THE FUNDAMENTALS OF HUMAN EMBRYOLOGY

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Embryology

- Embryology –

→ embryology is study of the formation & Development of the embryo or. fetus.

→ The study starts from the thime of conception (pregnancy) upto the time of Birth (Delivery) as an infant.

- embryo –

→ During the First 2 month of Development, the developing Individual is called as embryo.

- Foetus.

→ From the 3rd month, untill Birth the Developig individual is called as foetus

- Branches of embryology

1) Descriptive / General embryology
2) Experimental
3) Comparative
4) Chemical
5) Teratology

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1) Descriptive / general embryology

→ Studies to normal sequence of development
→ Includes - Fertilization
- Cleavage
- Gametogenesis
- Organogenesis etc-

ex. - formation of 3 germ layer

2) Comparative embryology

→ Studies to Different Species.
→ Helps understand evolutionary Relationships.

ex. - Similar early embryos in Birds, mammals.

3) Experimental embryology

→ Studies Mechanisms of Development using experiments
→ Helps to understand to Process of Development
→ also called as Analytical embryology

ex. In frog embryo → Transplanting the Dorsal lip of Blastopore → forms to twin embryo

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4) Chemical embryology / Molecular

→ Studies to gene expression, Biochemical & Physiological techniques

ex. Hox genes ⟶ control limb & vertebral development
↓
Blue Print
↳ Master Regulatory genes.

5) Teratology / Abnormal embryology

→ Studies of Birth Defects & Developmental abnormalities.

→ causes :- genetics, toxins, Radiation etc.

ex. Rubella → congenital Heart Defets.

- Scope & Importance of embryology.

→ explain of Development (fertilization)
→ clinical & Surgical Practice.
→ & evolutionary Biology
→ ART (Assisted Reproductive Technology)
- IVF
- embryo transfer etc.

- Conclusion

→ embryology explain How life Develops from a single cell.

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Sperm

→ Sperm is a Male Reproductive cell.
→ It is a Tiny Specialized cell.
→ When a Spermatozoon Matures completely Then only it is called Sperm.
→ The Maturation is completed only when the ~~Sperm~~ Spermatozoon enters the female Reproductive tract.
→ Sperms has the following Parts-

1) Head (3-5)
2) Neck ↰ Mid Piece (1-2)
3) Body ↲ (5-9)
4) Tail (40-45)

[Length of Sperm 50-60 µm]

1) Head
→ Shape :- oval
Length :- 3-5 µ.
Width :- up to 3 µ.
→ Ant. Portion of Head is thin
→ Ant. 2/3 of Head is called → Acrosome & gullet capitis.
→ Acrosome :- Thick cap like structure - containing enzyme, this enzymes is Help to Sperm enter the Ovum. (Secondary Oocytes)
(Acro = top, Some = Body)

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2) Neck.

→ Neck (Discle Shelped Parts)

→ consist 2 part
  i) anterior end knob (Proximal)
  ii) Posterior end knob

3) Body

→ Shape :- Cylindrical
Length :- 5-9 mm
Thickness :- 1 mm

→ contains : axial filament

→ axial filament :- central core
  :- covered By thin cytoplasmic capsule

- Start From Post. end knob of Neck and Pass through the Body and Perforated Disc or. Ring like structure is called Annulus.

→ Annulus Pass Tail

→ axial filament is surrounded By a closely wound Spiral filament consisting of Mitochondria

4) Tail

→ length :- 40-450 mm.

→ Help to movement

→ 2 Segment i) Terminal
  ii) Chief (main)

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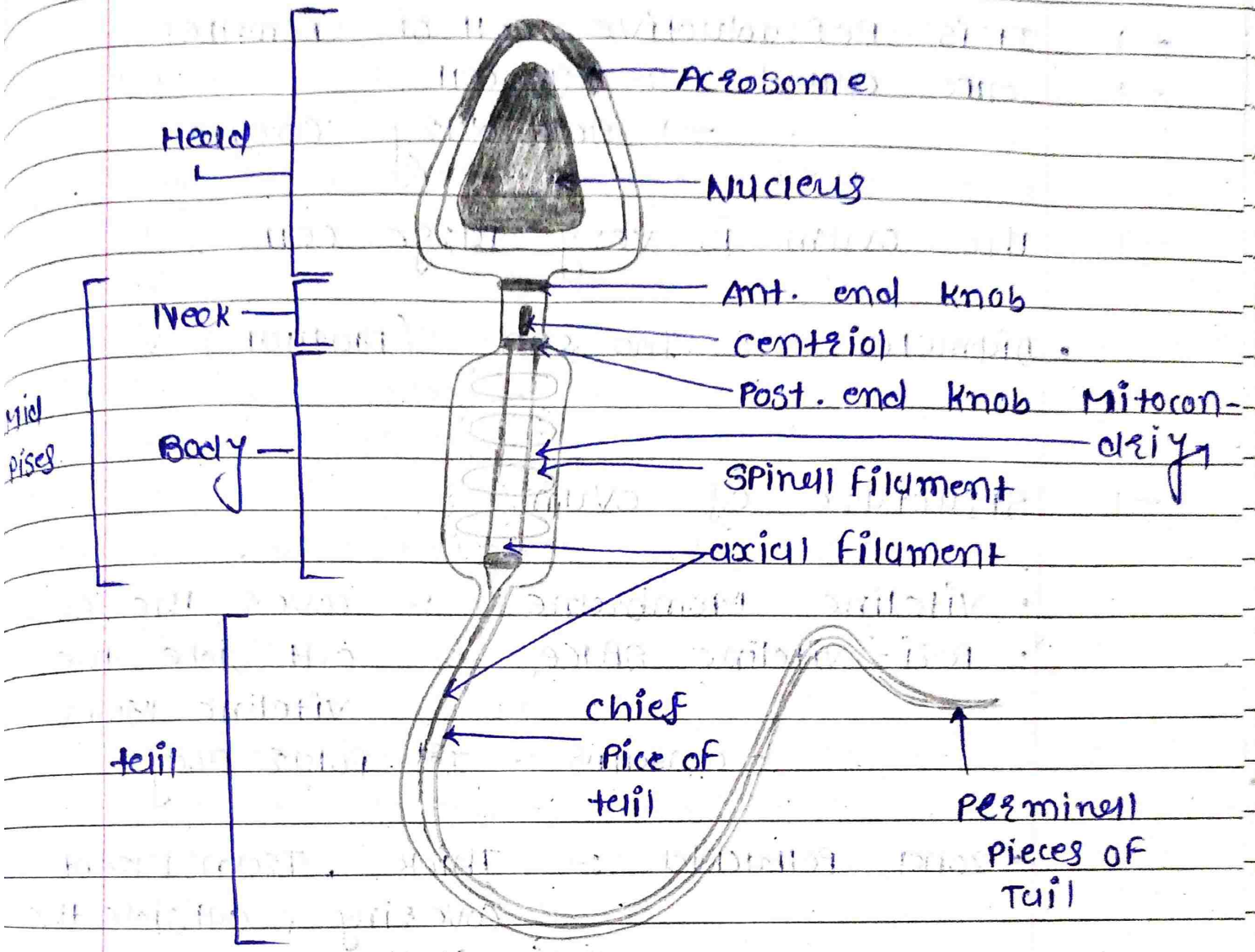

[Sperm cell]

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Ovum

→ It is Reproductive cell of Female
→ also called → egg cell.
→ Secondary Oocyte.

→ The ovum is very large cell.

- Diameter → 100 µm (Mature)

→ Structure of ovum.

- Viteline Membrane :- covers the ovum
- Peri-viteline Space :- out side the viteline Membrane
  - contains :- 1st Polar Body.
- Zona Pellucida :- Thick, Transparent covering, outside the peri-viteline space.
- Corona Radiata :- Surround the Zona Pellucida
  :- 1 layer of cells.

→ At the time of ovulations Nucleus is not seen in the ovum Bcz, The Nucleus Membrane is dissolved for the 2nd Miotic division of Chromosomes.

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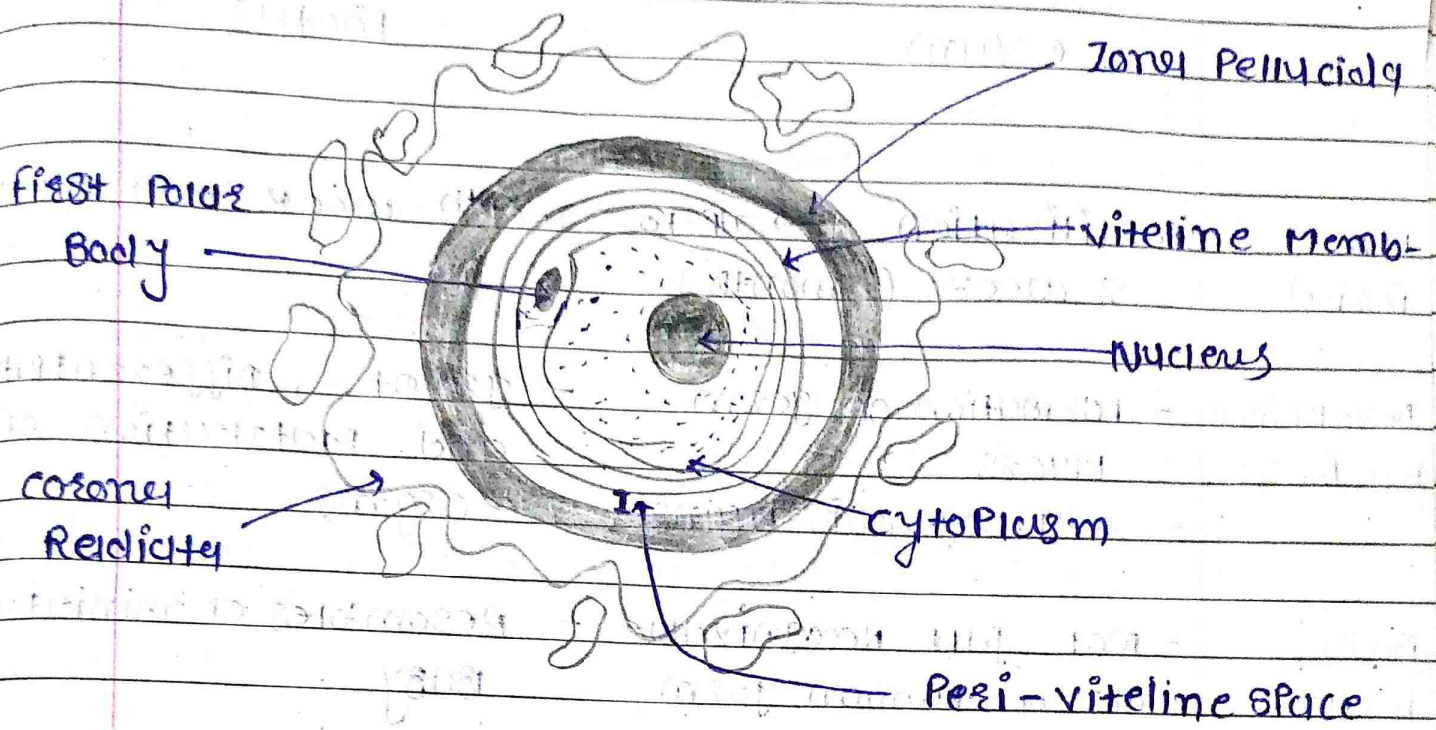

[ovum]

