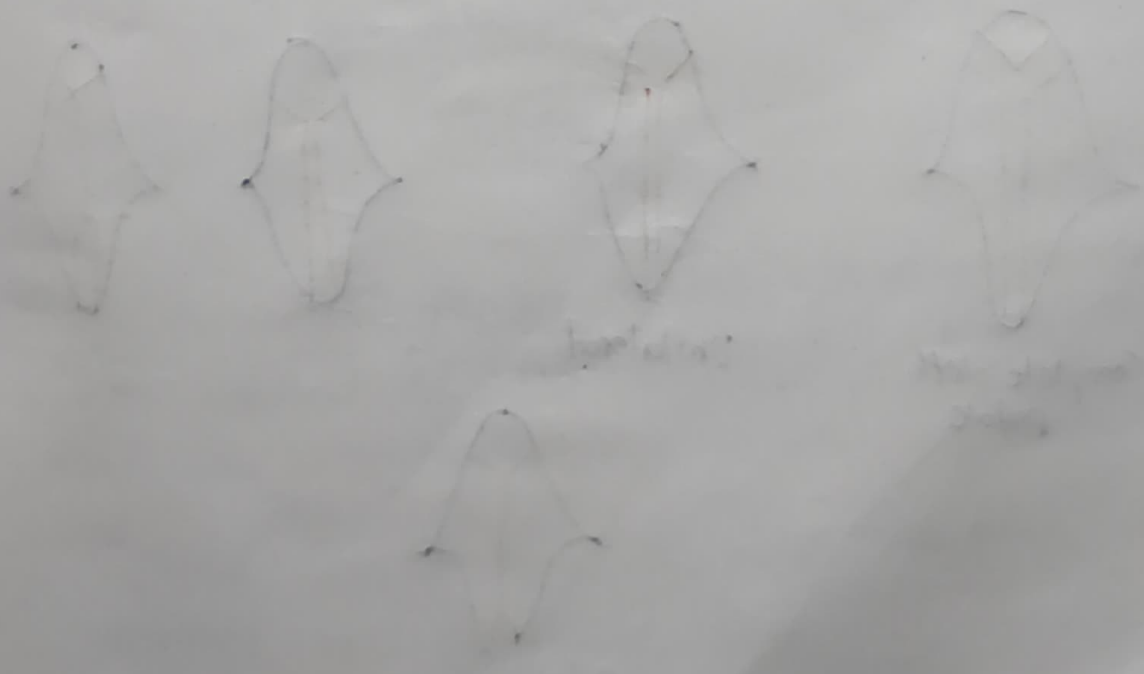
Trophoblast $\begin{cases} \rightarrow \text{Cytotrophoblast} \\ \rightarrow \text{Syncytiotrophoblast} \end{cases}$

Bilaminar germ disc $\begin{cases} \rightarrow \text{Epiblast} \\ \rightarrow \text{Hypoblast} \end{cases}$

2-cavities $\begin{cases} \rightarrow \text{Amniotic cavity} \\ \rightarrow \text{Yolk sac} \end{cases}$

2 yolk sac $\begin{cases} \rightarrow 1^\circ \\ \rightarrow 2^\circ \end{cases}$

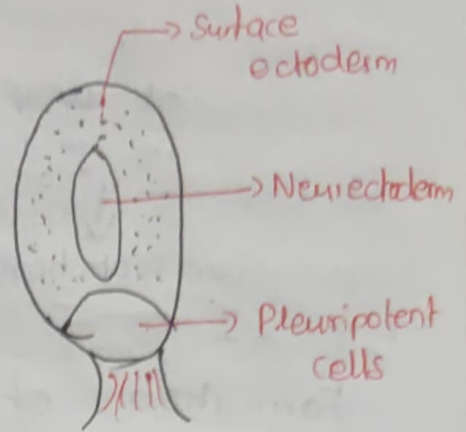
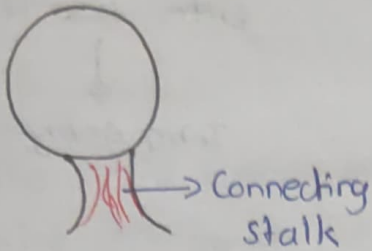
Extraembryonic mesoderm $\begin{cases} \rightarrow \text{Somatopleuric} \\ \rightarrow \text{Splanchnopleuric} \end{cases}$



(3rd) Third Week of Development

→ Remember it as formation of 3 germ layers, changes occurs at → embryoblast & trophoblast.

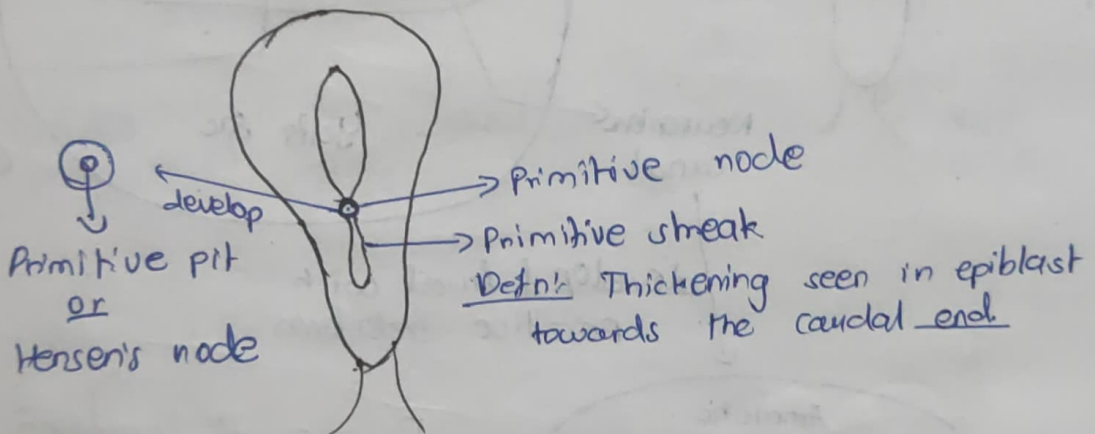
seeing from Above



(Cephalic) Surface ectoderm → Epidermis & skin

Neuroectoderm → CNS

(Caudal) Pluripotent cells → Can give rise to all three germ layers



* Primitive streak → (Primary organiser) → can give rise giving rise all 3 germ layers

→ Inducing formation of notochord & intraembryonic mesoderm

Changes at primitive streaks

Gastrulation :- Process by which bilaminar germ disc is getting converted into trilaminar germ disc with the intervention of a mesoderm (intraembryonic) in b/w - two layers.

x) The cells from primitive streak will go to lie b/w epiblast & hypoblast.

Divided into two groups

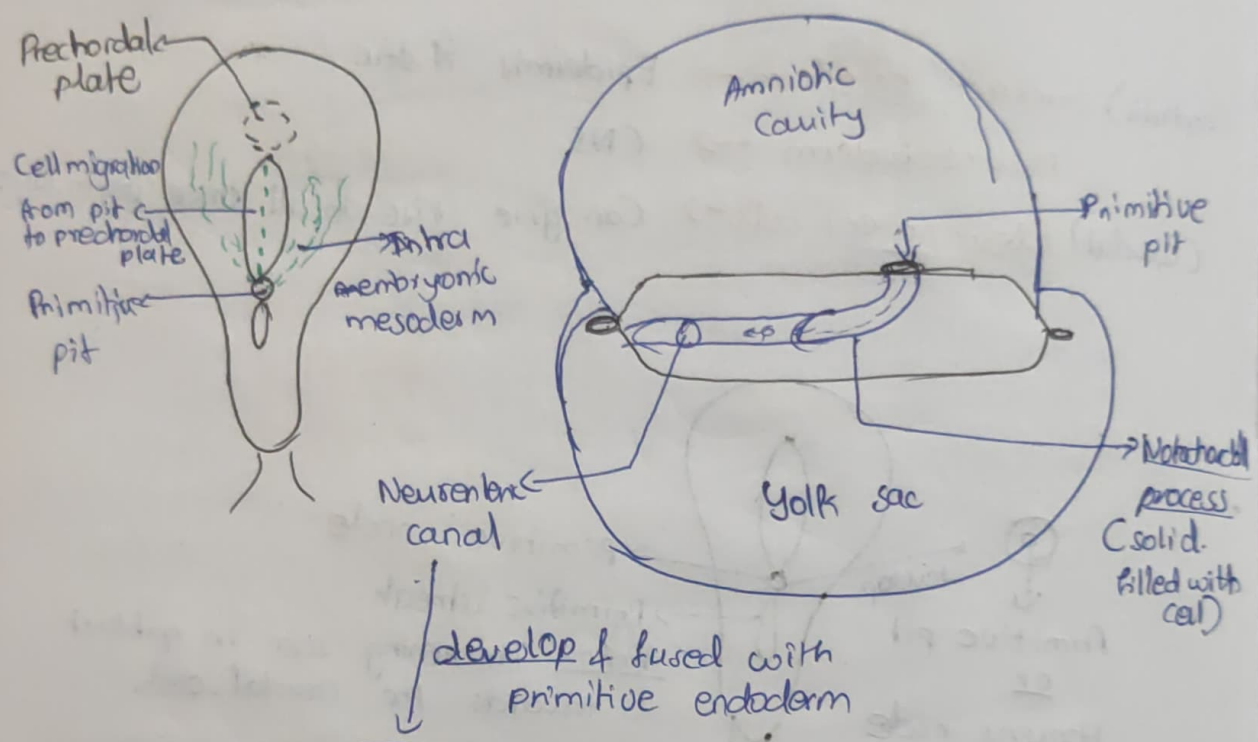
cells lying
in Mid-line

↓
Notochord

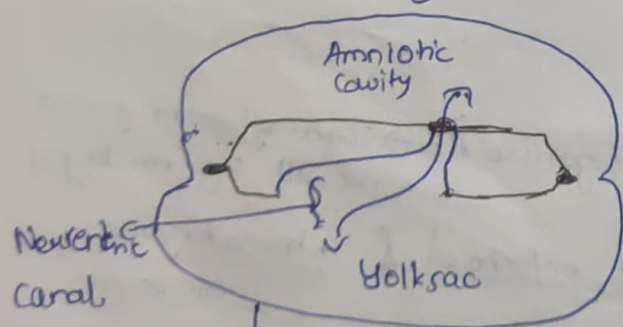
cells lying on
either side of Notochord
(mid-line)

↓
Intra embryonic mesoderm

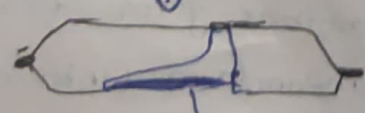
Formation of Notochord



develop & fused with primitive endoderm



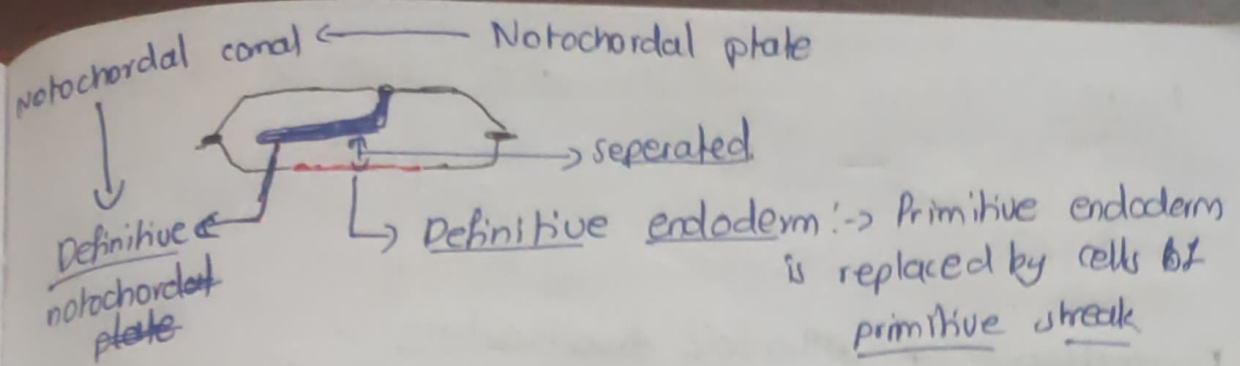
After nutrition made available



Purpose of Formation of Neurenteric canal

→ By the end of 2nd week placenta started developing but blood supply not established to get nourishment it's connected to yolk sac.

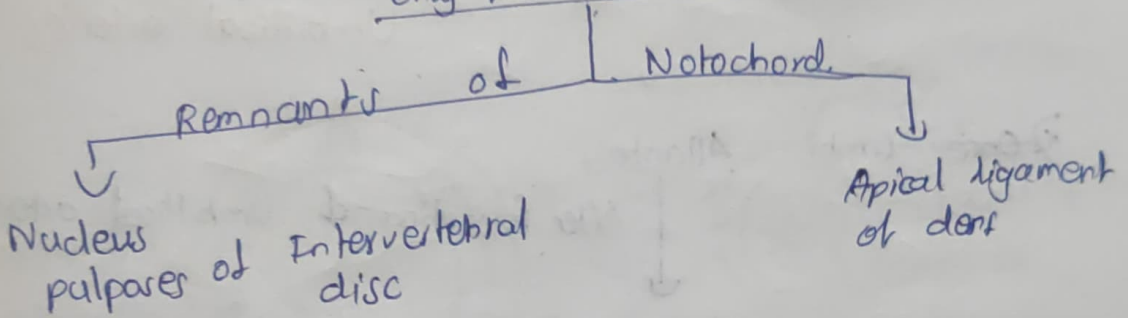
→ Nutrition available in Yolk sac diverted to amniotic cavity
Nourish Neurectoderm



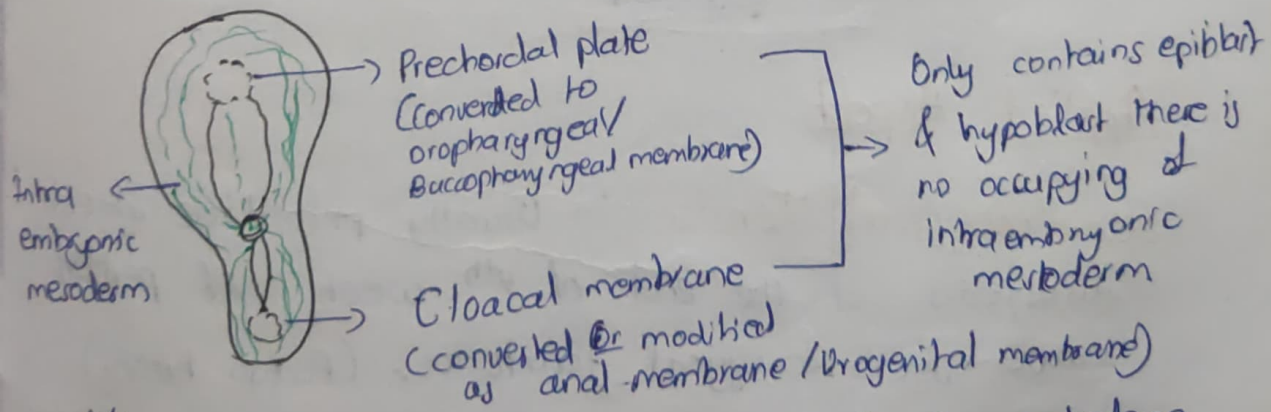
Purpose of Definitive Notochord: - Acting as a mold in the mid line so that our developing vertebral ~~canal~~ column will be formed around it.

After formation of Vertebral Column

↓
Notochord disappears
only present as remnants



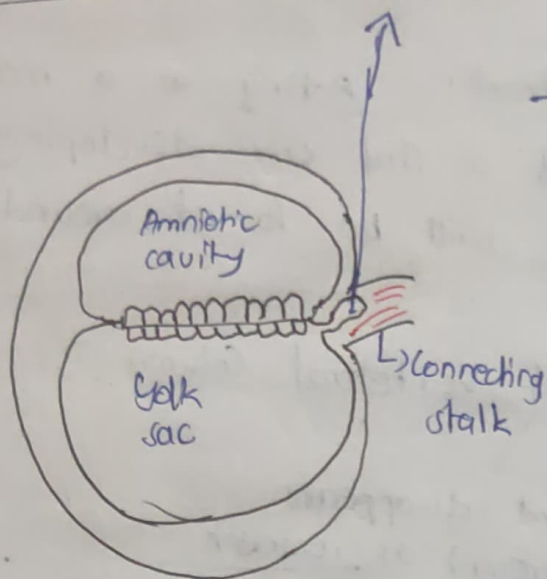
Primitive chain Induce → Notochord Induce → Neural tube
↓
Gonad



After
Primitive ectoderm → Definitive ectoderm
(replaced by primitive streak cells)

Note:- Primitive streak gives rise to all three germ layers

Formation of Allantois diverticulum



Purpose of Allantois diverticulum

→ Provided with blood vessels projecting into connecting stalk to vascularise.

Allantois

↓
Umbilical arteries

~~Once umbilical~~

Allantois

↓ After formation of Umbilical arteries

↓
Urachus (Intrauterine life)

↓
Median umbilical ligament (Adult)

Applied Aspect

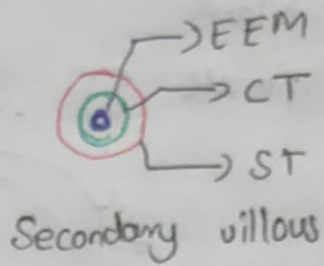
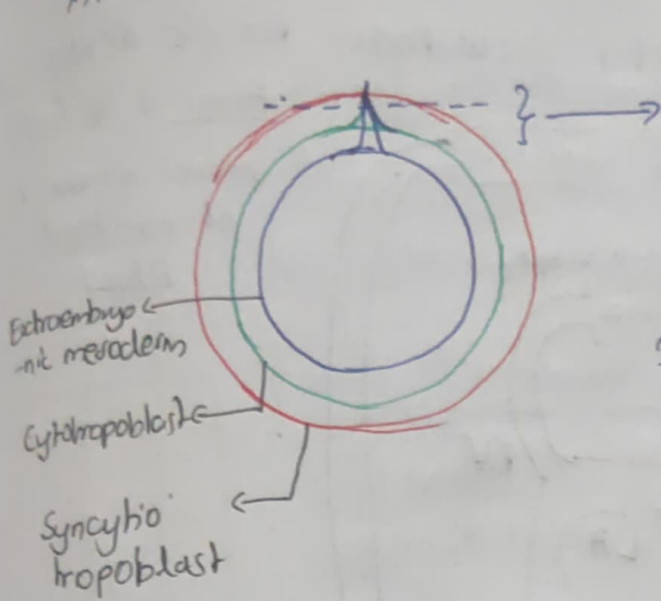
Sacrocaudal Teratoma:- Usually, primitive streak disappears at the end of 4th week. If persists cause sacrocaudal teratoma. (Benign tumor)

→ In teratoma we will get derivative of all 3 germ layers. Usually female newborn. Not good prognosis

Changes happening for Trophoblast

At beginning of 3rd week $\rightarrow$ Secondary villous formation

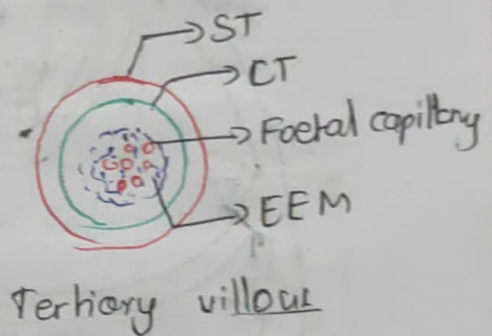
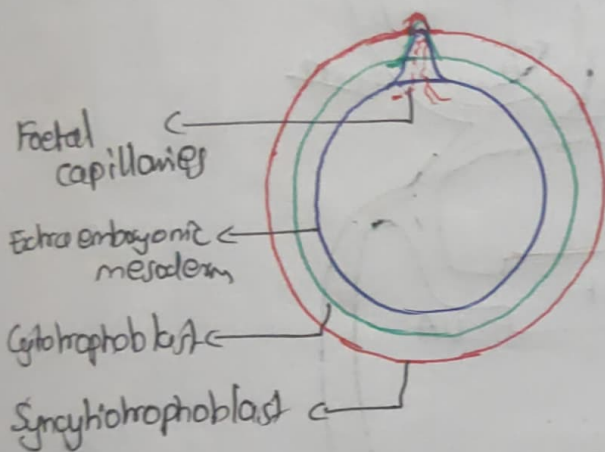
At the end of 3rd week $\rightarrow$ Tertiary villous formation



