



Handwritten Notes
on
Human Reproduction

- Cremaster and Dartos muscle contract the scrotum in cold conditions.

* Cremaster muscle helps in elevation of testis.

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Human Reproduction

Human — unisexual

Male Reproductive System

a pair of testes

Accessory Ducts

Islands

External genitalia

Testis

located in scrotum — an extra-abdominal pouch

Temperature is $2-2.5^{\circ}\text{C}$ lower than body temperature as lower temperature is required for sperm formation.

Intra-abdominal testes is present in elephants, whales, egg laying mammals.

Descent of testis occurs in 7th month of gestation under the effect of testosterone.

Inguinal canal → narrow duct joining scrotum to abdomen.

Spermatic cord → fibrous cord in the inguinal canal through which vas deferens, blood vessels, lymph vessels, nerves and cremaster muscle pass.

Dartos muscle is present around scrotum.

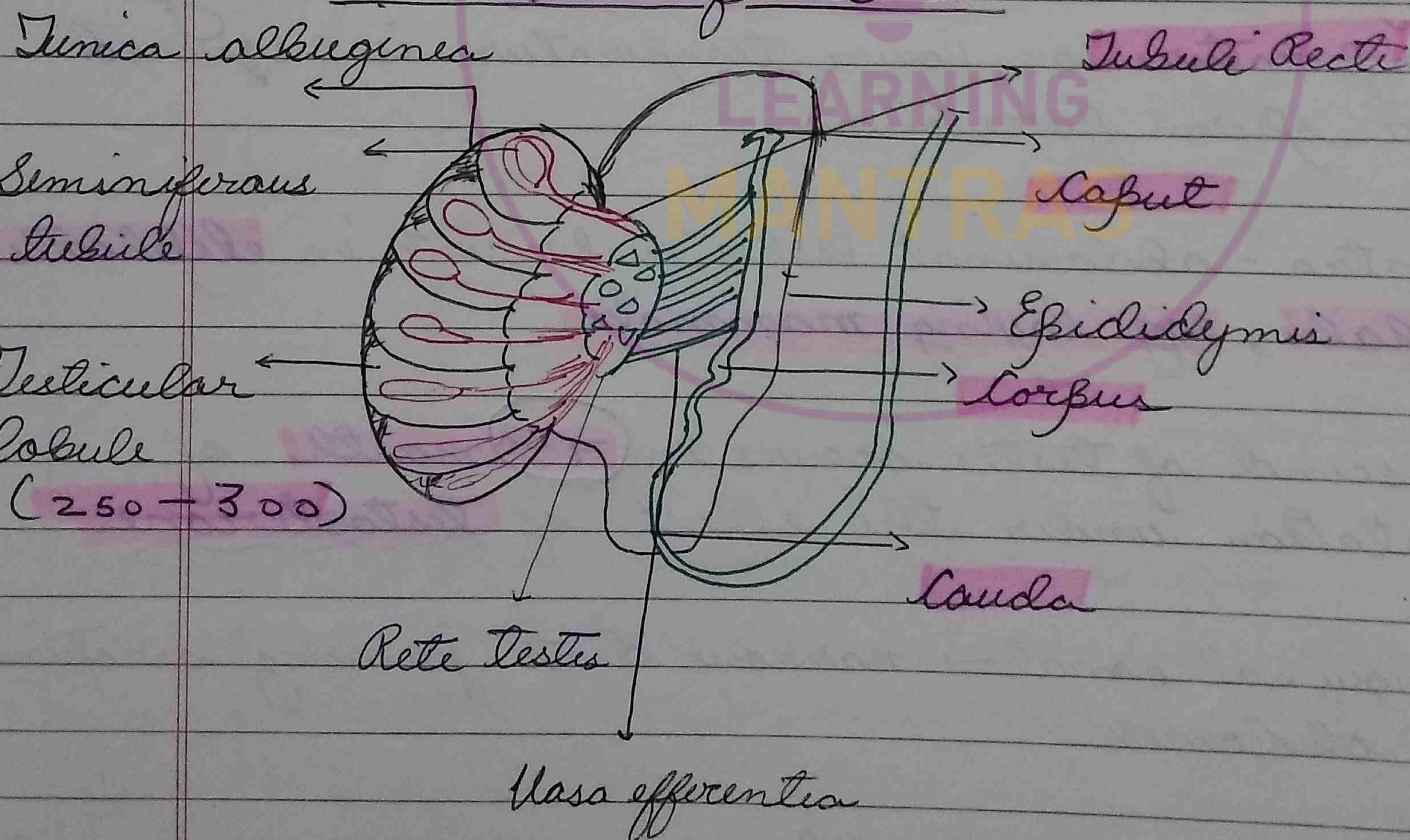
• Cryptorchidism → failure of the Testis to descend.

• Monorchidism → presence of single testis.
e.g. Ascaris

• Functions of testis:

- Formation of male gametes (sperms)
- Secretion of sex-hormone, Androgen (Testosterone).

• Structure of Testis



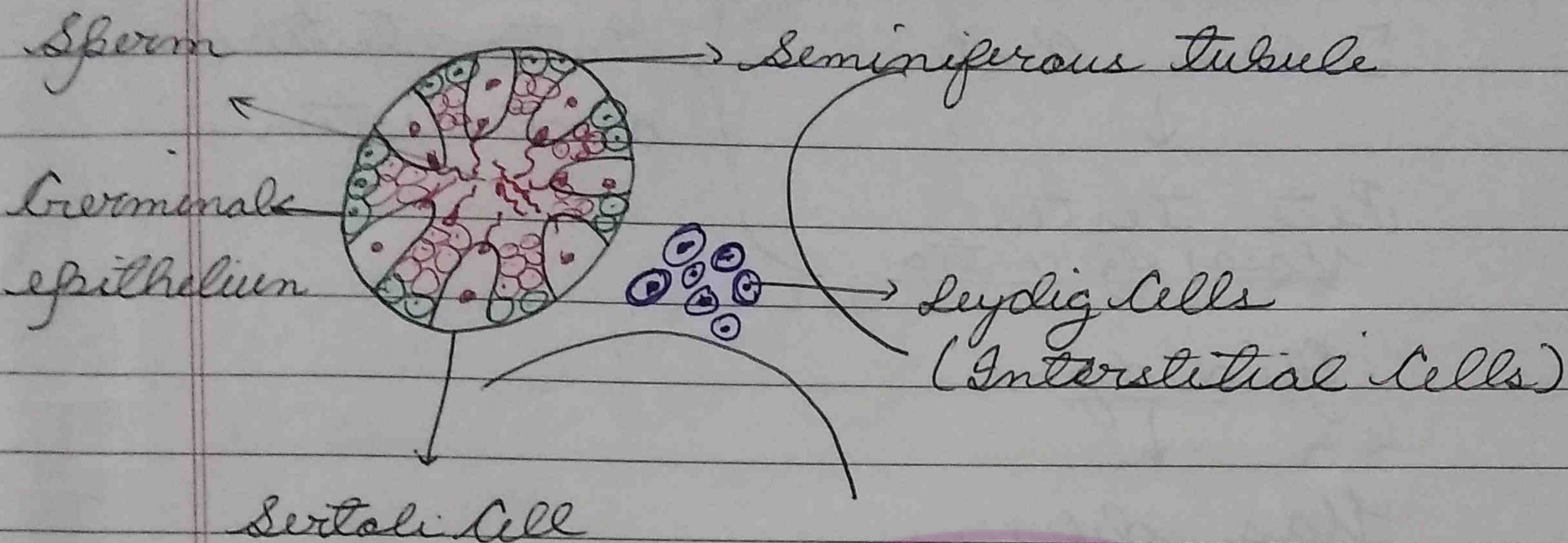
* Spermiation → Release of sperms from seminiferous tubules.

ABP: binds with testosterone and keeps its level high in seminiferous tubule.

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Section through Testicular Tubule



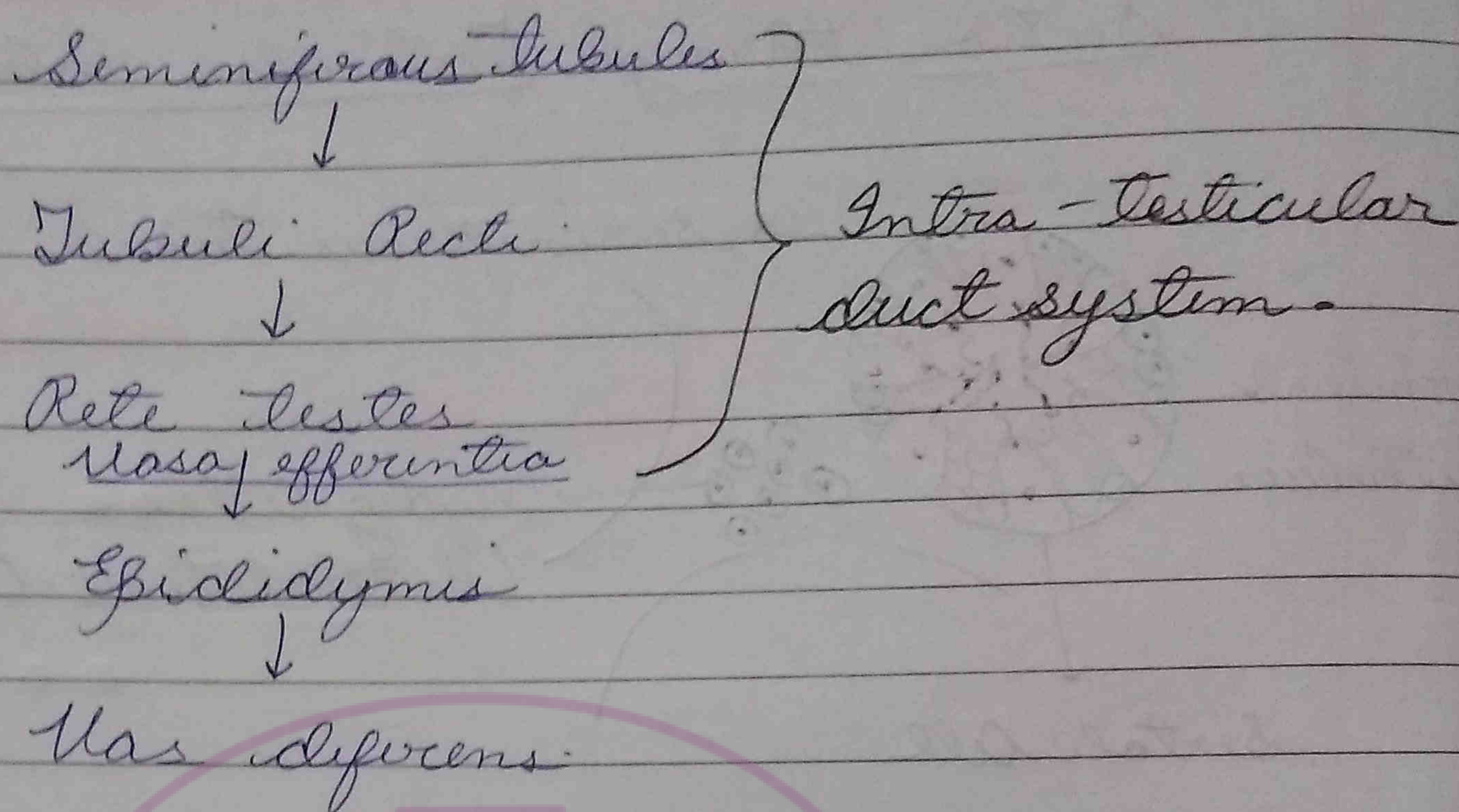
- Leydig cells
- Endocrine cells. (Steroid hormone)
↑
• Secrete androgens, mainly testosterone required for male secondary sexual characters.
- Sertoli cells
- Supporting cells which nourish the developing sperms
- Secrete inhibin which inhibit FSH.
- Secrete ABP (Androgen Binding Protein).
- In embryonic state, they secrete Mullerian Inhibiting Factor (MIF) which inhibits the female reproductive duct system in foetus.

• Stereocilia \rightarrow non-motile cilia.

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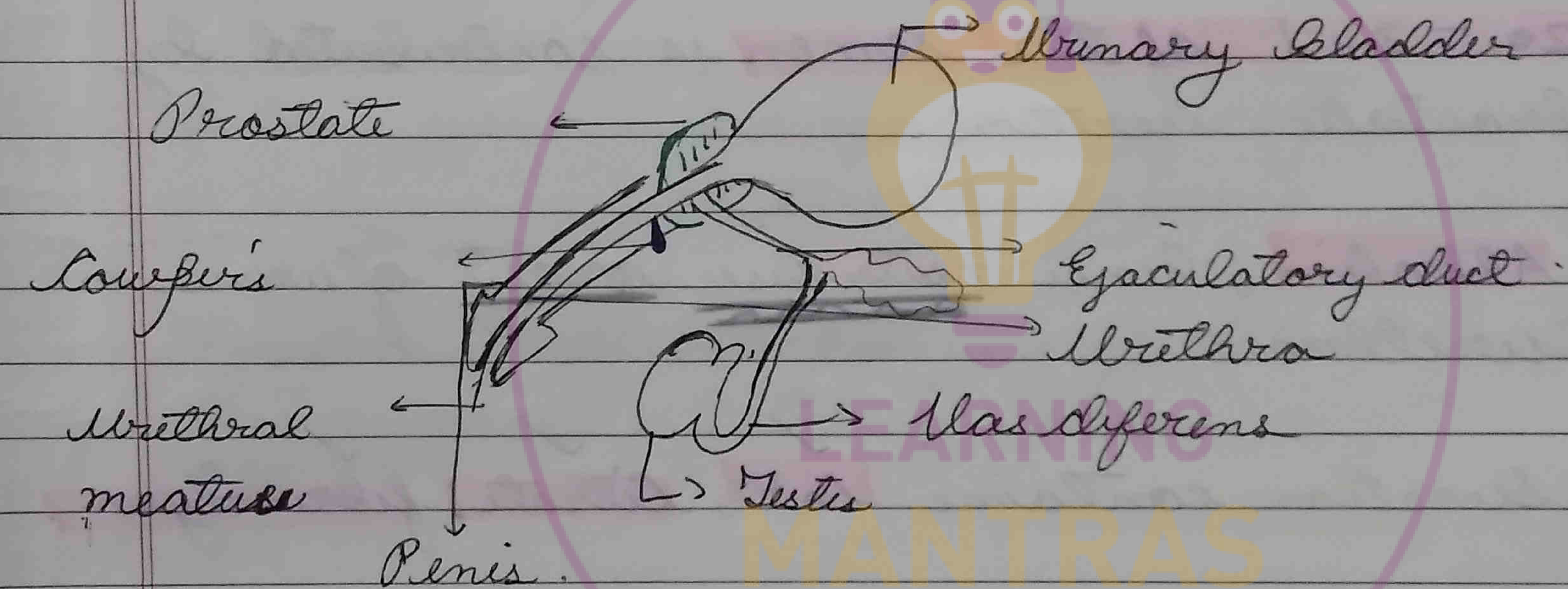
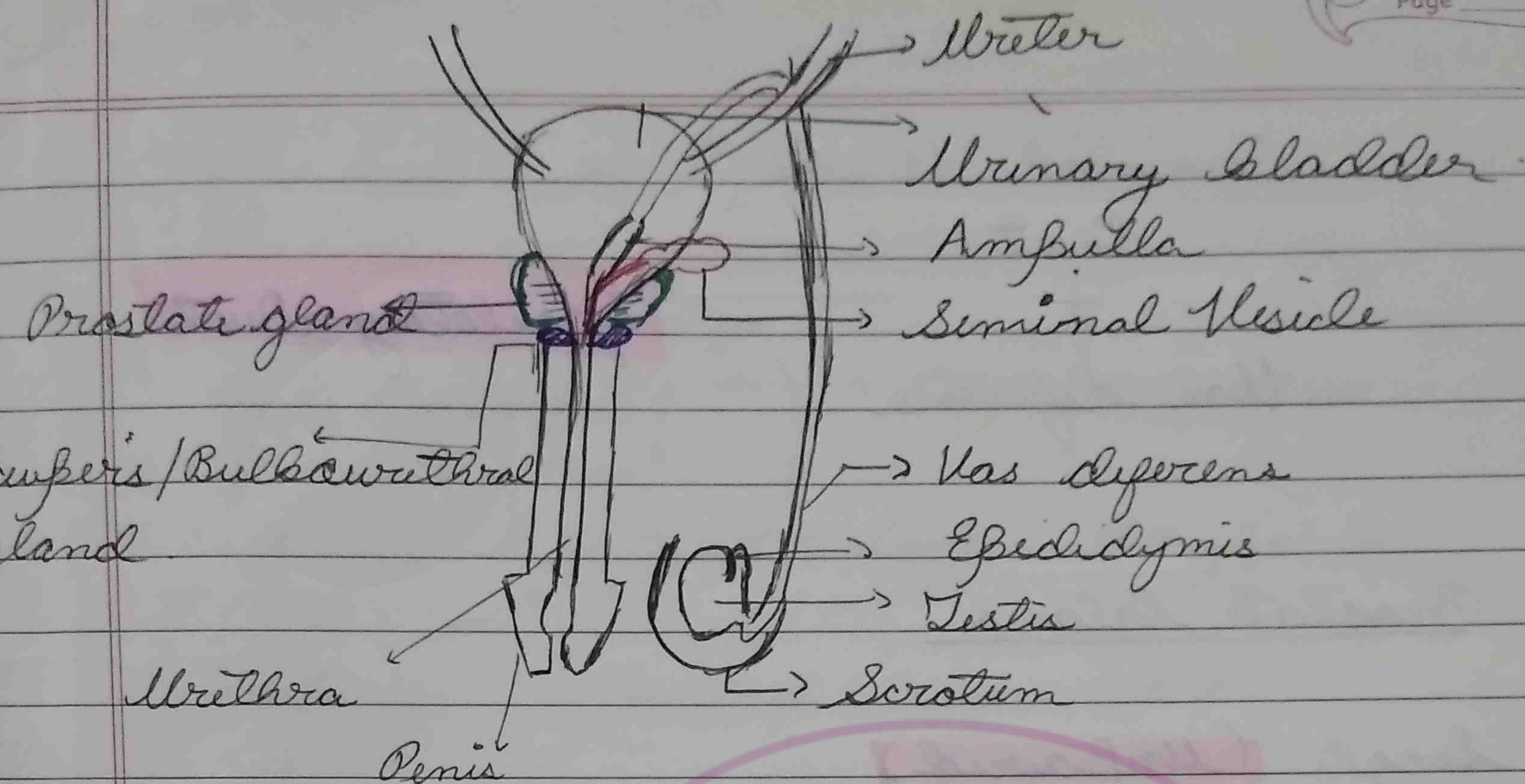
- Epididymes: lined by pseudostratified epithelium with stereocilia.
- ★ Secrete factors required for functional maturity of sperms.
- Vas deferens
- Lined by pseudo stratified epithelium with stereocilia
- Outer lining of smooth muscles.
- Re-enters abdomen, loops over urinary bladder forming a bulbous part i.e. ampulla

- sperms get collected in the ampulla.

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• Seminal Vesicles

- Paired gland
- Located behind the urinary bladder
- Secretes seminal fluid which contains fructose, inositol, fibrinogen.
- 60-70% of the semen is contributed by seminal vesicle. \Rightarrow Major contributor.