- abnormalites of structure

Sperm	ovum
- very large sperm	- very large Nucleus
- very small sperm	- 2 Nuclei
- Double Head & tail	- 2 oocytes in single follicle

- Chromosomal abnormalites
  - Trisomy → 23 Pair + 1 extra
    - → In 21 chromosome
    - → called down's syndrome
    - → XXX, XXY, XYY
  - monosomy → Turner Syndrome → X

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	Ovum	Foetus
Time Period	Fertilization → up to 8 week (2 month)	9th week → Birth
Developmental focus	- Formation of germ layers - Organogenesis Begins	- growth, Differentiation and Maturation of organs
Body form	- Not full Recognizable as a Human form	- Resembles a miniature Baby.
Major Process	- Cleavage - gastrulation Neurulation - early organ formation	- weight gain - tissue Specialization - Functional development
Placental Role	Placental formation Begins	Placental fully formation
movement	- very limited or - Absent	- active fetal movement - Present
Risk Sensitivity	- High • Teratogens	- mostly results in Functional defect of growth Restriction
Clinical Monitoring	Focus on developmental anomalies	Focus on growth Viability and wellbeing

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* Foetal Blood circulations

→ Foetal circulation is a circulation of oxygenated Blood, deoxygenated Blood, Nutritive Material etc — in the Fetus from mother., Bcz. foetal lungs not working

*→ Temporary Structure

i) umbilical vein (1)
- carries oxygenated Blood from Placenta to foetal Body

ii) umbilical Arteries (2)
- Branches of iliac artery
- Returning deoxygenated Blood from fetal Body to Placenta

iii) Ductus Venosus
- continuation of umbilical vein
- convey 85% O2 Blood.
- arises from - Foetal vein and Joint the left Hepatic vein.
- O2 Blood is Bypassed to IVC By Ductus Venosus.

iv) Foramen ovale.
- It is opening in the Septum b/w Right atrium and left atrium.

v) Ductus Arteriosus
- It is a leads from the Junction the Pulmonary A. to Descending aorta.

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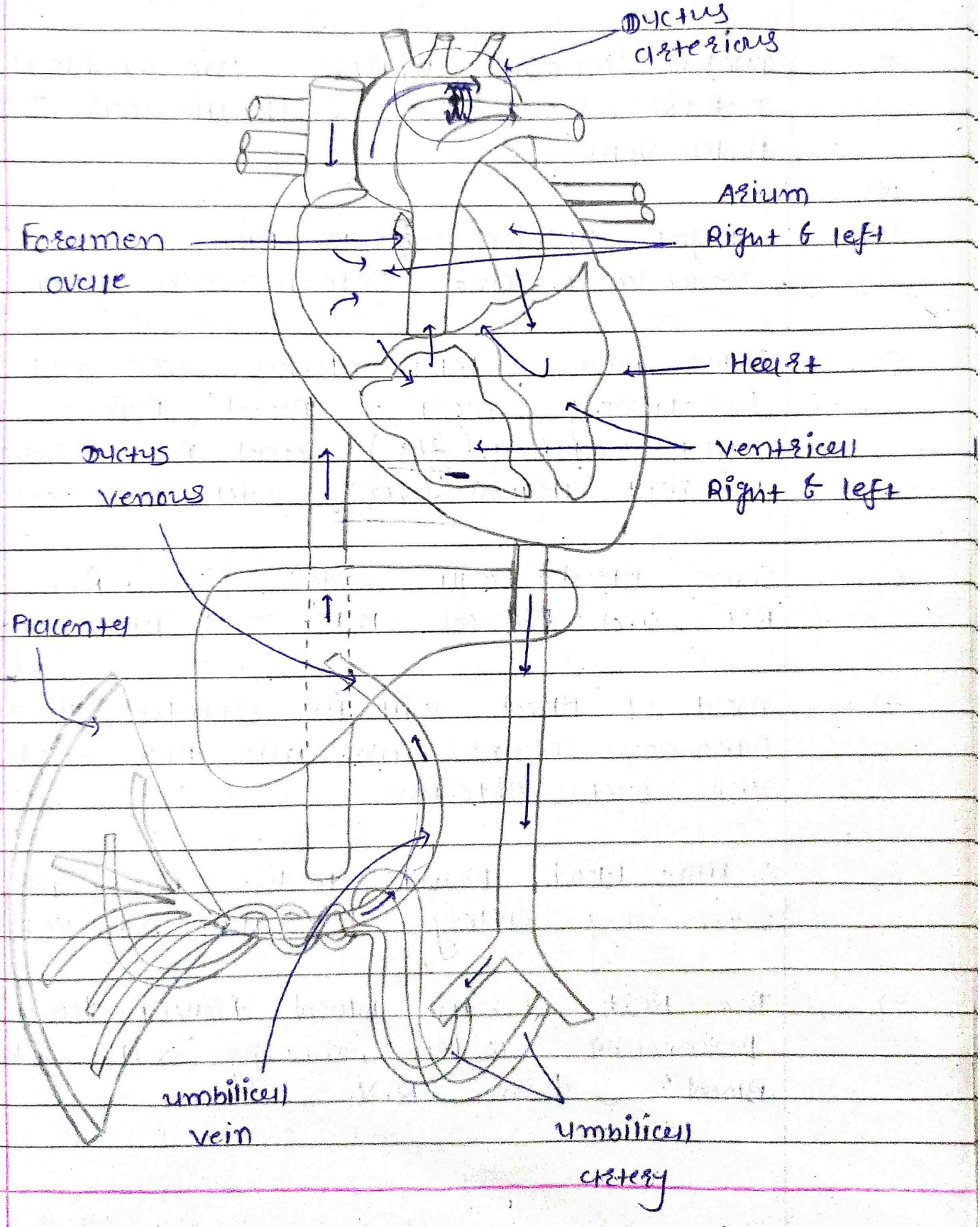
Steps in Foetal Blood circulation



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1) umbilical vein (o2 Blood carry) from placenta
2) umbilical vein enters the Body through umbilical Ring (umbilicus) and travels along the abdominal wall to liver
3) Ductus Venosus Bypass the o2 Blood in Inferior Venal cava & Hepatic vein join to Portal vein
4) Right atrium → mix Blood from Superior Venal cava and Inferior Venal cava
5) after that, fetal lungs are not Functioning most of Blood Bypass the Right ventricel (2/3) and Be Shunted to left atrium (1/3) via foramen ovale.
6) Some Blood will enter from R.A. to R.V and Proceed into → Pulmonary Trunk.
7) most of Blood will Be Shunted away from Pulmonary Trunk and into the Aorta via Ductus Arteriosus (8%)
8) A little Blood travels to the lungs in the Pulmonary artery for their development
9) The Rest of the Blood travel down the Descending aorta, mixing with deoxygenated Blood from R.V.

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10) Blood Pugs to umbilical artery → Brand of Internal iliac arteries and lead to Placenta

11) The Placenta Reoxygenated Blood Returing from the umbilical arteiees and Repeat the fetal cardiovascular cycle

* → After Birth —

- Lungs of the Baby Start working and Placenta circulation is Discontinued and some vessels occlude and Become fibrous ligaments -

1) umbilical arteries ⟶ medial umbilical ligaments.

2) umbilical vein ⟶ ligamentum teres of liver

3) Ductus Venosus ⟶ ligamentus Venosum

4) Ductus arteriosus ⟶ ligamentum arteriosus.

5) Foramen ovale ⟶ foramen ovale

→ Temporary organ

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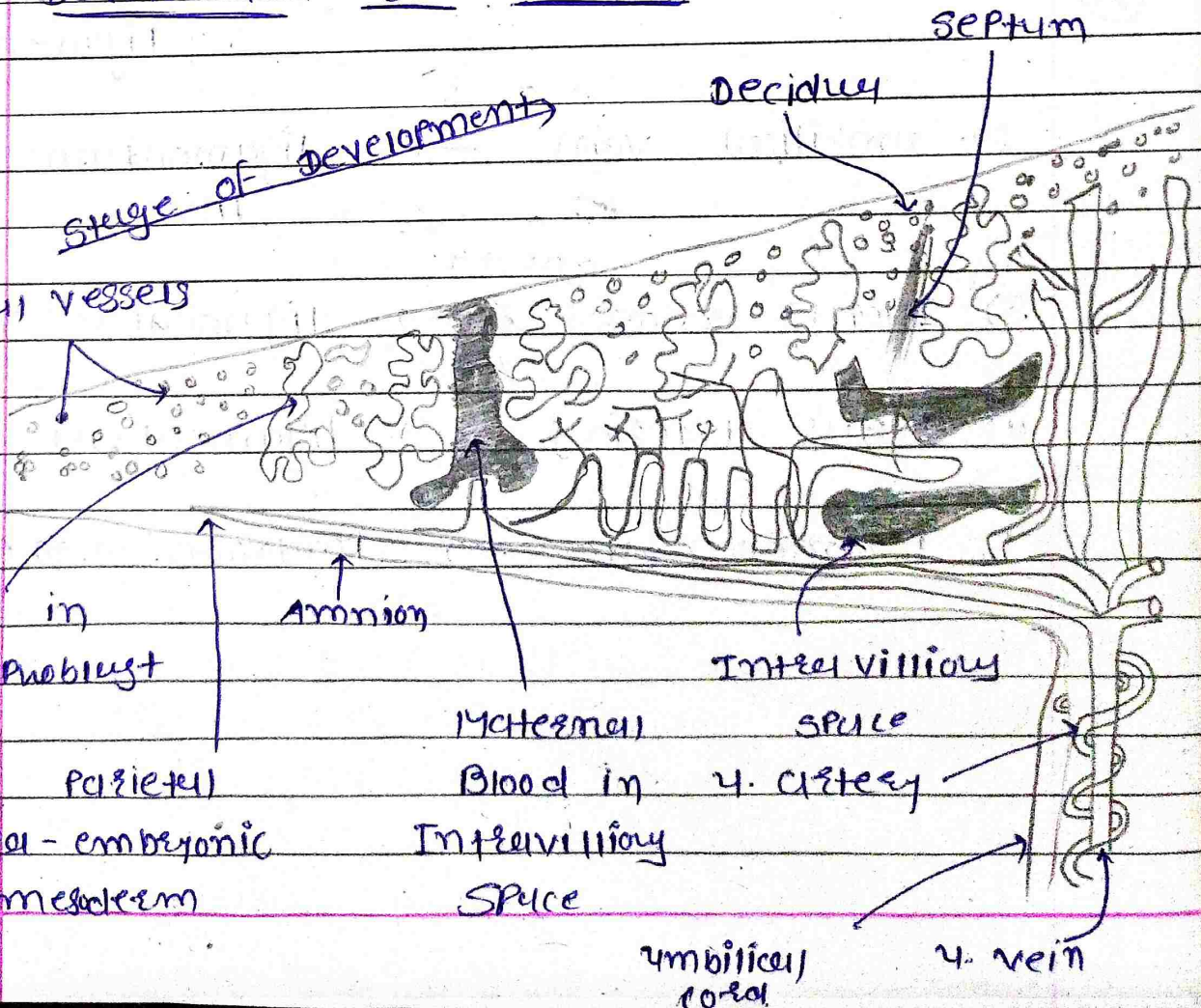
* Placental

→ Placental Provides O2 and Nutrient to the foetus and Remove CO2 and waste Products of Metabolisum

→ It is formed Partly From → Chorion and Partly from endometrium (Decidua) of the uterus.