1^o villous $\rightarrow$ 1 layer within ST

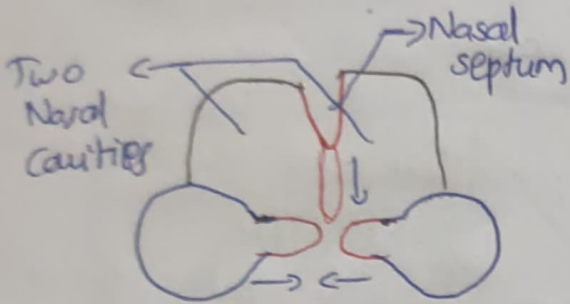
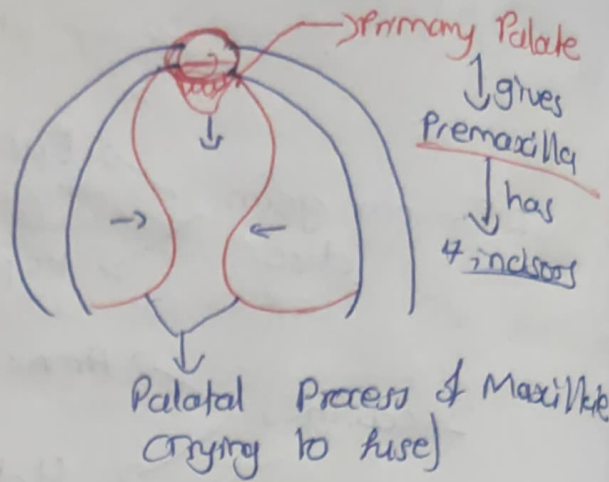
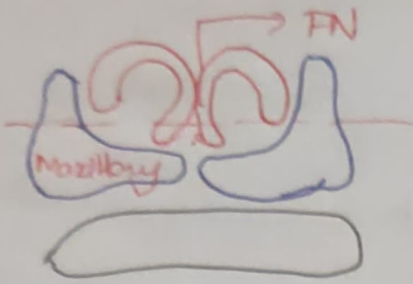
2^o villous $\rightarrow$ 2 layer within ST

3^o villous $\rightarrow$ 3 layers within ST
 (have 2+ foetal capillary)

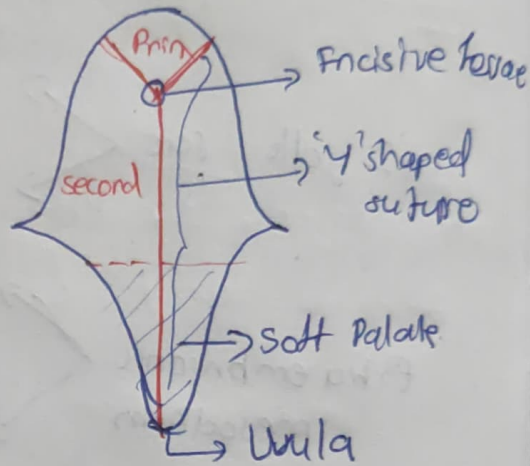


Development of Palate

Primary palate: - fused by two medial nasal process (FN)
Secondary Palate: - derived from maxillary process



→ Posterior part not ossified and forms soft palate



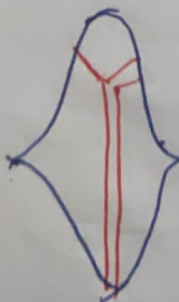
Definitive Palate

Anomalies

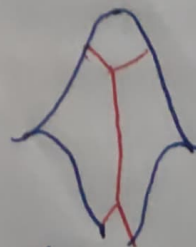
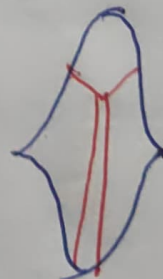
→ Common terminology cleft palate



Complete cleft palate

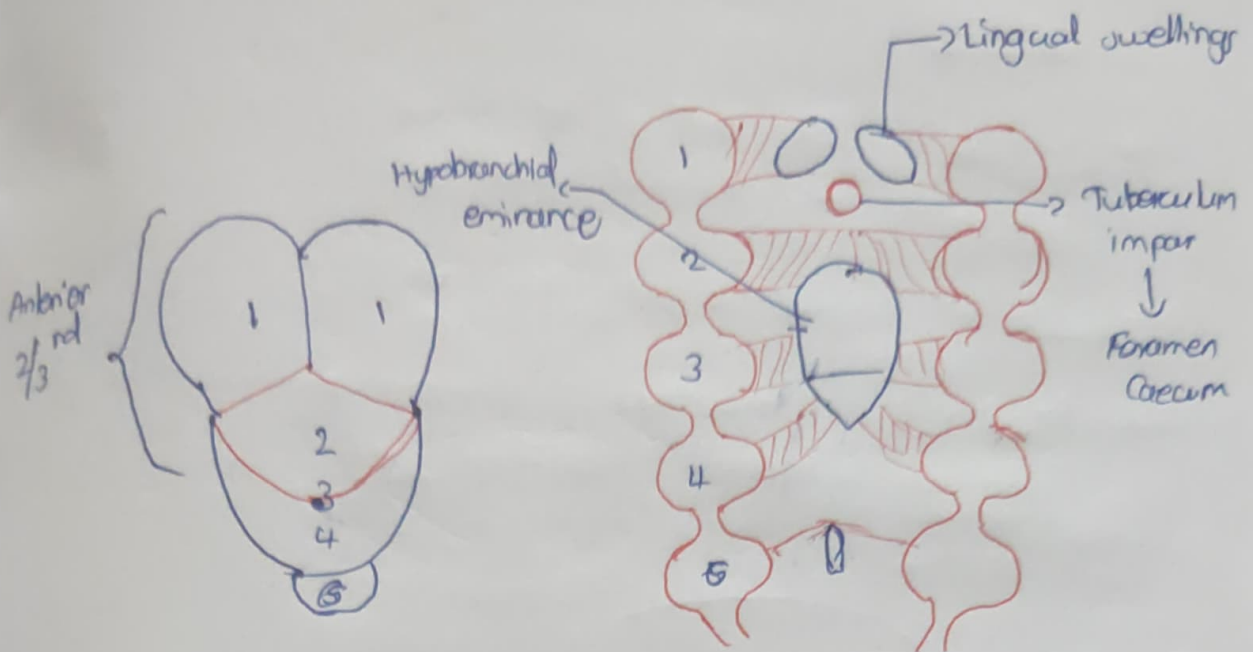


Unilateral

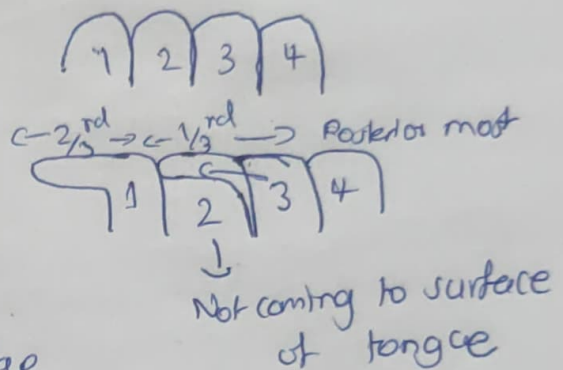
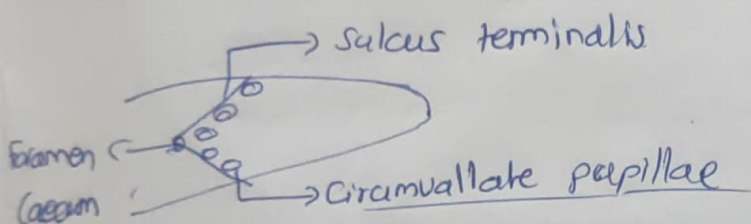


Bifid Uvula

Development of Tongue



- Mucous Membrane
- Fibrous Tissue
- Muscles of Tongue



Mucous Membrane

Anterior 2/3 → General sensory
Lingual

Posterior 1/3 → Glossopharyngeal

Posterior most → Superior laryngeal

Special sensory
chorda tympani.

Glossopharyngeal

Superior laryngeal

→ Circumvallate papillae, anterior to sulcus terminalis are supplied by Glossopharyngeal Nerve (IX)

Muscles of Tongue

→ ~~Developed~~ Derived from occipital myotome. So it is supplied by Hypoglossal nerve.

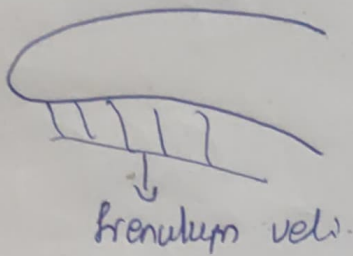
Fibrous hauma :-> Derived from embedded mesoderm.

Applied

Hemiglossia :- One half of the tongue is missing due to missing of one lingual swelling.

Aglossia :- Tongue is not developed.

Ankyloglossia / (Tongue tie) :- Unable to protrude tongue due to extended frenulum veli.

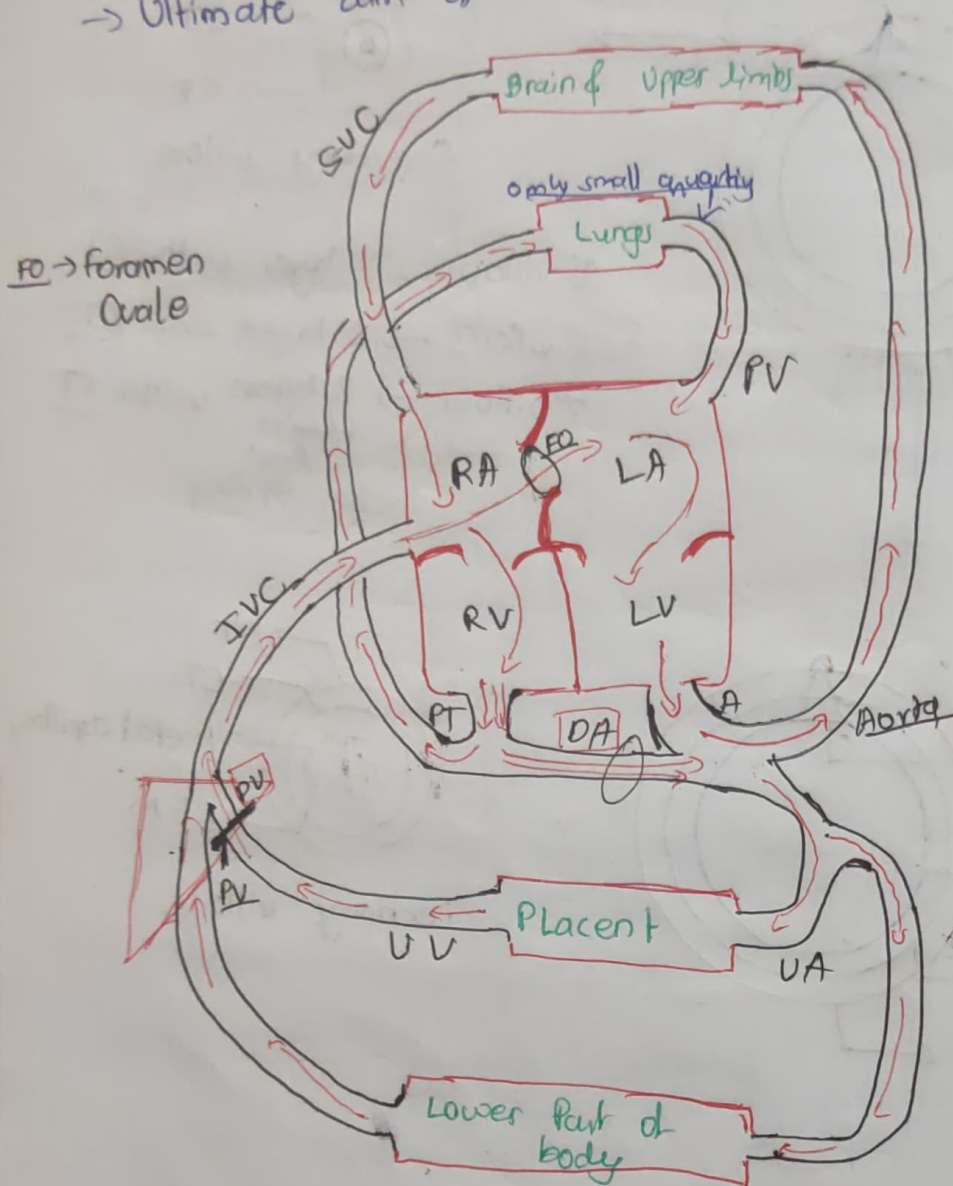


Foetal x Circulation

Intrauterine life

→ Lungs are not functioning so, Placenta is providing blood.

→ Ultimate aim of foetal circulation → Provide developing Brain of the foetus more amount of purified Blood



In Beginning,

→ It contains two(2) Umbilical Arteries & One(1) Umbilical vein.

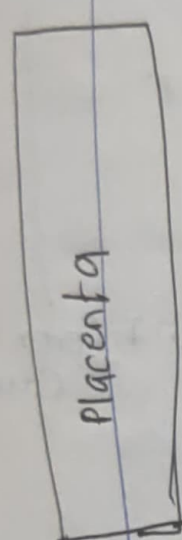
Placenta without deoxygenation → Brain

↓
left umbilical vein is left
left is left

Umbilical Vein $\xrightarrow{\text{joins}}$ Left Portal Vein? ~~shunt~~

* Umbilical arteries are two in number

Aorta
 $\downarrow$ Branch
Internal Iliac artery
 $\downarrow$ Branch
Umbilical artery



Ductus Venosus? Bypass
shunting

Inferior Vena cava

Right atrium

Foramen Ovale? Shunting

Left atrium

Left ventricle

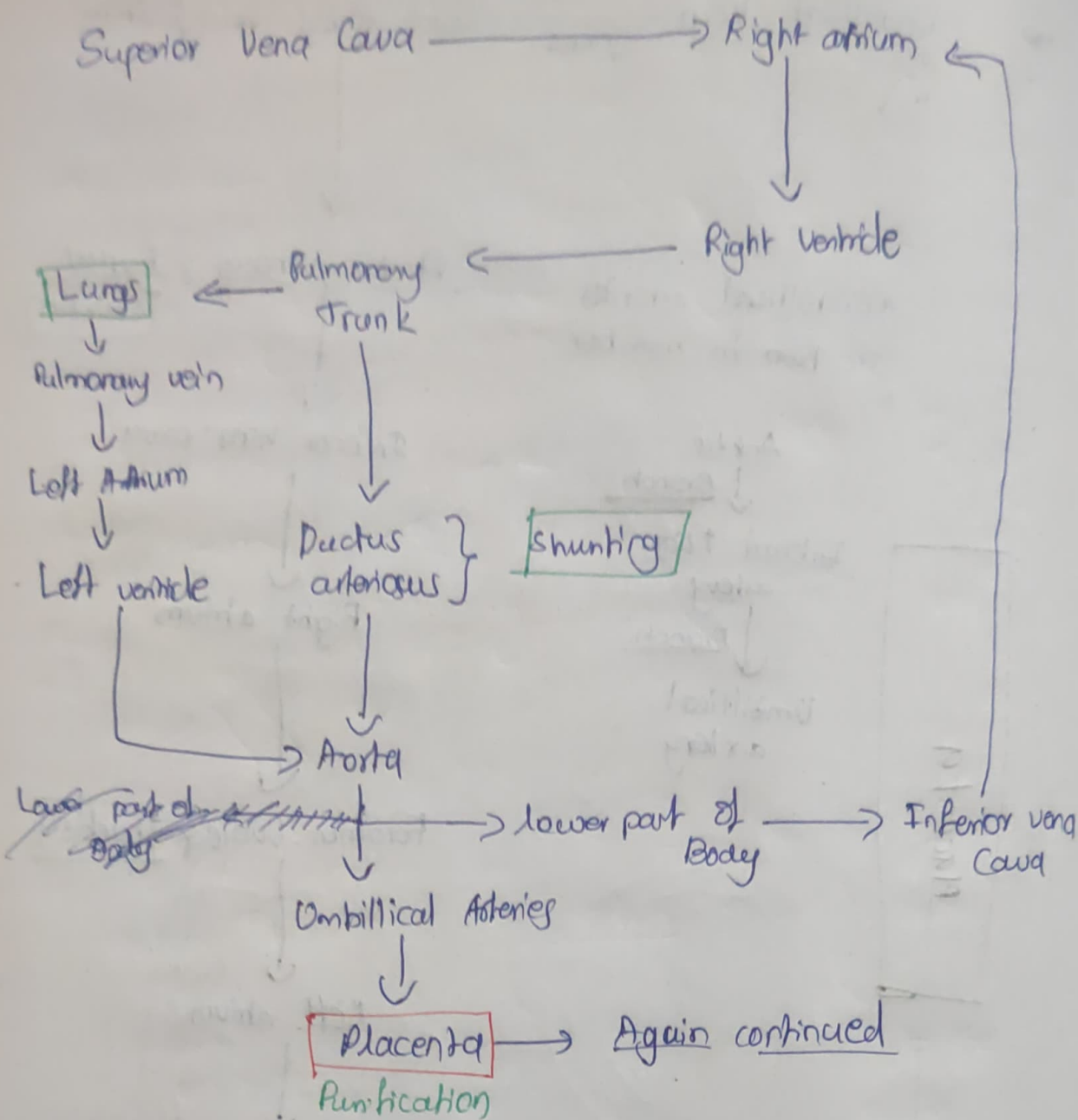
Aorta

Umbilical Arteries $\xleftarrow{\text{shunt}}$

Brain & Upper limb

Main Principle

- $\rightarrow$ Umbilical vein - Deoxygenated
- $\rightarrow$ Umbilical artery - Deoxygenated Blood
- $\rightarrow$ Umbilical vein - Oxygenated Blood



After Birth

→ The blood passing through the umbilical arteries should be stopped first. Req. Blood shouldn't be lost to outer (foetal) circulation.

- Umbilical arteries will occlude first.

vessel wall shrink.

↓
Tunica intima proliferate to occlude the lumen completely.

fibrotic
fibrotic

medial umbilical ligaments (Remnants of VA)

• Next Umbilical vein occludes.
↓ (degeneration)
Ligamentum teres hepatis

• Continued by Ductus venosus occludes.
↓ (degenerated)
Ligamentum venosum

• Ductus arteriosus will obliterate.
↓
Ligamentum arteriosum

→ Due to beginning of pulmonary circulation High blood flow to Left Atrium.

At Pressure difference between Right atrium & Left atrium
~~arteries~~ closes foramen Ovale.