★ Nourishment of sperms (Responsible for)

Semen = sperm + secretion of seminal vesicle and prostate

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Seminal Vesicle

Duct

+

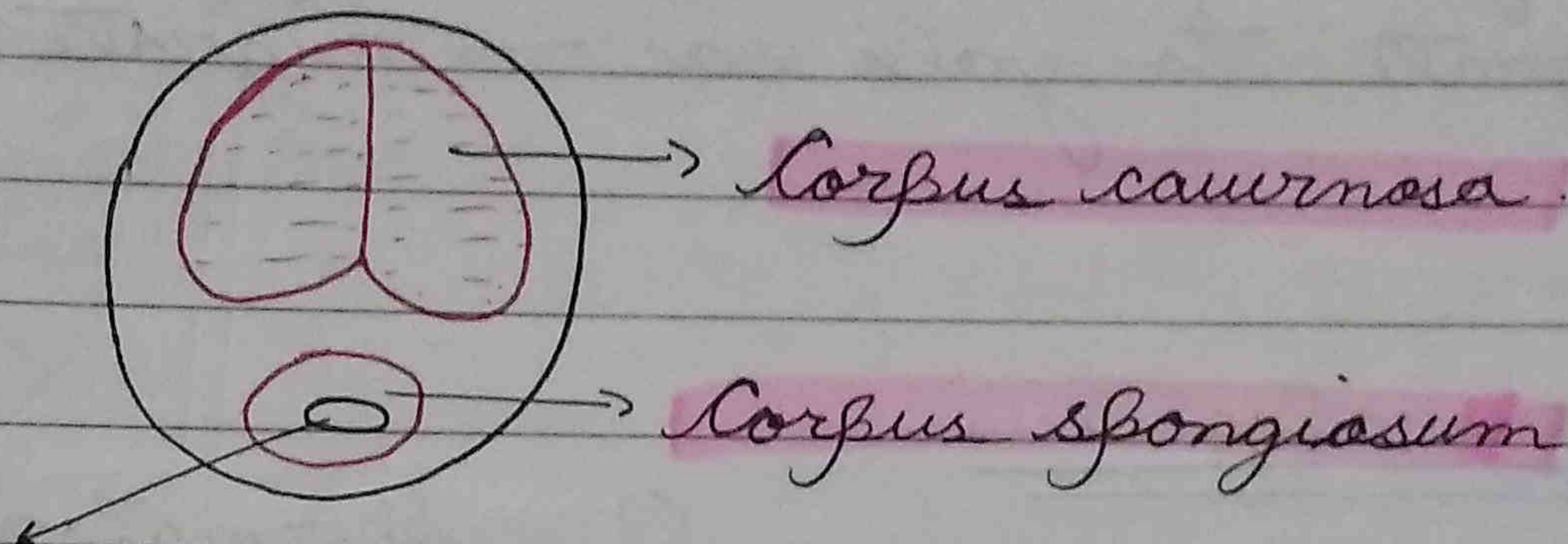
Vas deferens

Ejaculatory Duct

- Prostate Gland
- Single (Unpaired)
- 20 - 30% of the semen is contributed by prostatic secretion.
- Alkaline, hence neutralises acidity of urine in urethra.
- Secretion contains Ca^{2+} , Citrate, fibrinolysin.
- Couper's / Bulbourethral Gland
 - Paired
 - Its secretion helps in lubrication.
- Penis
 - Male copulatory organ.
 - It helps in Insemination i.e. Transfer of semen into the body of female.
 - True penis is found only in reptiles and mammals.

T.S of Penis

Dorso-lateral



Urethra

Ventral



Urine and Sperms

Balanitis Penis - enlargement of corpus spongiosum at the tip of penis.

Foreskin / Prepuce : covering of Balanitis Penis and is retractile fold of skin.

Preputial Gland / Gland of Tyson : secretion of this gland is called Smegma which is whitish, thick, odoriferous. This gland is +nt on inner lining of foreskin.

Spermatogenesis

- Process of formation of sperms.

- Occurs within the seminiferous tubules of testes.

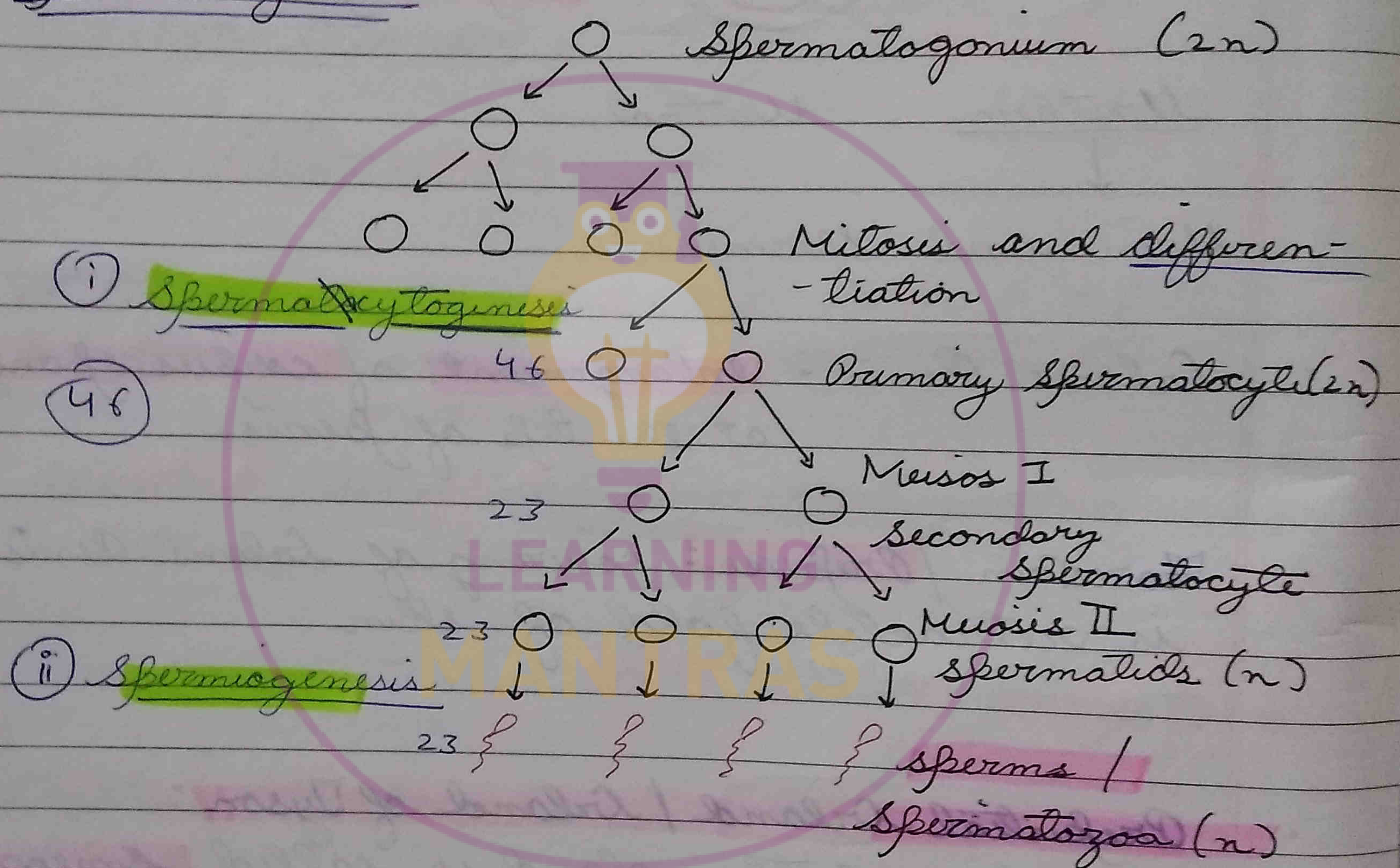
- Germinial epithelium : simple cuboidal epithelium having ability of meiosis also called Spermatogonia / sperm mother cells.

Spermatogonia are PGC hence extra embryonic in origin.

Differentiation occurs two times during spermatogenesis i.e. spermatocytogenesis and spermiogenesis.

- PGC (Primordial Germ Cells) = develop in the fetus from extra-embryonic mesoderm → migrate to yolk sac → migrate to gonads.

Spermatogenesis



4 Sperms are formed from 1 spermatocyte.

★ Spermatogenesis consists of three steps

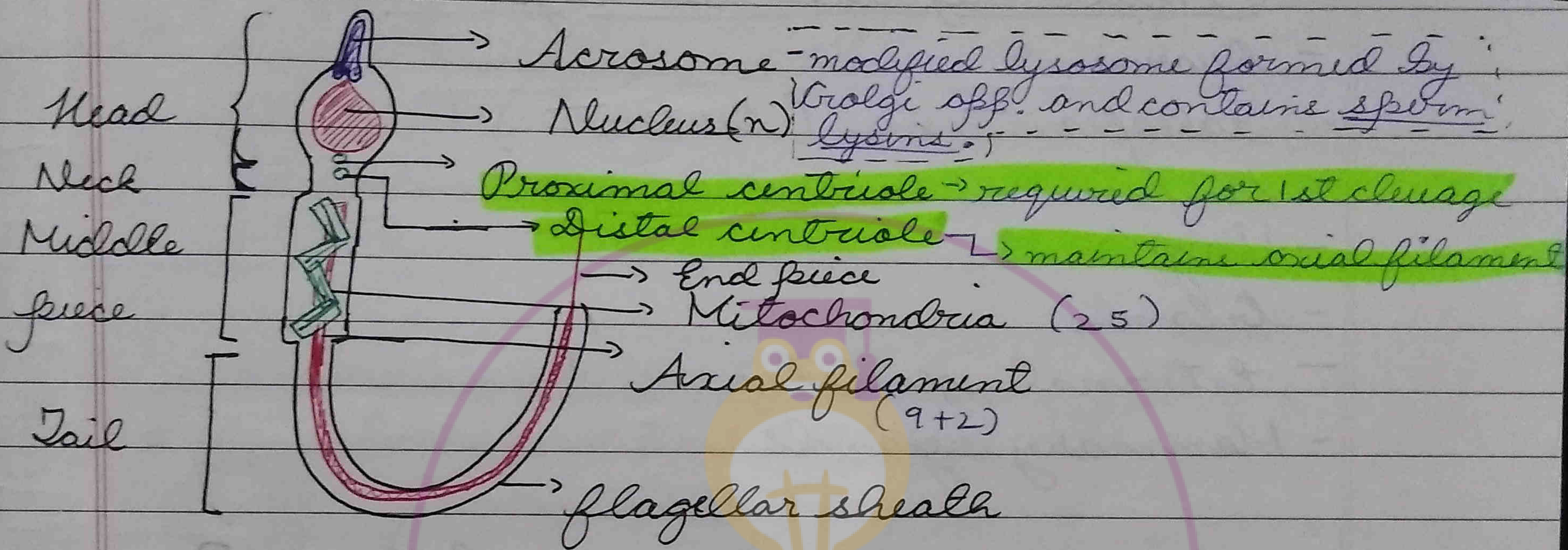
- Multiplication
- Growth
- Maturation

Sperm

200-300 millions sperms in one ejaculate

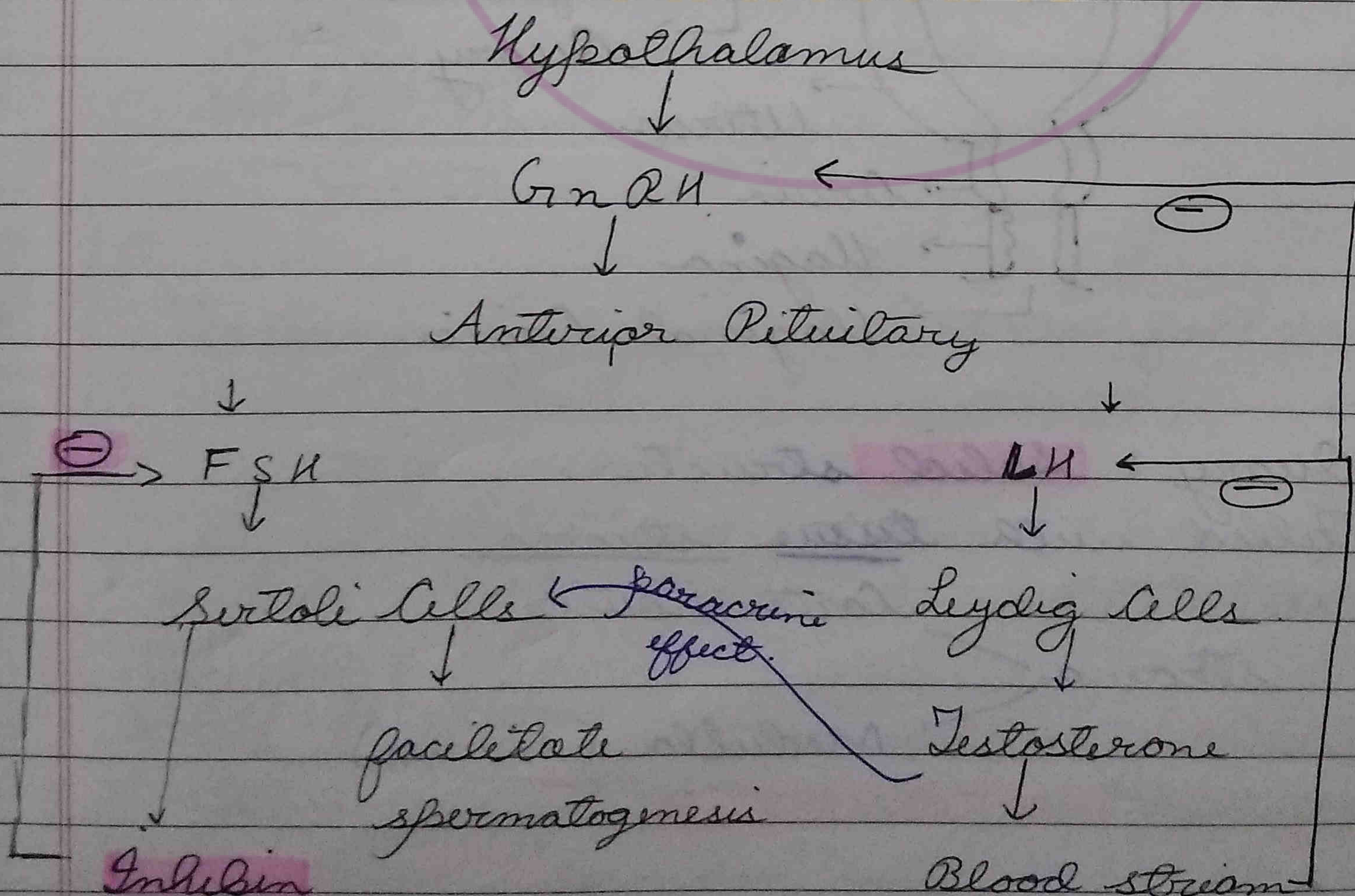
For fertility 60% of sperms should be of normal shape and size.

- All non ascalhelminthes have non-flagellar sperm.
- When secretion of one cell affects near by cells then this is called paracrine effect at sub membrane in paracrine effect.
- 40% of these should have normal motility.
- Oligospermia - 20 million / ml of semen
Cause of infertility.



Ascaris : amoeboid sperm without flagella.

Hormonal Control



Testicular degeneration and reproductive disorders in mammals due to lack of melanin E

gonadal epithelium is outside Tunica albuginea incision

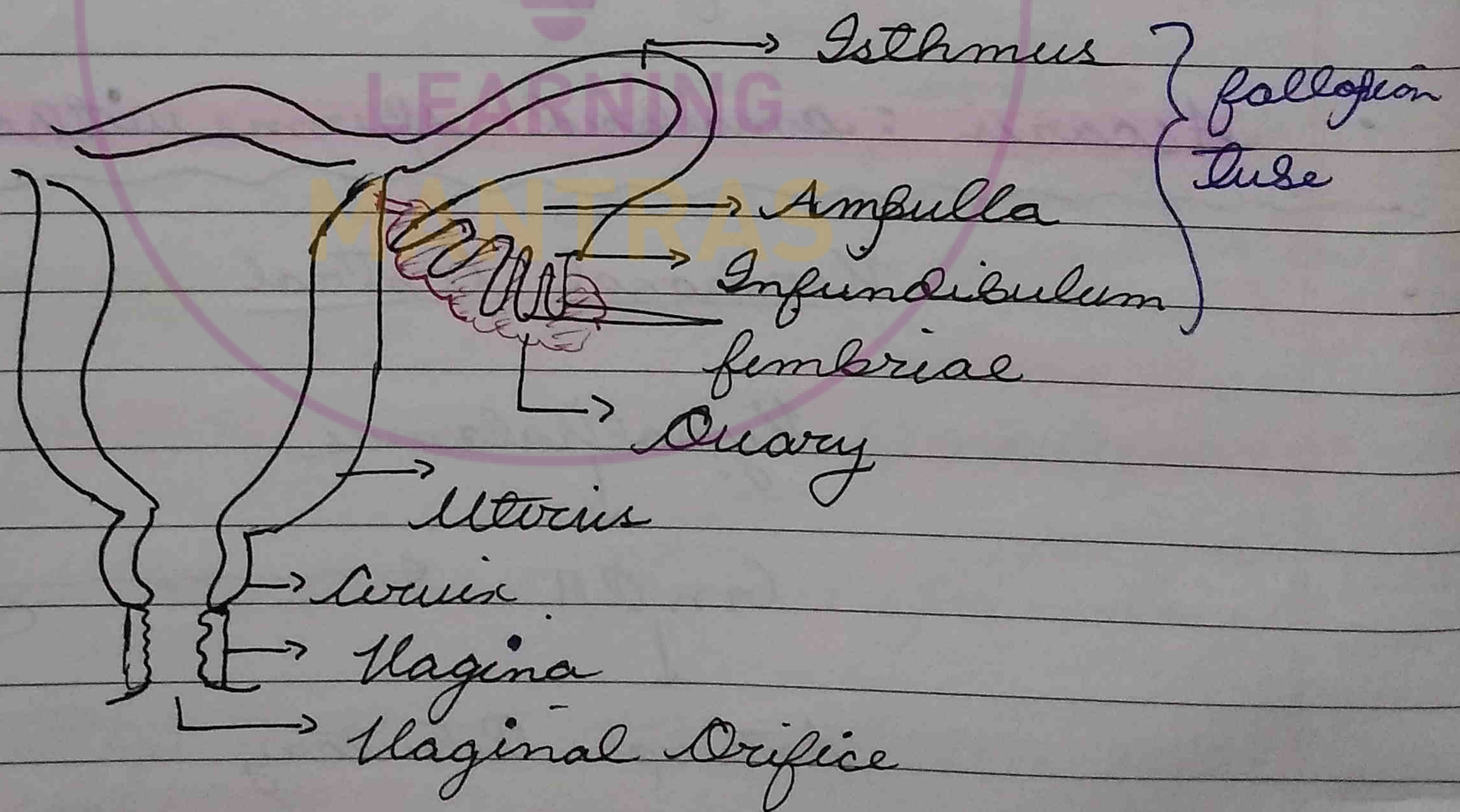
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- Testosterone provides negative feedback to LH and GnRH whereas Sertoli cells release inhibin for -ve feedback of FSH.

Female Reproductive System

- Ovaries
- Fallopian Tubes (Oviducts)
- Uterus
- Vagina
- Glands
- External genitalia
- Mammary glands.

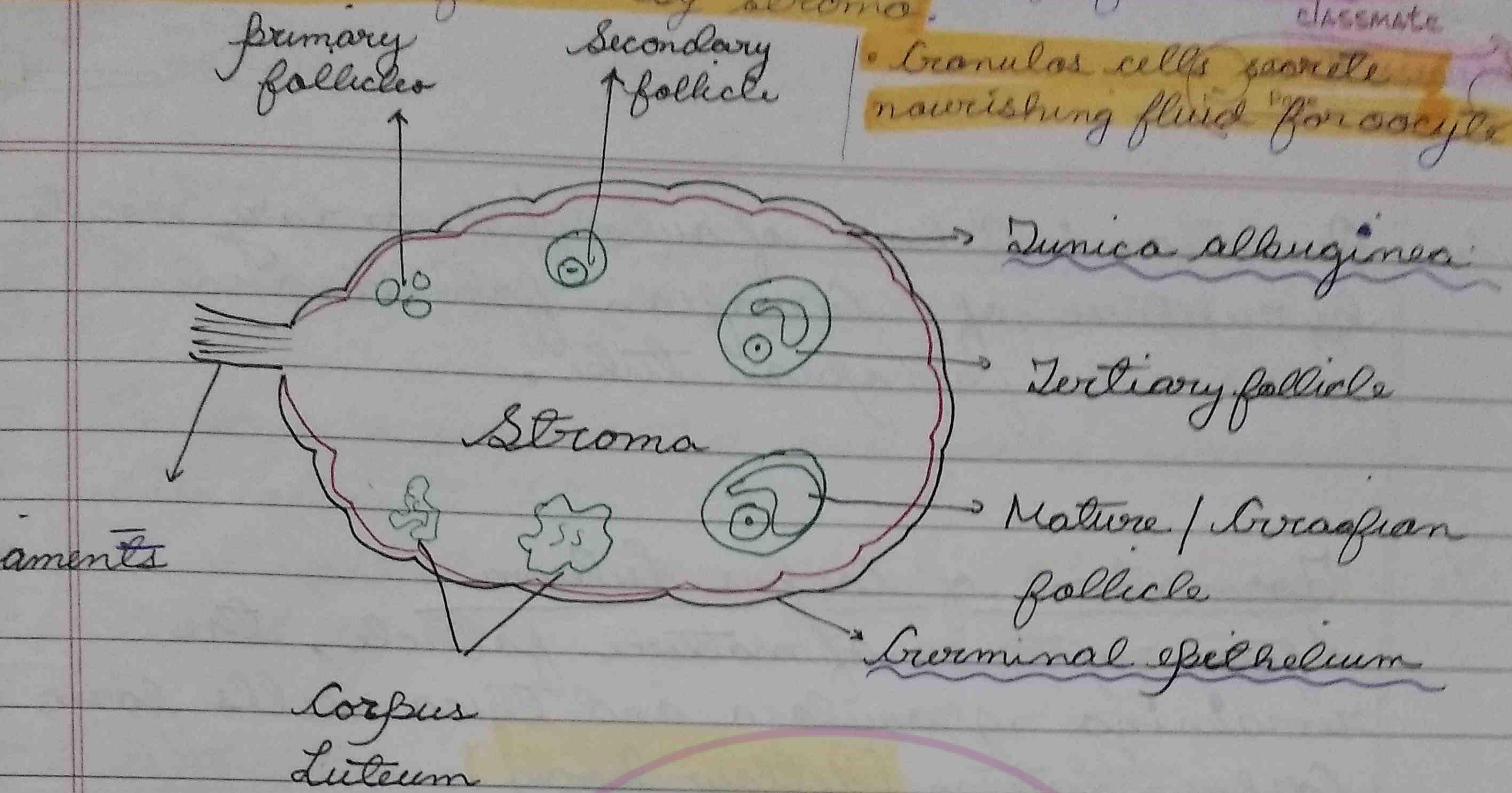


- Ovary : Solid structure
Filled with tissue stroma
Cortex (outer)
stroma
Medulla (inner)

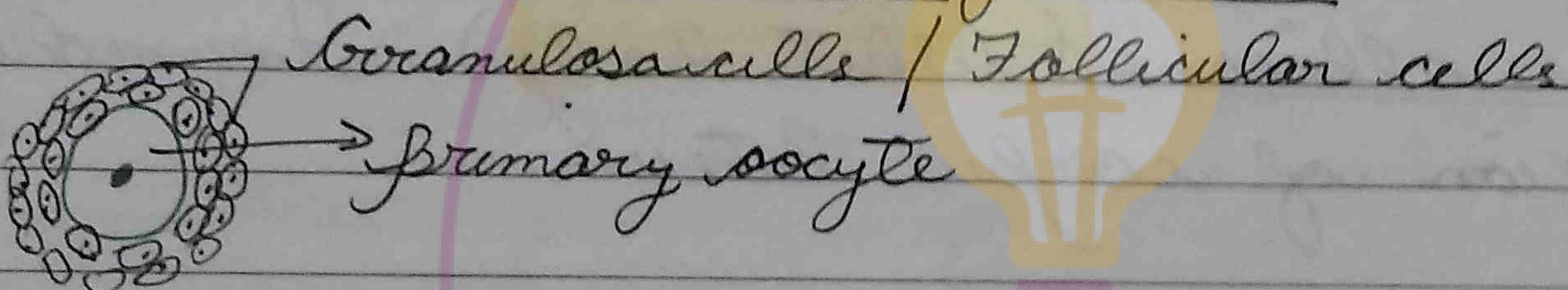
Primary oocyte is suspended in diakinesis stage of meiosis I.
Theca cells are formed by stroma.