→ In the Placental Blood vessels of foetus and Mother are Brought into intimate Relation , But Both Blood Remain Separated.

* → Development of Placental



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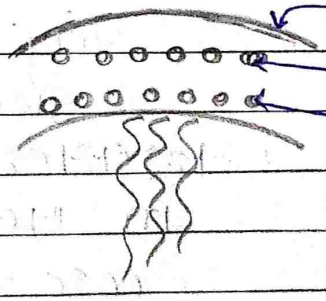
1) The morula surround by zona pellucida travels through the uterine tube and arrives in the uterine cavity become Implantation Process

2) formation of placenta this process in the endometrium (Decidua) & chorion

- Decidua Basalis :- Deep part
  :- united with chorion
- Decidua capsularis :- part of Decidua covering Blastocyte
- Decidua Parietalis :- Decidua of Rest of the uterine lining

- formation of chorionic villi - In Decidua Basalis villi grow from surface of trophoblast into surrounding decidua



- This process Decidua capsularis disappear

3) The Trophoblast differentiates two layer
- Inner (cytotrophoblast)
- outer (syncytiotrophoblast)

4) Syncytiotrophoblast (direct) erodes the wall of Maternal Blood Vessels and formed -

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trophoblastic lacunae into Flow of Maternal Blood flows.

5) Trabecule :- Blastocyst is surround on all side By lacunes spares around cords of syncytio-Trophoblast called Trabecule

↳ Trabecule develop the stem villi connect the

- Chorionic Plate : Inner part of the Foetal Placenta, Rise chorionic villi
- Basal Plate : Portion of Decidua Basalis Become essential part of Placenta

6) Stem Villi → Primary, Secondary & Tertiary villi are successively developed from Stemvill and complete to arteio-capillary Network in ~~Mesench~~ Mesenchymal core of each villi

7) Last made a vascular Network to Connecting Stalk.

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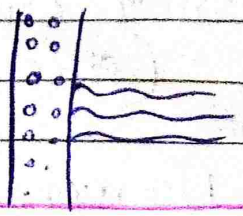
Full term of Placental —

- Shape – Disc Shaped
- Diameter – 15 - 20 cm
- Thickness – 2.5 cm
- Texture – Spongy.
- Weight – 500 gm
- Margin – Peripheral

- Surface

1) Foetal Surface	2) Maternal Surface
- Formed By Chorionic Frondosum	- Formed By Decidua Basalis
- umbilical coral are attached	- coral are not attached
- Shiny & grey colour	- Dull Red colour
- Smooth & glistening amnion covered By	- Rough & Spongy - 15 - 20 lobes - limited fissure

- Structure



- Maternal side has a Basal Plate
- foetal side has amniotic membrane & Chorionic Plate

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- Blood these two side the Intervillous Space containing the Stem villi with their Branches and the Space filled with maternal Blood

→ 1) Syncytiotrophoblast
2) Cytotrophoblast
3) Basemental membrane
4) central Stomal containing
   - Foetal capillaries
   - Primitive mesenchymal cells
   - connective tissue

← Structure of Terminal Villus

← Outward / Incorrect Structure

* → Function of Placental

1) exchange of material : O2 and Nutrient go to Fetal circulation and waste Product from fetus Return in maternal Blood through placental

2) Placental acts as a Barrier - Because most of microorganisms can not cross the Placental Barrier, some Drugs can cross the Placental Barrier they may cause adverse effect on fetus (alcohol & Nicotine)

3) Secretes Hormons due maintain Pregnancy HCG (Human Choerionic gonadotropin)

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* Umbilical cord —

→ The umbilical cord is actual connection B/W placenta and foetus.

→ It is develops from the connective stalk.

→ Consist of -
- 2 umbilical arteries - carry deoxygenated Blood
- 1 umbilical vein - carry oxygenated Blood.

→ Surrounding connective tissue which is a gelatinous substance called → wharton's jelly. (amion)

Hence is appears shiny

→ Dimentions —
- length - 30 cm to 130 cm
- Diameter - 2 cm

→ Umbilical cord shows much torsion (spinal twisting) . which is probably due to foetal movement

→ The cord allows free movement of embryo/foetus within the amniotic cavity

→ Consist of
1) external covering
2) core of mesoderm (2 artery + 1 vein)
3) Remains of the vitelline duct
4) Small part of extra embryonic coelon.

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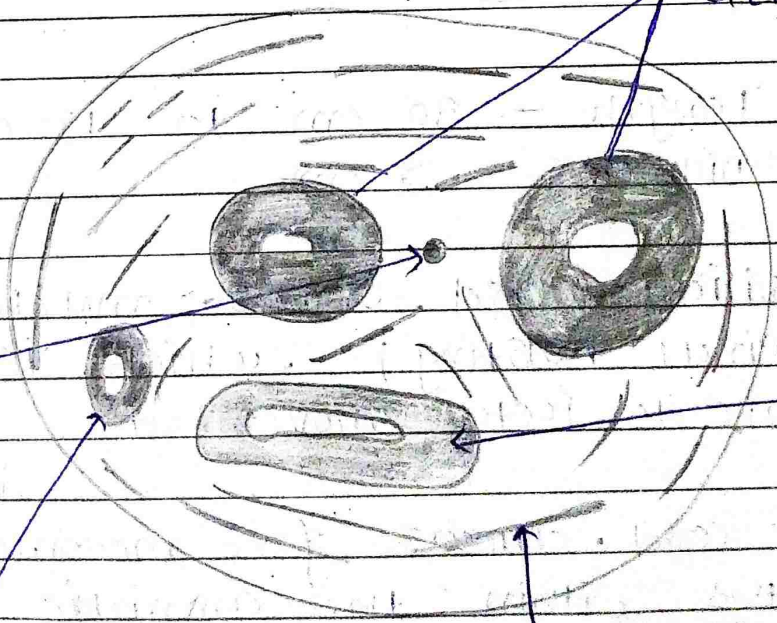
* → Fate of umbelical cord after Birth

→ dries, darkens (yellow-green to Brown to Black) and fell of naturally within 1 to 3 weeks.

→ after Birth - 1st tied about 1 inch from umbilicus of foetus, and in little Bit away from 1st pice

→ Then Placenta comes out of the uterus the cord is cut blw the two knots.

→ The area when the cord was attached Becomes covered by thin layes of skin and scar tissue forms
↳ umbellicus



(Umbilical cord)

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* Clinical Anatomy

1) Cord Vein & Placental Vein can be used in Blood Vessel grafts.

2) Cord Blood is Frozen from this Pluripotent Stem cells are used in future and many diseases of that person can Be treated with the Help of these Cells
   ↳ This Research is called Stem cell Research

3) umbilical cord is attached at other Places of the placenta (and not in the middle)

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* Foetal Membrane

→ Consists two layer

i) Outer Chorion
ii) Inner amnion

These are fused together → amniochorionic membrane

1) Chorion → Remant of Chorion leave
- Smoot & non-villous Portion of Chorion
→ It ends at the margin of Placenta
→ externally covered By - Trophoblastic layer
- decidual cell
→ Internally attached - amnion

2) Amnion → It's Internal Surface is smooth & connect with liquor amnii

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* Amniotic fluid

→ It is a clear, slightly yellowish liquid around the foetus into which it floats.

→ The quntity :- 1-8 week → 20 ml
:- 20 weeks → 350 ml
:- 37 weeks → 700 - 1000 ml
:- 40 weeks → 600ml.

→ continuous exchanges of water B/w amniotic fluid and Maternal Blood.

→ when the kidney of the foetus start filtering urine ; the foetus pass urine into the amniotic fluid. But doesn't cause any harm to the foetus as its urine contains mainly water.

→ Significance

- foetus moves in the fluid
- allows proper growth of Bones, muscle etc.
- Retains a constant Temperature around the foetus.
- Protects the foetus from external Injury

→ Clinical Significance

1) Oligohydramnions - Condition these is deficiency of amniotic fluid

2) Polyhydramnions (Hydramnios) - Condition these excess amniotic fluid

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* Fertilization

→ Fertilization is the fusion of sperm and ovum Both Nucleus to produce a zygote (fertilized egg)

→ Fertilization Bring the Haploid Nuclei of sperm and ovum together, forming a Diploid zygote.

→ The sperm's contact the egg's surface initiates Metabolic Reactions in the egg that trigger the ~~one~~ onset of embryonic Development.

*→ Types of fertilization
1) External (ex. fishes)
2) Internal (ex. Humans)

*→ Events of Fertilization

1) Transport of Oocyte
2) Transport of Sperm
3) Acrosome Reaction

1) Transport of Oocyte
- sweeping movement of fimbrie
- femal gamete (ovum) enter the fallopian Tube

2) Transport of Sperm
- sperm are enter the female genitical Tract

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→ In ampulla widest part of the fallopian Tube where The Sperm meets the egg.

- Zonal Pellucidal - a membrane to Prevent Implantation and Polyspermy
↓
- Sperm Binds to zonal Pellucidal
↓
- Triggers the Releases of acrosomal enzymes called - Acrosomal Reaction
↓
- acrosin, acid Phosphatase, Hyaluronidase
↓
- The Sperm Penetrates the Zonal Pellucidal
↓
- The cortical granules release its secretion (ovum) called - cortical Reaction
↓
- The cortical enzymes Reach the zonal
↓
- zonal changes Permiability of Sperms called - zonal Reaction (Fast & Slow Block)
↓
Fusion of Male and female Pronucleus
↓
Forms Zygote (46 chromosomes)

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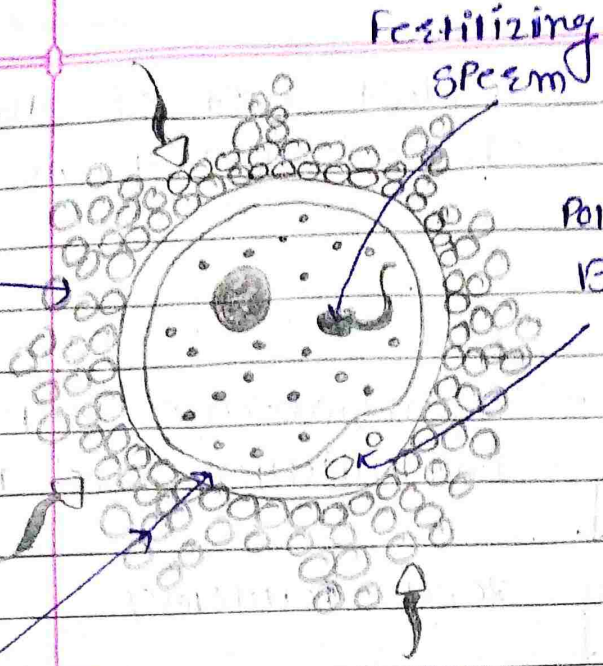
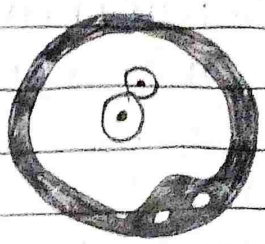
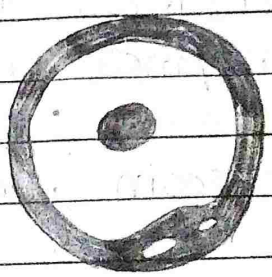


Penetration of Spermatozoon in the ovum



union of male & female Pronuclei



Zygote

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* Cleavage —

→ Cleavage is a Rapid series of Miotic cell division a zygote,

undergoes after fertilization, Transforming it form a single cell into multicellular Structure (Morula) <u>without overall growth</u>

creating smaller cells called Blastomeres and eventually forming a Blastula & Blastocyst.