↓ Persistent

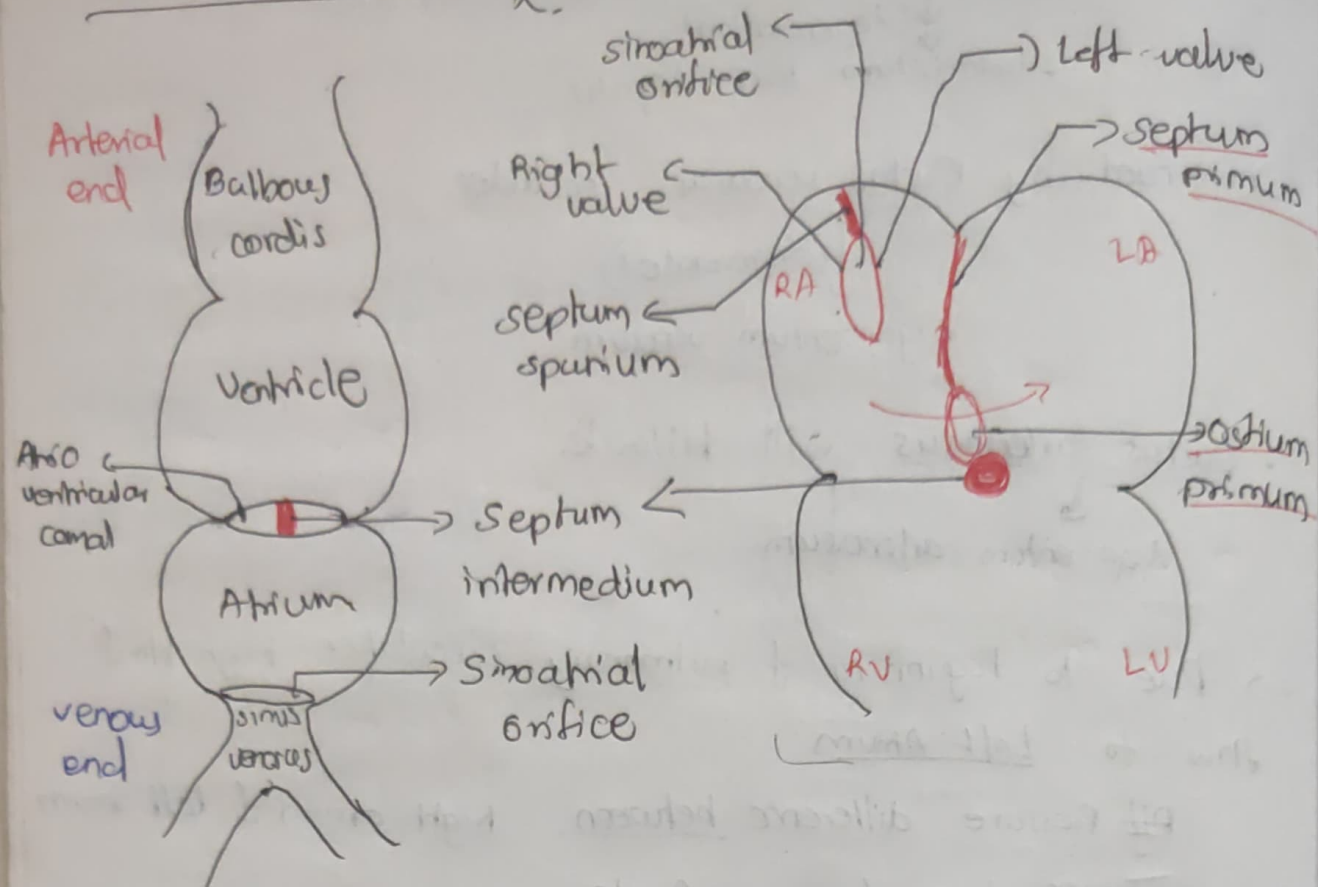
Patent foramen Ovale

Transformations

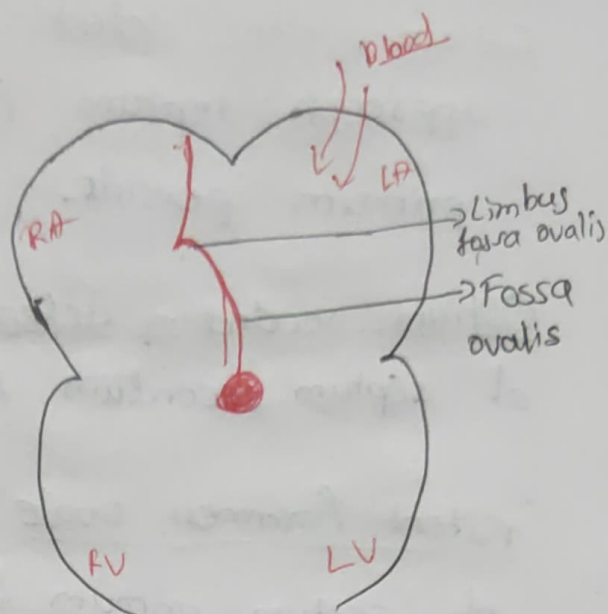
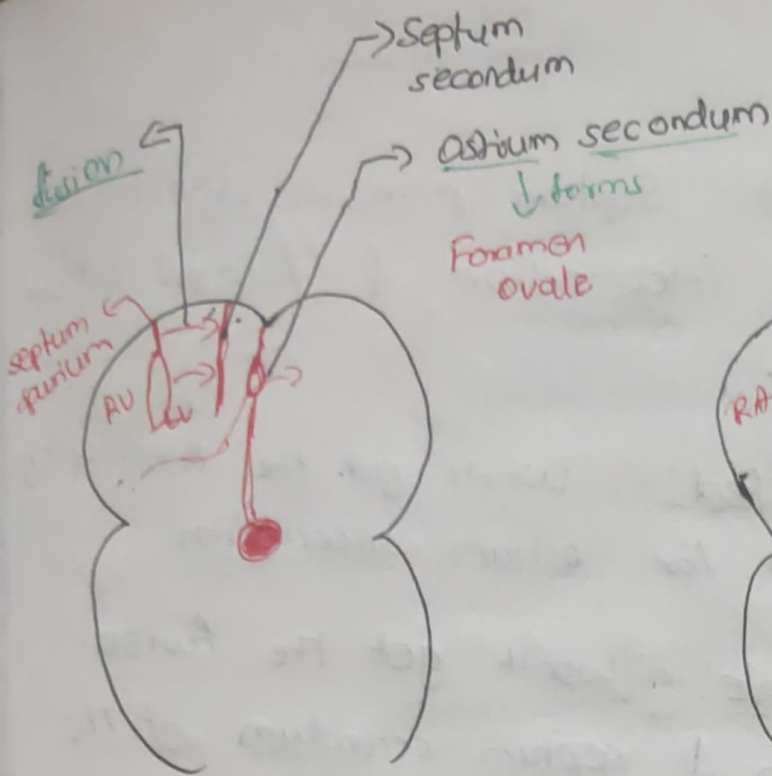
- Umbilical Arteries → Median umbilical ligaments
- Umbilical Veins → Ligamentum teres hepatis
- Ductus venosus → Ligamentum venosum
- Ductus arteriosus → Ligamentum arteriosum

Note! - Refer Netter's Atlas of embryology. (Pg 104 & 105)

Development of Inter Atrial Septum



- Septum intermedium is formed by the growth of Anterior & posterior AV Cuspid in Atrioventricular canal
- The sinoatrial orifice getting attached to the Right atrium by Septum spurium.
- The first formed septum ⇒ Septum primum
 - Try to meet septum intermedium
- Before septum primum meets intermedium there is gap called Ostium primum ⇒ its gone as septum primum reached intermedium.
 - This stage doesn't last longer as blood should pass to LA.
- ↓
- So, some cells of upper part of primum undergo, Programmed cell death / Apoptosis.



→ This programmed cell death results in formation of septum secundum.

Septum secundum :- another septum arise from atrial wall to slightly right to septum primum.

→ It grows just lower to the lower limit of septum secundum doesn't try to reach septum intermedium.

→ Now, septum secundum is called Foramen Ovale.

→ Septum secundum is slightly rigid than septum primum.

Fusion :- septum primum & left venous valve will getting fused to septum secundum.

→ Free edge of septum secundum forms arch over fossa ovalis called limbus foras ovalis.

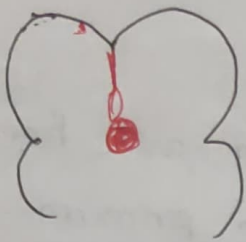
Applied - Aspects

patent

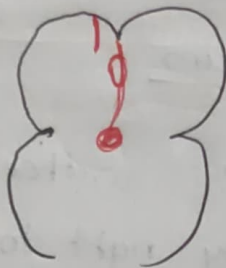
Ostium primum defect: - Septum primum doesn't approach septum intermedium. & formed atrium primum persists.

Ostium secundum defect: - won't get the overlapping of septum secundum for ostium secundum.

Patent foramen ovale: - won't get the fusion of septum primum & septum secundum at the time of birth.



Ostium primum defect



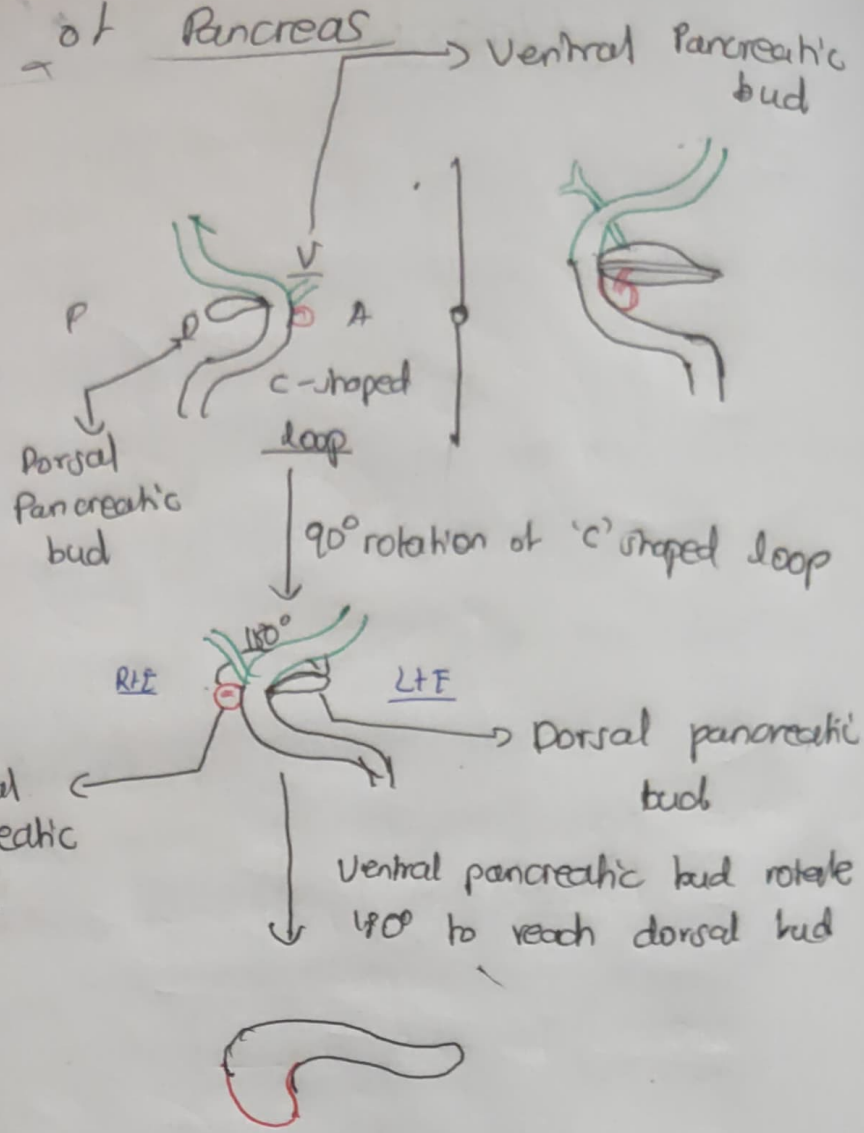
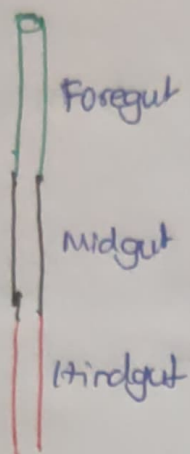
Ostium secundum defect



Patent foramen ovale

→ Probe patent foramen ovale: - The defect is not much effective bcz of no intermixing of blood. ~~to~~ even though there is foramen.

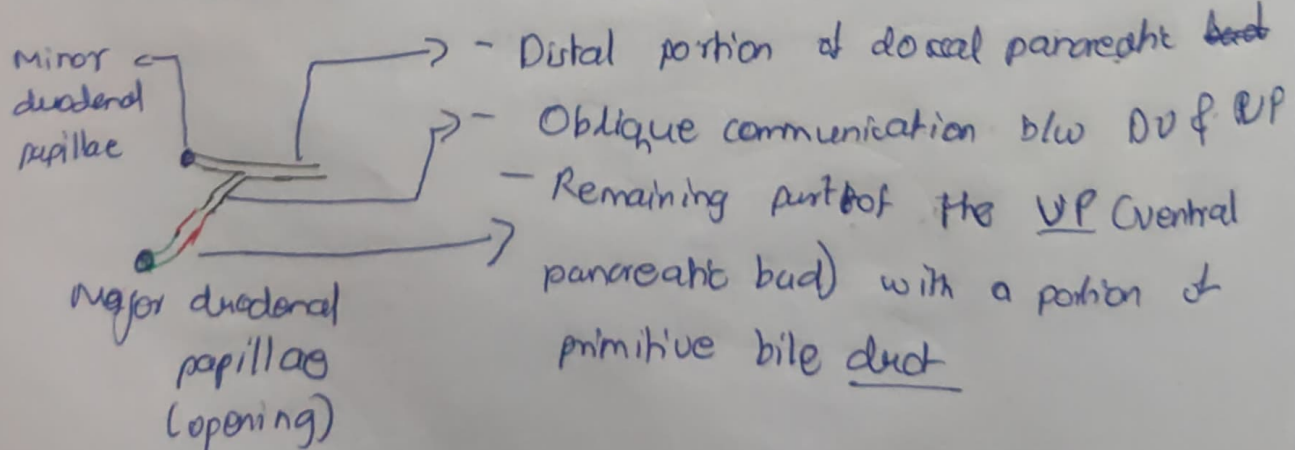
Development of Pancreas



Two Pancreatic ducts

'Duct of Wirsung (major pancreatic duct)
M for major

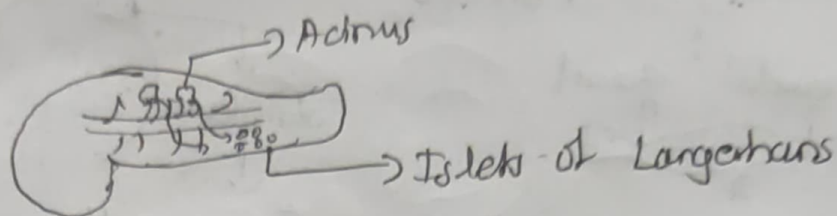
Formation → from 3 sources



Duct of Santorini (Minor pancreatic duct) / Accessory Pancreatic duct

→ Proximal portion of the ~~for~~ duct of dorsal pancreatic bud is called minor-pancreatic duct.

Formation of Islets of Langerhans



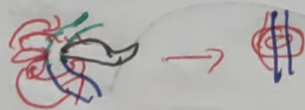
→ Formed at the 3rd month of IUL.

→ Separated cells of the acini which are clustered to form small groups known as Islets of Langerhans

Applied

•) Annular ~~Pana~~ Pancreas:-

Ventral bud remains & when it tries to reach dorsal bud. One goes → anterior duodenum
Another goes → Posterior duodenum

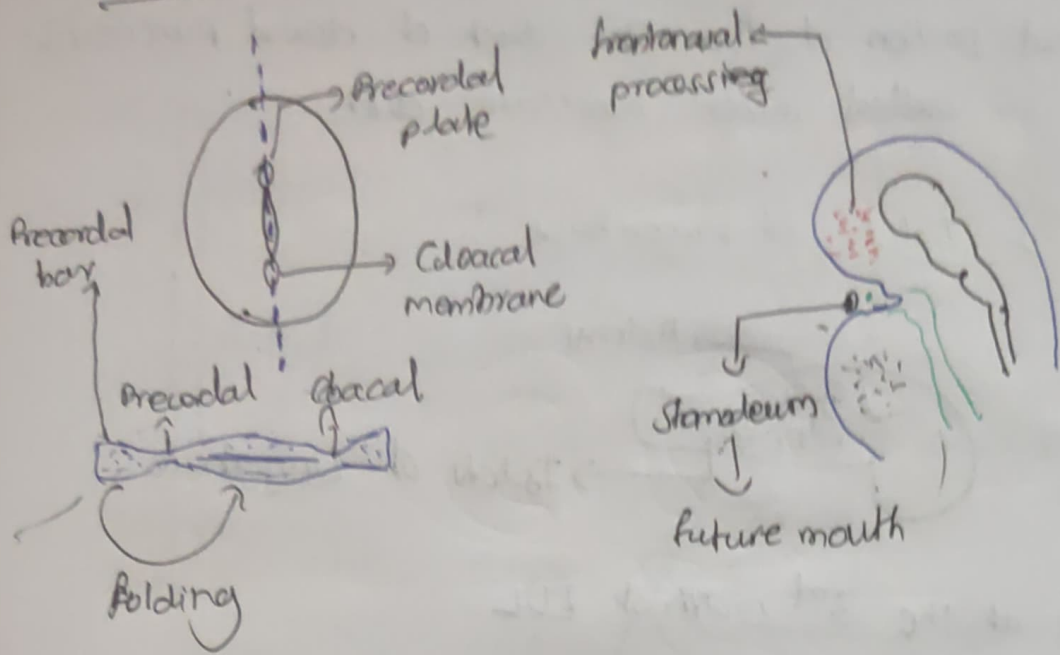


•) Accessory Pancreatic Tissue

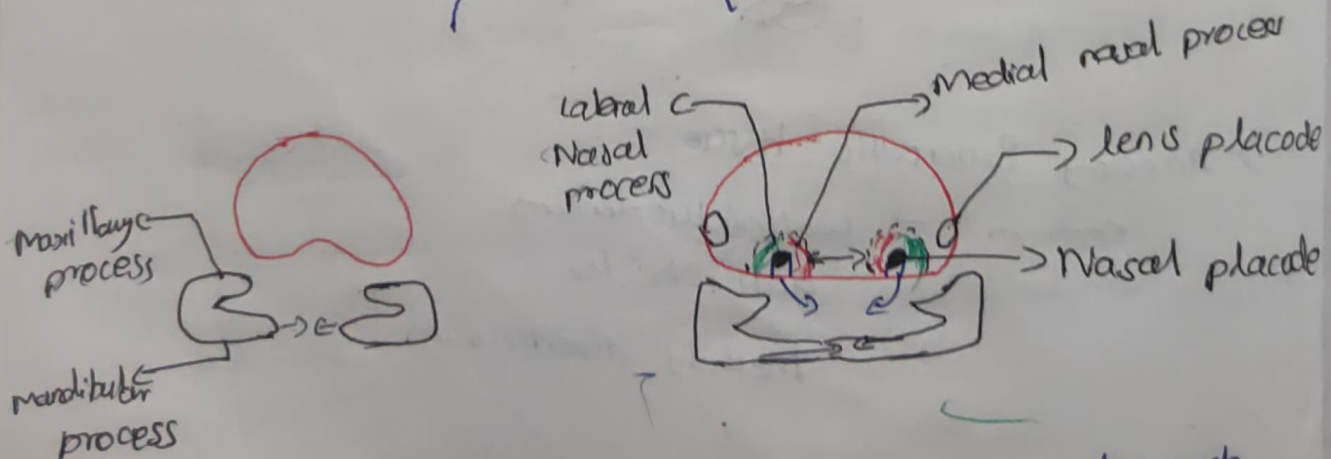
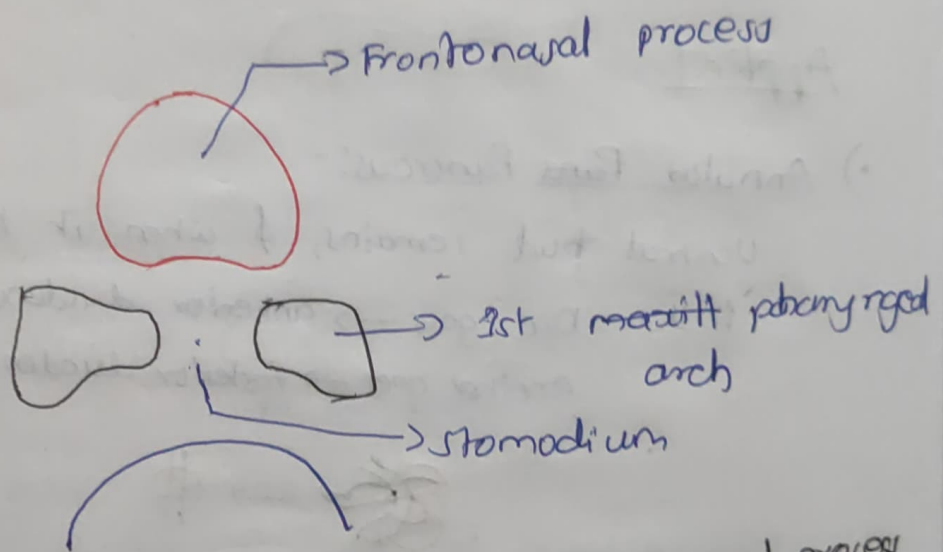
seen in → wall of duodenum
gall bladder

Meckel's diverticulum

Development of the Face



→ The developing brain vesicles will push a part of mesoderm anteriorly form frontonaval process

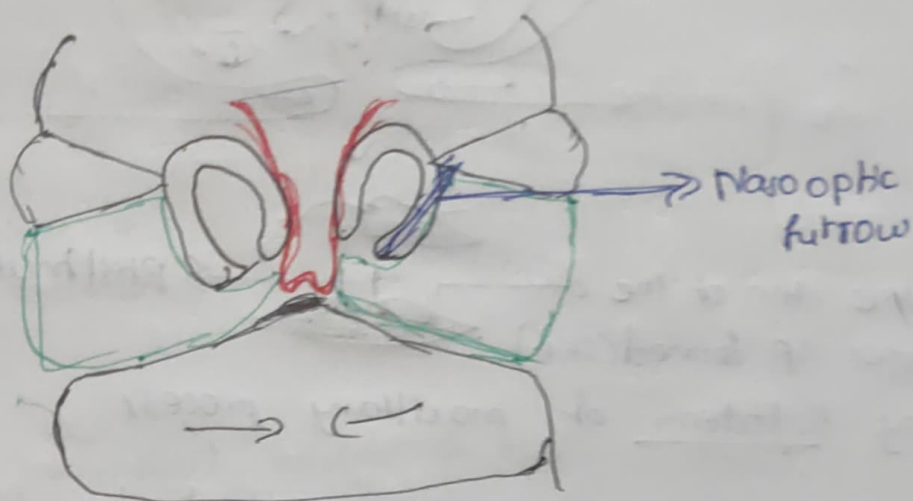


→ Mandibular process will approximate to each other.

→ ~~the~~ Nasal placode is getting converted into Nasal pit.