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Granular cells secrete nourishing fluid for oocyte.

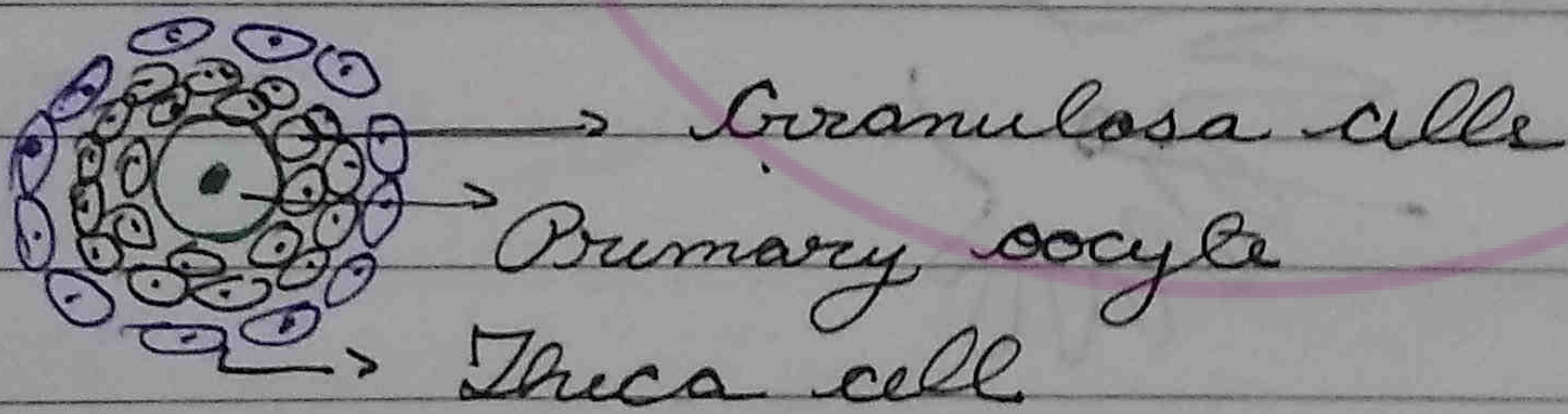


Ovarian follicles

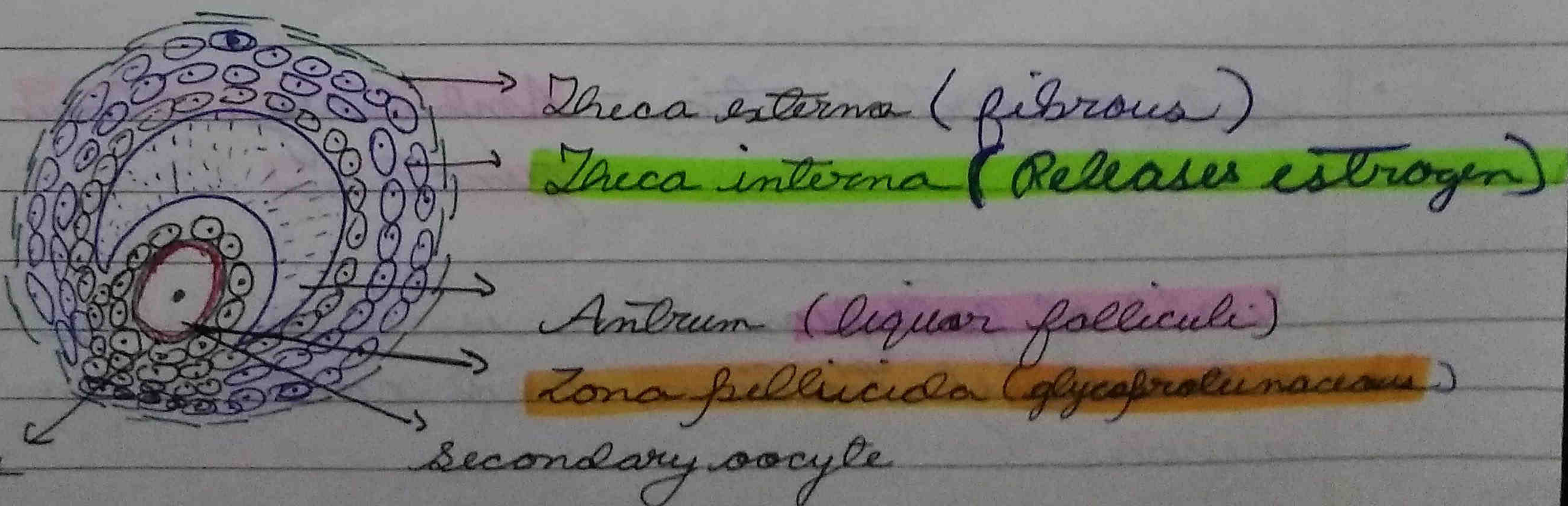


Primary follicle

Secondary follicle



Tertiary follicle → Graafian follicle (mature)



- Secondary oocyte is suspended at metaphase II stage of Meiosis II.

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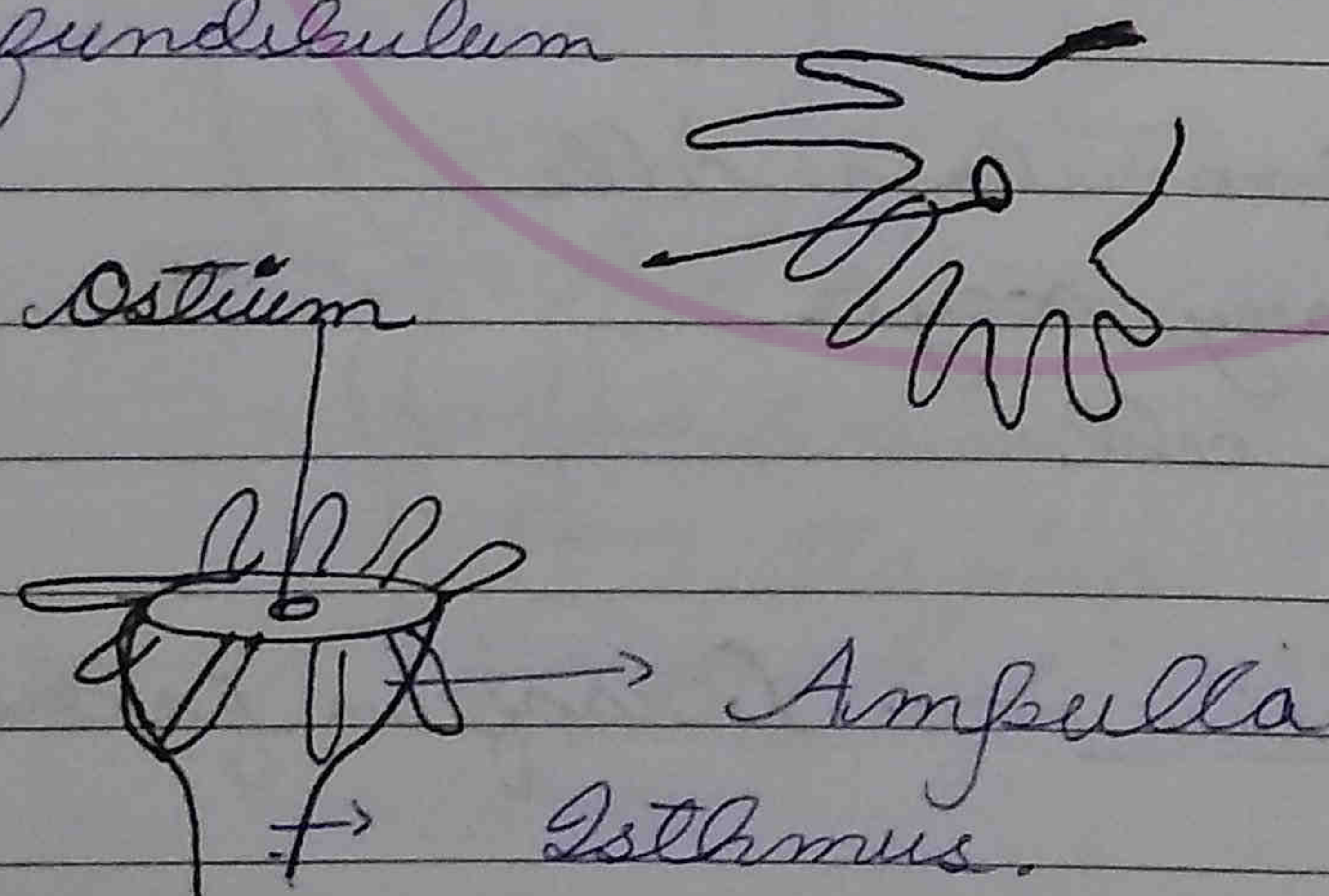
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- Ovulation: Release of ova / secondary oocyte by rupture of Graafian follicle and move into fallopian tube.

- Formation of Corpus Luteum
After rupture of mature follicle, the remaining granulosa and theca cells form Corpus Luteum (Yellow body).

- Corpus albicans (White body): Formed after regression of corpus luteum.

- Fallopian Tubes
Infundibulum



- Site of fertilisation - Ampullary isthmus junction.

- Wall of fallopian tube is lined by ciliated epithelium and contains smooth muscles.

Only endometrium has varying thickness, through the month.

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- Uterus (Womb)
- Inverted pear-shaped structure
- Embryo is implanted and foetus undergoes development here.
- Wall of Uterus consists of three layers:
 - Outer layer → Perimetrium, peritoneum.
 - Middle layer → Myometrium: muscular layer having smooth muscles.
 - Innermost layer: Endometrium

↓
Ciliated, glandular
columnar
epithelium

↓
Lamina propria
(Loose connective
tissue).

- Cervix
 - Neck of uterus
 - Strong muscular sphincter.
 - Cervical canal: narrow space formed by cervix
↓
opens into vagina.

Vagina: lined by stratified, non-keratinised squamous epithelium.

Cervical + Vaginal Canal \Rightarrow Birth canal.

No glands in the vaginal lining.

Vaginal orifice is covered by perforated membrane called Hymen.

- Ruptured during sexual intercourse or during strenuous exercise.

Vulva: External genitalia

Two openings in vulva.

— Urethral opening
— Vaginal opening

External Genitalia

- Mons pubis \rightarrow fat deposition over pubic bones in the pelvic area.
Hair growth present.

- Labia majora \rightarrow thick lip-like folds.
Homologous to male scrotum.

- Labia minora \rightarrow Thin lip like folds inner to labia majora.

- Vestibule \rightarrow narrow space b/w the labia.

Two openings in vestibule - vaginal opening and urethral opening.

- Clitoris: At the anterior end, labia minora join to form clitoris.

Made of spongy tissue and is a finger like projection.

Glans clitoridis \rightarrow covered by foreskin.

Clitoris is homologous to penis.

* Bacteria causes abortion in women.



Bartholin's / Vestibular gland

Located on the lateral sides of vaginal opening.

Homologous to Cowper's gland of males

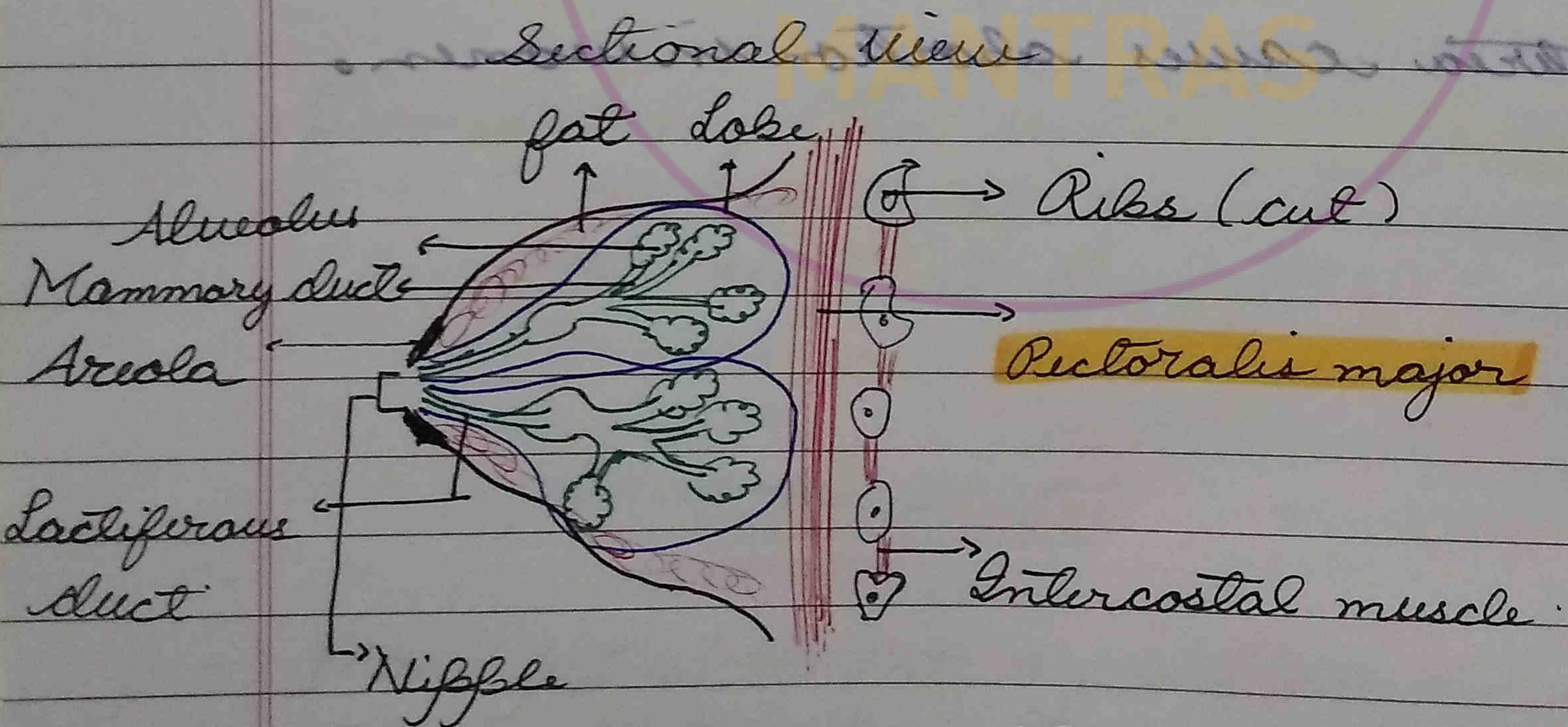
• Mammary Glands

- most characteristic feature of mammals.

- It produces milk to nourish new-born.

- Location $\left\{ \begin{array}{l} \text{Thoracic} \\ \text{or} \\ \text{Abdominal} \end{array} \right.$

- In humans females mammary glands are located as Thoracic prominence.



15-20 mammary lobes.

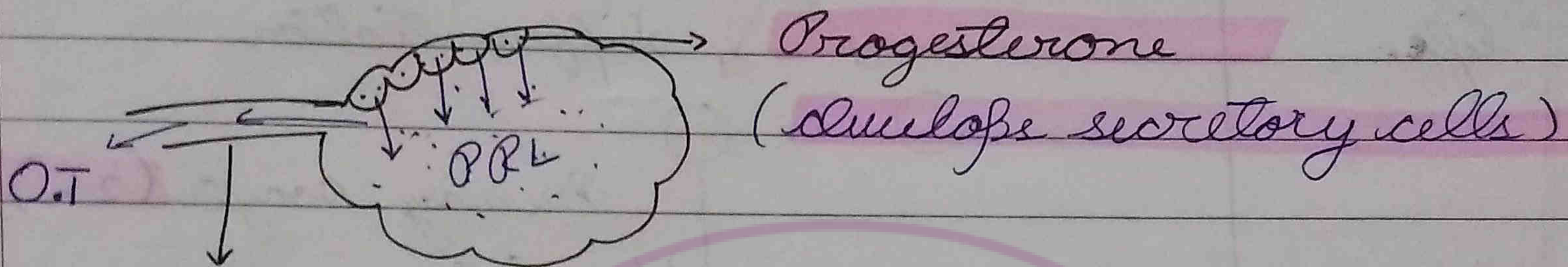
• Modified sweat glands

- Apocrine



In egg laying mammals - riffls are absent.

Hormonal control of Mammary Glands



Estrogen

- development of mammary ducts
- fat deposition around lobes

- hPL (human placental lactogen)
 - Secreted by placenta during pregnancy.
 - helps in enlargement of mammary gland.
- Prolactin : responsible for synthesis and secretion of milk.
- Oxytocin : responsible for milk ejection.

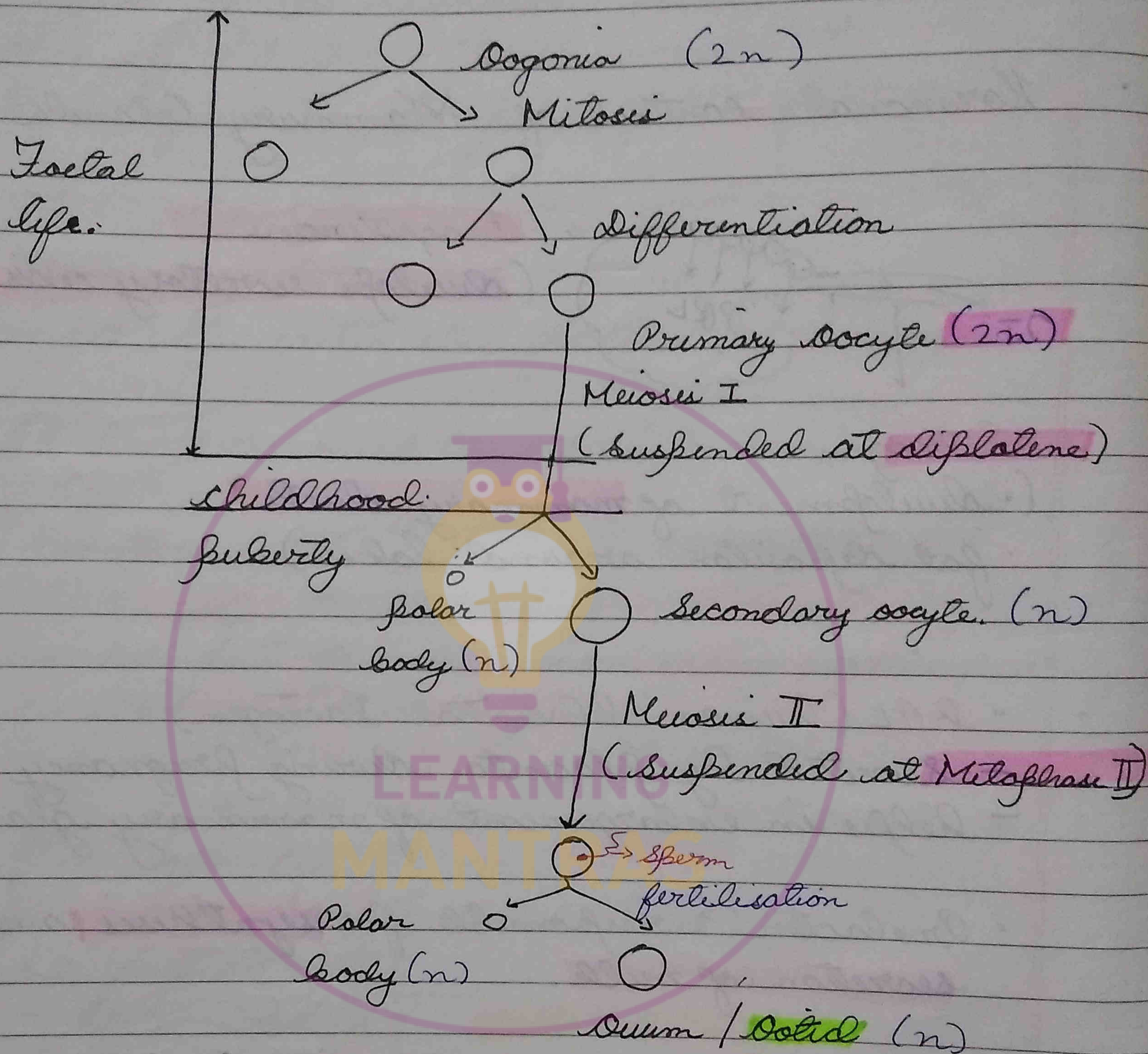
- Diplotene more correct ans. than diakinesis.
- From primary oocyte only one ovum is formed.