→ Cleavage also called → Pre-embryonic Development.

→ In Humans cleavage is Holoblastic and unequal.

→ It occurs in the fallopian Tube
→ It Result is formation of Morula & then Blastocyst.

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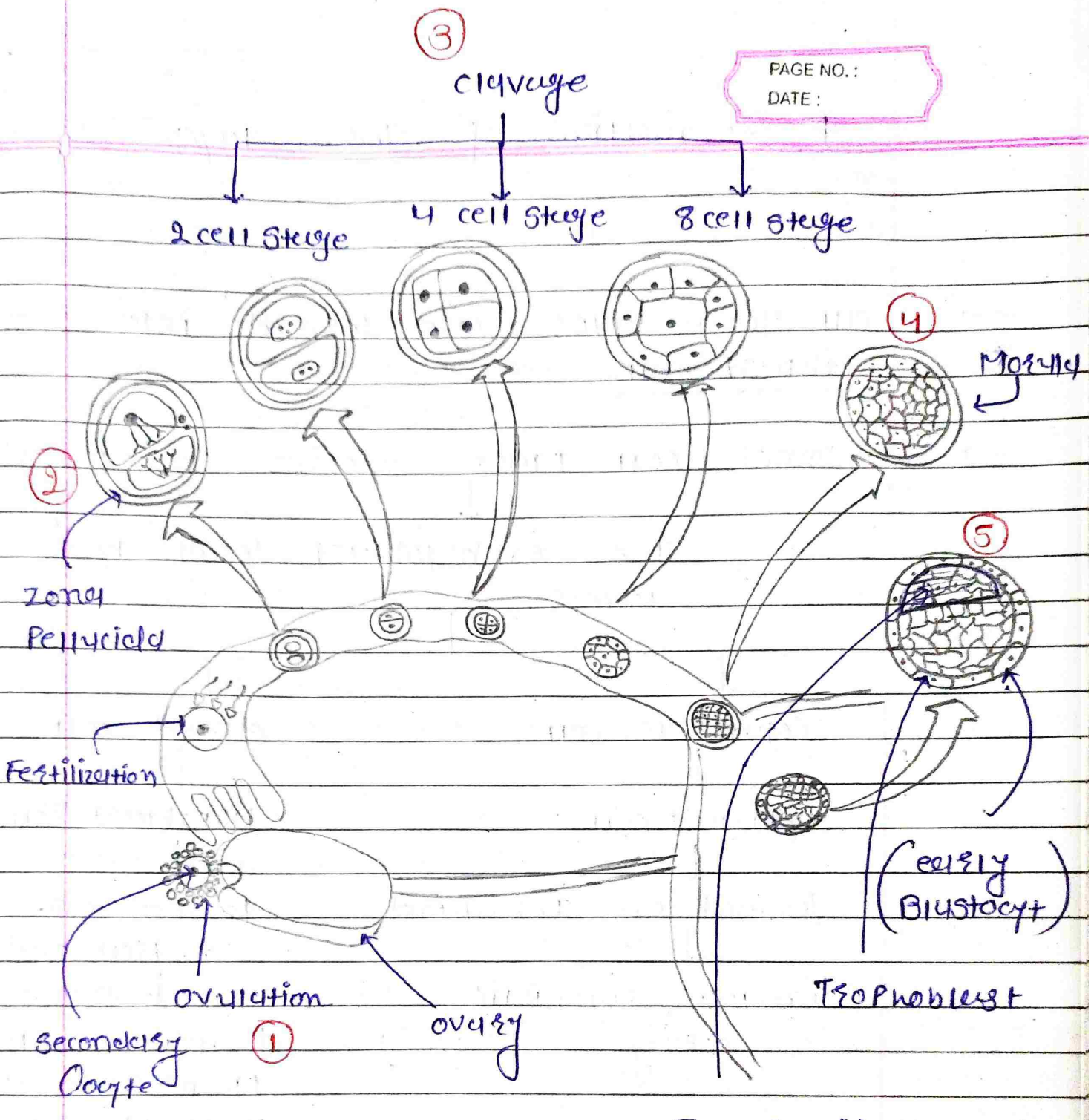
	Stage	Description	cell Number and feature
1)	Zygote	formed after fertilization	2n
2)	1st cleavage	Mitotic division of zygote	2 Blastomeres
3)	2nd cleavage	Further Mitotic division	4 Blastomeres
4)	3rd cleavage	Continued Division	8 Blastomeres
5)	Morula	Solid Ball of cells	16-32 cells
6)	Compaction	Cells tightly cavity appears	Inner & outer cell Mass Begin
7)	Blastocyte	fluid filled cavity appears	Blastocel present
8)	Tropho Blast	outer cell layer	forms placenta
9)	Inner cell Mass (embryoblast)	Inner group of cells	forms embryo
10)	Implantation	Attachment to uterine wall	Begin ~6th Day.



(Pre-embryonic development)

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* formation of germ layers -

→ All germ layers are formed into epiblast cells.

→ Inner cell Mass - forms embryoblast

↓

The embryoblast forms two layers

↓

Columnar cell

↓

epiblast cell

↓

formed on Dorsal end

↓

encloses amniotic cavity.

cuboid cell

↓

Hypoblast cell

↓

formed on ventral end

↓

forms exocelom Membrane / Heuser's Membrane

↓

It is flattened cell

↓

Encloses the primary yolk sac cavity.

→ They layers are separated to Bilaminar disc & Bilaminar amniotic disc

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→ on 8th Day Trophoblast Divided into 2 layers

(Inner Side) ↓ cytotrophoblast
- cells have single Nucleus and well-defined Membrane

↓ syncytiotrophoblast (Outer Side)
- cells are Multi-Nucleated & no well Difined Membrane

→ During the Implantation the syncytiotrophoblast secrete enzymes that digest and liquefy the cells of endometrium
- Thus Blastocyte can Penetrate the endometrium

→ Another secretion of the Trophoblast is HCG and acts Similar to LH
↓
- Prevent the Degeneration of corpus luteum and corpus luteum secrete Progesteron & estrogen

Hormones
→ Both layers are Maintain the layer of uterus and Prevents Menstruation

→ Placenta is full Developed at 9th week of Pregnancy, so Maximum Secretion of HCG

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1) The flattened cells of Inner cell mass of epiblast cells formed endoderm

2) The Remaining cells of Inner mass Becomes columnar to formed ectoderm

3) amniotic cavity → space B/w ectoderm & Trophoblast cells
→ filled with amniotic fluid
→ Roof of amnio-genic cells.

3) Primary yolk Sac → endoderm cells spread to line cavity of Blastocyst.

4) extra-embryonic Mesoderm → formed By Trophoblast
→ Present B/w Trophoblast and flatted endodermal cells, lining the primary yolk sac.

5) extra-embryonic coelom (chorionic-cavity) → A large cavity Creat the extra embryonic Mesoderm.

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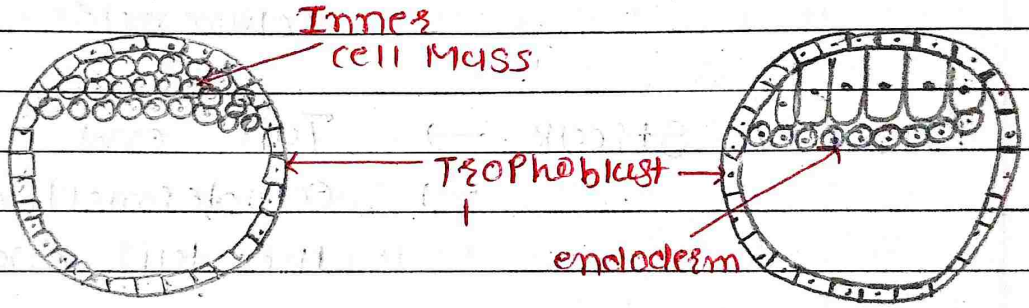
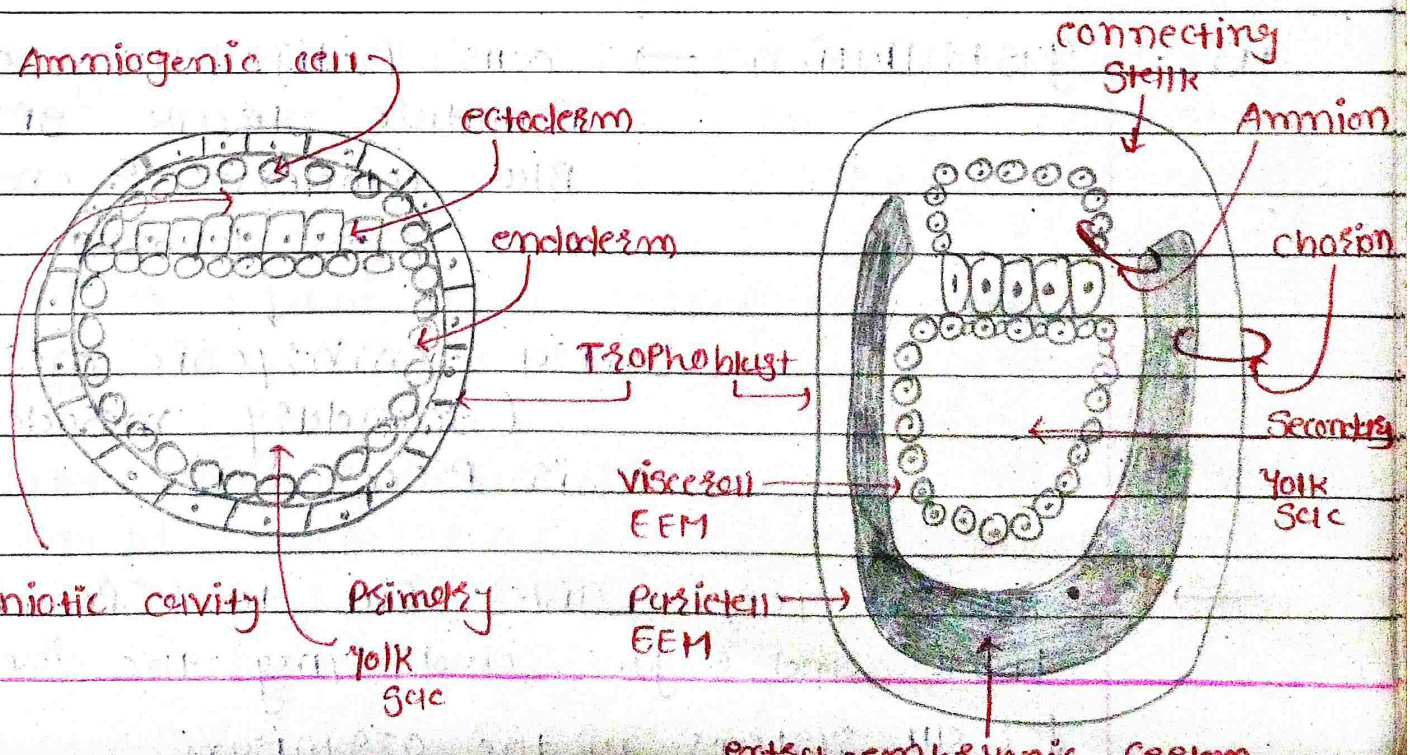
6) Parietal extra embryonic Mesoderm → lining in Trophoblast and extra amniotic celom and outer side of amniotic cavity.