→ The medial & lateral sides of the Nasal pits start thickening to form Medial Nasal Placode & Lateral Nasal placode

→ Medial nasal process will approximate when there shifts anteriorly nasal placodes lens placodes come & lie towards midline



→ Naso optic furrow, - gap seen b/w lateral nasal process and maxillary process, filled with the ectoderm it can be seen as a cord extending b/w future eye & stomodaeum

→ The cord will canalise to form Nasolacrimal duct

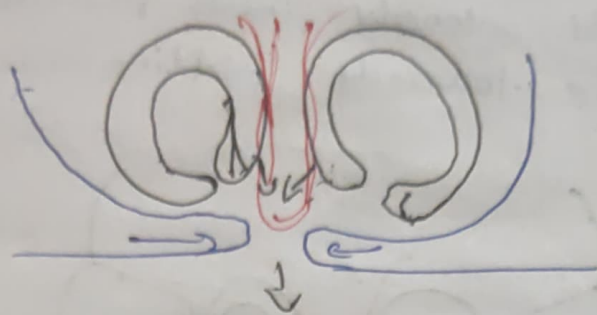
Nasolacrimal Duct:- duct which connects conjunctival sac with the future nasal cavity. Opened into the inferior meatus

→ Lacrimal sac:- Cranial end of nasolacrimal duct forms lacrimal sac

Formation of upper lip

→ formed from '2' components

- Maxillary processes from side
- Frontonasal process especially medial nasal process.



Entire skin of the upper lip formed (skin) by Ectoderm of maxillary process



Philtrum (from fronto nasal process)

• Entire upper lip is supplied by Maxillary division of trigeminal nerve

Imp:- Though the philtrum is formed by the frontonasal process its ~~not~~ surface is covered by ectoderm of the maxillary process so the supply is maxillary division not optic division.

Lateral nasal process → Alae of Nose

Applied

Facial cleft:- If the Nasolacrimal groove not obliterated. Cleft connects the eye to the mouth in new born.

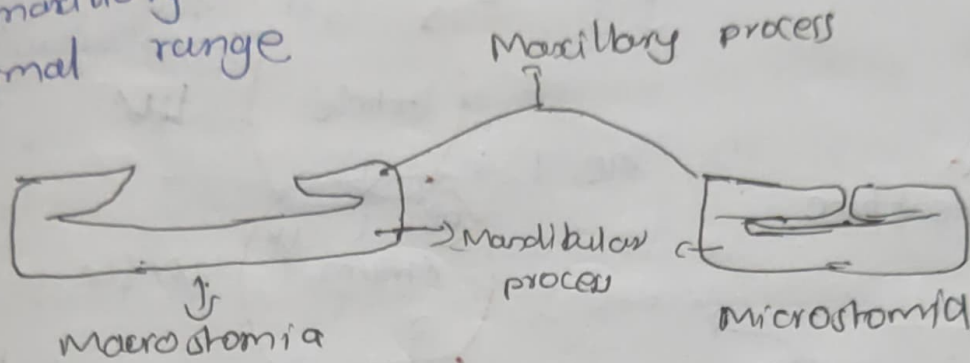
- The fusion doesn't happen between maxillary process & lateral nasal process.

Macrostomia :- (Larger mouth)

→ when maxillary and mandibular process are not fusing accordingly & lateral angle stay at a distance

Microstomia :- (Smaller mouth)

→ when lateral angle shifting medially by the process & maxillary and mandibular process beyond the normal range



Summary

FNP → Forehead, bridge & Nose

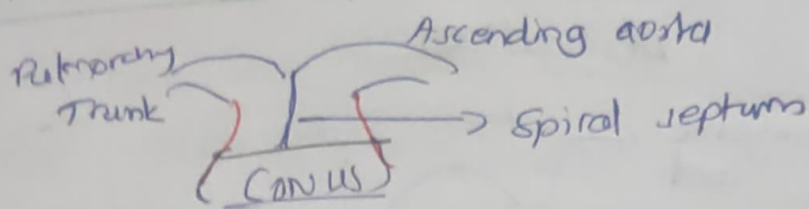
MAX → Upper lip & cheek

MAND → Lower lip & jaw.

MED NASAL → Tip & Nose & Philtrum

LAT NASAL → Alae

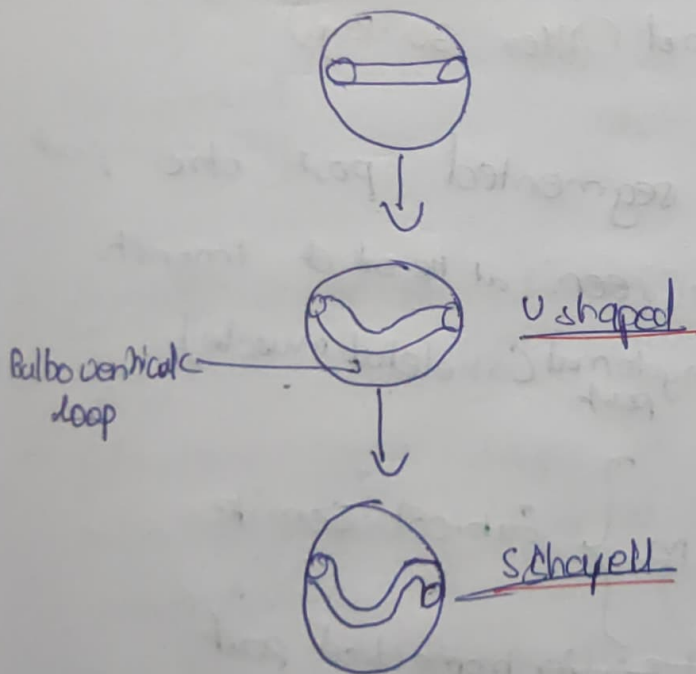
Trunk aorticus



- A V canal splits up to form Bicuspid & tricuspid valve.
- Entire body of sinus venosus is getting absorbed into Right Atrium forms the smooth Posterior Part of Right atrium

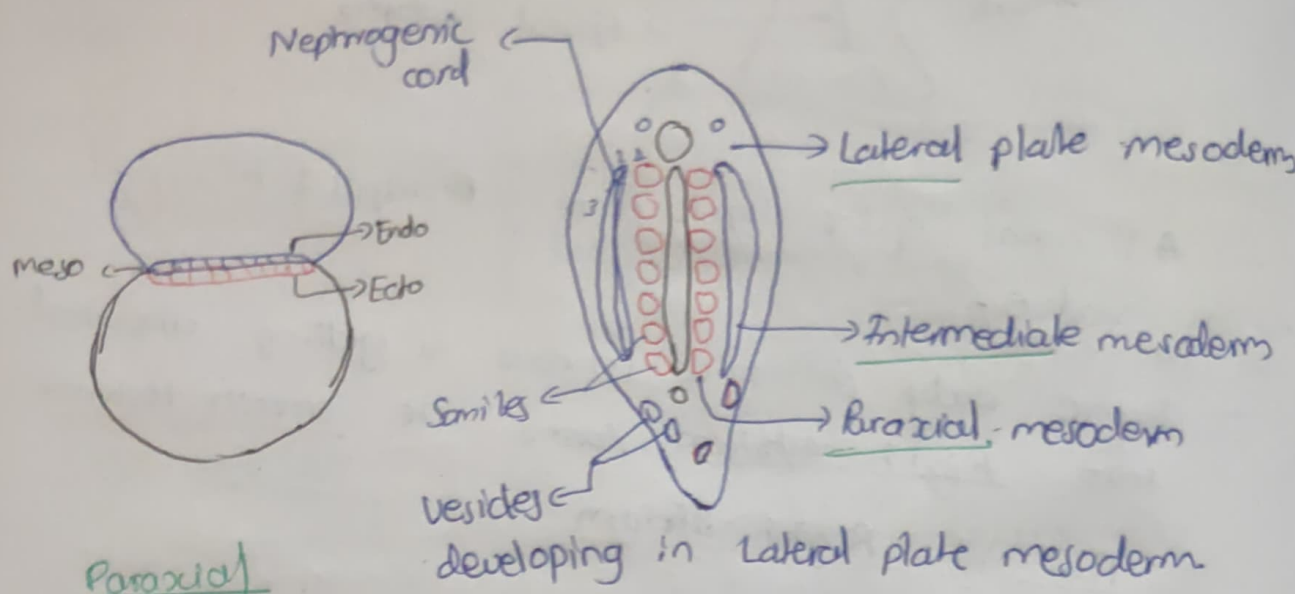
Bending of Heart tube

- Occurs bcz of development of heart within a limited space of pericardium.



Intra - Embryonic mesoderm & its

Derivatives

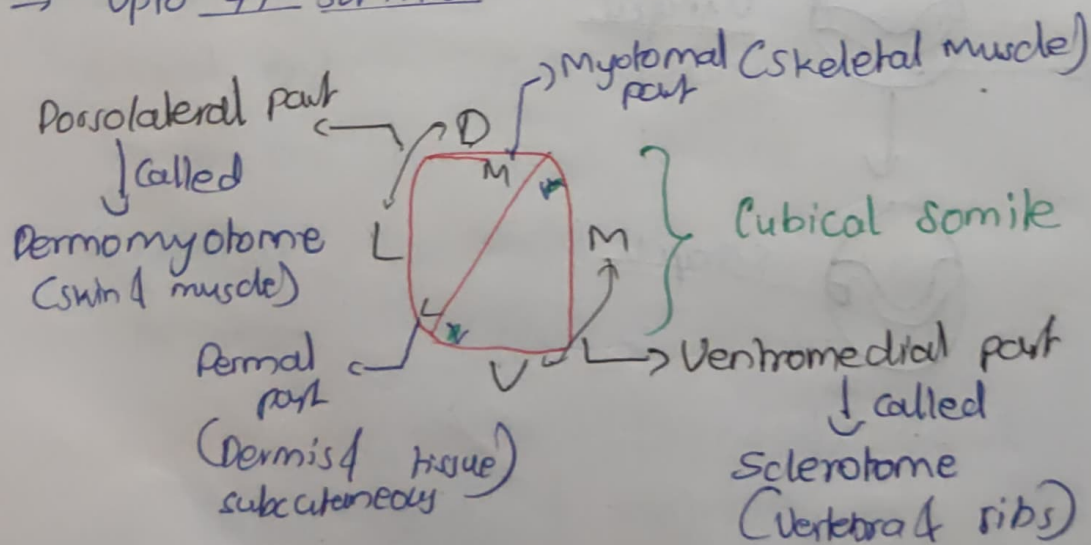


Development of embryo is divided into 3 periods

- Presomite period (15-20 days)
- Somite period (20-30 days of IUL)
- Post somite period (After 30 days)

→ Paraxial mesoderm is segmented post olic part

→ Upto 44 somites are seen at the end of 1 month



Intermediate → gives Kidney & gonads

→ Forms cord from cephalic end to the caudal end called Nephrogenic cord
↓
Kidney & Gonad

Lateral

→ Many vesicles developing in lateral plate mesoderm

→ They coalesce to form a

Canal → Pericardio pleuro
peritoneal canal

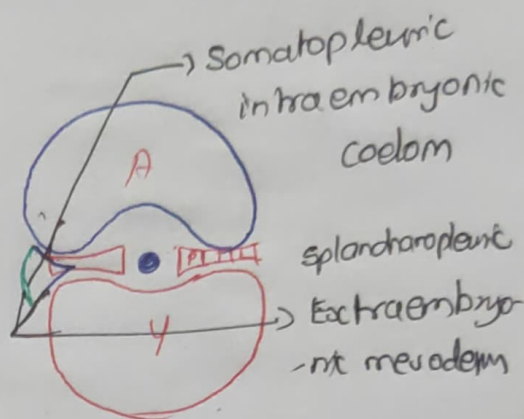
↓ Entire cavity

Intra embryonic Coelom

Pericardial
cavity

Pleural
cavity

Peritoneal
cavity



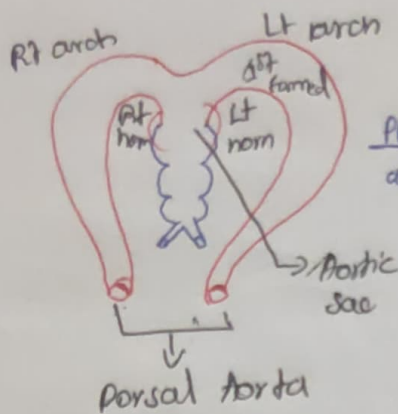
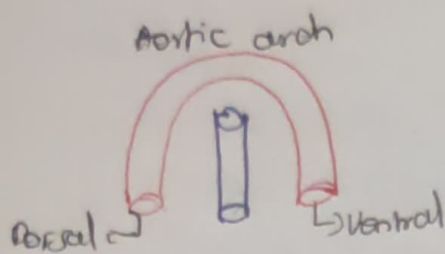
→ Somatopleuric layer of Intraembryonic coelom gives somatic layer of the above cavities.

→ Splanchnopleuric layer of Intraembryonic coelom gives splanchnopleuric layer of above cavities along with musculature of the above cavities

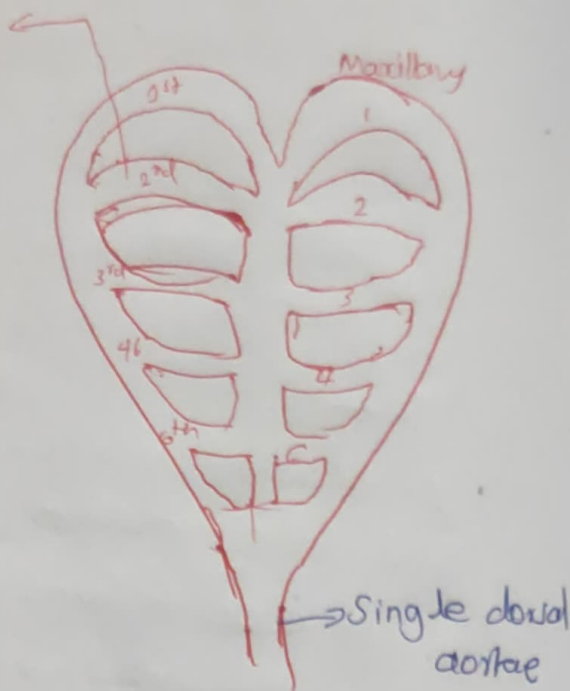
→ Cephalic to caudal are cardiogenic are - There is ~~not~~ diff no separation of somatopleuric & splanchnopleuric layer. They are continuous.

↓
Septum transversum → Diaphragm

Aortic Arches



Hyoid & stapedius



→ we can see ph aortic arches mainly supplying the head & neck region and dorsal aortae rest of body.

Aortic Arches:- These are the vessels connecting dorsal & ventral aortae & which are passing through the pharyngeal arches

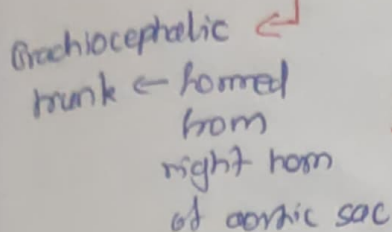
Aortic sac:- The fused part of ventral aortae is called aortic sac → fits around truncus arteriosus

modification & derivatives of pharyngeal arches

→ 1st & 2nd aortic arches,

Remnant of 1st aortic arch → Maxillary artery

2nd aortic arch → Hyoid & stapedial artery



- 3rd & 4th aortic arch arising from ventral aspect of aortic sac → carries blood from trunkus arterialis
- 6th aortic arch is connected to dorsal aspect of aortic sac → carries blood from pulmonary trunk of the trunkus arterialis
- The connection between 3rd & 4th arches is called Puctus caroticus. Usually disappears
- 7th intersegmental artery combines to dorsal aortae of 4th aortic arch.
- On Right side, 7th intersegmental artery along with 4th aortic arch gives rise to right subclavian artery
- On left side 7th intersegmental artery alone gives rise to left subclavian artery.
- Arch of aorta: → derived from Aortic sac, left horn of aortic sac, as well as 4th arch artery.

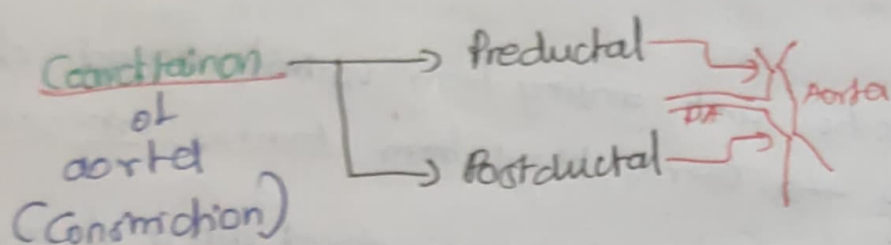
→ 6th arch artery gives pulmonary bud, which is going to the developing lung (this will be giving rise to the pulmonary artery).

→ 6th arch artery on left side seen to be connected to the dorsal aorta beyond the lung bud. is called Ductus Arteriosus.

Applied:-

↓ Persists

Patent ductus arteriosus



Summary

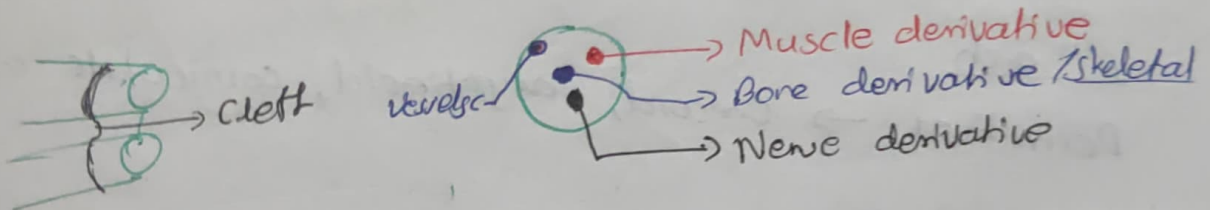
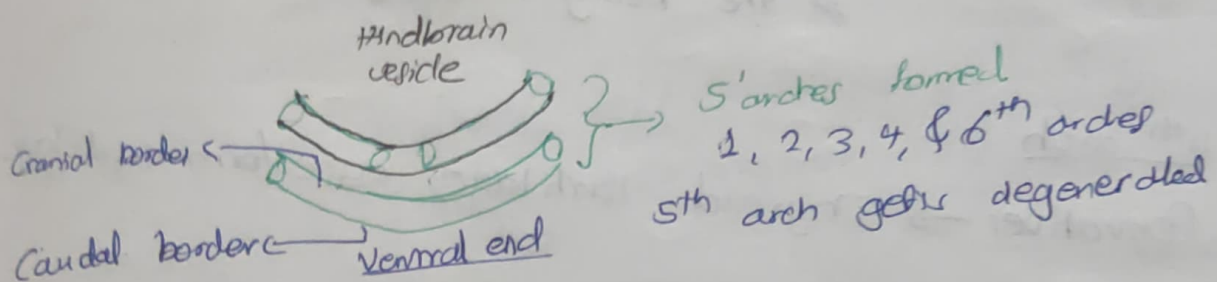
	Right	Left
External Carotid →	carotid bud of 3 rd arch	Carotid bud of 3 rd arch
Internal carotid →	3 rd arch, cranial dorsal aorta	3 rd arch, cranial dorsal aorta
Common carotid →	3 rd arch	3 rd arch
Subclavian artery →	4 th arch, 7 th cervical intersegment	7 th cervical intersegment
Brachiocephalic trunk →	Right horn of aortic sac	
Arch of Aorta →		Aortic arch, left horn 4 th arch
Pulmonary artery →	6 th arch	6 th arch
Asc. aorta & Pulmonary trunk →	Truncus Arteriosus	
Descending aorta →	left dorsal aorta	

Pharyngeal or Branchial Apparatus

Part - 1

- Apparatus formed during 5th & 6th weeks of intrauterine life.
- Three imp derivatives
 - Mesodermal core
 - Extra Ectodermal lining
 - Endodermal lining
- Its called Pharyngeal Apparatus Bcz its forming the floor.

Pharyngeal arch → Mesodermal core



Skeletal derivative of Arches

1st Arch (Mandibular arch)

- Maxillary process → Upper lip, Upper jaw & Palate
separates nasal cavity from oral cavity
- Mandibular process → Malleus & Incus body & mandible, Anterior ligament of malleus & sphenomandibular ligament
- Meckel's cartilage of 1st arch

2nd arch (Hyoid Arch)

Second → Most of derivative has S as starting alphabet.

• → Second pharyngeal arch cartilage Reichert's cartilage

Derivatives → Stapes, styloid process, stylohyoid ligament, superior horn of hyoid, superior aspect of body of hyoid bone

3rd arch

Derivatives → Greater horn of the hyoid bone, rest of the body of hyoid bone

4th arch

Derivatives → Thyroid cartilage, cuneiform cartilage

6th arch

Derivatives → Cricoid, arytenoid, corniculate cartilage

Muscles of Pharyngeal Arches

1st arch

→ Tensor tympani, Tensor veli palatine, muscles of mastication, Anterior belly of digastric & mylohyoid

2nd arch

→ Stapedius, stylohyoid muscle, Posterior belly of digastric, facial muscles, Platysma

3rd arch

→ Stylopharyngeus

4th arch

→ Cricopharyngeus ^{thyroid} (only intrinsic muscle of larynx seen externally)

6th arch

→ Laryngeal muscles

Vessels derived from Pharyngeal arches

→ Dorsal and ventral aorta are connected to form arches which run through the pharyngeal arches
→ we can see the remnants of the arches

1st arch → Maxillary artery

2nd arch → Stapedial artery

3rd arch → Common carotid artery & internal carotid artery

4th arch → Right subclavian artery & arch of aorta (on left)

6th arch → Right & left pulmonary artery, Ductus arteriosus (on left)

Nerve derivatives

→ Two, Pretrigeminal & Post trigeminal. (Trigeminal → cleft)

Pretrigeminal → passing through the caudal border.