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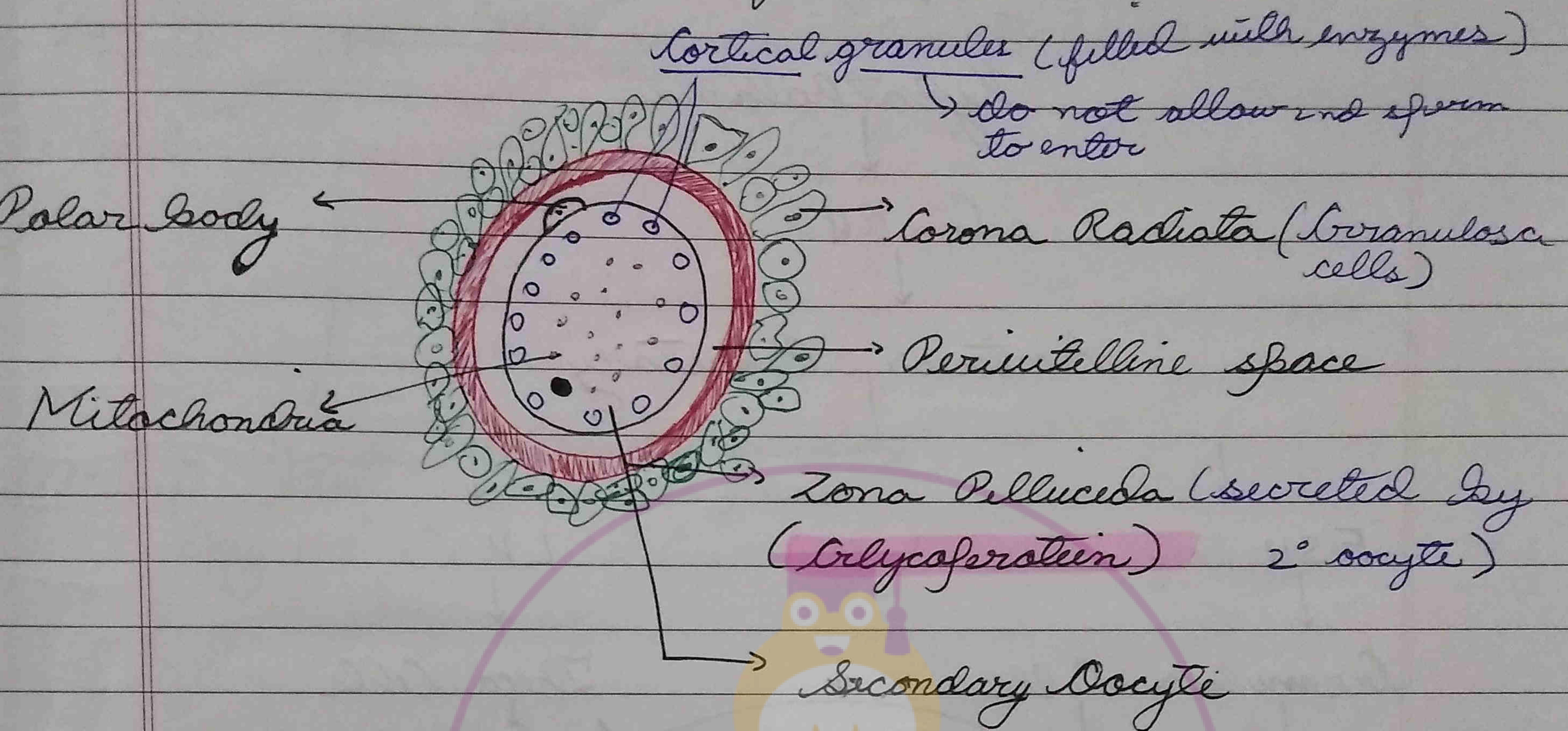
Oogenesis



- Primary Oocytes - 7 million are formed in the ovary of female foetus.
- At the time of birth 2-4 million primary oocytes are left.
- By puberty - 400,000 primary oocytes are left.
- e.g. 11 — 51 years
40 years
- ★ $40 \times 12 = 480$ oocytes

- Zygote get mitochondria only from maternal side.
- Granulosa cells are stuck together with hyaluronic acid.
- Cortical granules are filled with enzymes.
- After ovulation oovum is covered by Corona Radiata.

Structure of Oovum



Menstrual Cycle

Mensem = month

- Primates (Humans, apes, monkeys)
- Cyclical event in which there is periodic shedding of uterine endometrium followed by its proliferation in preparation for implantation.
- Menarche : Beginning of menstrual cycle in a female.
11 - 13 yrs.
- Menopause : Cessation of menstrual cycles
45 - 52 yrs.

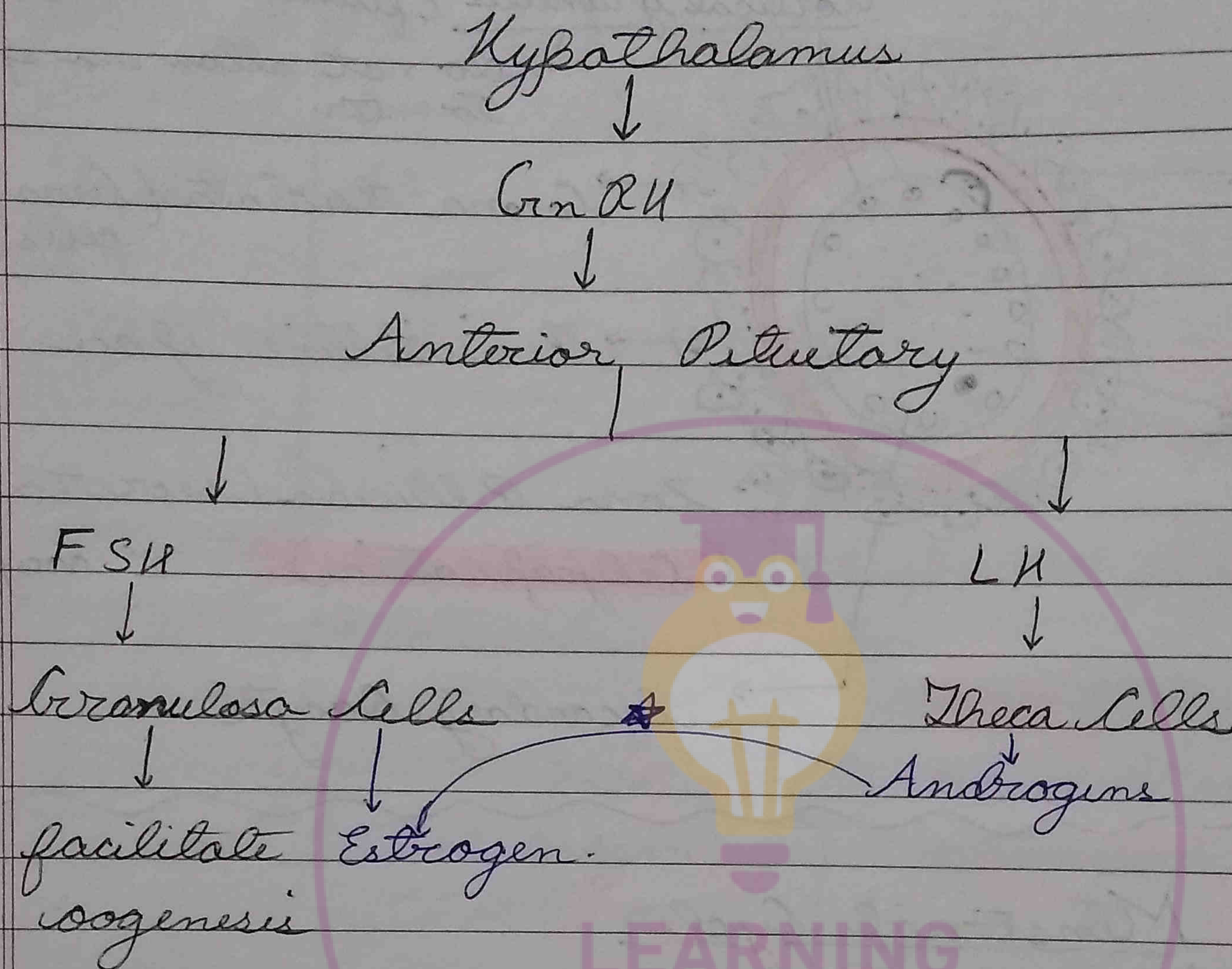
★ Granulosa cells convert androgens into estrogen
was secreted by theca cells.

estrogen & LH

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Hormones of female reproductive system



• Low concentration of estrogen
↓ ⊖ negative feedback
LH

• High concentration of estrogen
↓ ⊕ Positive feedback
LH

• Corpus luteum secretes Progesterone and Estrogen.

Progesterone and estrogen create -ve feedback on GnRH and LH

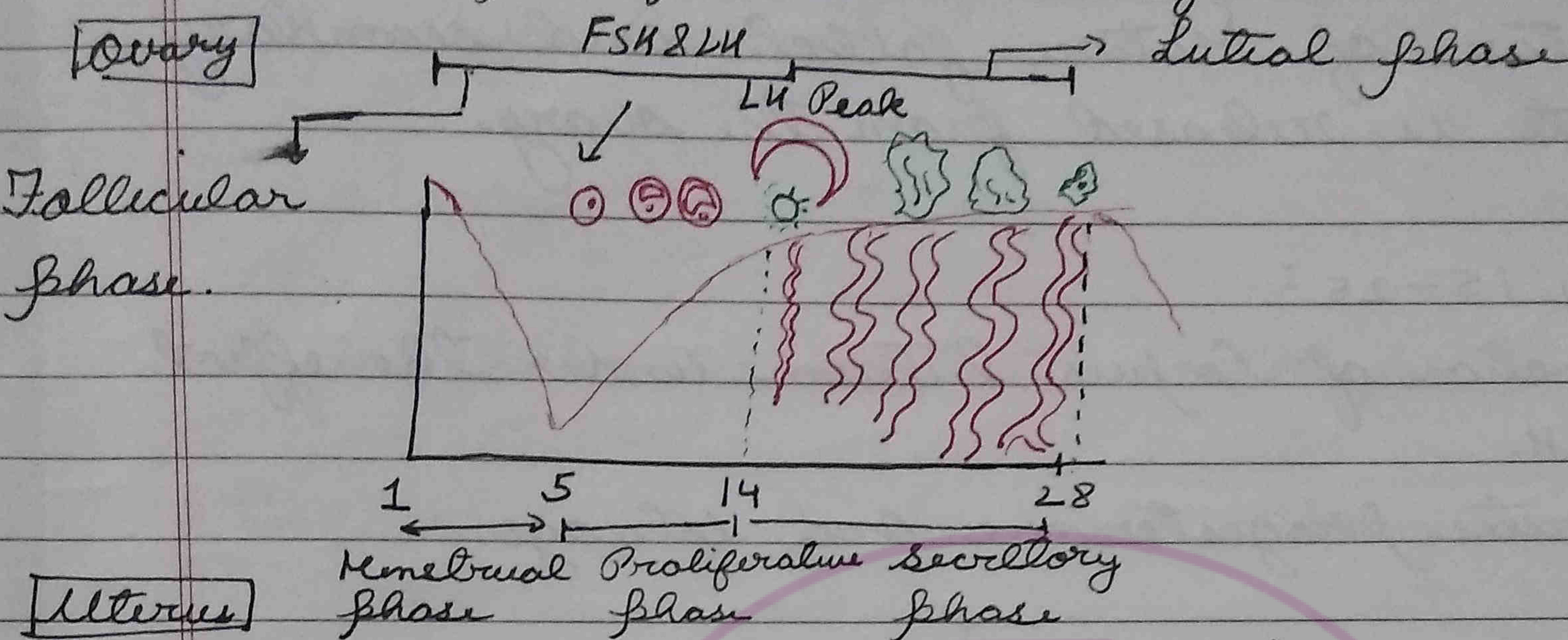
Inhibin → inhibits FSH.

- Luteal phase and secretory phase overlap.
- Follicular phase and proliferative phase overlap.

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Stages of Menstrual Cycle



- Day 1: Corpus luteum of previous cycle is completely regressed.
- Day 1-5: Levels of estrogen and progesterone are low. FSH and LH are free from inhibition.
 - Several follicles begin to develop in the ovary.
 - Endometrium sloughs off and menstrual bleeding occurs.
- Day 7: One dominant follicle is selected.
- Day 7-12: Estrogen level increases.
 - Increase in LH level. (\because +ve feedback from estrogen)
 - Proliferation of uterine endometrium. (Proliferative Phase).
- Day 13 - LH Peak / LH Surge.
 - Stimulates primary oocyte to complete meiosis I and secondary oocyte to reach meiosis II.

- Estrogen makes proliferates the endometrial lining but progesterone makes it glandular and secretory.
- Estrogen is the dominant hormone before ovulation and progesterone is the dominant hormone after ovulation.

Day 14 : Ovulation

Rupture of Mature follicle and secondary oocyte is released from the ovary.

Day 15-25 :

Formation of Corpus luteum under the effect of LH.

Secretes progesterone and estrogen.

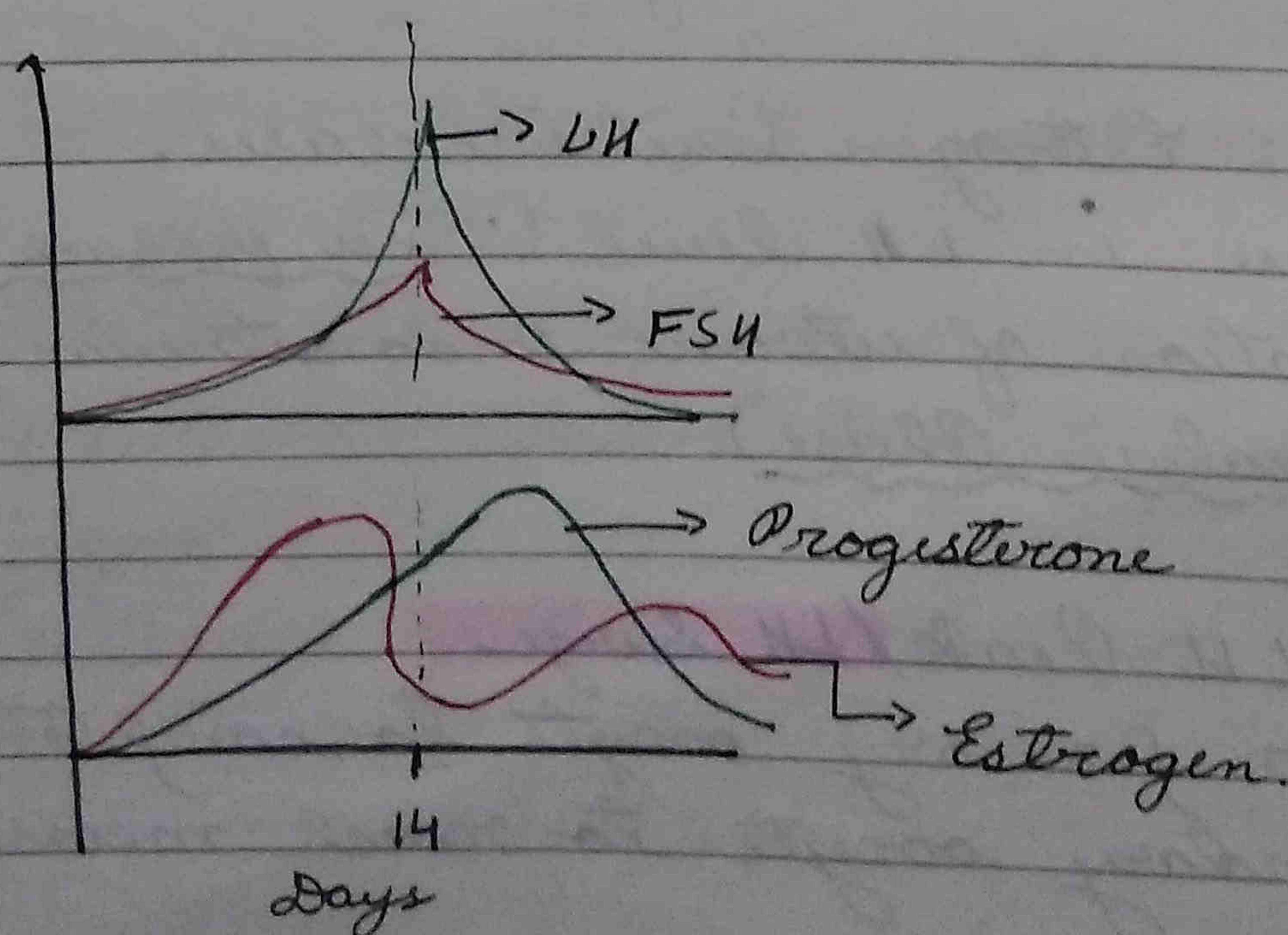
Secretory endometrium develops.

Day 26-28

Corpus luteum begins to regress, because LH levels are too low.

By the end of day 28, corpus luteum is fully regressed. Progesterone and estrogen level decrease.

New cycle begins.



★ LH responsible for maintaining corpus luteum which in turn maintains progesterone level and endometrial lining

Prolactin inhibits FSH activity.

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Menstrual Cycle
28 days (average)

22 days — 38 days

Luteal phase is constant : 14 days.

- For a 38 day cycle ovulation occurs.
 $38 - 14 = 24^{\text{th}}$ day.

- Menstrual phase : 3-5 days
- Proliferative phase : 7-11 days
- Luteal / Secretory phase : 14 days.

• Amenorrhea : Suspension of menstrual cycle.
Primary reason \rightarrow Pregnancy.

Secondary reason \rightarrow Hormonal imbalance.

Estrous Cycle

Non-primate mammals.

- No menstrual bleeding occurs.
- The proliferated endometrium is reabsorbed within the uterus.
- Female is receptive for the male only during high levels of estrogen. (Heat period)
(Estrous = heat).

Stages in estrous cycle →

Proestrous

Estrous

Metestrus

Diestrus

Anestrus : It is a period quiescent stage between two estrous cycles.

Monoestrous animals e.g. Dog, wolf.

Polyestrous animals e.g. Cattle, cat, rat, horse.

Menstrual Cycle

Estrous Cycle

Occurs in primates only

Occurs in non-
- primate mammals.

Endometrium slough off in menstrual bleeding.

No menstrual bleeding.

No specific receptivity in females

- Females are receptive only during brief heat period.

Types of Eggs

Yolk (Vitellin) → contains phosphoproteins and provides nourishment to developing embryo.

★ In humans the egg is alecithal.

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• On the basis of amount of yolk:

- Alecithal: No yolk

e.g. Eutherian mammals. i.e. Humans also

- Microlecithal: Small amount of yolk

e.g. Amphioxus, Sea Urchin.

- Mesolecithal: moderate amount of yolk

e.g. Amphibians.

- Macrolecithal / Megalecithal: huge amount of yolk.

e.g. fish, birds, reptiles, insects.