→ formed of parietal extra embryonic mesoderm The primary yolk sac is now called to Secondary yolk sac

7) Visceral extra embryonic Mesoderm → The part of lining of outer side of secondary yolk sac.





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8) Development of foetell membreme

i) chorion :- formed By Parietell extral embryonic mesoderm & trophoblast

ii) Amnion :- formed By ~~Amnion~~ amniogenic cells of amniotic cavity.

9) Prochordell Plate → Heald end
→ one end of the embryonic disc the cubicell cells of endoderm. become columnar

10) Primitive Streak → Tail end
→ ectodermell cells of the tail end

11) gastrulation → cells Prolifereting at Primitive streak spread Btw ectoderm & endoderm forming

Intral-embryonic mesoderm
(secondary mesoderm)
This Process is - - -

→ each layers gives rise to Specific tissue and organs and lying the foundations for all systems in the organism

• Derivatives of germ layers —

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	Ectoderm	Mesoderm	Endoderm
1)	CNS & PNS - Forms the Neural tube, which become the Brain, Spinal cord and Neural crest	- Responsible for forming a wide variety of tissues and organs. + Especially These Related to Movement and circulation	- It forms the epithelial lining of Many organs - Especially To CVS & Respiration
2)	Skin & Related Structure Includes: Nails, epidermis, Hair Sebaceous and Sweat glands	Musculo-Skeleton organs. - All Muscles Bones, cartilage Bone marrow connective Tissue	CVS - Pharynx to Rectum all organs and CVS glands (liver, Pancreas)
3)	Sensory organs. eyes, ears, Nose Ectodermal Tissue	Lymphatic circulatory syst. Kidney, Ureter gonads (ovaries Testies) & Reproductive System	- Urinary Bladder, urethra epithelial lining.
4)	Tooth enamel & Slivary gland	- Dermis of Skin - adrenal cortex Spleen also	Thyroid, Thymus Parathyroid glands

→ Neuro ectoderm specialized part gives Rise Nervous system

* cells.

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* Neurulation

→ It is a crucial embryonic process when the Neural plate (Thickened part of the ectoderm) folds inwards to form the Hollow Neural Tube the precursor to the CNS (Brain & Spinal cord)

→ Steps

1) Development of Notochord.
2) Development of - Neural plate
   - Neural groove
   - Neural folds
3) Fusion of Neural folds.
4) Separation → Neural Tube detaches
5) Neural crest cells.

1) Development of Notochord

→ It is development B/w Prochordal plate and primitive streak.

1) The primitive node with a pit called the blastopore is developed on primitive streak.

2) cells from primitive node extend towards Prochordal plate B/w the ectoderm and endoderm to form Notochordal Process which Transform into Notochord

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2) Development of Neural Tube

→ It is develops into Brain and Spinal cord.

1) The Neural Tube is formed from the ectoderm over the Notochordal Process. It extends from the Prochordal plate to the Primitive Node. It become thick to form Neural Plate.

- The Depression in its mid line is called Neural groove.

- Neural groove become deeper and their 2 edges of the Neural Plate approach each other and fuse forming a Neural Tube

- Neural Tube enlarged cranial part and caudal tubular part

★ - cranial part ⟶ Brain
- caudal part ⟶ Spinal cord

2) Brain develops 3 dilatations, cranio-caudally.

- Prosencephalon
- Mesencephalon
- Rhombencephalon

3) Spinal cord is developed caudal cylindrical part of Neural Tube

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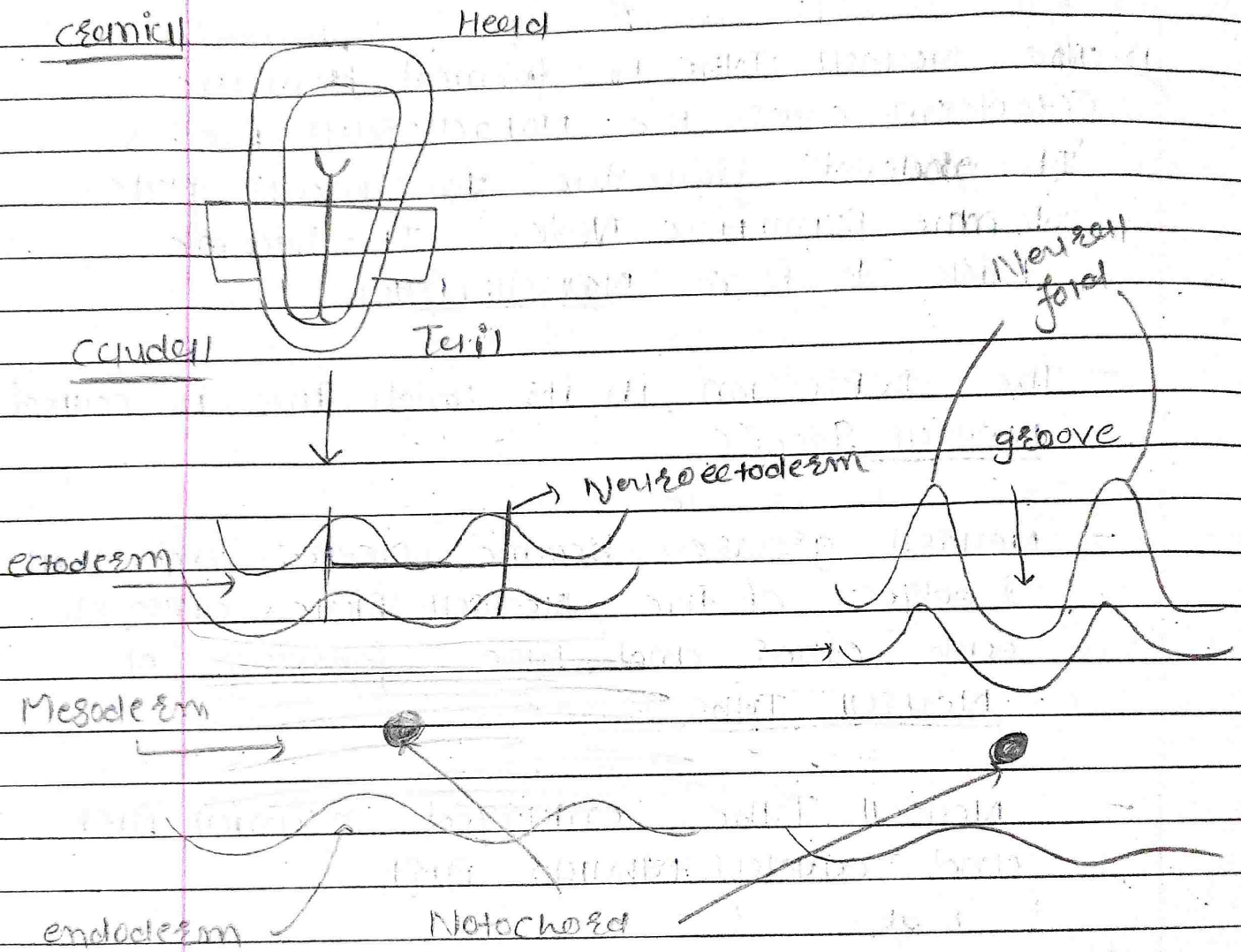
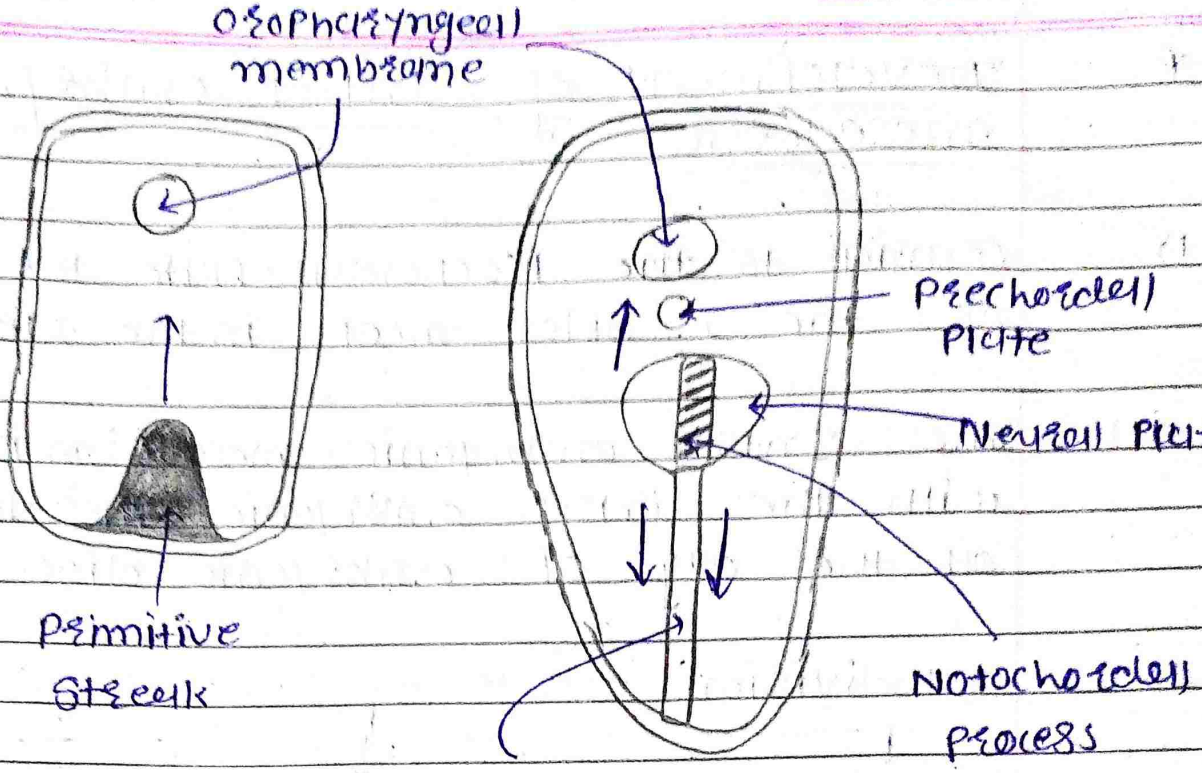
* Development of Intra-embryonic Mesoderm —