Post trigeminal → cranial border of the subdividing arch

→ Only the first arch will be having Pretrigeminal & post trigeminal nerve, whereas rest of the arches we have only post trigeminal nerve

1st arch → Posttrigeminal - mandibular nerve
Pretrigeminal - Chordae tympani

2nd arch → ~~facial~~ facial nerve

3rd arch → Glossopharyngeal nerve

4th arch → External laryngeal nerve

6th arch → Recurrent laryngeal nerve

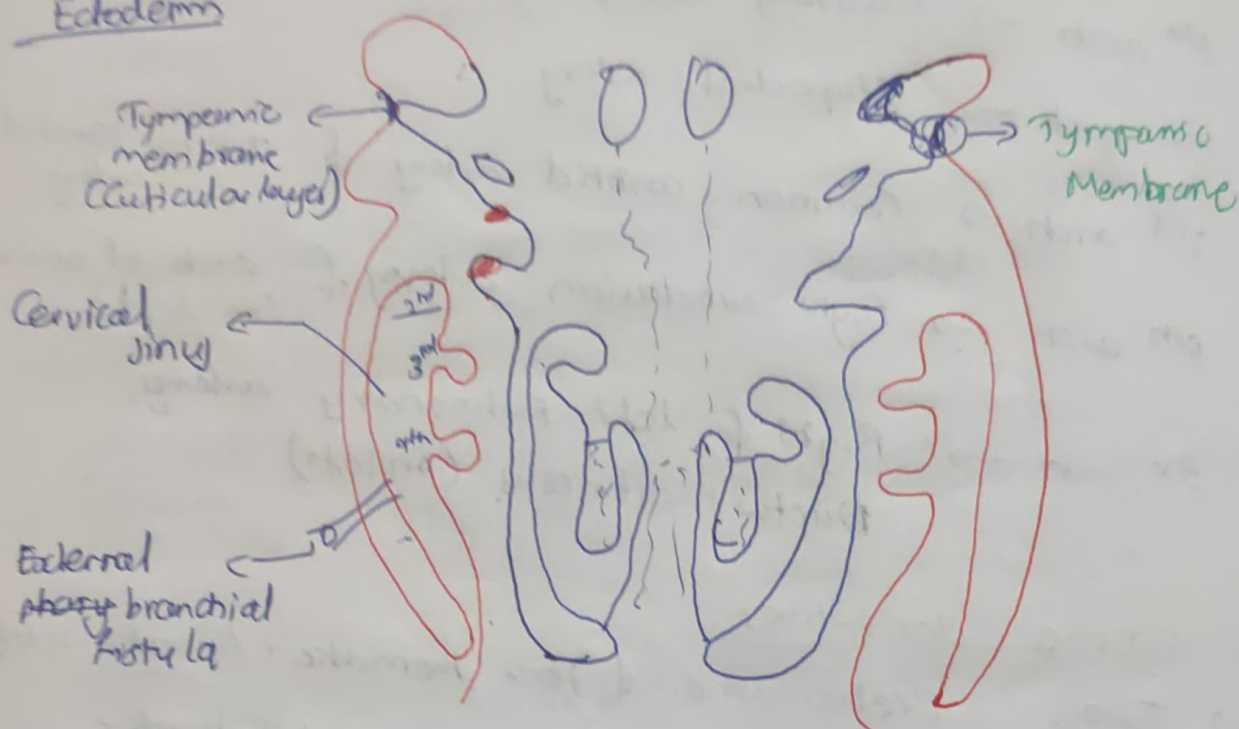
THE Pharyngeal or Bronchial Apparatus

Part-2

Pharyngeal Clefts :- Arches are covered by ectoderm in b/w dipping of this called clefts.

Fate of Ectodermal Clefts

Ectoderm



Endodermal Pouches :- Arches are covered by endoderm with pharyngeal apparatus, dipping in b/w is called Endodermal pouches.

1st Ectodermal Cleft :- External acoustic meatus of articular layer of Tympanic membrane

→ 2nd arch overgrows the 3rd & 4th cleft. The 2nd arch will merge at the bottom. Here it forms

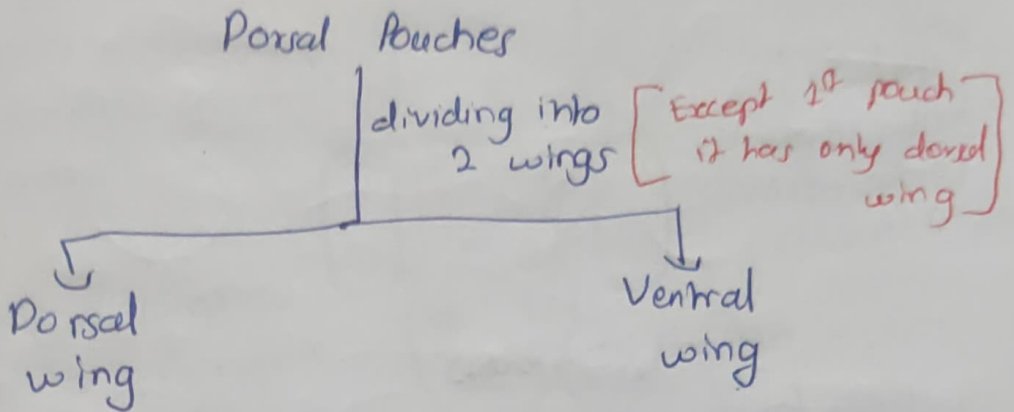
Cervical sinus → will get obliterated later

Branchial cyst :- Persistent cervical sinus Not obliterated

- This overgrowth of 2nd arch is reason for extension of Platysma from mandible throughout neck
- 3rd & 4th clefts are also obliterated

Pouches

- There are 4 pouches.
- Ventral aspect of all the pouches are filled by the developing tongue.



1st pouch :- Tympanic cavity, Auditory tube, Mastoid
Dorsal wing of 2nd pouch antrum, mucosal lining of tympanic membrane

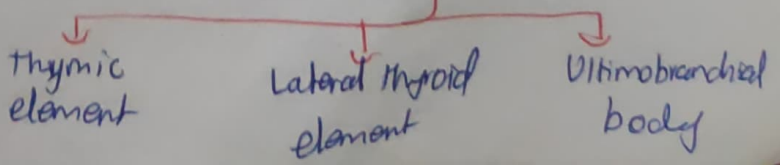
Tympanic membrane → derived from all 3 germ layers

2nd pouch :- Tonsil, (Remnant of 2nd pouch Intra tonsillar cleft)
Ventral wing

3rd pouch :-
Dorsal wing :-> Inferior Parathyroid
Ventral wing :-> Thymus

4th pouch :-
Dorsal wing :-> Superior Parathyroid
Ventral wing :- + (along) with 5th pouch (rudimentary)

forms Caudal Pharyngeal Complex



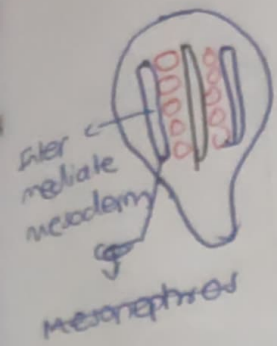
Thymic element:- Contributes to formation of Thymus

Lateral thyroid element:- Arrest the growing thyroid Gland at the neck. Thyroglossal duct is not further descended. (Induce formation of Thyroid Gland)

Ultimate branchial body:- Parafollicular 'C' cells of thyroid gland

Development of kidney & Gonads

→ As evolutionary basis there are developed from Metanephros of intermediate mesoderm



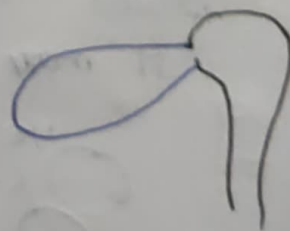
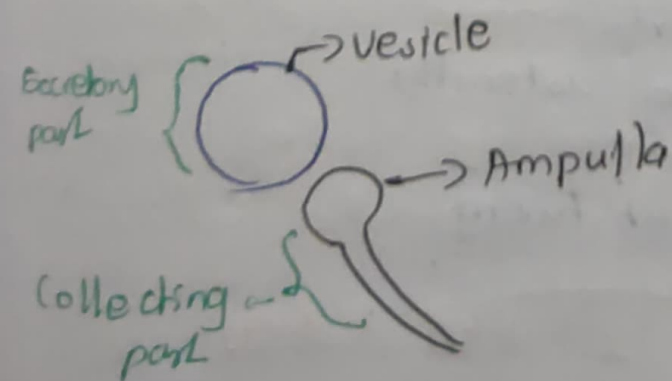
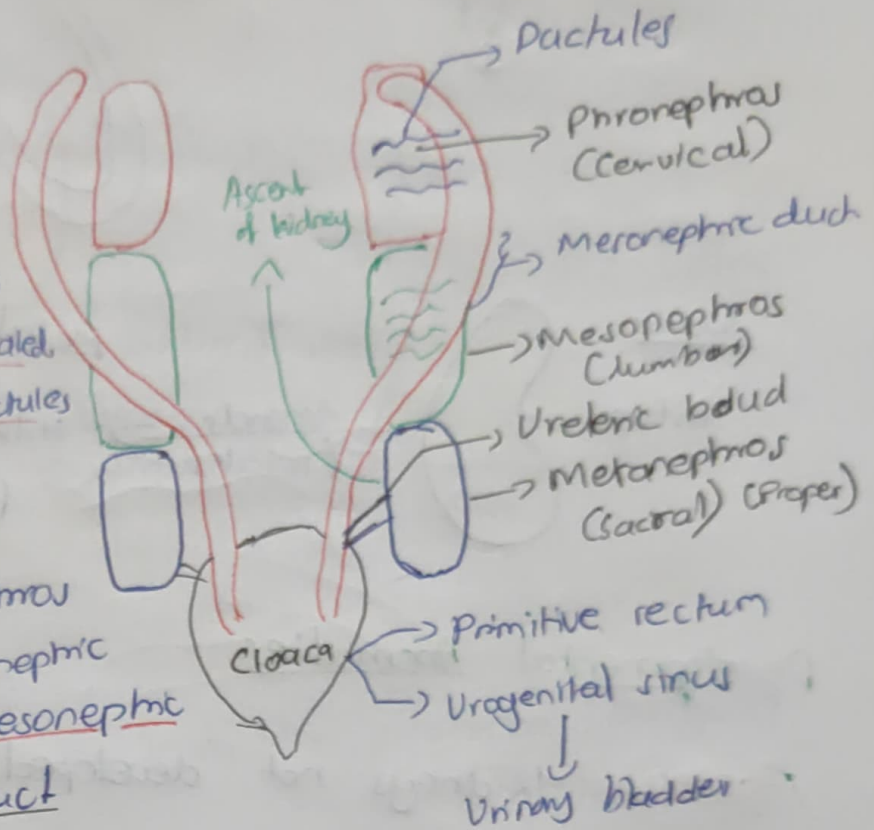
→ As soon as pronephros develop it gets degenerated, only duct remains. Ductules also degenerate

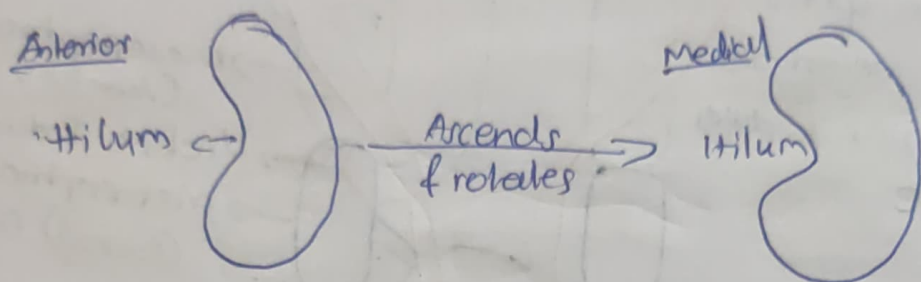
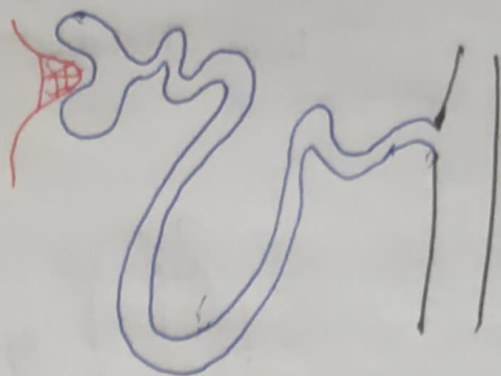
→ As soon as mesonephros forms ductules. Pronephric duct renamed as Mesonephric duct / Wolffian duct

→ These mesonephric ducts will degenerate in females & remains in males

→ There is bud arising from mesonephric duct called Ureteric bud

→ The metanephros where kidney proper is developing is called Metanephric blastema



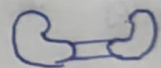


Developmental Anomalies

Agensis:- Kidneys not developed. Unilateral or Bilateral

Duplication:- Additional kidney may be developed

Horse-shoe shaped kidney:- lower pole get fixed

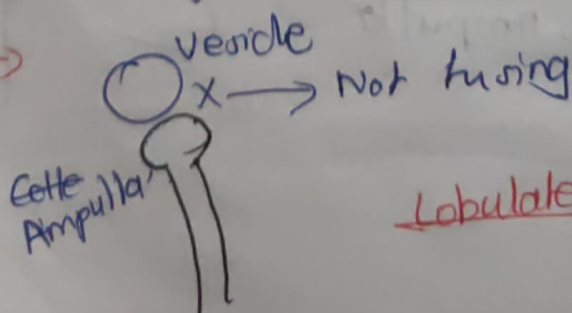


Pancake shaped kidney:- Just looks like pancake (2)

Position:- $\rightarrow$ Remained in Sacral & ~~Remained in F~~
Ascended to Thoracic

Rotation:- $\rightarrow$ May not rotate medially. And hilum
faces Anteriorly
 $\rightarrow$ It may rotate laterally

Polycystic $\rightarrow$



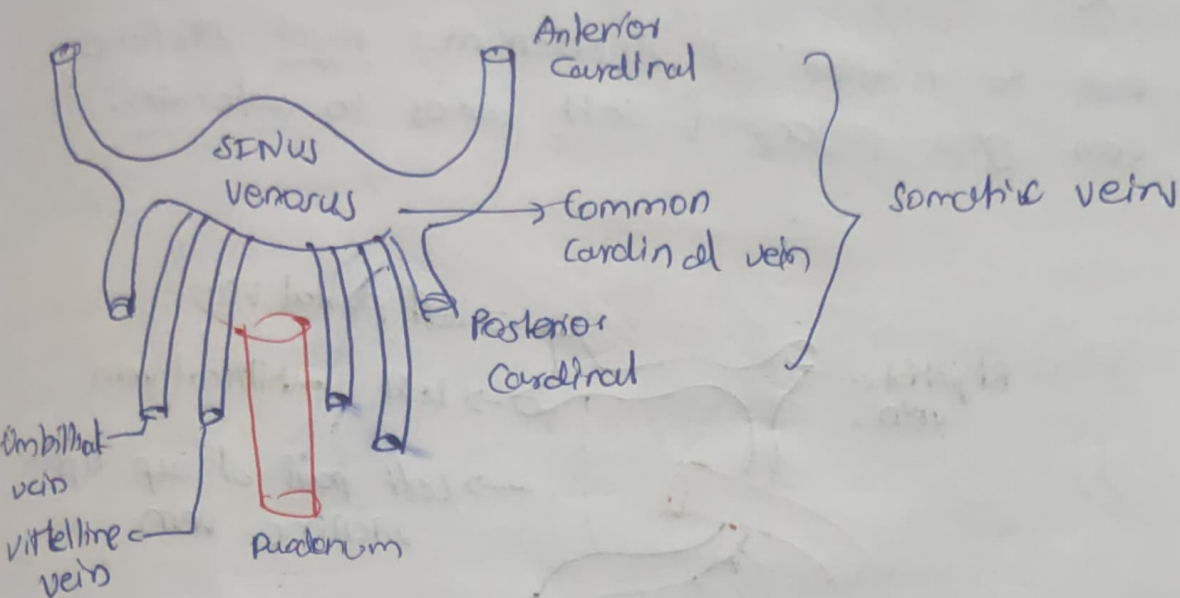
Lobulated kidney

Development of PORTAL VEIN

Initially the developing fetus contains 3 sets of veins

- i) Umbilical vein
- ii) Vitelline vein
- iii) Somatic veins

↓
visceral veins

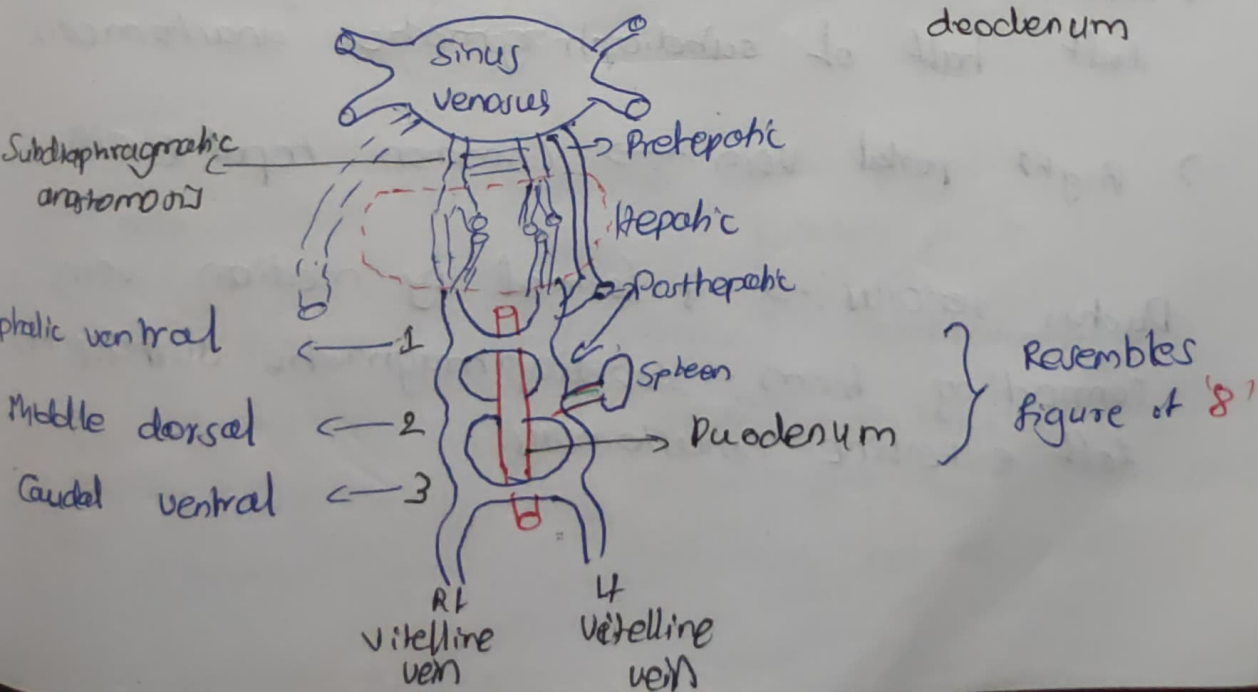


Umbilical vein:- Coming from the placenta carrying oxygenated blood

Vitelline vein:- Coming from the walls of the Yolk sac.