• On the basis of distribution of yolk

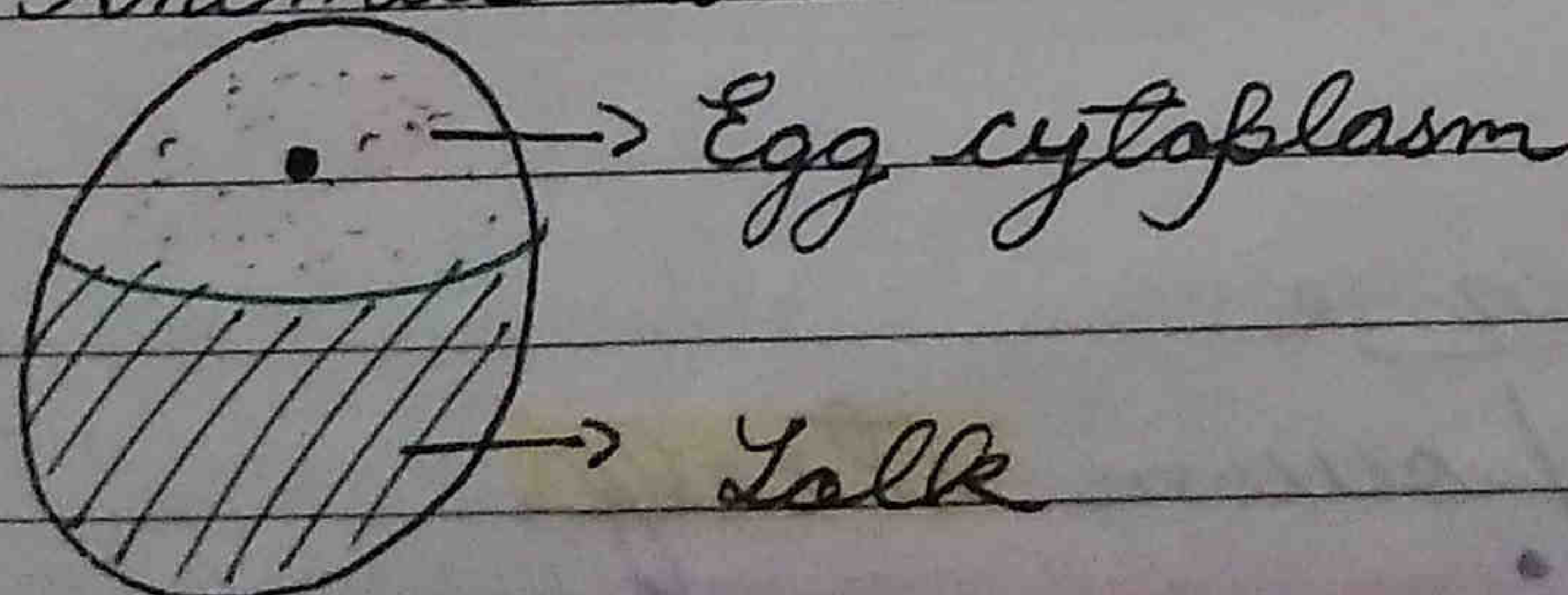
a) Isolecithal: Yolk is evenly distributed in the egg cytoplasm.

e.g. Microlecithal eggs (Amphioxus, sea urchin).

b) Heterolecithal: Yolk is not evenly distributed in egg cytoplasm.

• Isolecithal → yolk on one side

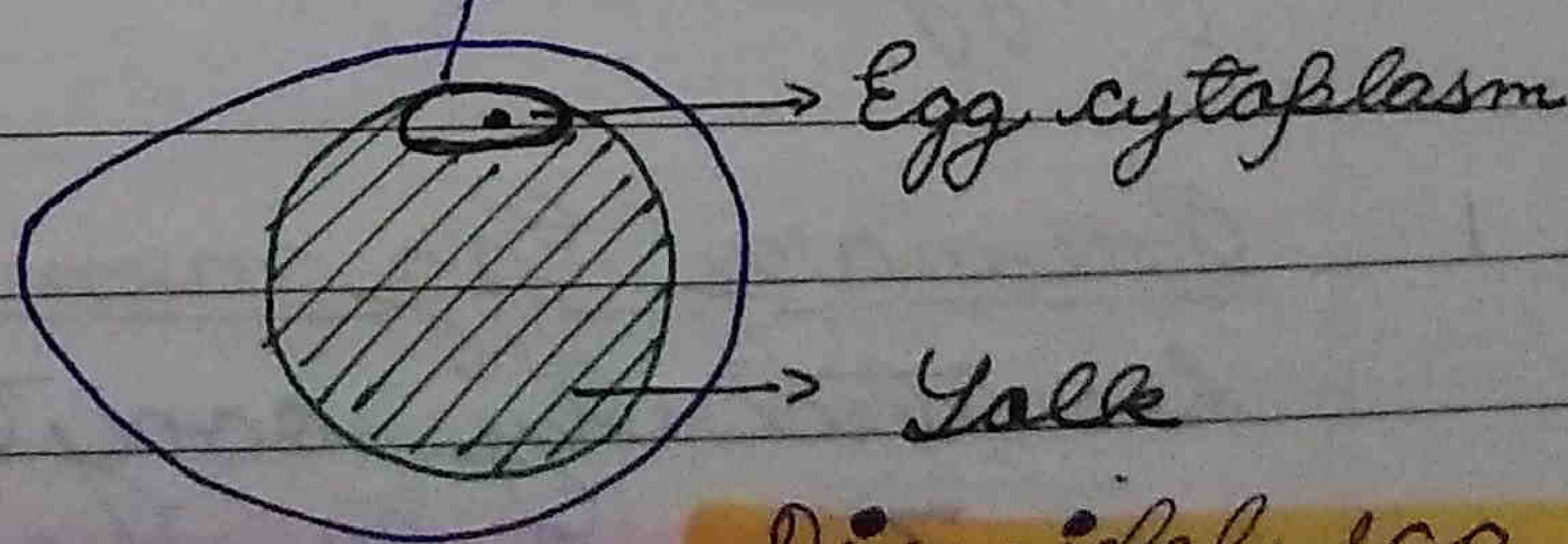
Animal Pole



Vegetal Pole

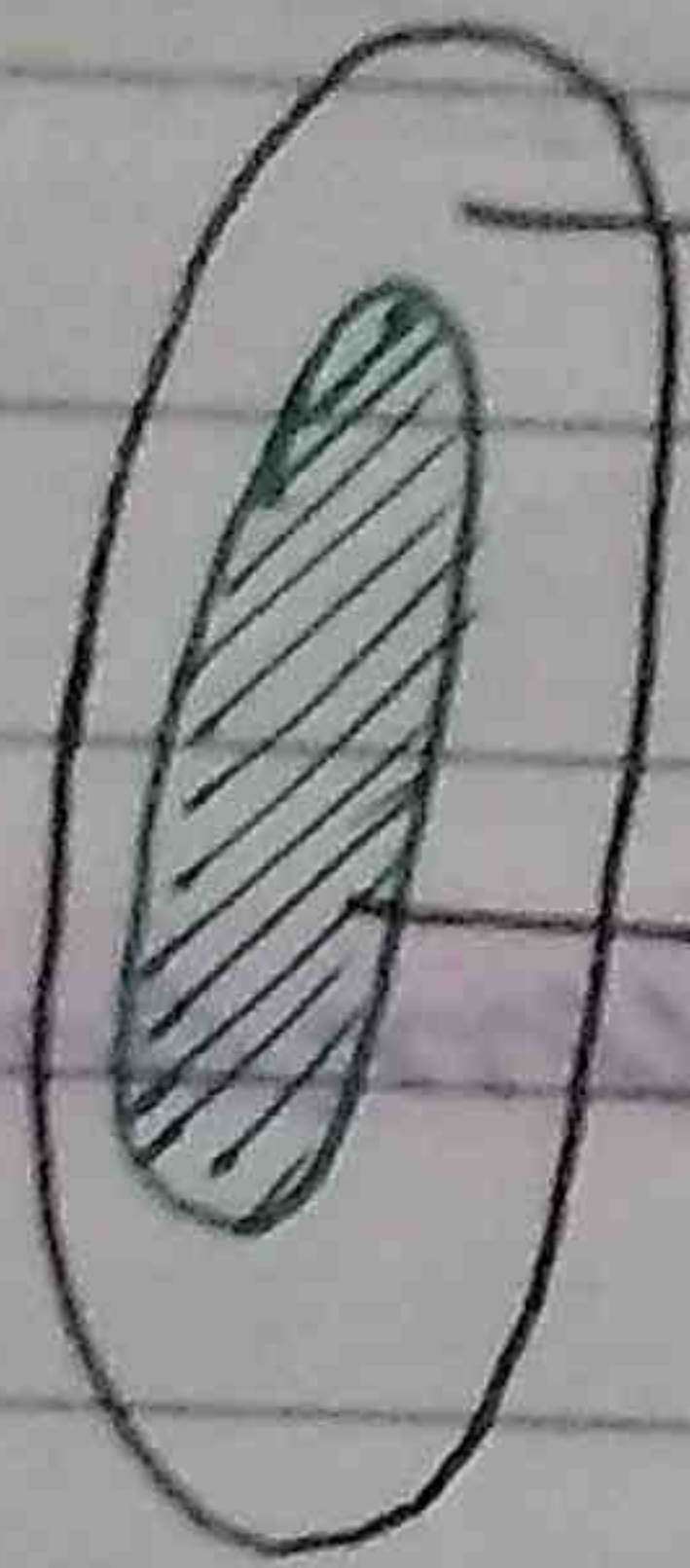
e.g. Frog.

albumen



Discoidal egg

e.g. Birds, Reptiles



Egg cytoplasm

Yolk

peripheral cytoplasm

* yolk in middle of egg cytoplasm surrounding it.

Centrolecithal: e.g. Insects

• On the basis of shell —

- Cleidoic Eggs : shelled eggs
e.g. Reptiles — leathery shell
Birds — calcareous shell
Insects — chitin
Monotremes — calcareous shell.

- Non-cleidoic eggs.
Shell-less eggs
e.g. Fish
Amphibians
Eutherian mammals.

• Egg Membranes

Formed after oogenesis for the protection of egg.

1. Primary Egg membrane

Secreted by oocyte / ovum itself.

e.g. Zona pellucida in mammals

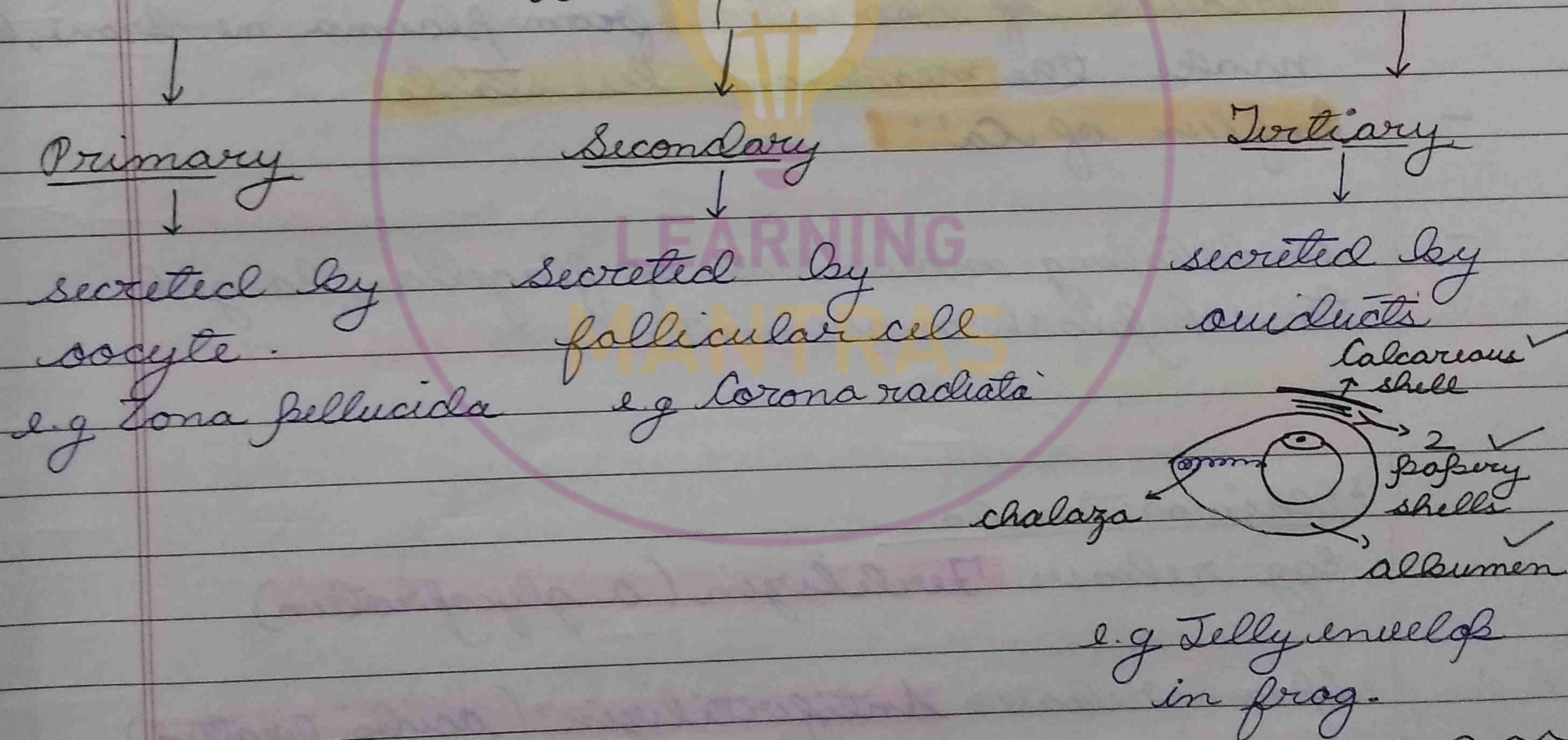
Vitelline membrane in birds, reptiles.

Zona radiata in sharks.

- 2 Secondary egg membrane
 Secreted by follicular cells.
 e.g. Corona radiata in mammals.

- 3 Tertiary egg membrane
 Secreted by walls of oviducts.
 e.g. Jelly envelope in frog.

Egg Membranes



Steps Fertilisation

- (i) - Capacitation
- (ii) - Binding of sperm to Zona Pellucida
- (iii) - Acrosome Reaction
- (iv) - Egg activation and Cortical reaction
- (v) - Syngamy

Capacitation

- Conditioning of the sperm so that it becomes hyperactivated for fertilization.

★★★

- Occurs in the female's reproductive tract.

- Requires 6 to 7 hours.

- Rearrangement of glycoproteins in the plasma-membrane of sperm.

- Removal of cholesterol from plasma membrane, to make the membrane less stable.

- Influx of Ca^{2+}

- Undulating movement of flagella changed to whiplash movement.

Chemoattraction

Egg releases Fertilizin (a glycoprotein)

Sperm releases Antifertilizin (acidic protein)

- Agglutination

- Species specific and helps in maintaining purity of species.

* Sperm receptors are present on zona pellucida.

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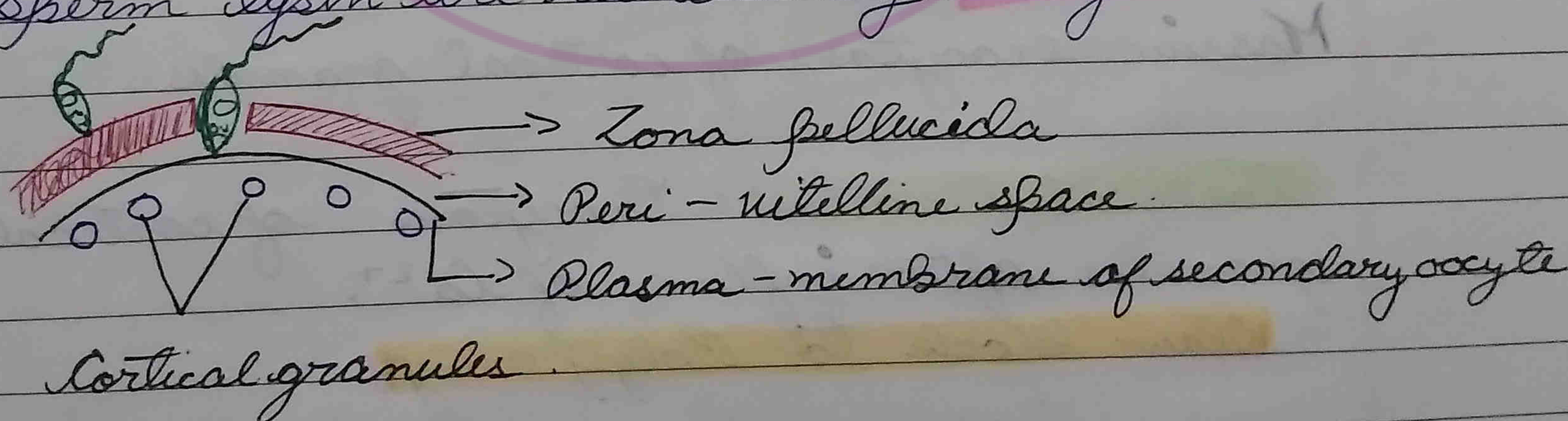
- Binding of sperm to Zona Pellucida
 - Zona pellucida is a glycoproteinaceous egg membrane (Primary egg membrane).
 - Sperm Receptors - to which the sperm binds.
 - Na^+ influx and the membrane depolarises.
 \Rightarrow Fast block to Polyspermy.

• Acrosome Reaction

↓
modified lysosome formed by Golgi bodies containing sperm lysins.

↓
Acrosin \rightarrow digests zona pellucida
Hyaluronidase \rightarrow digests extra-cellular matrix
Corona penetrating enzyme : digest corona radiata.

- Sperm lysins are released by exocytosis.



• Binding of sperm to oocyte membrane

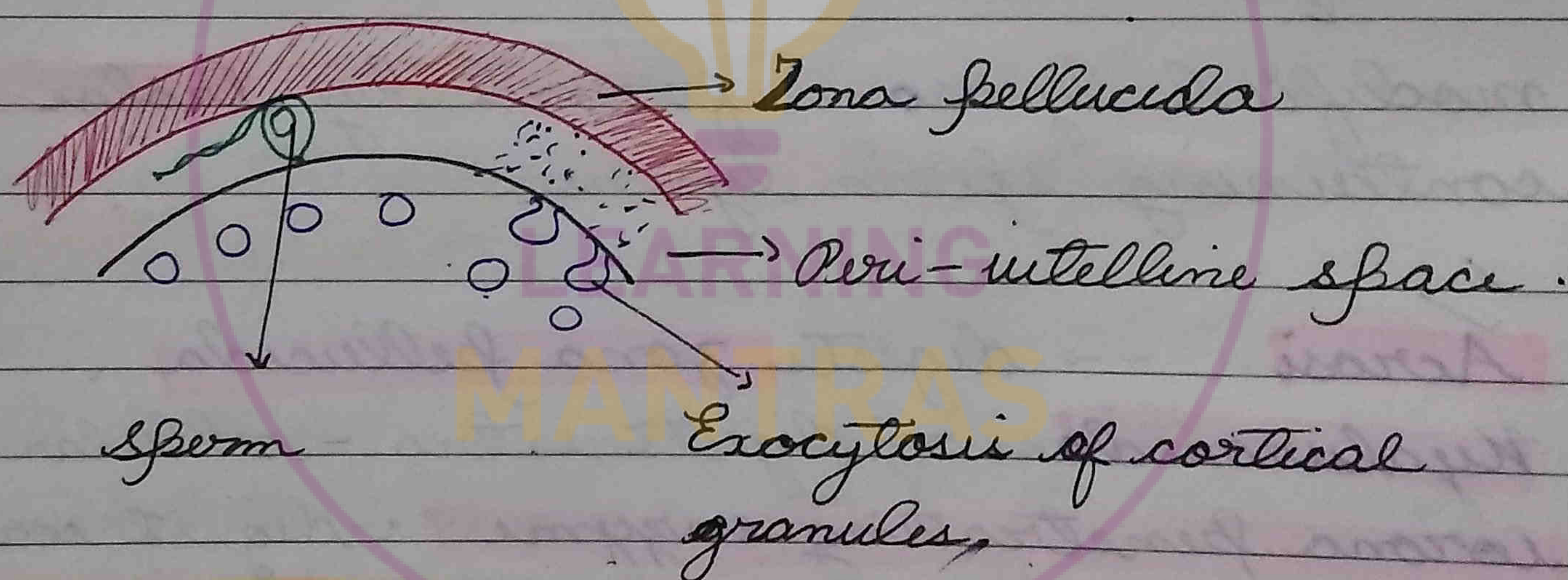
- Sperm releases Fertilin which causes activation of oocyte.
- Egg activation : Secondary oocyte is stimulated

- Secondary polar body is formed after entry of sperm but before syngamy (fusion of nucleus) addition of chelating agents like sodium oxalate / citrate are precipitated hence polyspermy will occur. to complete Meiosis II.