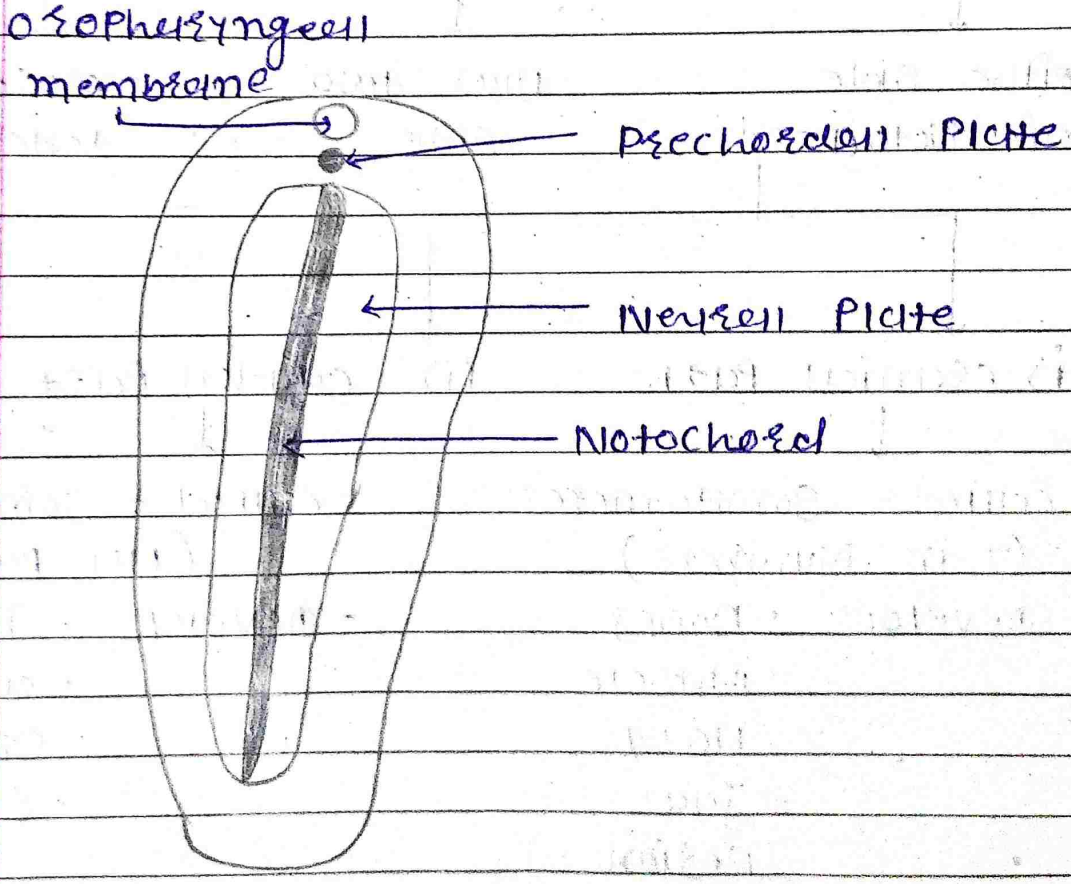


4) Neural crest

→ 2 grooves are fusion and Rest cells are knows as Neural crest

→ Neural crest develops to PNS
- Dorsal ganglia
- Sympathetic & Parasympathetic Nerve
- etc —


Oropharyngeal membrane
Prechordal Plate
Neural Plate
Primitive Streak
Notochordal Process
Primitive Streak


Oropharyngeal membrane
Prechordal Plate
Neural Plate
Notochord

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* Development of Intra embryonic mesoderm

1) Cranial to the Prochordal plate the Mesoderm of the 2 sides meet in the Midline.

→ The Intra embryonic mesoderm is continuous with the extra embryonic mesoderm at the edge of embryonic disc.

2) Subdivision

- Paraxial Mesoderm → either side of Notochord
- Intermediate Mesoderm → B/w two Side
- Lateral Plate Mesoderm → more Lateral

Paraxial Mesoderm:

i) Cranial Part
- Called - Somitomeres (7 in Numbers)
- Develops · Bones · Muscle · Head · Jaw Region

ii) Caudal Part
- Called - Somites (44 pairs)
- Develops · Tounge · axial Skeleton · Skeleton Muscle · Skin

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* Development of Intra embryonic Coelom

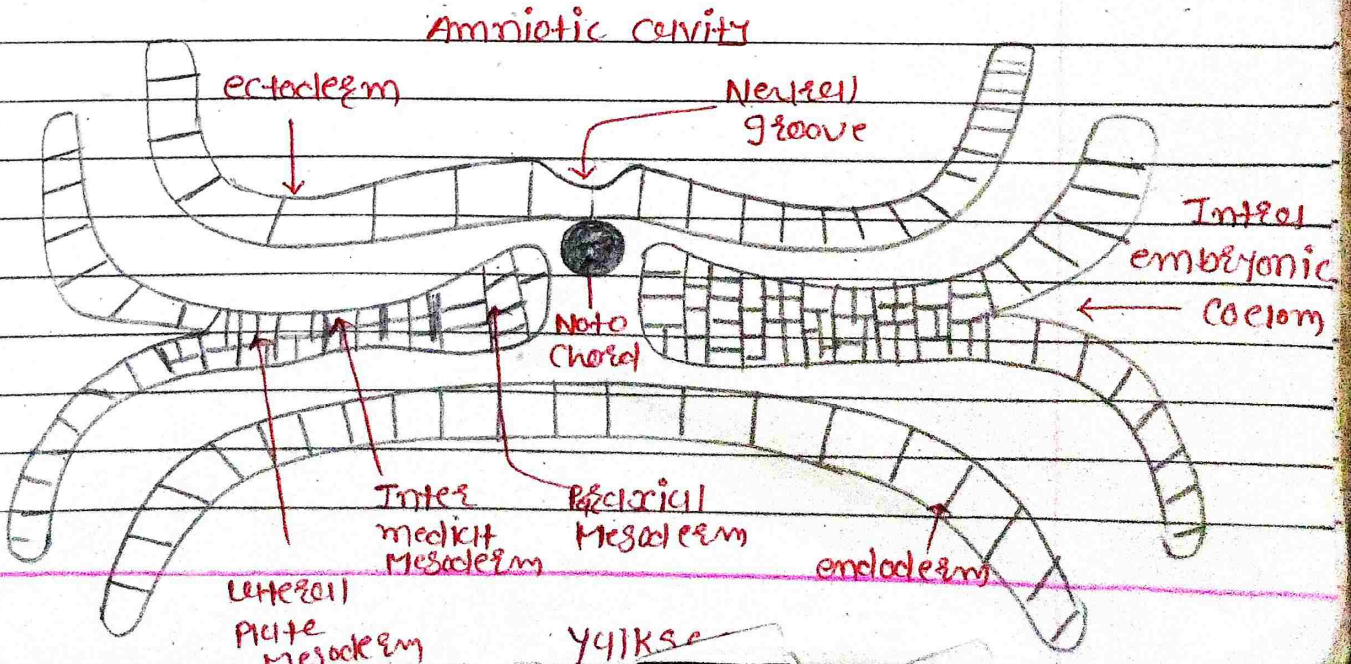
1) Large cavity formed in lateral plate mesoderm is called Intra embryo Coelom

- These Bilateral cavities join together Cranial to prochordal plate

2) It's communicates with Extra embryonic Coelom

3) Develops to - Pericardial
- Pleural
- Peritoneal cavity.

4) Lateral plate mesoderm 2 layers.
i) Somato-Pleuric or Parietal Intra-embryonic mesoderm ⟶ connect to ectoderm
ii) Splanchno Pleuric or Visceral Intra-embryonic mesoderm ⟶ connect to endoderm



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* Implantation

→ It is a crucial process where a Blastocyst (early embryo) attaches to and burrows into the uterus's lining (endometrium)

→ establishing Pregnancy By forming a Connection for Nutrient exchange occuring about 6 - 12 days Post - fertilizat

within specific window of Implantation when the endometrium is Receptive

* → Steyes

1) Apposition → Blastocyst Sheds its zona Pellucida and move to find Optimal Site on the endometrium

2) Adhesion → Trophoblast cells make Close Molecular Contact with the uterine lining (endometrium)

3) Invasion → Trophoblast cells Proliferate and Invade deeper into the endometrium breaking down maternal Blood vessels (Sinusoids) to establish Blood Flow.

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4) Decidualization → the endometrium transforms (Decidualize) into the supportive decidua, forming the Maternal part of Placenta

* → Timing & Receptivity

- Timeline :- Begins around day 6-8 after fertilization
  :- completes at day 12

- coincides of Implantation :- A short Hormonally Period (around day 20-24 of the M.C)

* → Significance

1) First step of Pregnancy :- Marks the Transition from free-living embryo to Developing fetus

2) Nutrient supply :→ exchange of via placenta

3) Hormonal Signals :→ HCG

* → Abnormality Related to Implantation

1) Implantation Bleeding :- light spotting from disrupted blood vessels during Invasion

2) Ectopic Pregancy :- Implantation in fallopian Tube

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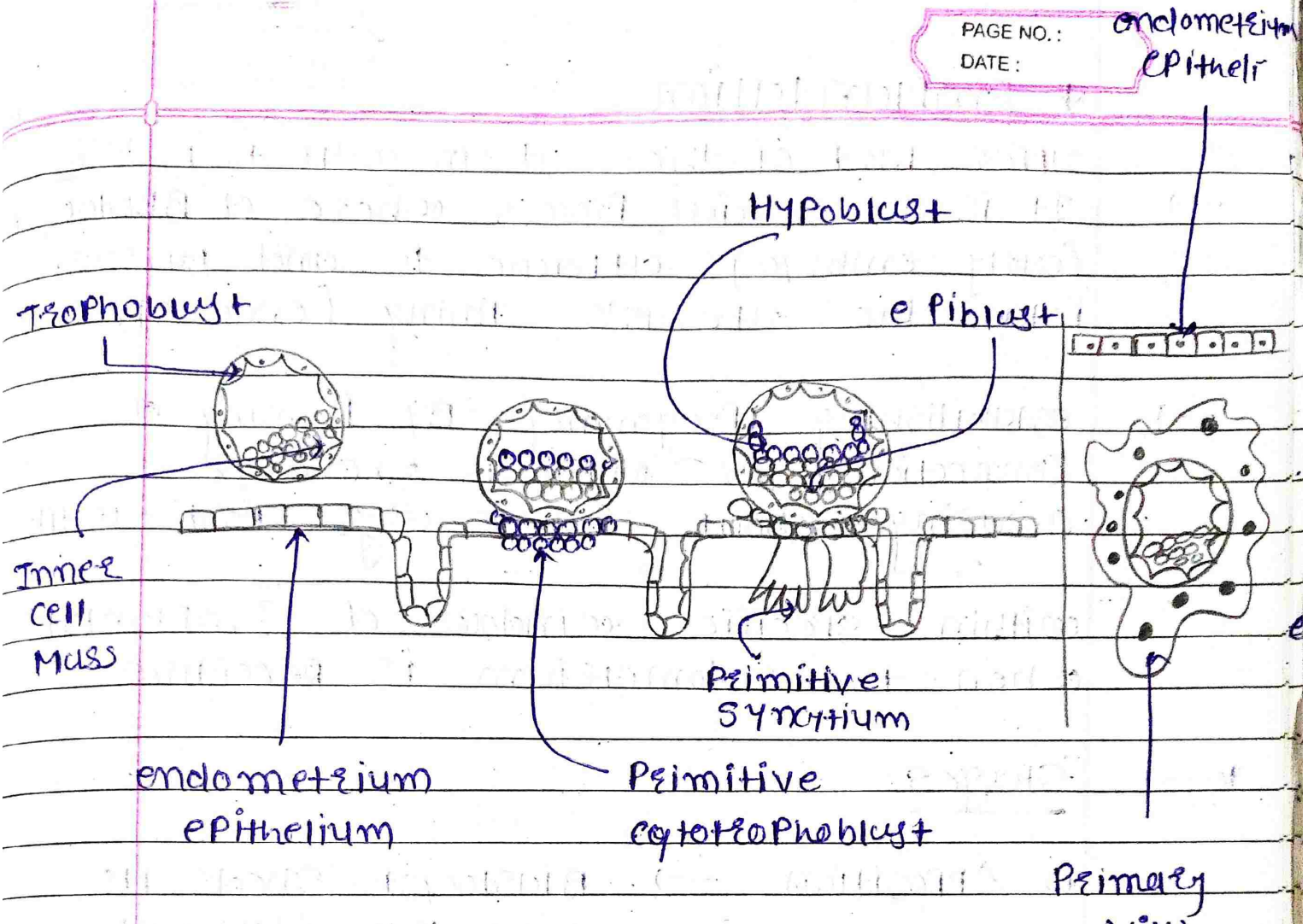

[Implantation]

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* Laws of Heredity

→ The law of Heredity is explain How Traits are Passed from Parents to off Spring Through genes.