Cardinal Veins:- Coming from the rest of the body parts

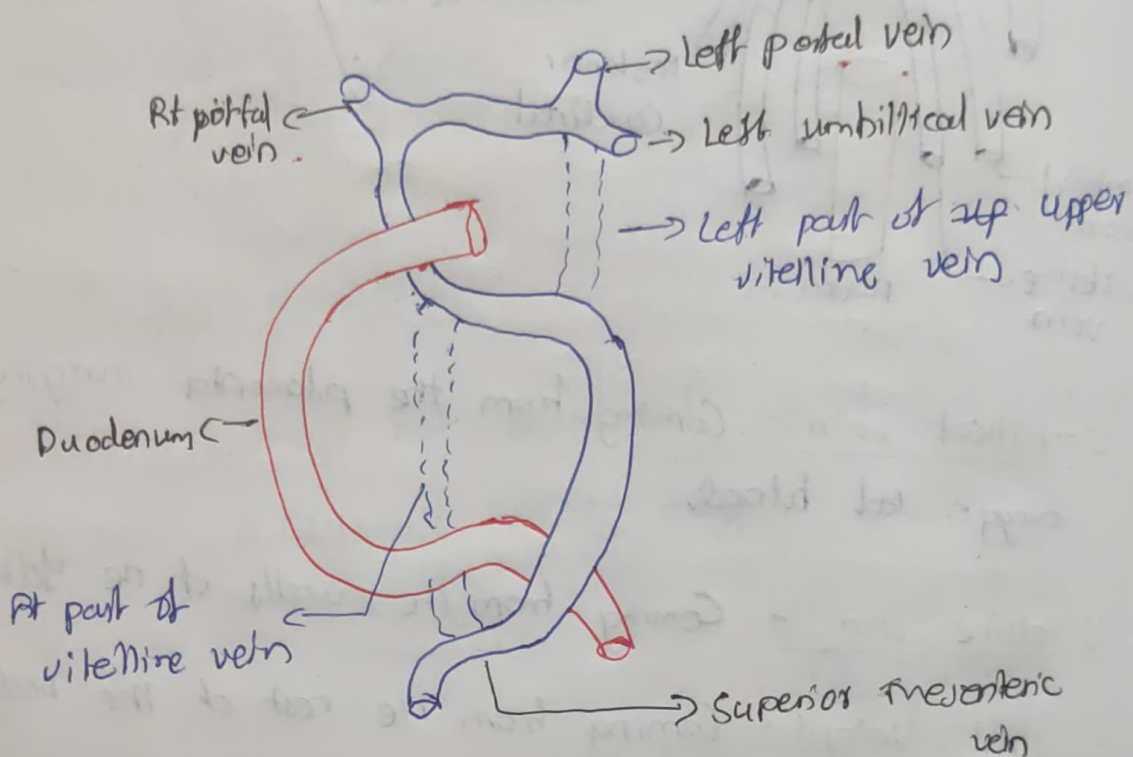
2 → Going behind the duodenum



→ Left umbilical vein is connected to the left end of the 1st anastomotic channel.

→ Splenic vein joins the 2nd anastomotic channel of left side.

→ Due to rotation of duodenum, Right vitelline vein goes posterior & left comes to anterior.



→ Left vitelline vein will be disappearing along with left half of subdiaphragmatic anastomosis

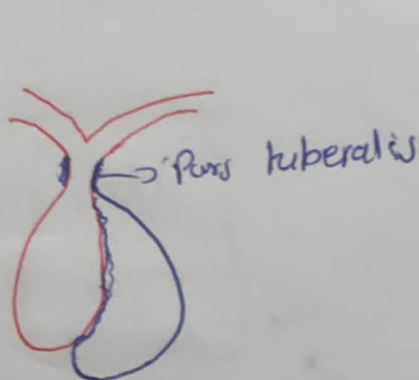
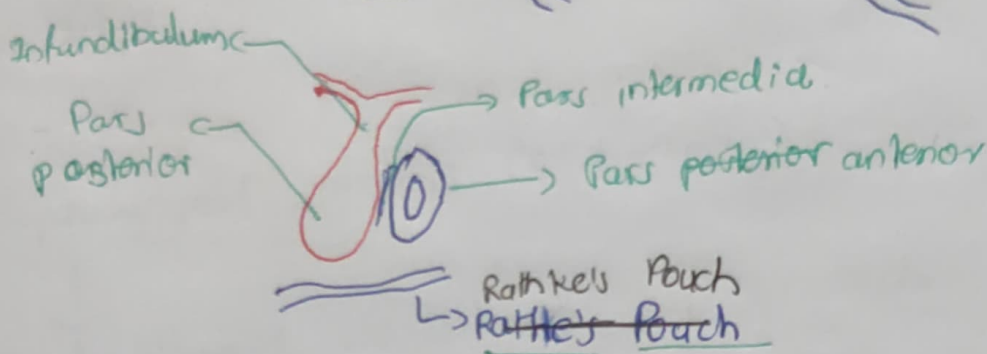
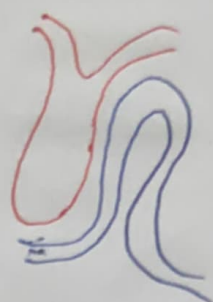
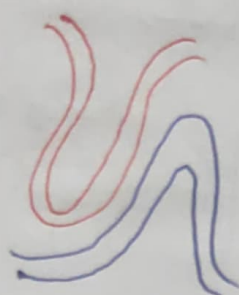
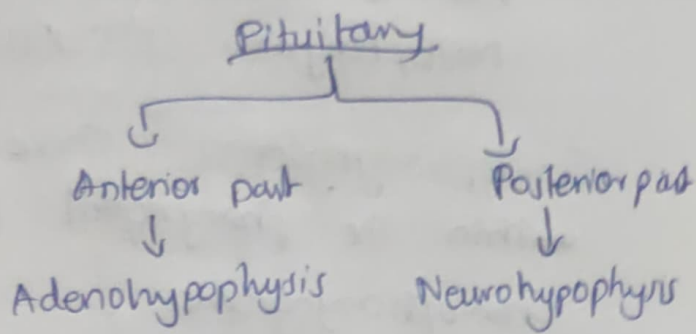
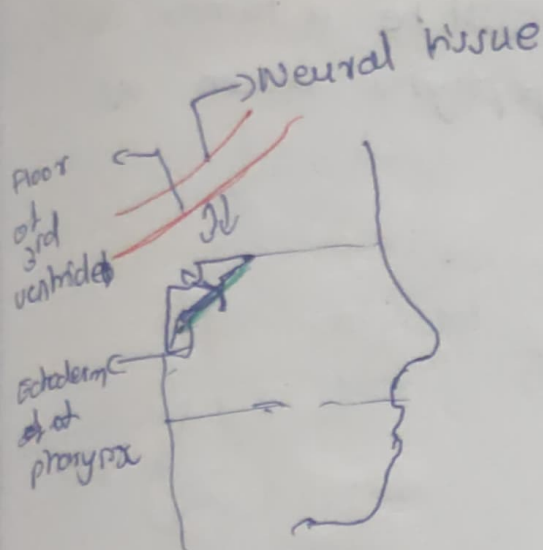
→ Right portal vein → Common hepatic vein

: Ductus venosus → formed by median vein connecting from subdiaphragmatic surface to left vitelline anastomosis.

Development of PITUITARY GLAND

→ 2 sources of origin.

- Ectodermal
- Neuroectoderm



— Neuronal
— Rathke's pouch

Adenohypophysis

- Pars anterior (Ant. portion of Rathke's pouch)
- Pars intermedia (Pos. portion of Rathke's pouch)
- Pars tuberalis (Extends around infundibulum)

Neurohypophysis

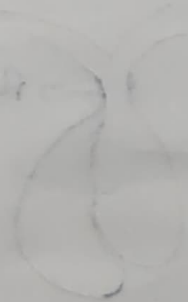
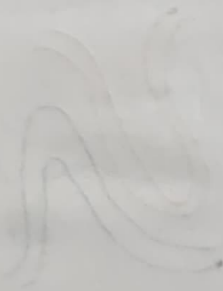
- Pars posterior
- Infundibulum

Note:- Posterior pituitary is not exactly neuronal pcz, as they are actually glial cells not neurons.

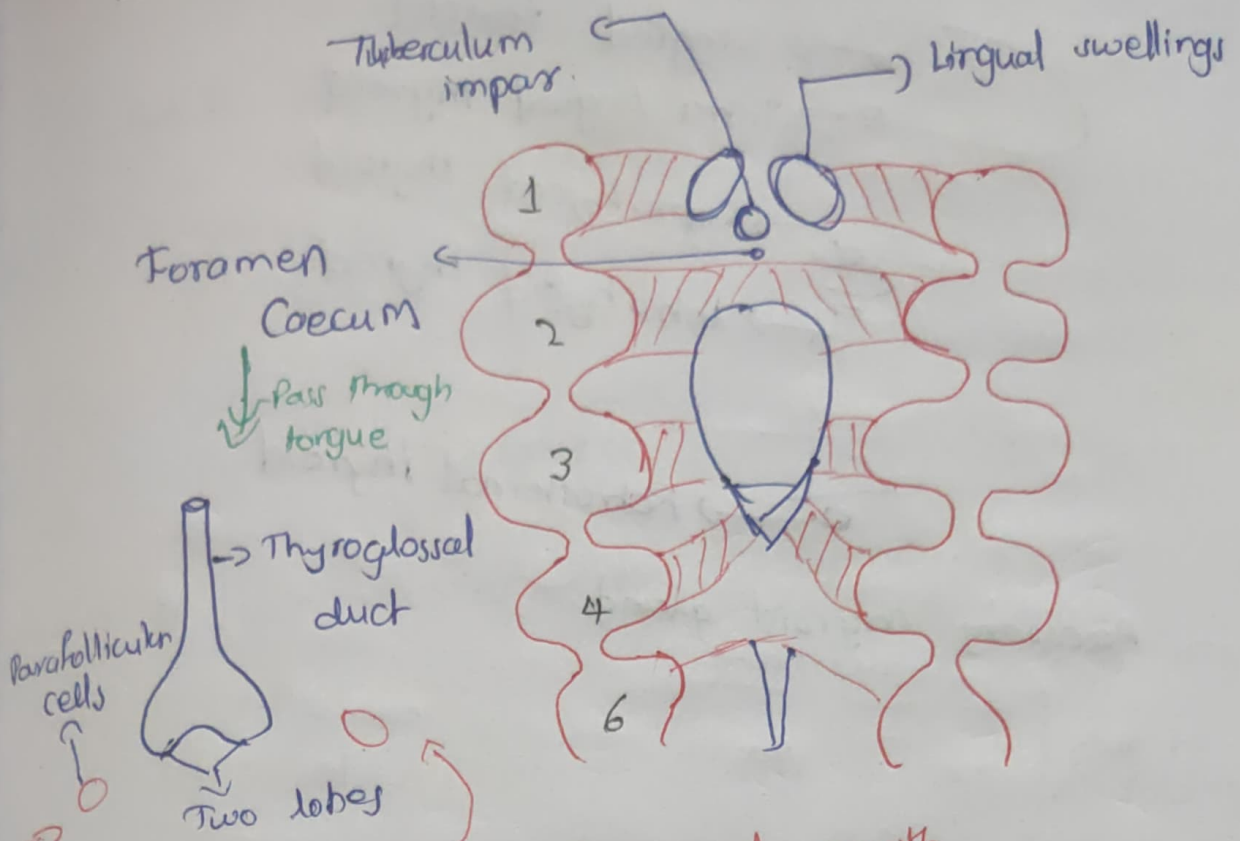
Applied

- Pituitary won't be developed
- Part of adenohypophysis can be seen within nasopharynx (Pharyngohypophysis)

Cranio-pharyngioma → There will be a tumor developing within the pharyngeal hypophysis known as Cranio-pharyngioma.

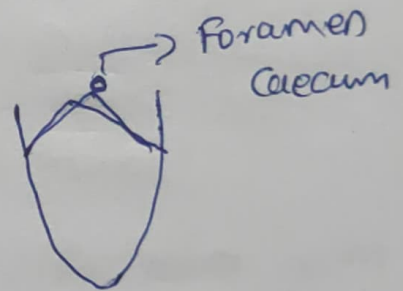
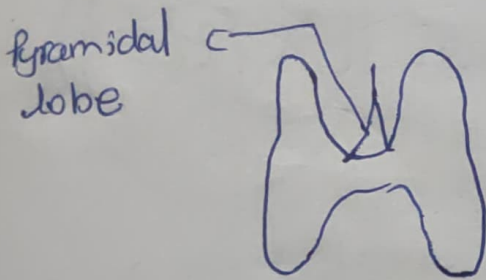


Development of Thyroid



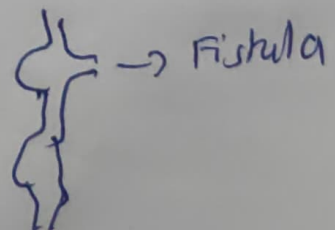
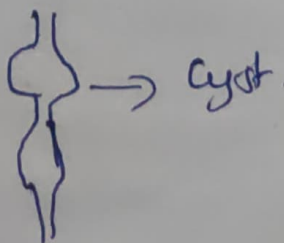
Factors controlling the downward growth
caudal pharyngeal complex (9th & 10th)

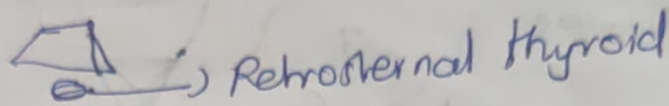
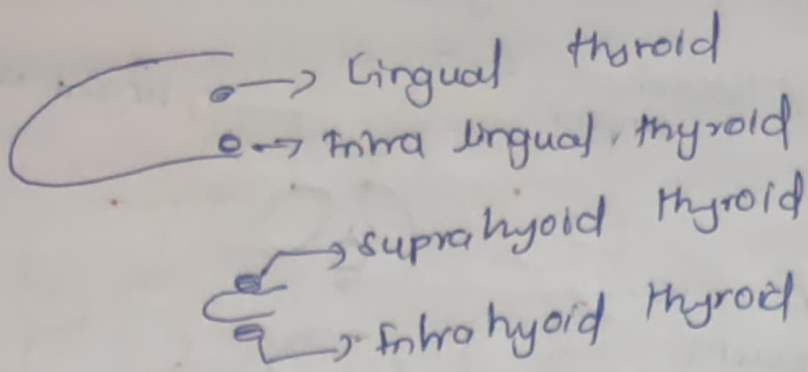
Lateral thyroid element. → acts as check



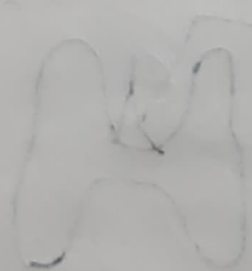
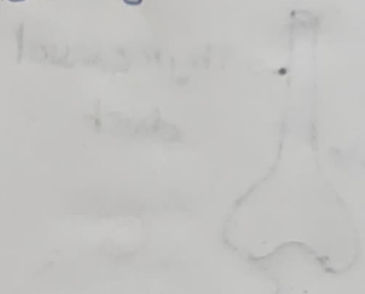
→ Thyroglossal duct degenerate. Some-times it persists to form persistent.

→ Sometimes we can see inverted masses **Thyroglossal cyst**



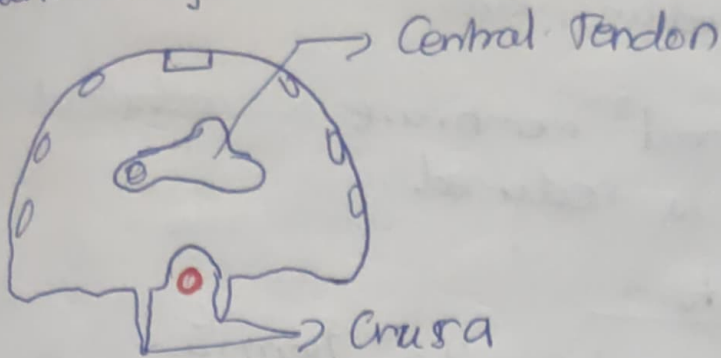


→ Accessory thyroid gland



Development of Diaphragm

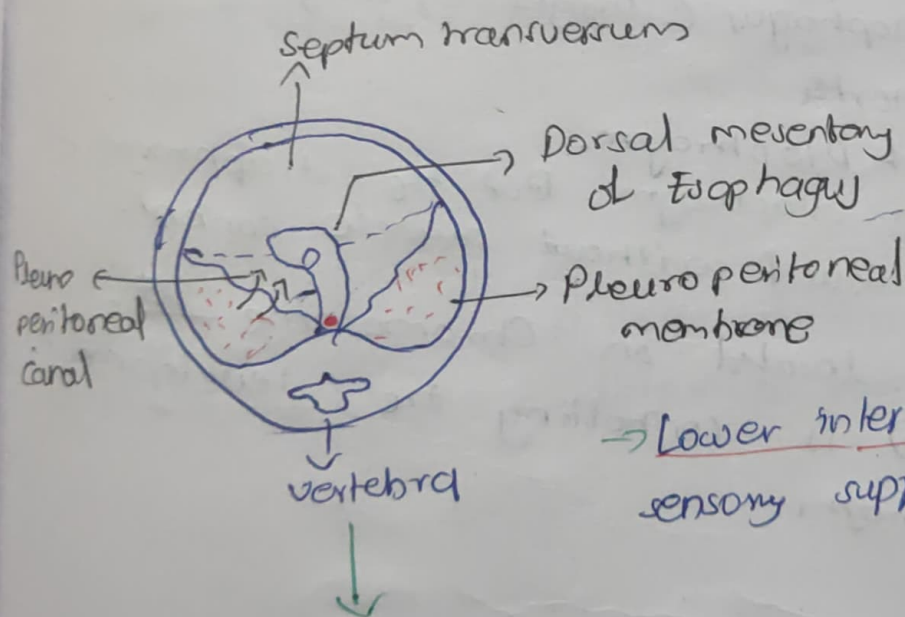
~~Adult diag~~



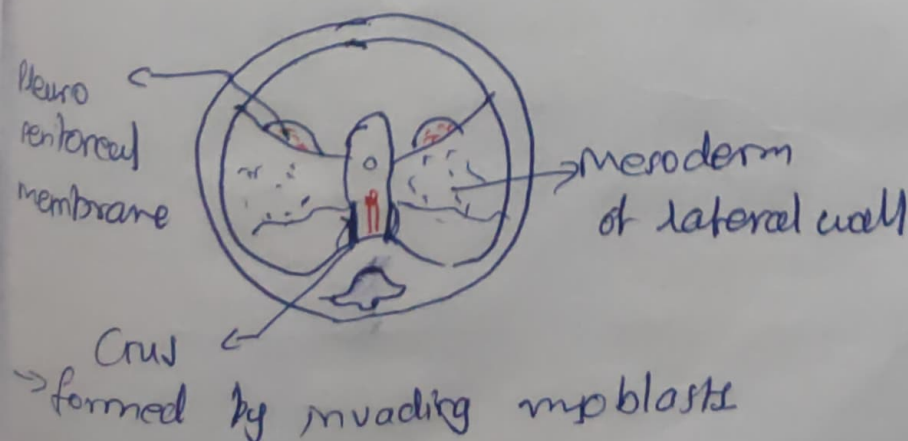
→ 4 main sources of development.

- i) Septum transversum → initial position C_3, C_4, C_5
- ii) Dorsal Mesentery of Esophagus
- iii) Pleuroperitoneal membrane
- iv) Lateral body wall

↓ due to folding
lies at T_7-T_{12}
↓ Nerve supply
Phrenic Nerve
 C_3, C_4, C_5



→ Lower intercostal nerves giving sensory supply to diaphragm



Crura
→ formed by invading myoblasts

→ Towards the end of fetal period. Another mesodermal prolongation is seen. This will encroaches median plane

→ Pleuroperitoneal membrane is ~~reduced~~ in contribution is reduced

Applied Aspects

→ Congenital diaphragmatic hernia.

• Seen commonly on left side. (bco it fuses later)

Bochdalec hernia

→ Retrosternal diaphragmatic hernia

Hernia ~~in~~ of Morgagni

→ Hiatal Hernia,

- Vena Cava

- Esophagus (larger opening)

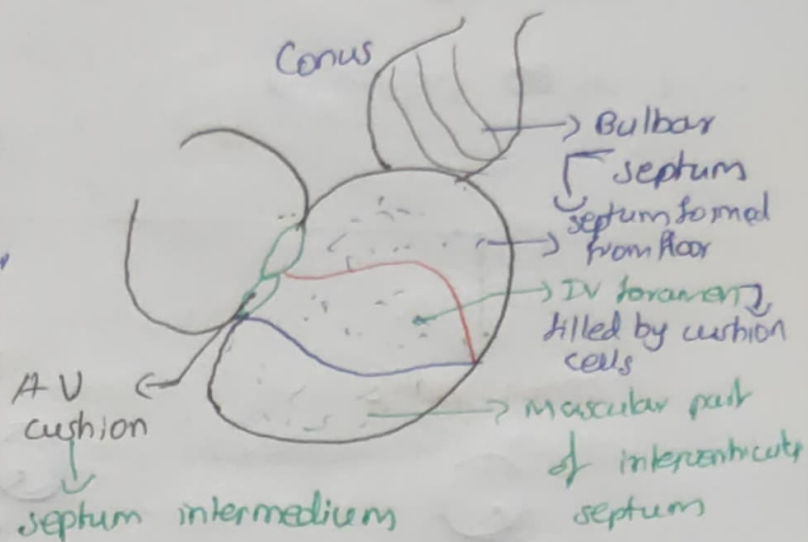
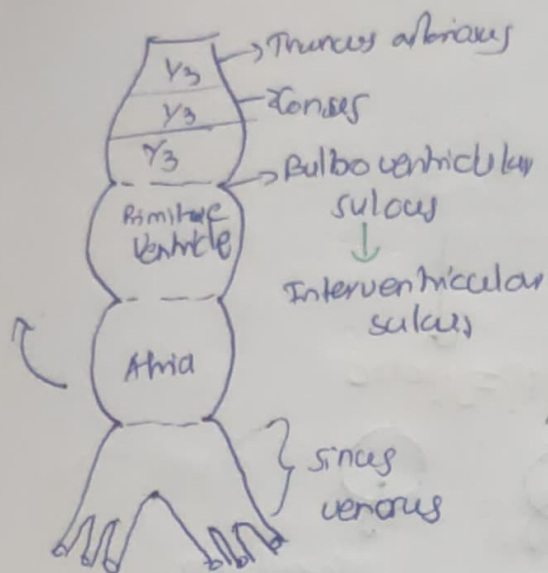
- Aorta

→ Eventration of Diaphragm.