- MPF (Metaphase Promoting Factor) - Breaks down.

- APC (Anaphase Promoting Complex) - turned on.

- Secondary oocyte forms ovum / ootid and the second polar body.



Influx of Ca^{2+}
↓ leads to

Massive exocytosis of cortical granules.

• **Cortical Reaction**: Exocytosis of cortical granules after influx of Ca^{2+} .
Slow block to Polyspermy.

• **Zona Reaction**: Zona pellucida hardens. The sperm receptors are lost.
→ Formation of fertilisation membrane.

oocyte is viable for only one day

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Syngamy

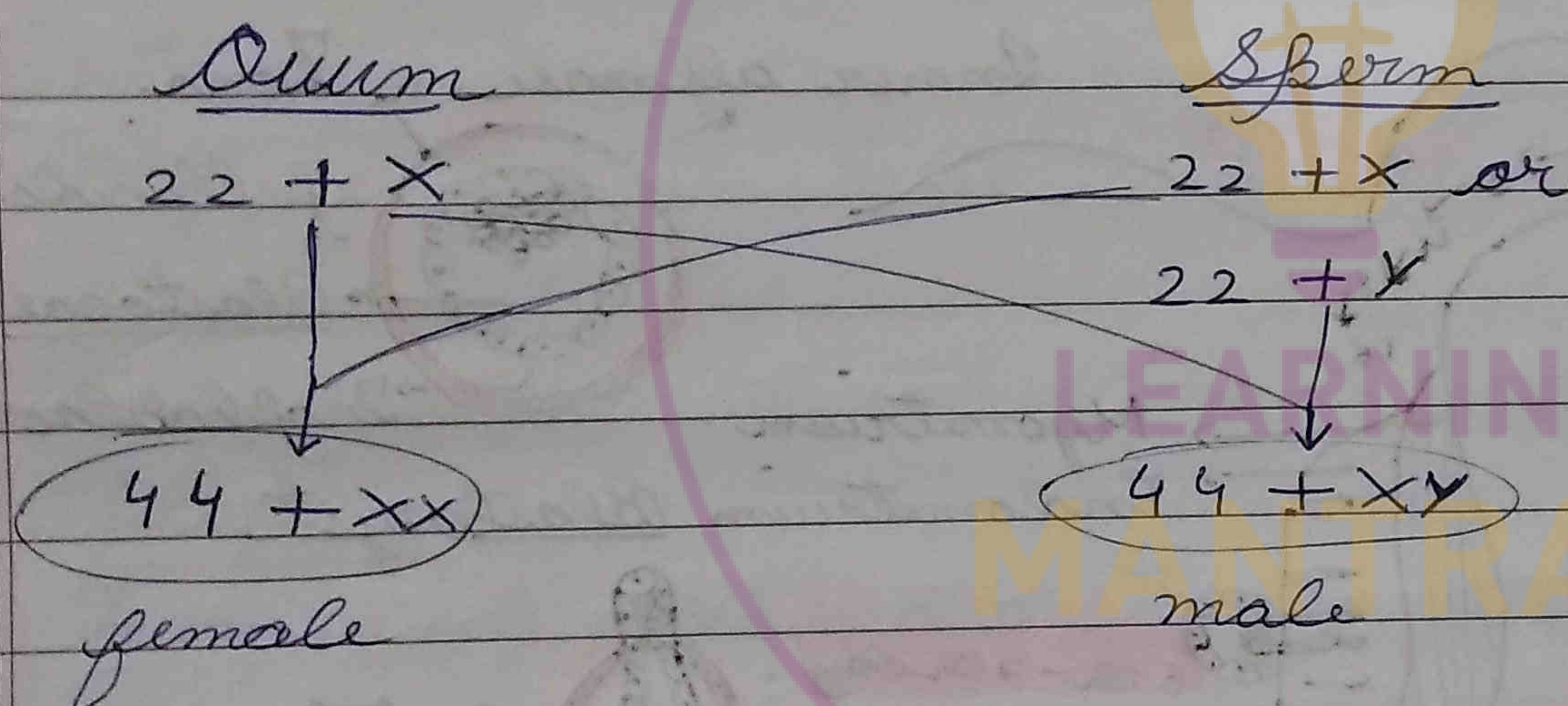
Sperm nucleus and oocyte nucleus swell and their chromatin decondenses.

Male and female pronuclei fuse to form zygote.

Fertilisation

Restoration of diploid chromosome number.

- Determination of sex



Initiation of cleavage

(In the absence of fertilisation, the secondary oocyte degenerates in 24 hrs).

Embryonic Development

- Cleavage: Division of the zygote to form morula.

Mammalian cleavage

slow and asynchronous

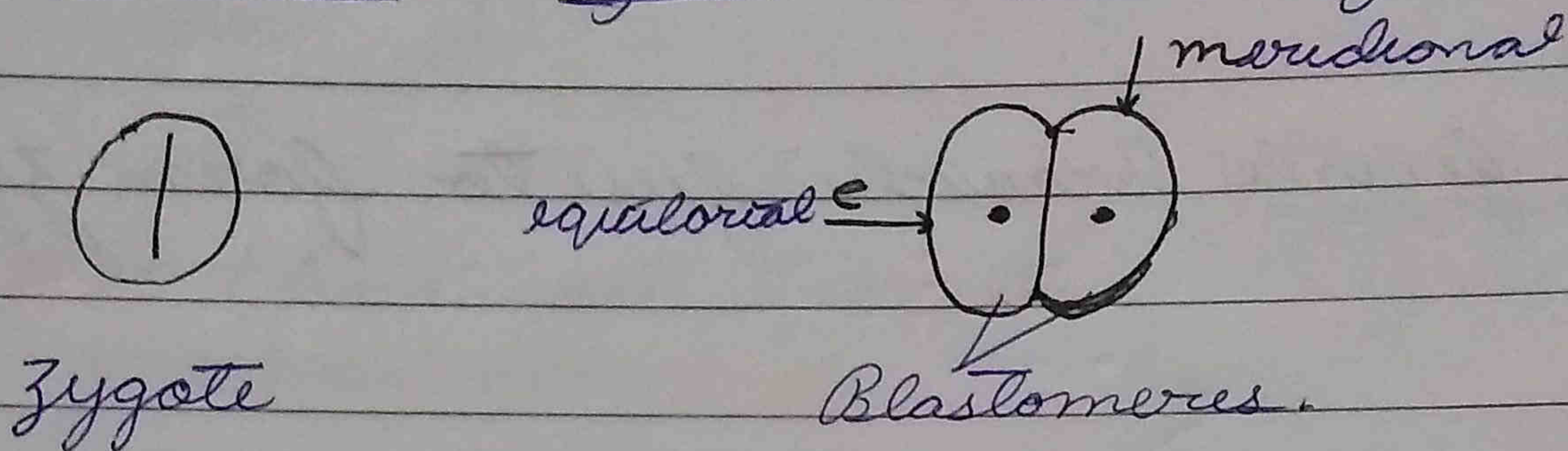
$1 \rightarrow 2 \rightarrow 4 \rightarrow 8 \rightarrow 16$ other animals (geometric)

$1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 5$ mammals (arithmetic)

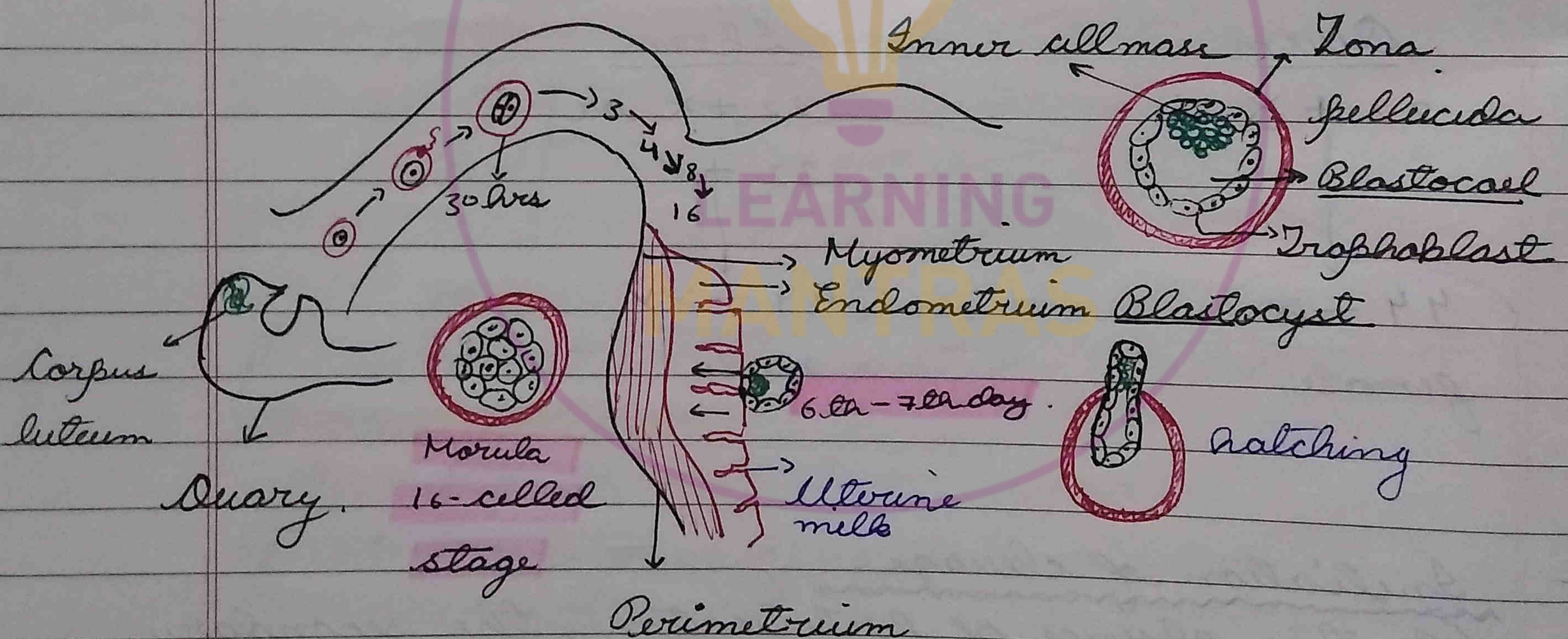
- For cleavage it is necessary that proximal centriole reaches inside the egg intact.
- Zygote and Morula are of same size as Zona Pellucida the size of morula.

Holoblastic cleavage.

Meridional plane (1st cleavage).



Rotational cleavage (i.e. equatorial + meridional)



Morula undergoes compaction (many tight junctions are formed).

same size.

{	Zygote	—	1
{	Morula	—	16 more DNA

★ If Blastocyst breaks into two during hatching, it will lead to formation of twins.

★ Maternal tissue which is part of placenta is decidua basalis.

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• Implantation

- Blastocyst gets embedded in the uterine endometrium.

6th to 7th day after fertilisation.

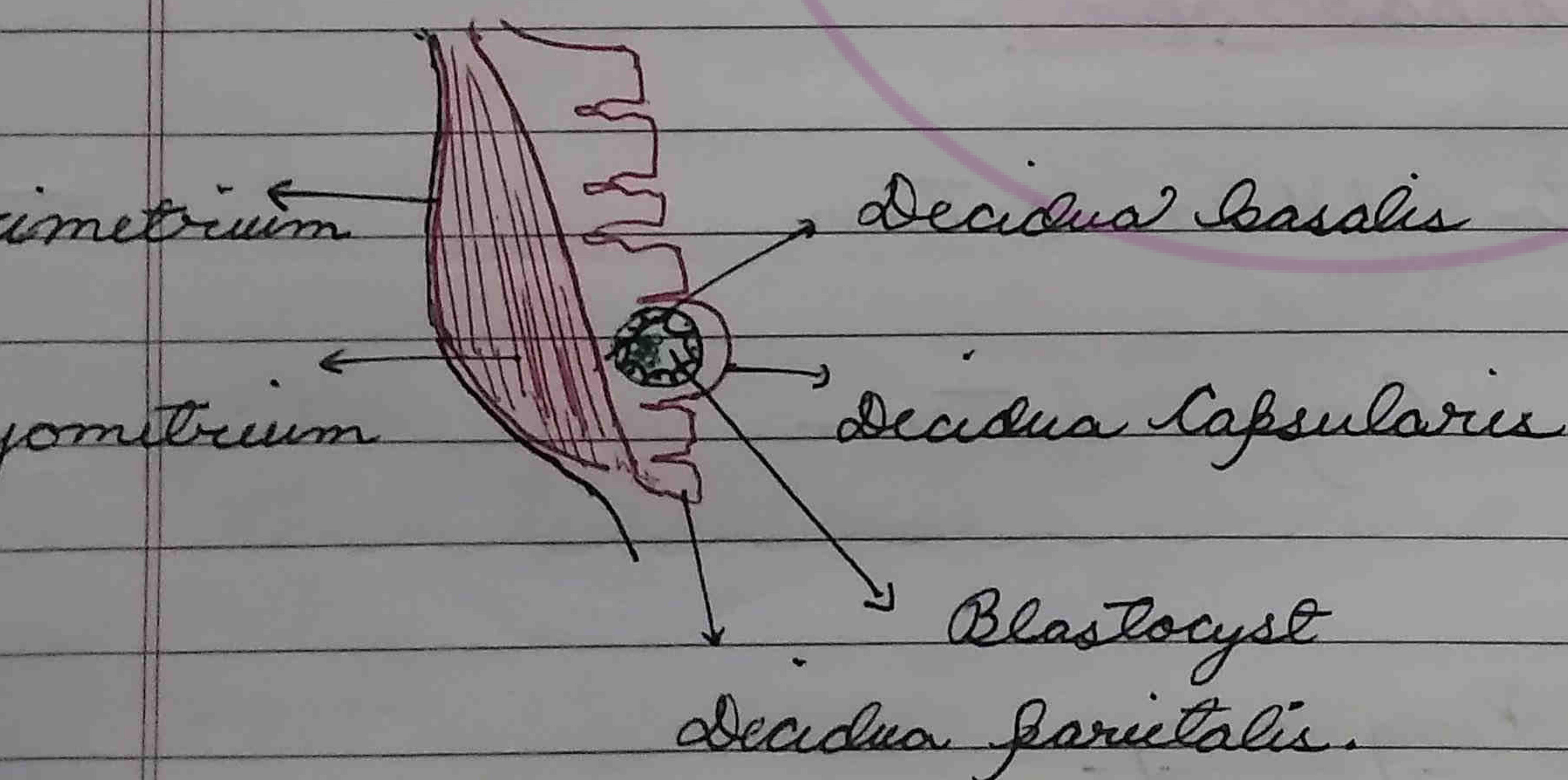
★ If zona pellucida is removed before the conceptus reaches the uterus, then implantation can occur in fallopian tube.

• Ectopic pregnancy : abnormal condition in which implantation occurs at a site other than uterus.

e.g Fallopian tube → Tubal pregnancy.

• Decidua

Term used for endometrium after implantation.



Decidua basalis : Thin layer of endometrium present between blastocyst and myometrium.

→ Contributes to placenta formation.

- Decidua capsularis : outgrowth of endometrium which covers the blastocyst.
It later breaks as em the embryo grows bigger.

- Decidua parietalis : Remaining endometrial lining

Hormones required to maintain pregnancy:

Progesterone : secreted by Corpus Luteum.

↓
maintained by LH.

In the absence of LH, corpus luteum degenerates.

- Trophoblast cells secrete HCG (Human Chorionic Gonadotropin).

- Similar to LH in action.

- Maintains Corpus luteum.

Test for Pregnancy

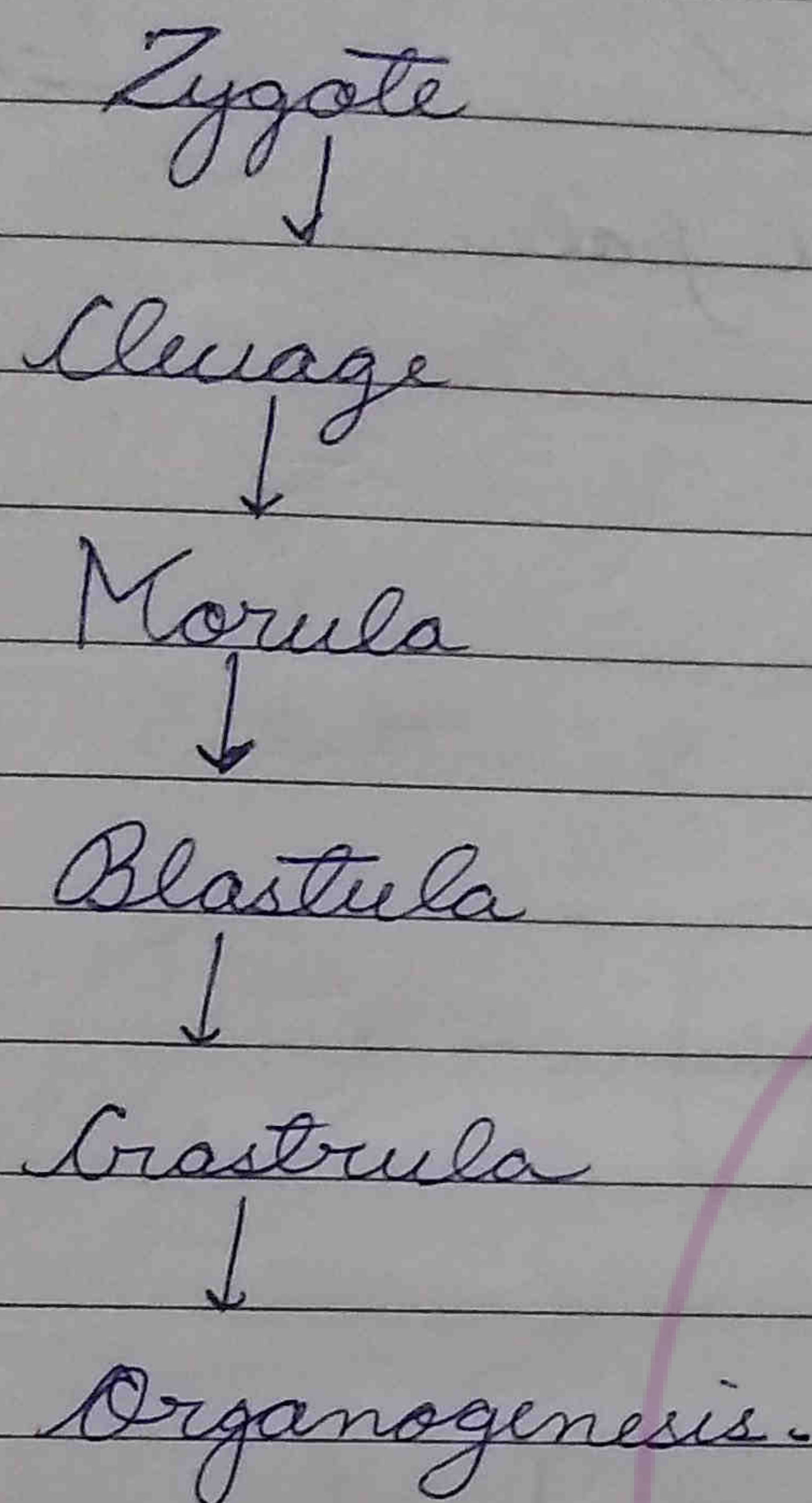
- Gravidex Test: Presence of HCG is detected in urine.

- Absence of menstrual bleeding (Amenorrhoea).

Size of blastomeres is less than that of zygote.