→ It was Proposed By gregor Mendel known as the father of genetics

→ genes are units of Heredity Present on Chromosomes.

→ Offspring inherit one gene from each Parent for every trait

→ These genes determine characteristics ~~Parent for every~~ like, High, eye, color & Blood group.

(1) Law of Segregation

→ Mendel's 1st law.

→ It states that each organism has 2 alleles for a trait and these alleles seperate (Segregate) during the for-mation of gametes

→ as a Result each gamete Receives only one allele for that trait.

→ During fertilization the alleles pair up again

eg → In 'Pea' Plants, a Plant with alleles (Tt) Produces gametes T and t seperately

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(2) Law of Independent Assortment
→ Mendel's 2nd law.
→ It states that alleles of different genes assort independently during gamete formation
→ So, the Inheritance of one trait doesn't affect the Inheritance of another. (if genes are one different Chromosomes)

ex. In 'Pea' plant seed shape and seed colour are inherited independently of each other

(3) Law of Dominance
→ Mendel's 3rd law
→ The law of Dominance states that when two different alleles of a gene are present together
→ only one allele (dominant) is expressed while the other (Recessive) remain Hidden

ex. In a 'Pea' plants the gene for Tallness (T) is dominant over Shortness (t)

– A plant with (Tt) will be Tall

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* Oogenesis —

- ova are derived from oogonia found in ovary cortex
- Primary Oocytes Form During the foetal Period and Remain in Prophase of the 1st Miotic Division until Maturation B
- Before ovulation the 1st Miotic Division of a Primary Oocyte Produce Secondary Oocyte and the 1st Polar Body.
- Ovulation occurs when the Secondary Oocyte in the Metaphase of the miotic Division, which is only Completed after Fertilization

(1) Primordial follicle
- It's Consist of an Oocytes Surrounded By granulosa cells.

(2) Development of Oocyte
- Oocytes it self enlarges and a membrane called the Zona Pellucida Forms around

(3) Secondary follicle (antrum) (2oom)
- Development is Stimulated By FSH.
- large fluid filled cavity → antrum follicul.
- Oocyte is Surrounded By the cumulus oophorus, The Innermost layer of which is a Corona Radiata

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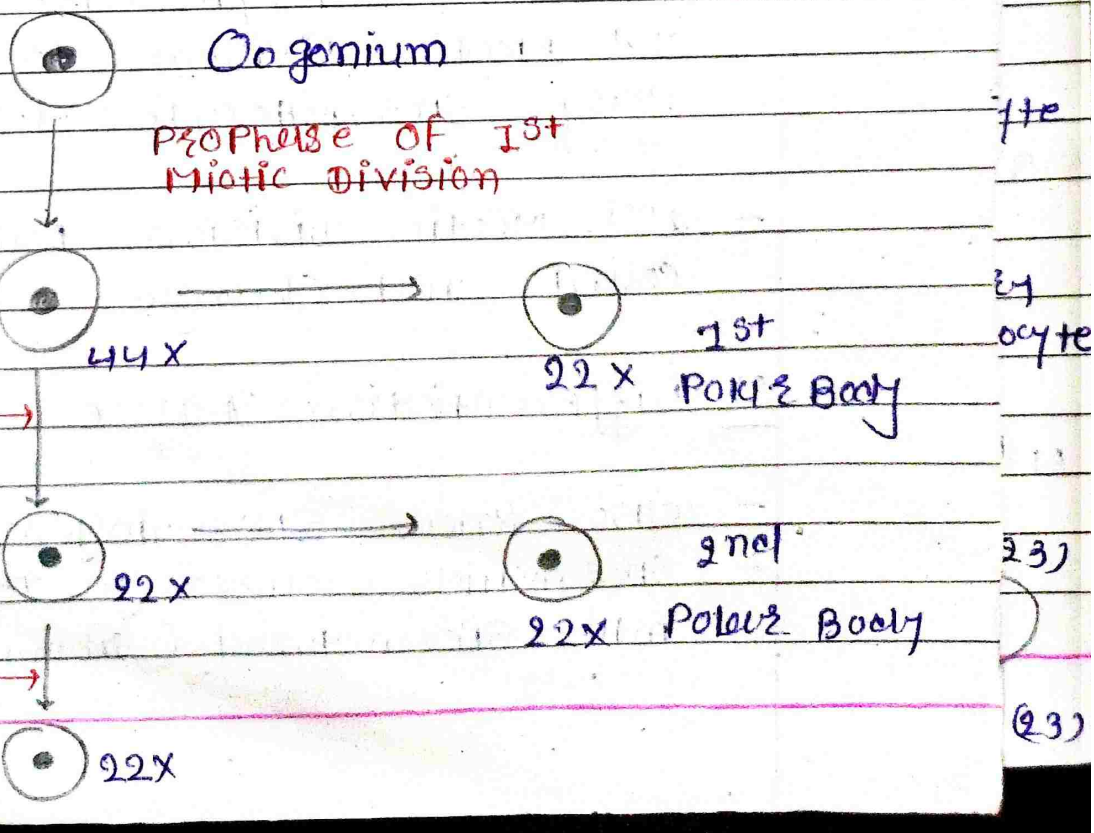
④ Tertiary follicle (graafian follicle)

- This is a Mature stage, where the follicle enlarge significantly
- The Oocyte floats freely in the follicular fluid after the coronal Radiata separates.
- The Primary Oocyte completes it's 1st Miotic Division yielding a Secondary Oocyte and a 1st Polar Body.

⑤ Ovulation

- Secondary Oocyte start it's Secondary miotic Division But stop at Metaphase
- follicle forms a Bulge on the ovarys surface
- The surface layer thins → Stigma (weak
- Stigma through ovum Releas to ovary from



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* Spermatogenesis —

→ It is the process of the male germ cells (Spermatogonia) Develops into Mature Spermatozoa in Seminiferous Tubules of Testis.

→ Begins at the age of 12 to 16 year
→ 74 days to complete (~ about 2 to 2.5 month)

→ Stage of Spermatogenesis —

1) Proliferation Phase
- (44 + X + Y) Spermatogonia cells located in Basal Region of tubular epithelium

- Spermatogonia undergo Mitosis to give Rise to Primary Spermatocytes (44+XY)

2) Miotic Phase

- each Spermatocytes are Divides By 1st Meotic Division to give Rise to 2nd Spermatocyte (22 + x or 22+Y)

- 2nd Meotic Division But chromosomes count not Change

3) Differentiation Phase

- also know Spermiogenesis
- Spermatids under go Transformation into Spermatozoa (Sperm)

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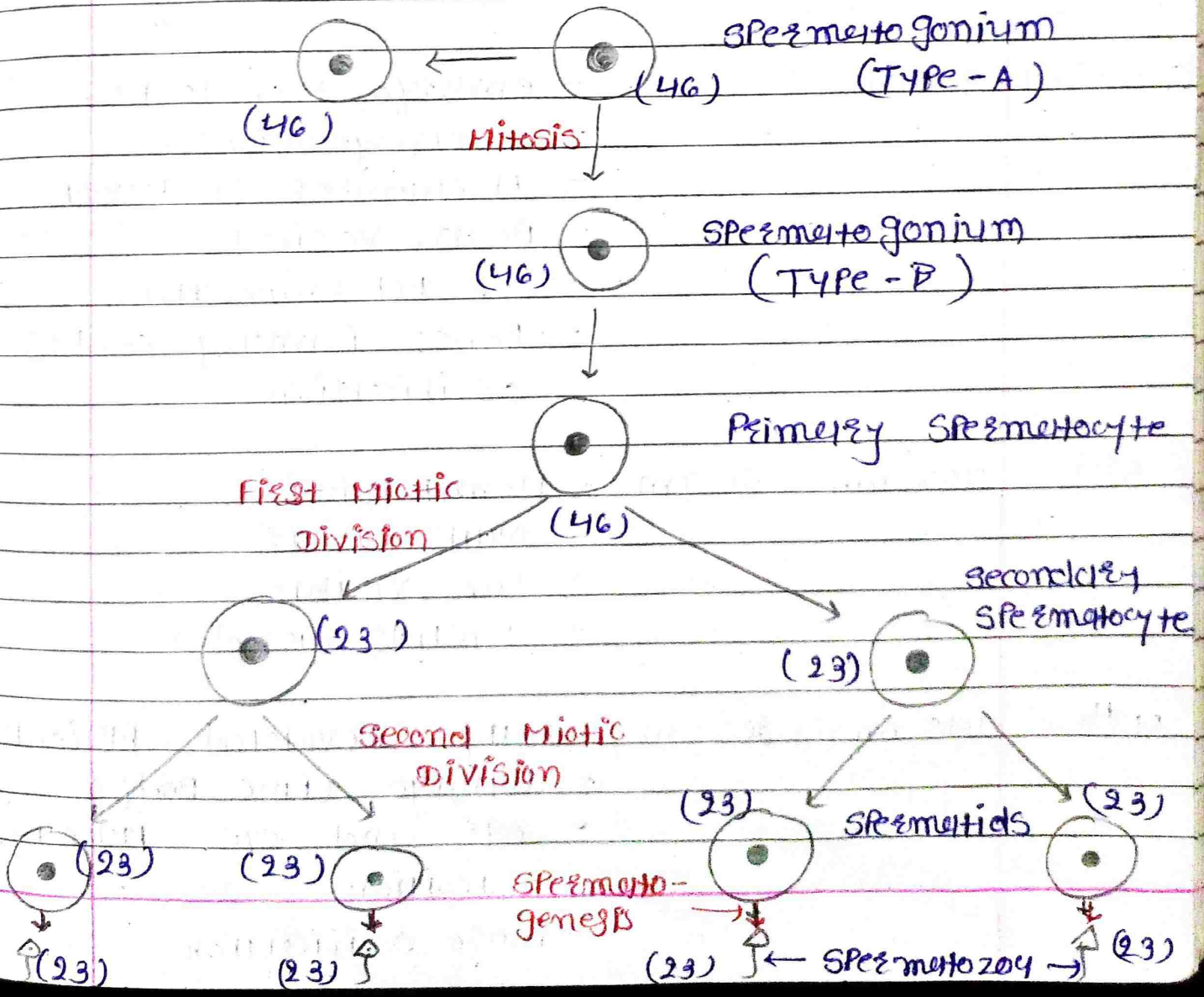
4) Maturation of Spermatozoa.

→ Spermatids Reshape into motile sperm with Acrosome, Nucleus, Body, Tail

5) Capacitation of Spermatozoa.

→ It's the step in which Spermatozoa Become Competent to fertilize an oocyte.

→ The Capacitation occurs after Ejaculation into female Reproductive Tract.