No defect in diaphragm. But the diaphragm is thin membranous without muscle content

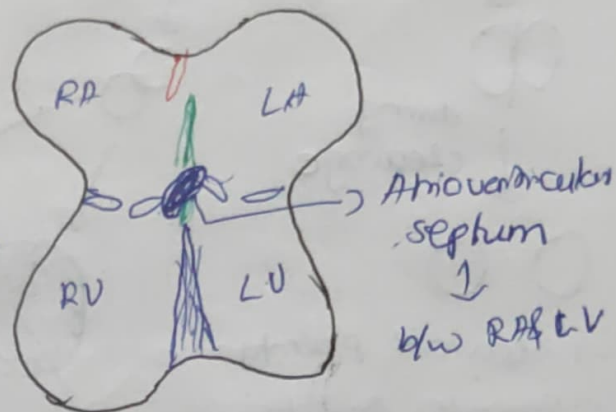
→ The gene located on Chromosome 19. (long arm) is controlling the development of diaphragm

Development of Interventricular Septum



IV septum forms from 3 structures

- Bulbar septum of Conus
- Proliferation from AV cushion
- Muscular part derived from IV sulcus (Bulboventricular sulcus).



Applied [VSD]

- Muscular portion is affected most commonly
- Membranous portion defect is most dangerous

Fallot's Tetralogy

- Pulmonary stenosis
↓
- Right ventricular hypertrophy
↓
- with ventricular septal defect
→ Over-riding of aorta

Development of stomach

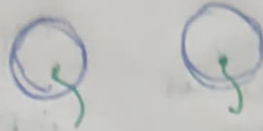
Twinning of Embryo

→ 1 in 80 pregnancy

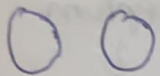
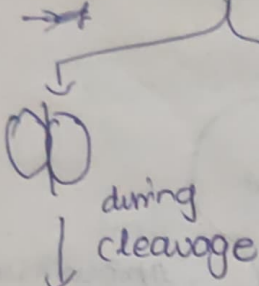
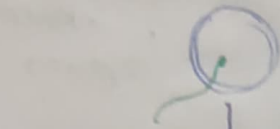


Monozygotic

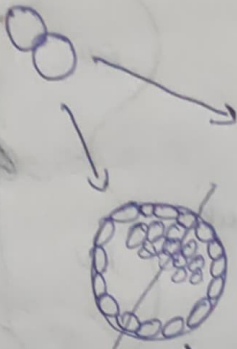
Dizygotic



- Same or different sex
- share nothing in common
- Two separate oocytes fertilised



- Separate placenta
- Separate Amniotic cavity
- Same genetic contribution
- Most common



- Monochorionic monoamniotic
- most dangerous



- Monochorionic
- Bi-amniotic



Thoracopagus



Craniopagus



Conjoined thoracopagus



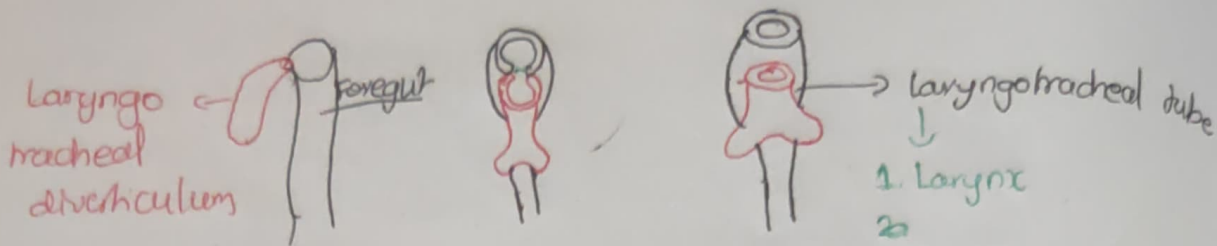
Pygopagus

Parasitic Twin

Foetus in fetu

Development of Respiratory System

→ Derivative of foregut



1. Larynx

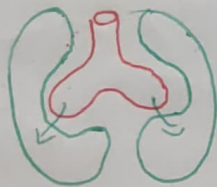
- Mucosa → Endoderm
- cartilage/muscle → 4th & 6th pharyngeal arches
- Nerve supply → Vagus

2. Trachea

- Epithelium → Endoderm
- muscle cartilage
- Fibrovascular stroma

→ Splanchnopleuric mesoderm

4 stages of maturation of lung



1) Pseudoglandular stage (6-16 weeks)

→ Proximal aspect → columnar epithelial cells
Distal aspect → cuboidal epithelial cells

→ Looks like tubulo-acinar gland

2) Candicular stage (16-26 weeks)

→ terminal bronchiole lumen enlarged - lung tissue vascularised

→ Cells get differentiated → type I pneumocytes
not differentiated → type II pneumocytes
↓
stem cells, surfactant synthesis

3) Terminal sac stage (26w-Birth)

- Establishment of Blood-air barrier.
- Cells get thinned out and (epithelium) there is perfect gap gas exchange between Endothelial & epithelial cells.

4) Alveolar stage (32 weeks - Birth, can extend upto 8 years)

- Alveolar sac should secrete surfactant
- Lung should transform from secretory to gas exchange phase
- Establishment of pulmonary & systemic circulation

Steps for production of surfactant

surrounding lung fibroblasts secrete a substance



Fibroblast pneumocyte factor ~~EPF~~ (FPF)



Type II pneumocytes



Secretions

7th month
of Intra
uterine life

In premature birth,

→ Cortisol is given → that stimulates (EPF)

Applied

→ seen as one of the components of the group of anomalies known as

- V → Vertebral anomalies
- A → Anal atresia
- C → Cardiac defects
- T → Tracheo oesophageal fistula
- E → Esophageal atresia
- R → Renal anomaly
- L → Limb defect

VACTERL

Hyaline Membrane disease

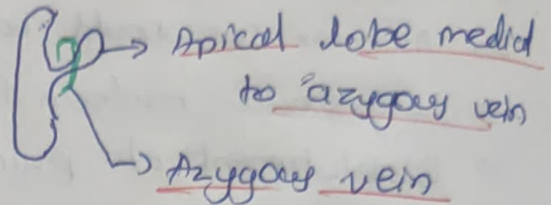
→ Surfactant is absent, waxy lining known as hyaline membrane.

Abnormal lobes

Azygos lobe

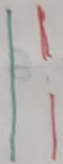
→ Increase in number of lobe

lobe of Azygos vein

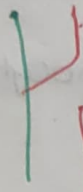


Tracheoesophageal Fistula

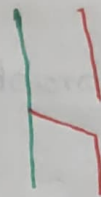
→ Defective tracheoesophageal septum.



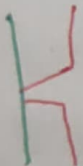
Type A



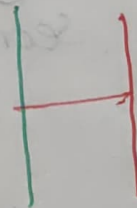
Type B



Type C - (common)
C → common 85%



Type D

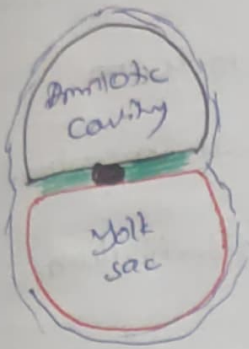


Type E/H

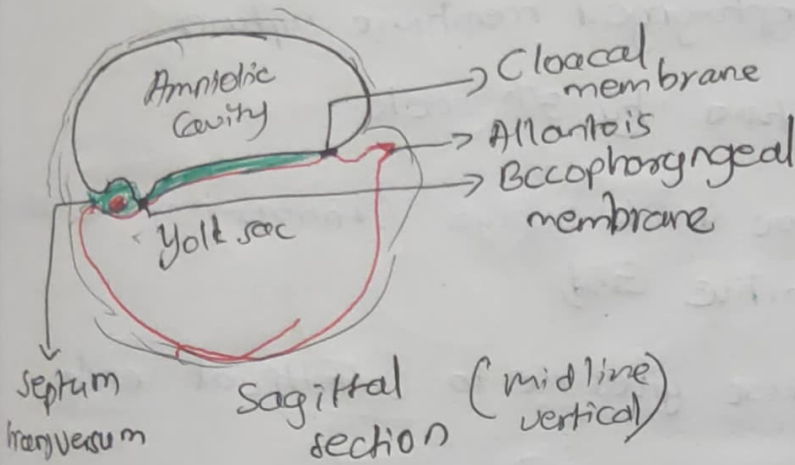
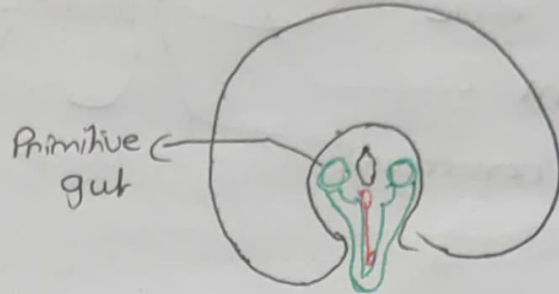
— trachea
— esophagus

Folding of Embryo Part - 4

- Cephalic folding
 - Caudal folding
 - Lateral folding
- Craniocaudal folding



Coronal section

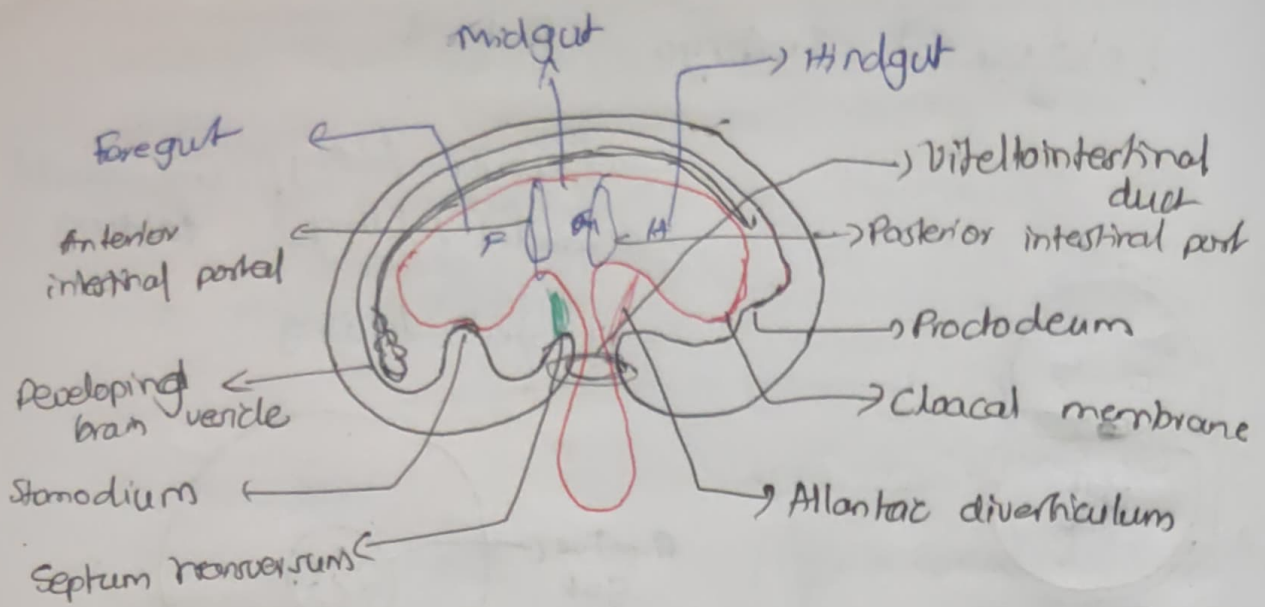


Cephalocaudal folding

- Growth of central nervous system (length wise)
- It overshoots causing the bending.
- Amniotic cavity enlarges

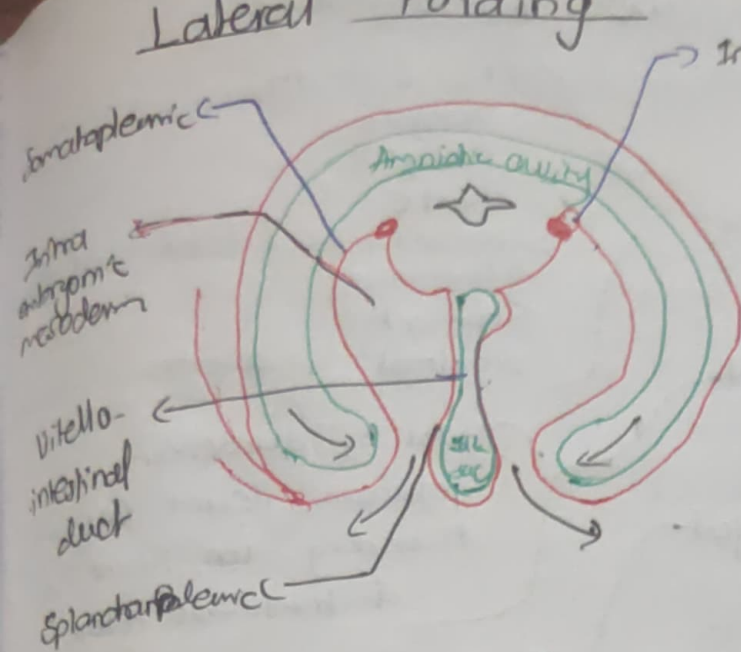
Lateral folding

- Growth of somites -

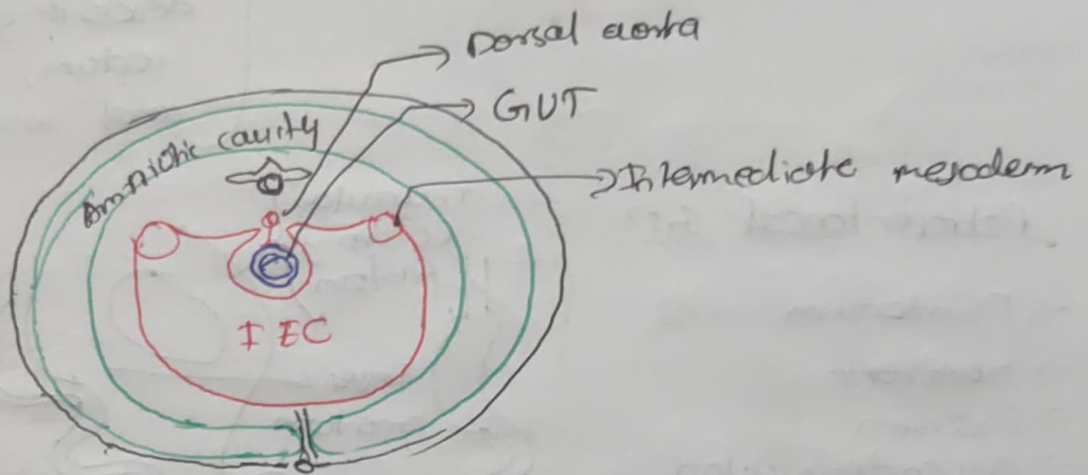
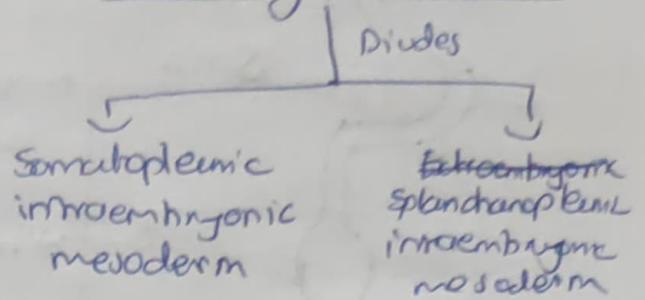


- By 4th week buccopharyngeal membrane ruptures
- Cloacal membrane ruptures by 5th week
- The part of yolk sac inside embryo (Intraembryonic yolk sac) gives rise to primitive Gut.
- Extraembryonic yolk sac gives rise to Umbilical vesicle.

Lateral Folding

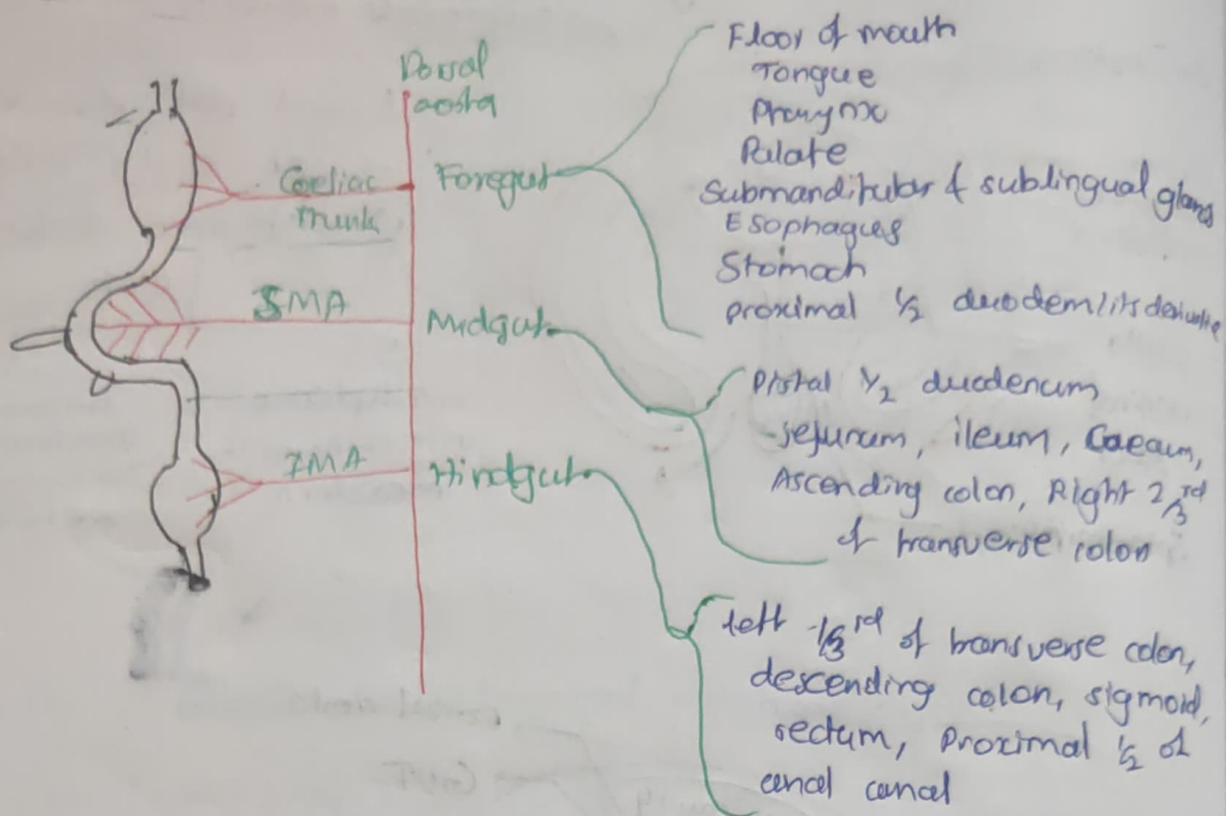


→ Lateral plate mesoderm
we get cavity called intraembryonic coelom.



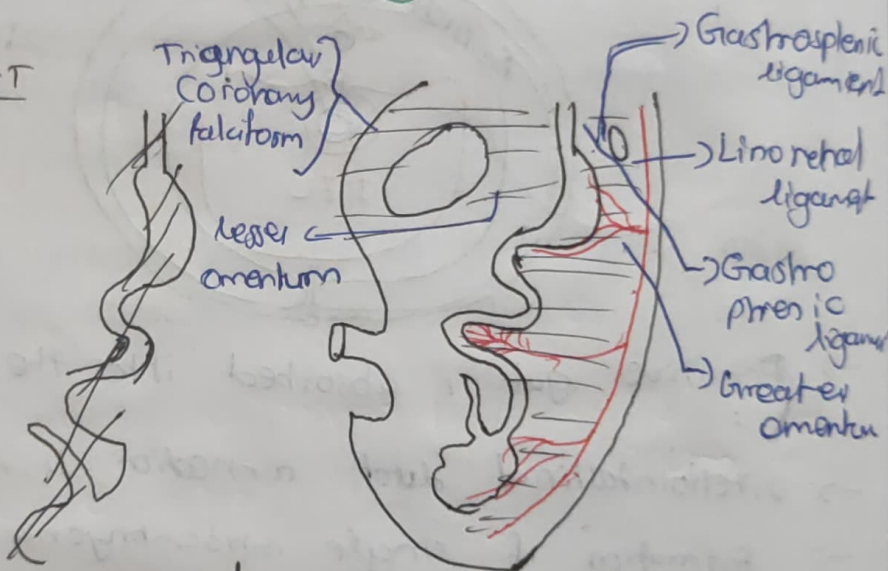
- Primitive gut is absorbed into the cavity embryo
- Vitellointestinal duct connection is lost.
- Formation of single intraembryonic coelom.
- Mesoderm modified as mesentery which suspends the gut-tube. Though it we have blood vessels enter through it.
- Embryo starts floating in amniotic cavity. Bcz it surrounds the embryo

Derivatives of Gut Tube & Mesentery



Retropertitoneal GIT

- Duodenum
- ~~transverse~~
- Caecum
- Ascending colon
- Descending colon
- Rectum



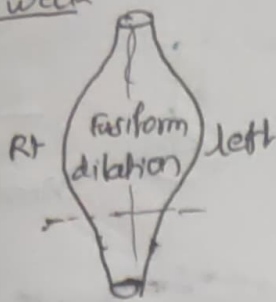
Mesentery renamed
 Transverse mesocolon
 Sigmoid mesocolon
 Mesoappendix

- The main purpose of mesentery is to provide **blood supply** to the gut.
- **Parotid** is not the derivative foregut. Bcz its ectodermal in origin.