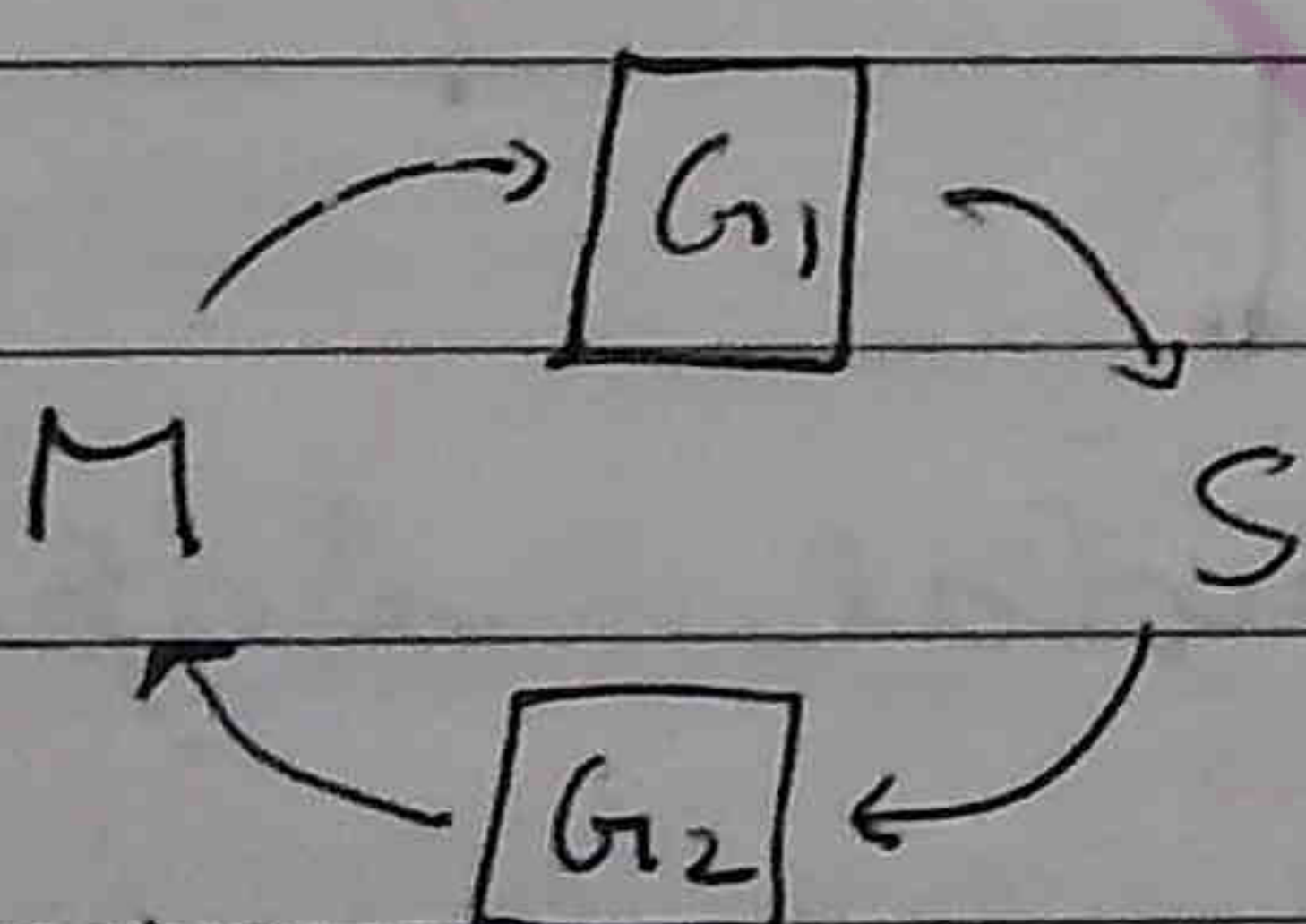
If amount of yolk and its distribution are changed in the egg then pattern of cleavage is affected.

Embryonic Development Developmental Biology.



→ closed cell division/mitosis is found during cleavage.

Cleavage : division of the zygote to form blastomeres.

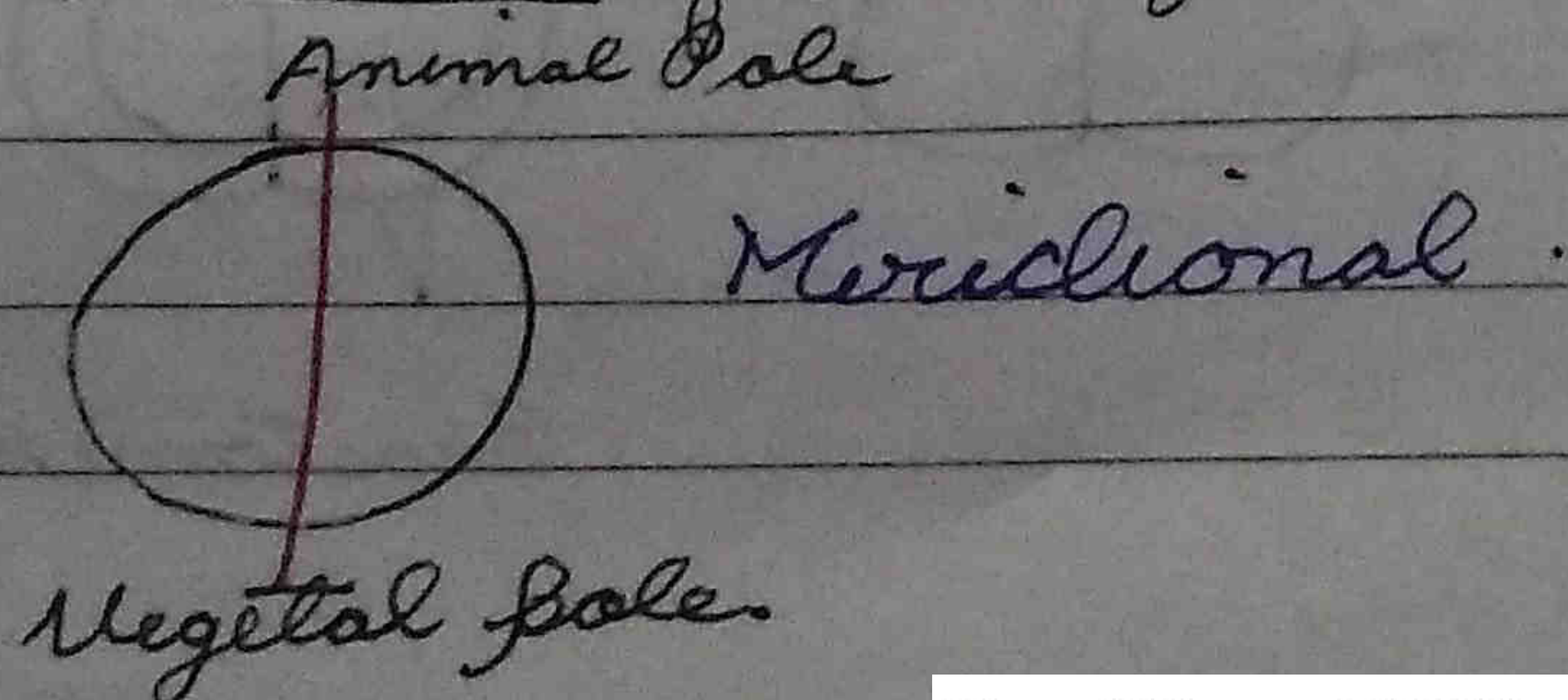


• G_1 and G_2 phases are very rapid in cleavage & hence their duration are negligible.

With every cleavage division nucleo-cytoplasmic ratio increases.

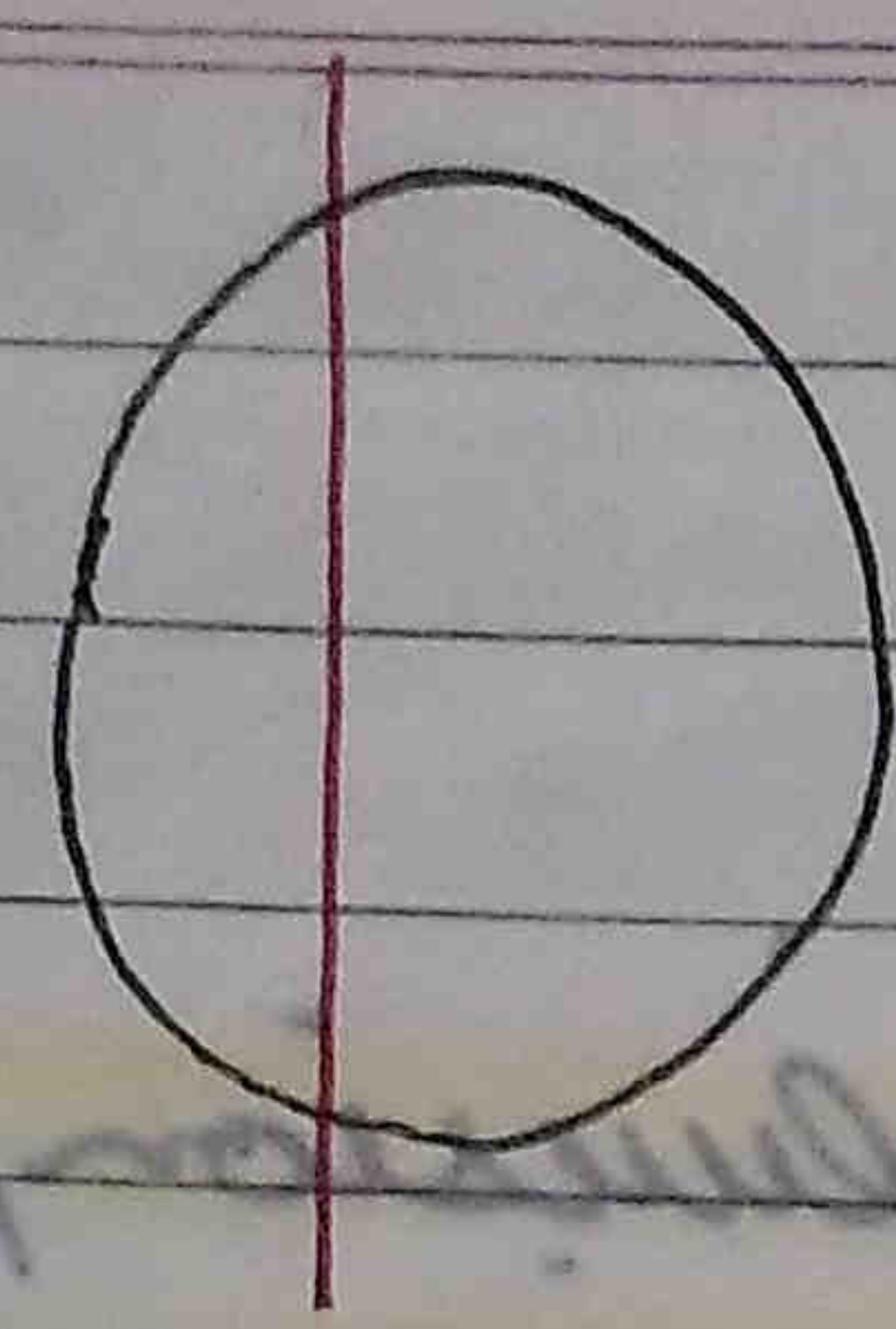
Pattern of cleavage depends on amount and distribution of yolk.

Planes of cleavage

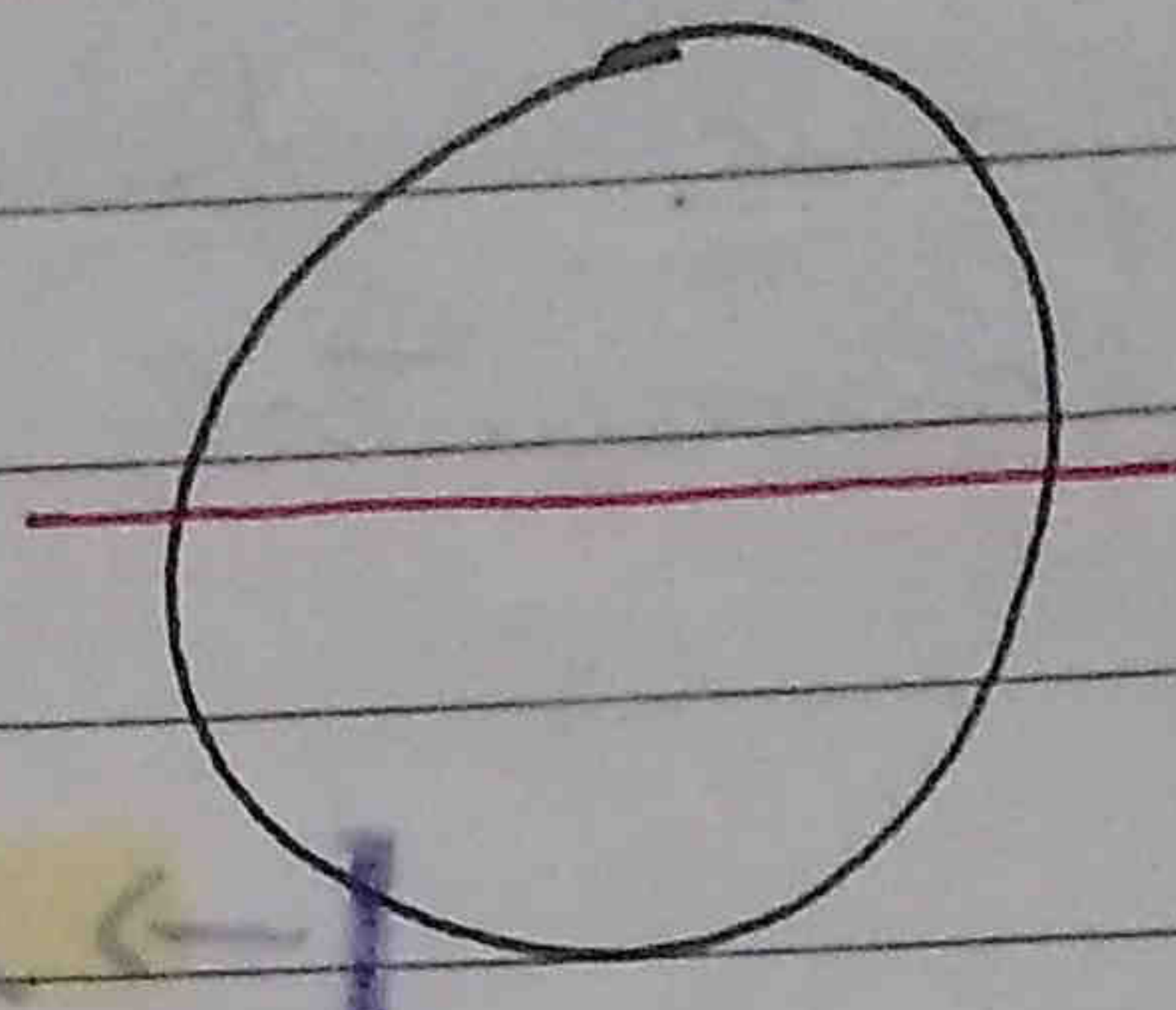


P.Y.Q. → Radial cleavage occurs in deuterostomes whereas spiral cleavage occurs in protostomes. CLASSMATE

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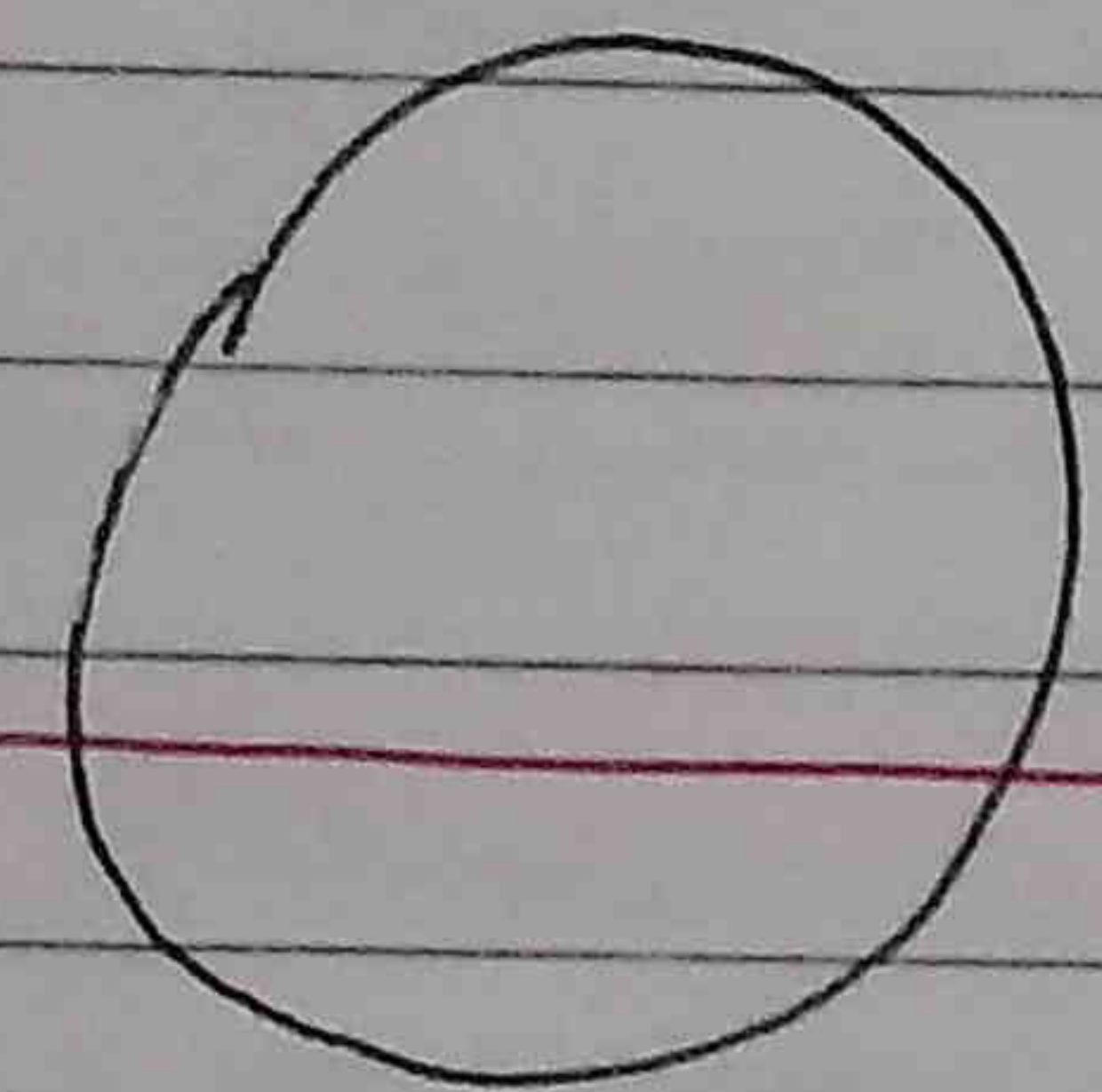
Vertical.



Equatorial

Animal pole

Vegetal pole



Latitudinal

Patterns of cleavage

Holoblastic
complete egg divides including yolk

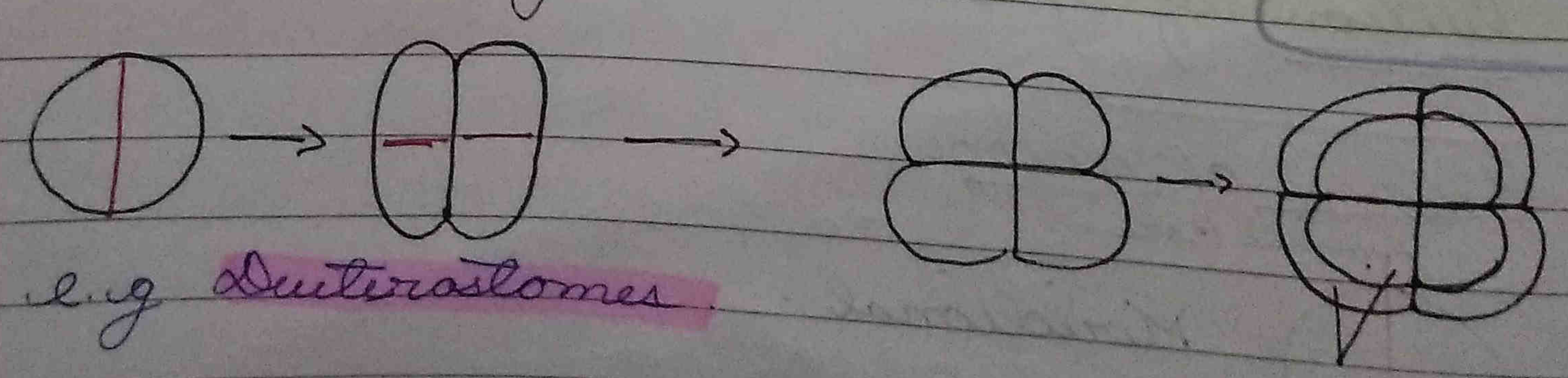
Meroblastic
Only egg cytoplasm divides.