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* Monthwise Development

Month	Length	weight	
1st (4th week)	3mm		- Folding of Head & Tail takes Place. - Heart Beats. - Pharyngeal arch & grooves are appearing.
2nd (7 week)	18 mm		- Rudiments of eyelids have appeared - Thighs and Toes have appeared
(8 week)	30mm		- embryo ⟶ foetus. - Oogenesis. - 4 chamber of Heart - Brain vasical - Sex Determination - Bones Primary centers ossification
3rd	100 mm	50 gm.	- Hemato Poiesis - Nails appear - Sex visible - eyelids closed
4th	145 mm	200 gm	- fully Developed Placenta. - Lanugo (Fine Body) - ear and eye Place in Position - more ossification

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5th	200 mm	450 gm	- Heart Sound - Vernix (Yellow covering to Baby) - mother feels to foetal movement - Uterus formed - Testes Begin to descend
6th	300 mm	600 gm	- Translusent Skin - Respond To Sound (Initiate)
7th	350 mm	1.5 kg	- Fat Deposision - eyes Open - Lungs and Their Blood Vessels are develops - CNS is mature - Therme Regulation Improve
8th	400 mm	2 kg	- Skin Become Pink & smooth - Weight gain
9th	450 mm	2.5 kg	- Fat Deposion - Reduce Lanugo - umbilicus is at the centre of Trunk - Testes descend fully and are in Scrotum
10th	500 mm	3 to 3.5 kg	- Lanugo Disappeared

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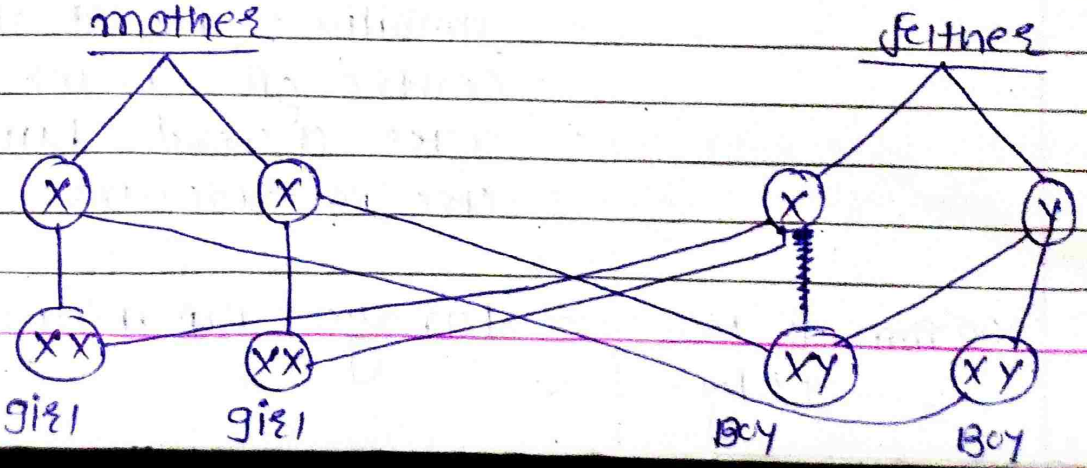
* Sex Determination

- The gender is Determined By Genetic Inheritance
- Genes inherited from the Parents determine whether an offspring will be a Boy & girl.
- Sex Determination takes Place at the fertilization
- A Sex Chromosome that carries the genes for male characters is called "Y" Chromosome
- Female Characters is called "X" Chromosome
- 46 Chromosome that Chromosome in women are 44 + XX and in male are 44 + XY

→ The ovum is X and Sperm is X or Y
The fusion of X + X → girl or
X + Y → Boy.



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* **Development of embryonic disc and yolk sac**

1) The embryonic Disc Increase → Bulges upwards in the amniotic cavity.

↓

2) Head and Tail ends are fold

↓

3) Part of yolk sac Become enclosed within the embryo

↓

- Tube lined endoderm is inside called Primitive gut (formed GIT)

↓

Divided into foregut, midgut, Hindgut.

↓

Yolk sac Become narrow called, Definitive Yolk sac.

↓

Narrow cavity - connecting to gut is called vitello - intestinal duct.

↓

It is circular aperture around umbilical opening

↓

lateral folds are formed

↓

amniotic cavity containing fluid surrounds and surround the embryo which protects it.

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* Development of Connecting Stalk

→ Connecting Stalk becomes smaller and its attachment near the caudal end of embryonic Disc.

↓

moves to the ventral aspect of the embryo in the Region of umbilical opening.

↓

Blood vessels pass through the connecting Stalk

→ amnion surrounds the umbilical opening and a Tube formed with contents called the umbilical cord

* Development of Head & Tail fold.

→ embryonic Disc Before folding, The Structure from cranial to caudal ends are septum Transversum, Pericardial cavity and Heart Tube, Prochordal Plate, Neural Primitive Streak and cloacal Plate membrane

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2) Head fold → Pericardial cavity and Heart tube to come Ventral to the foregut

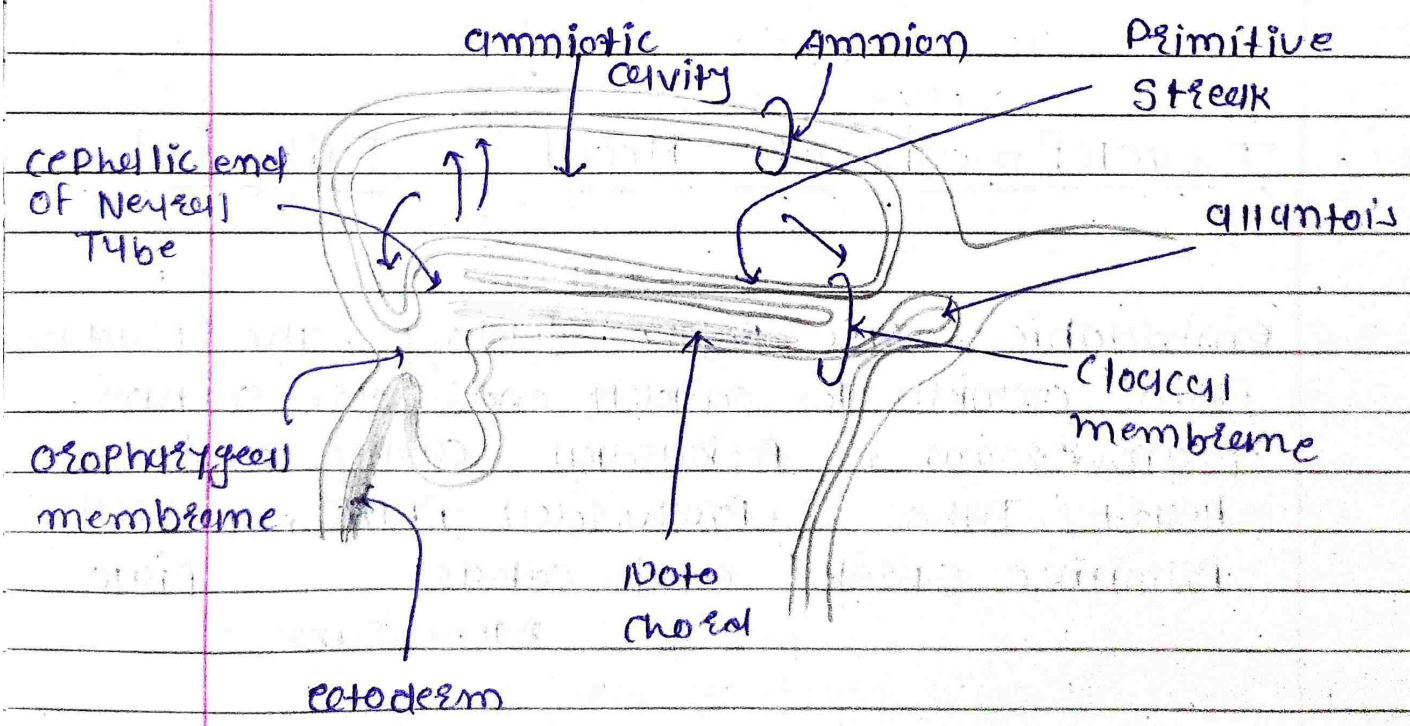
3) Septum transversum → Heart Tube

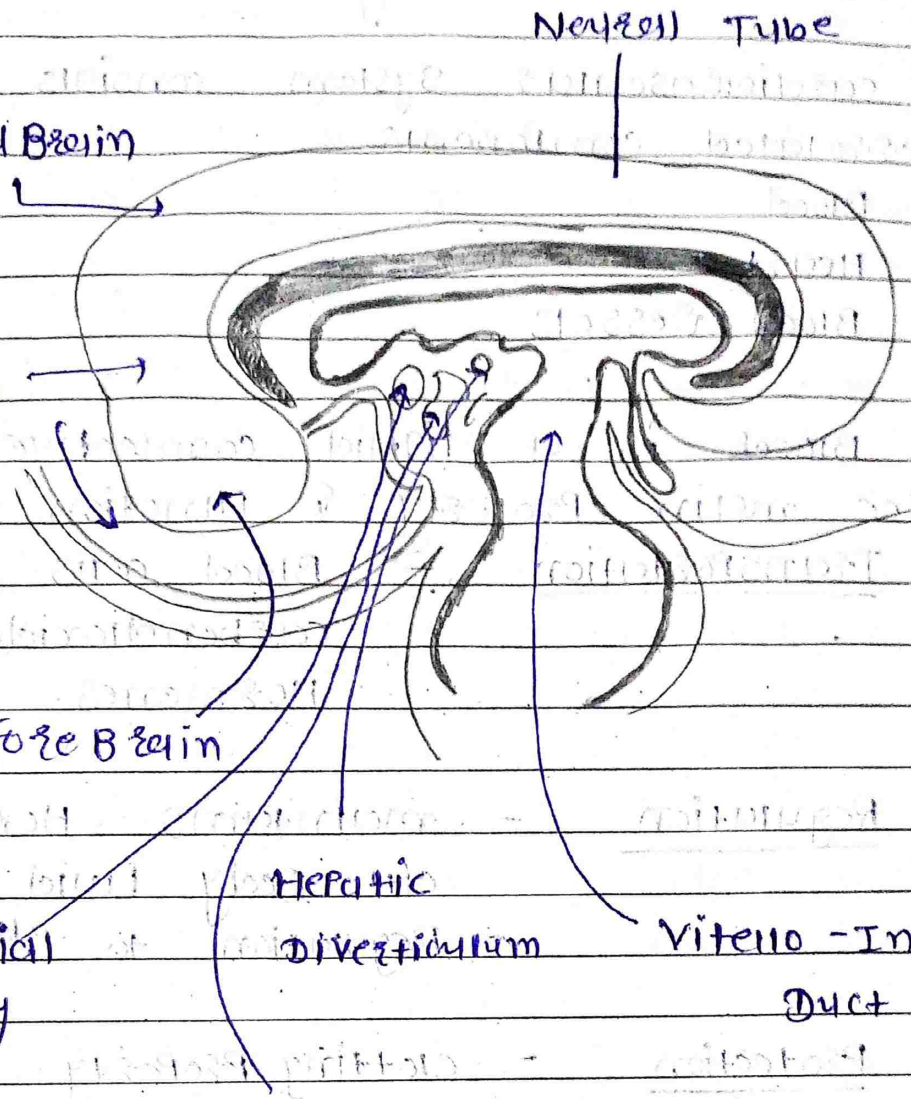
4) Prochordal plate forms → Oropharyngeal Membrane

foregut ← closing

5) Primitive streak Disappears.

6) Distal end of Hindgut is closed By the Cloacal membrane which comes ventrally




Neural Tube
Hind Brain
MidBrain
Fore Brain
Pericardial cavity
Hepatic Diverticulum
Vitello-Intestinal Duct