Development of stomach

→ Developed from distal portion of ~~stomach~~, foregut

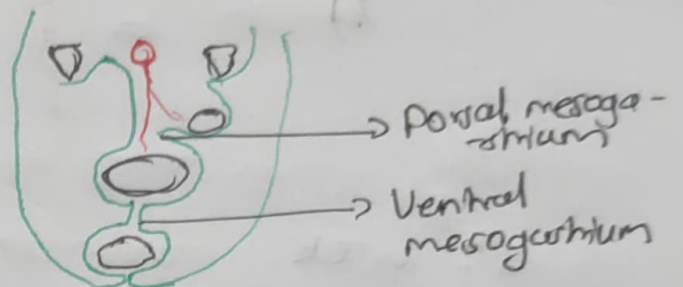
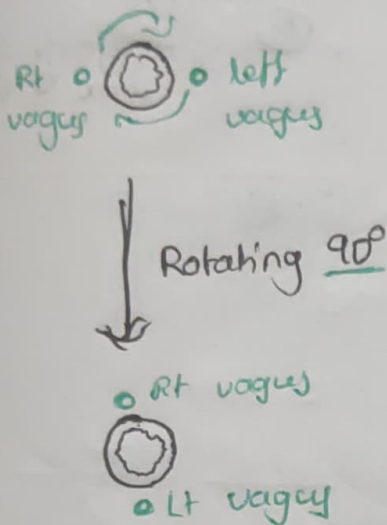
4th - 5th week



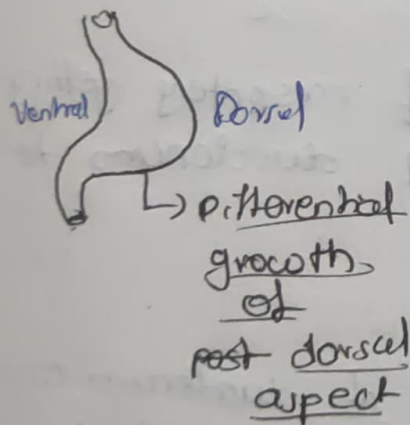
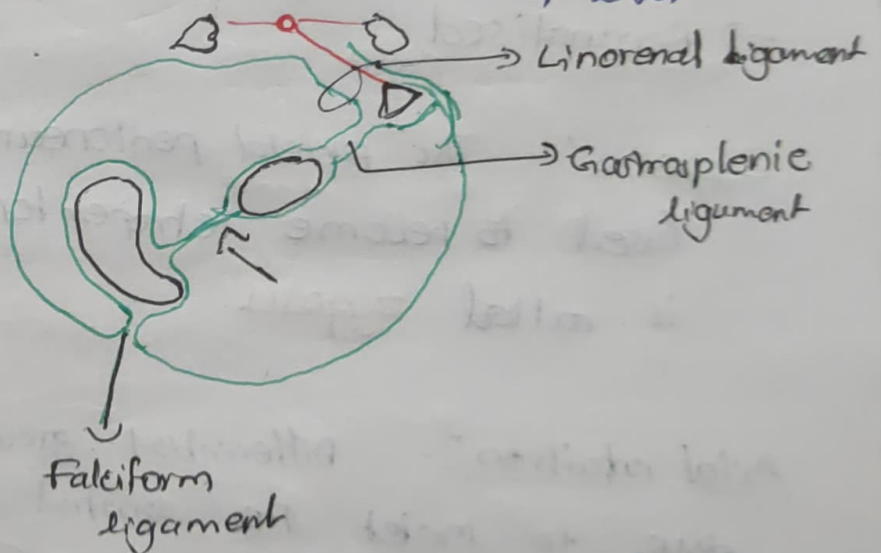
3 Factors for rotation

- Rapid enlargement of liver
- Omental bursa, lesser sac behind stomach
- Rotation by active growth process

Supporting structures



Stomach rotates due to the development of liver



Development of glands

- gastric glands - 3rd month
- Oxyntic & zymogen cells - 4th month
- Renin starts functioning - 5th month

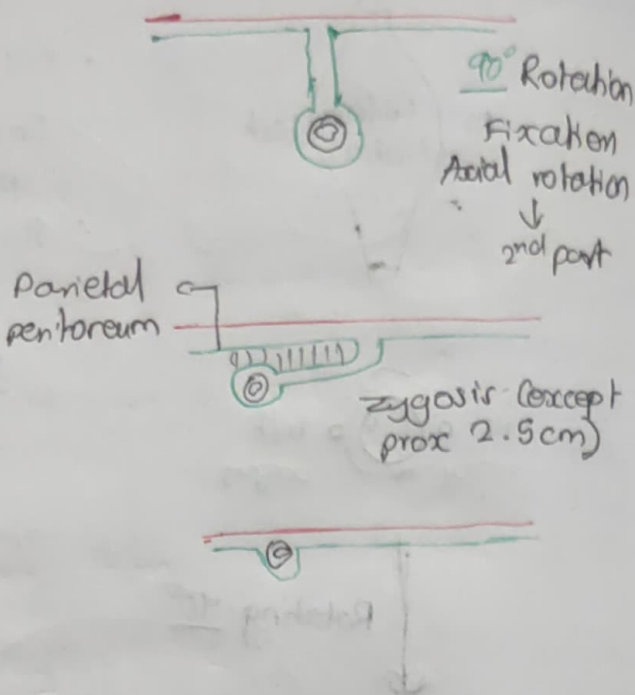
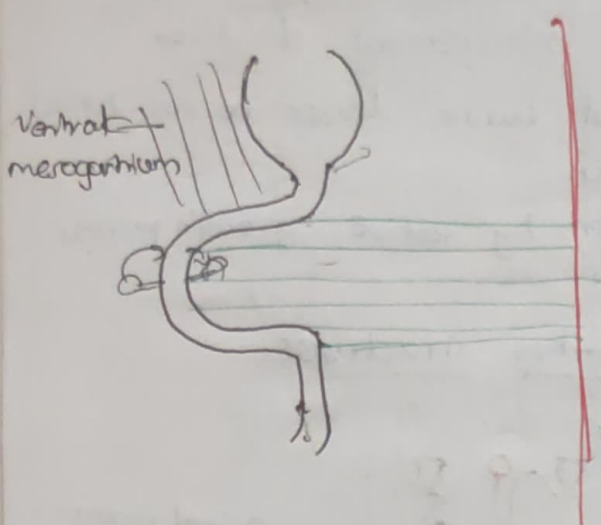
Applied

~~Congenital~~
Congenital hypertrophic pyloric stenosis

↓
2 weeks to 2 month
progressive vomiting
↓
Boys commonly affected

Development of Duodenum

→ Partly derived from foregut & partly derived from midgut



8th week

→ lumen obliterated

3rd month

→ Recanalised

Zygosis! - The parietal peritoneum & mesentery getting fused to become retroperitoneal duodenum is called zygosis.

Axial rotation! - Differential growth of duodenum occurs due to meet the ventral pancreatic bud to dorsal pancreatic bud.

Anomalies

→ Duodenal Atresia

→ Double bubble sign - USG

Blood Supply

→ since develops from foregut & midgut supplied by their main branch

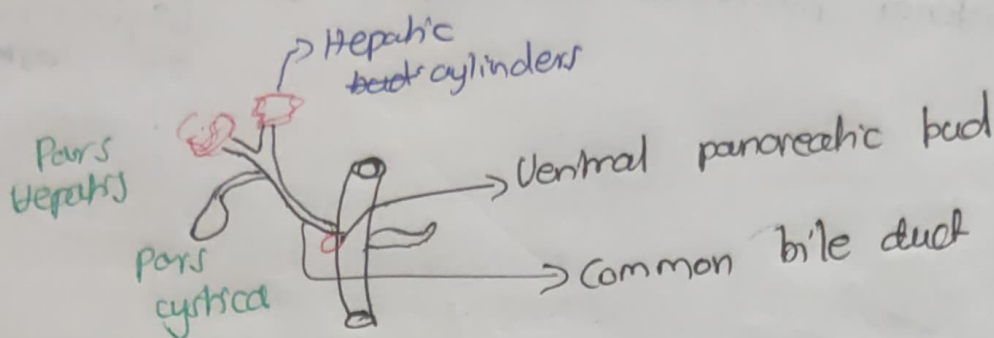
superior pancreaticoduodenal artery → Foregut artery (Coeliac trunk)

inferior pancreaticoduodenal artery → Midgut artery (Superior mesenteric artery)



Development of Liver & Extrahepatic Biliary Apparatus

→ Develops as hepatic bud from at the Junction of foregut & midgut



→ Liver grows ~~very~~ bigger than other organs,

- Getting maximum O_2 .

- Hematopoietic function of Liver.

- This is reason for Physiological Hernia

→ Hepatic cylinder are of equal in size,

Pars cystica → forms,

Gall bladder

Cystic duct

Formation of ligamentum venosum

→ Remnant of ductus venosus

Formation of ligamentum teres hepatis

→ Remnant of left umbilical vein

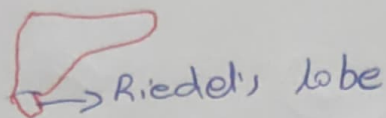
Athresia of duct

→ It may be missing, anyway between its path

Accessory bile duct

→ Bile leaks after cystectomy if not ligated

Riedel's lobe



Intrahepatic biliary atresia

Polycystic disease of liver → Connection is not formed

Cardi's disease

Rudimentary liver → Not formed normally

Agenesis gall bladder → Gall bladder not formed

Sessile gall bladder → Cystic duct is absent, bladder opens into duct

Phrygian Cap → Fundus fold on itself

Hartman's pouch → Neck of gall bladder has pouch

Septae / double gall bladder

Intrahepatic gall bladder

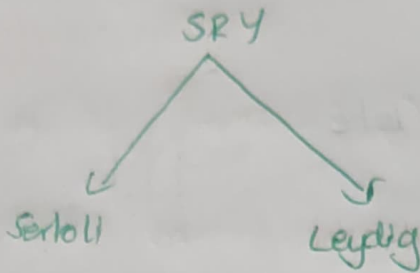
Floating gall bladder

Development of Gonads: Testis & Ovary

→ Upto 5-7th week development of gonadal system is same

Factors determining sex

- The chromosome X & Y.
- SRY - gene



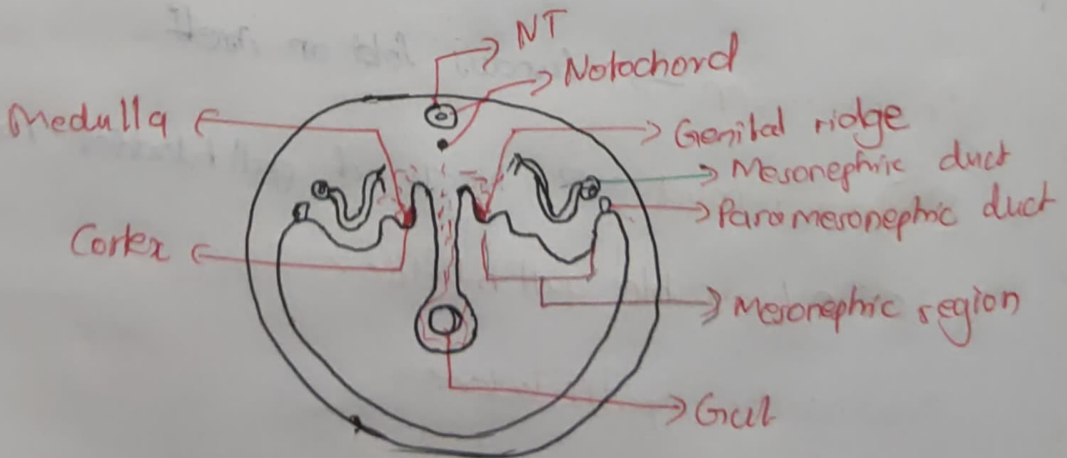
at 18th week of IUL they disappear
→ Reappear at the time of puberty

Mullerian inhibiting substance

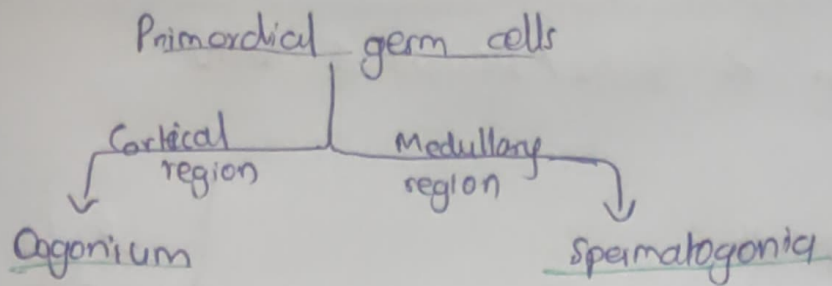
Inhibit Mullerian duct development in females

Testosterone

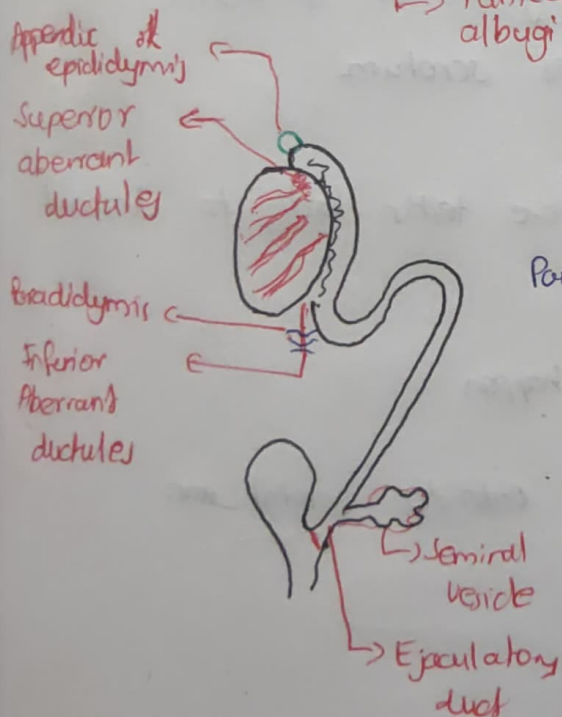
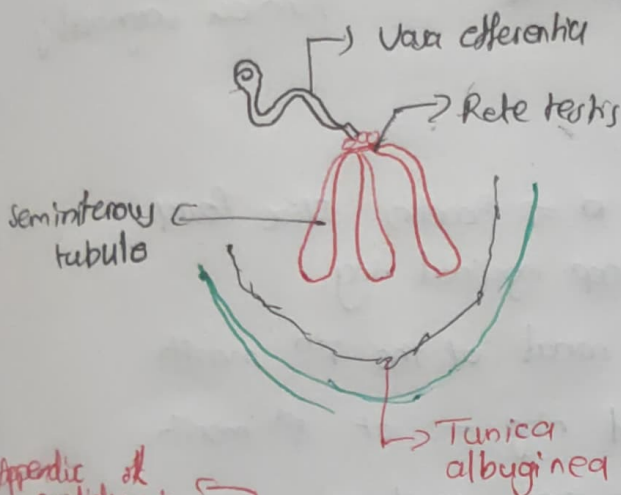
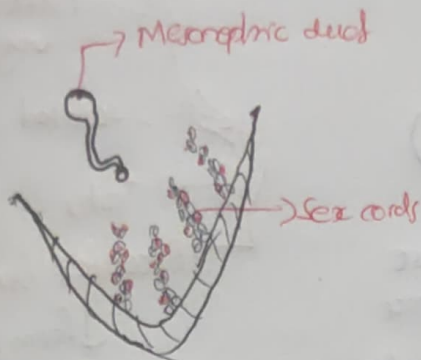
genital duct's development in male



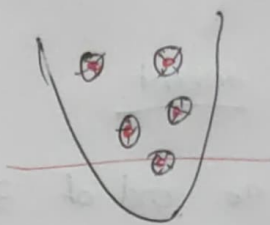
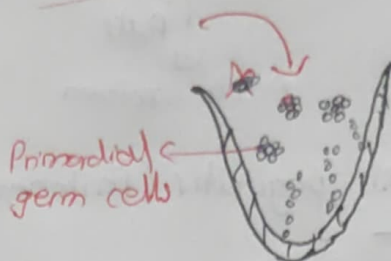
→ Primordial germ cells ⇒ are derived from epiblast



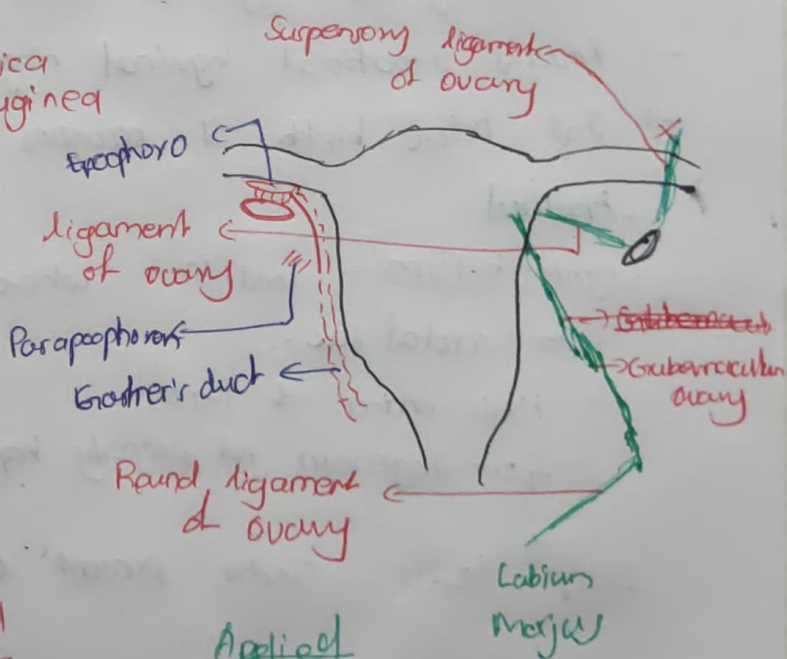
Events occurring in Male



Events occurring in Female



Descent of Ovary



Applied

Hermaphroditism

- The patient will be having female gonads but external features are male. (Female Hermaphroditism)

Male Hermaphroditism

Vice - Versa

Final position of Testis / Descent of Testis

Factors

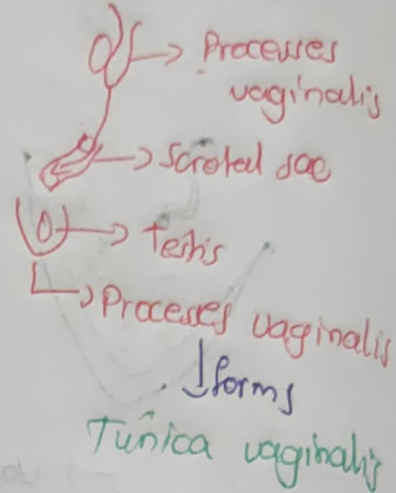
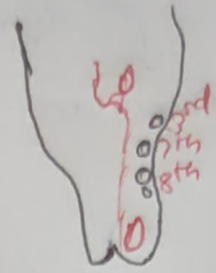
- i) Body $\rightarrow$ growth
- ii) Gubernaculum $\rightarrow$ Fibrous strand
lower end of testis

↓ Pulls
Reach scrotum

- iii) Processes vaginalis (Peritoneal sac)

Applied

- Patent processes vaginalis = cause hernia
- Fluid collection forms hydrocoele



Descent

- By the end of 3rd month $\Rightarrow$ Reaches ilioce fossa
- By 7th month $\Rightarrow$ Reach deep inguinal ring
- Traversing the inguinal canal at the 7th month
- $\rightarrow$ Reaches superficial inguinal ring $\Rightarrow$ at 8th month.
- $\rightarrow$ But before birth it occupies scrotum.

Applied

Cryptorchidism - condition where testis fails to descent into scrotal sac.

- High chance of tumor
- Spermatogenesis not properly happen

Ectopic testis - Testis present outside scrotal sac