Radial Spiral Rotational

Discoidal Superficial

Holoblastic

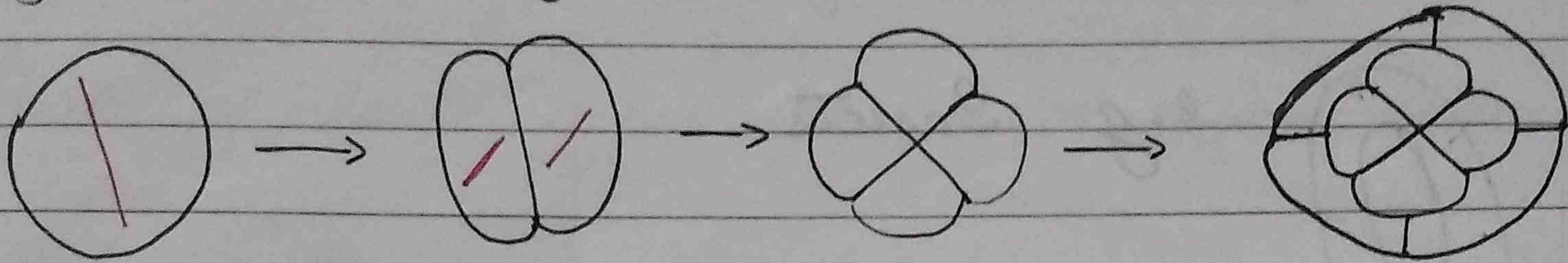
1) Radial Cleavage



e.g. Deuterostomes

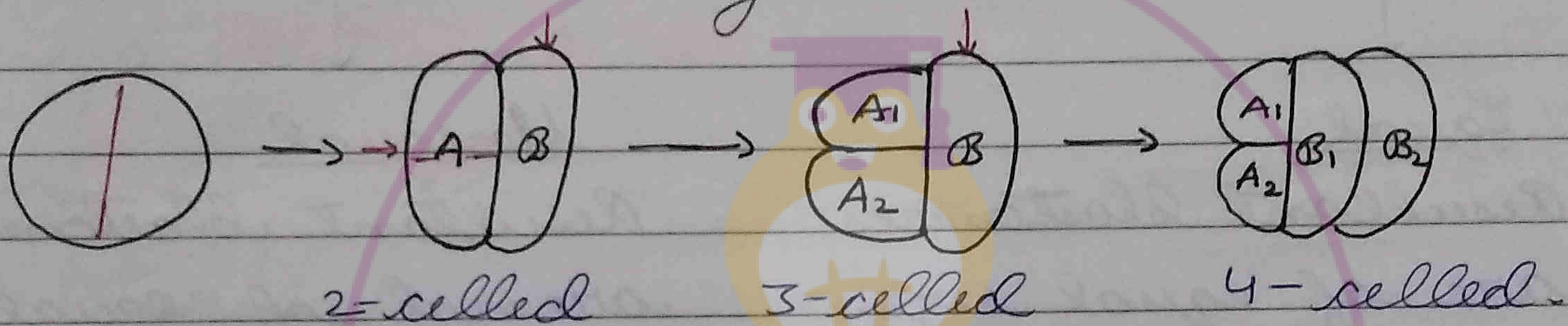
Blastomeres

2 Spiral Cleavage



e.g. Protostomes (except cephalopods)

3 Rotational Cleavage



e.g. Mammals

- Slowest cleavage in the animal kingdom

- Asynchronous

1 → 2 → 4 → 8 → 16

1 → 2 → 3 → 4

↪ odd no. stages also present.

• Meroblastic Cleavage

- Partial cleavage

- characteristic of Macrolecithal eggs.

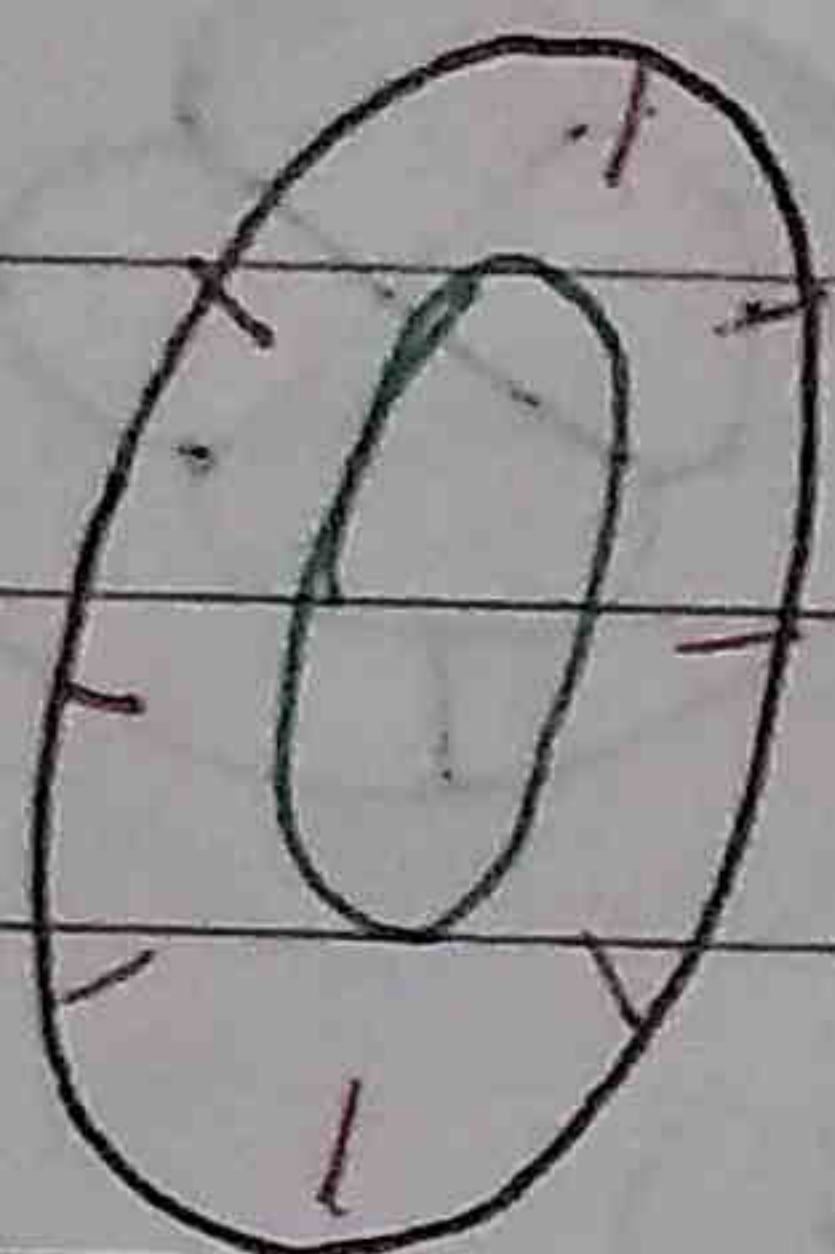
e.g. Birds and Reptiles

• Discoidal



unequal cleavage: vertical or latitudinal
 ★ Determinate cleavage is found in protostome, ~~invertebrates~~
 indeterminate cleavage found in deuterostomes

Superficial Cleavage



e.g. Insects

Holoblastic Cleavage

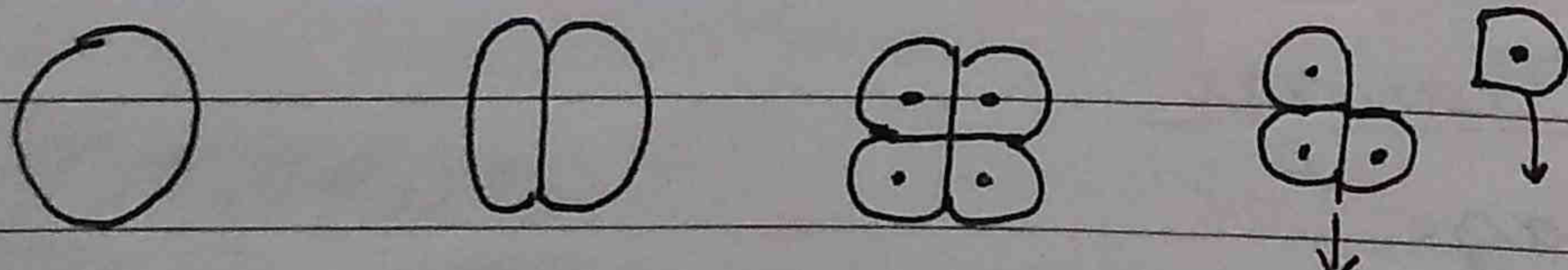
Equal
 Resultant blastomeres
 are of equal size.

Unequal
 Resultant blastomeres
 are not of equal
 e.g. In frog - from
 3rd cleavage division
 onwards.

Fates of Blastomeres

- Cleavage is of two types -

a) Determinate / Mosaic cleavage
 - Protostomes



complete organism
 does not develop.

morula → solid like cricket ball

blastula → hollow like tennis ball

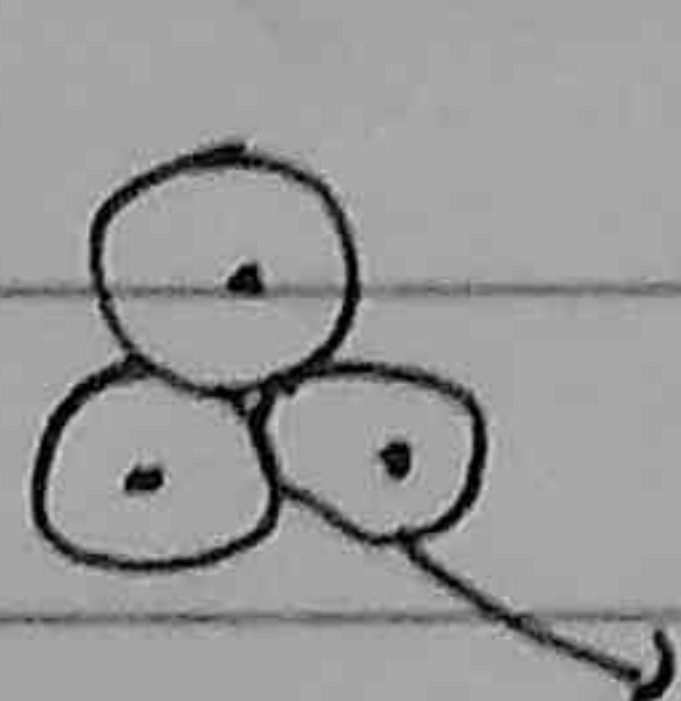
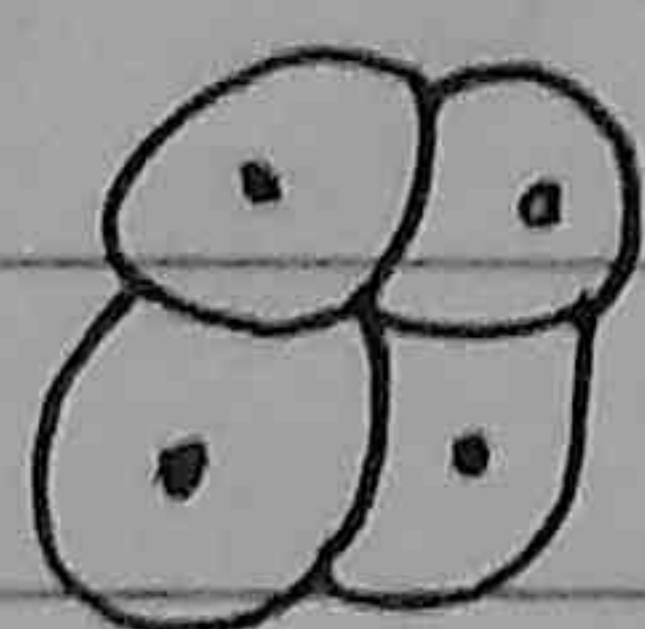
classmate

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B) Indeterminate / Regulative cleavage

- Fate of blastomeres is decided much later
- Potency to form complete organism is high



→ complete organism

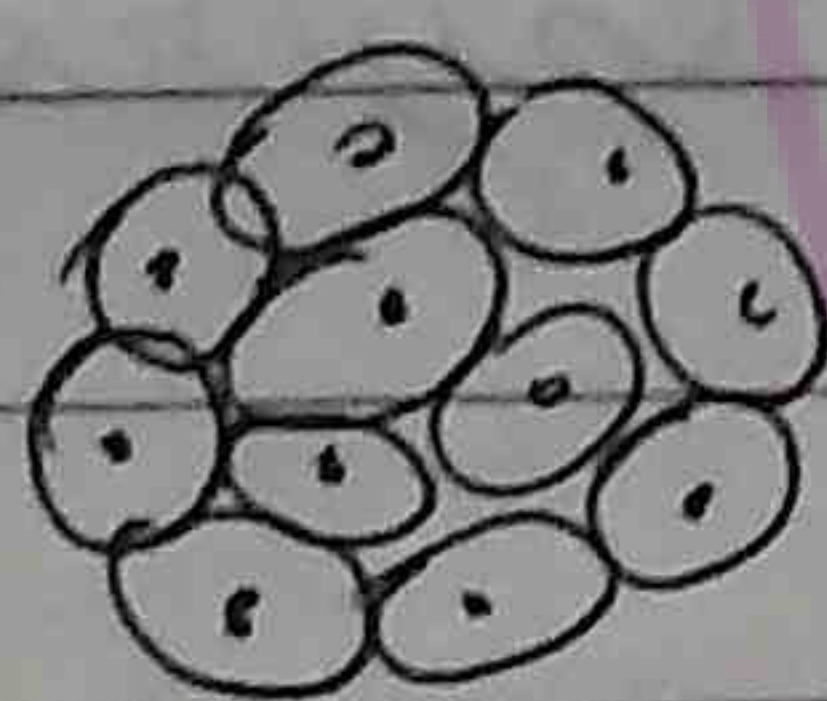
complete organism

e.g. Deuterostomes

• Morula

(Mulberry)

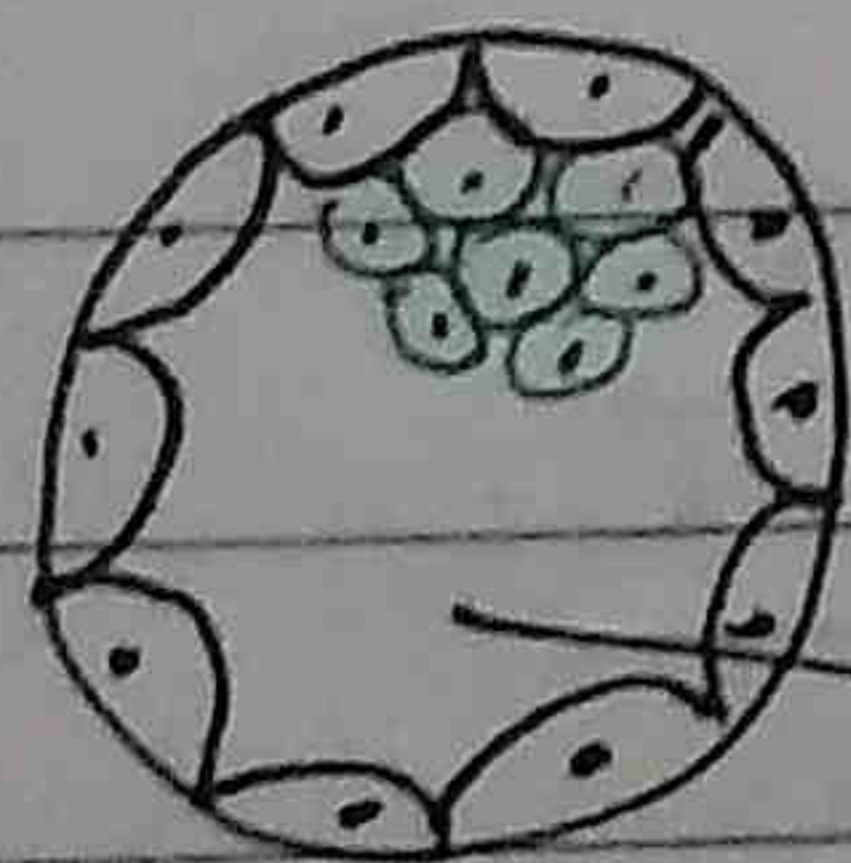
16-32 cell stage



∴ solid ball of cells.

• Blastula

— hollow ball of cells.

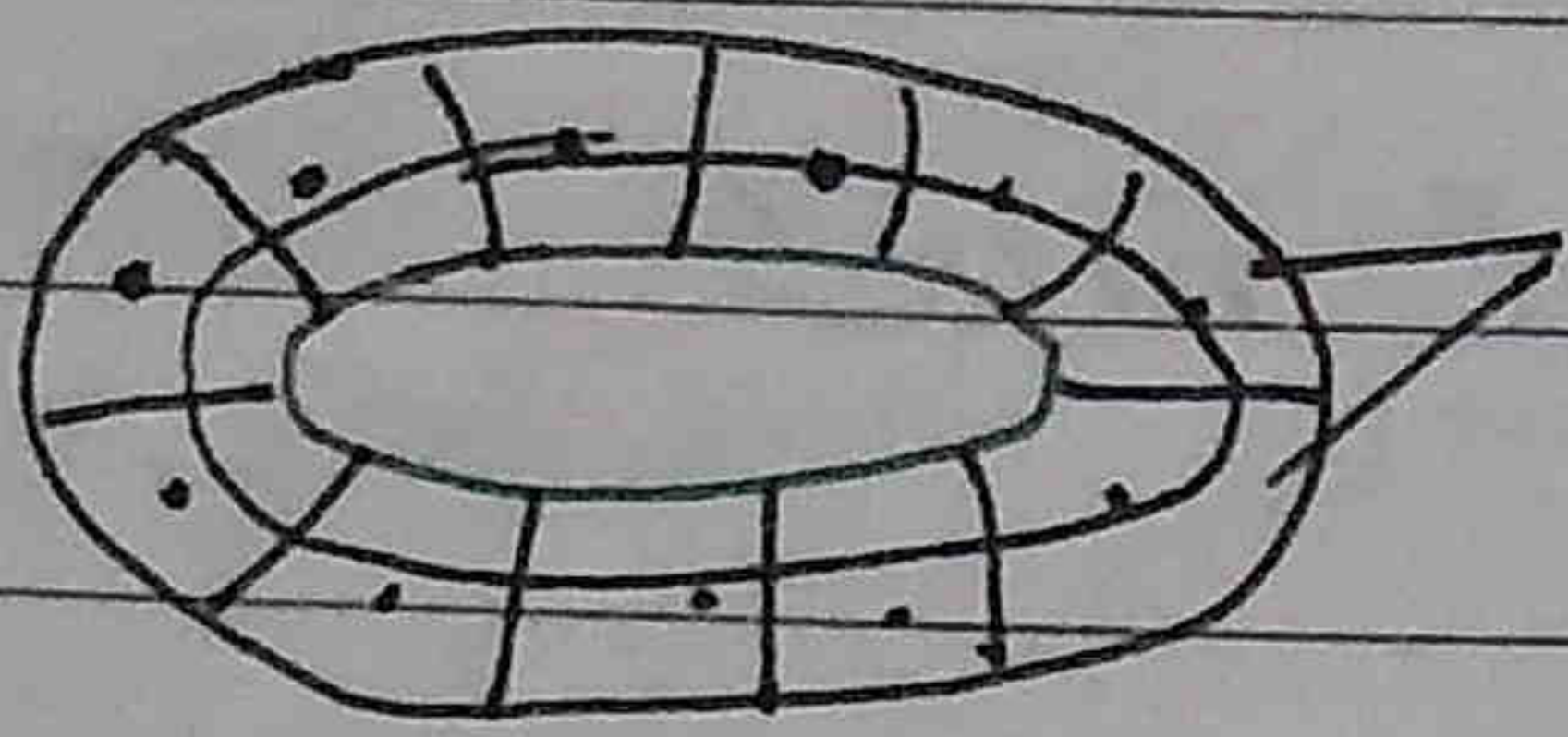


→ Blastocoel

→ Coeloblastula → hollow blastula
e.g. Frog

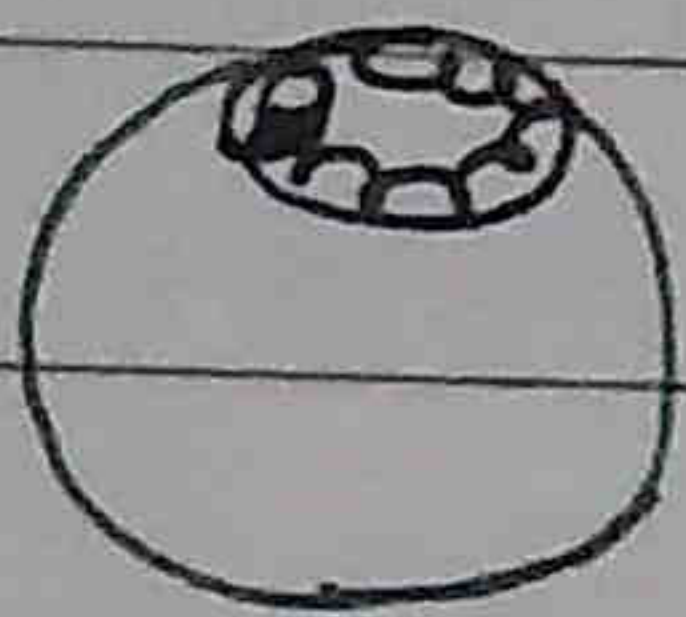
→ Stereoblastula → solid
e.g. Nereis, coelenterates

- Periblastula : eg. Insects



Blastomeres

- Discoblastula : eg. Birds, Reptiles



- Gastrula

★ -- Most important phase in the embryonic development

-- Dynamic event in which blastomeres move to organise into germ layers.

Morphogenetic Movements
During a Movement by blastomeres during gastrula to form germ layers.

Types of morphogenetic movement

Epiboly
(throw over)

Presumptive ectoderm
cells move over and cover the surface.

Emboly
(throw in)

Presumptive endo and mesodermal
cells move in.

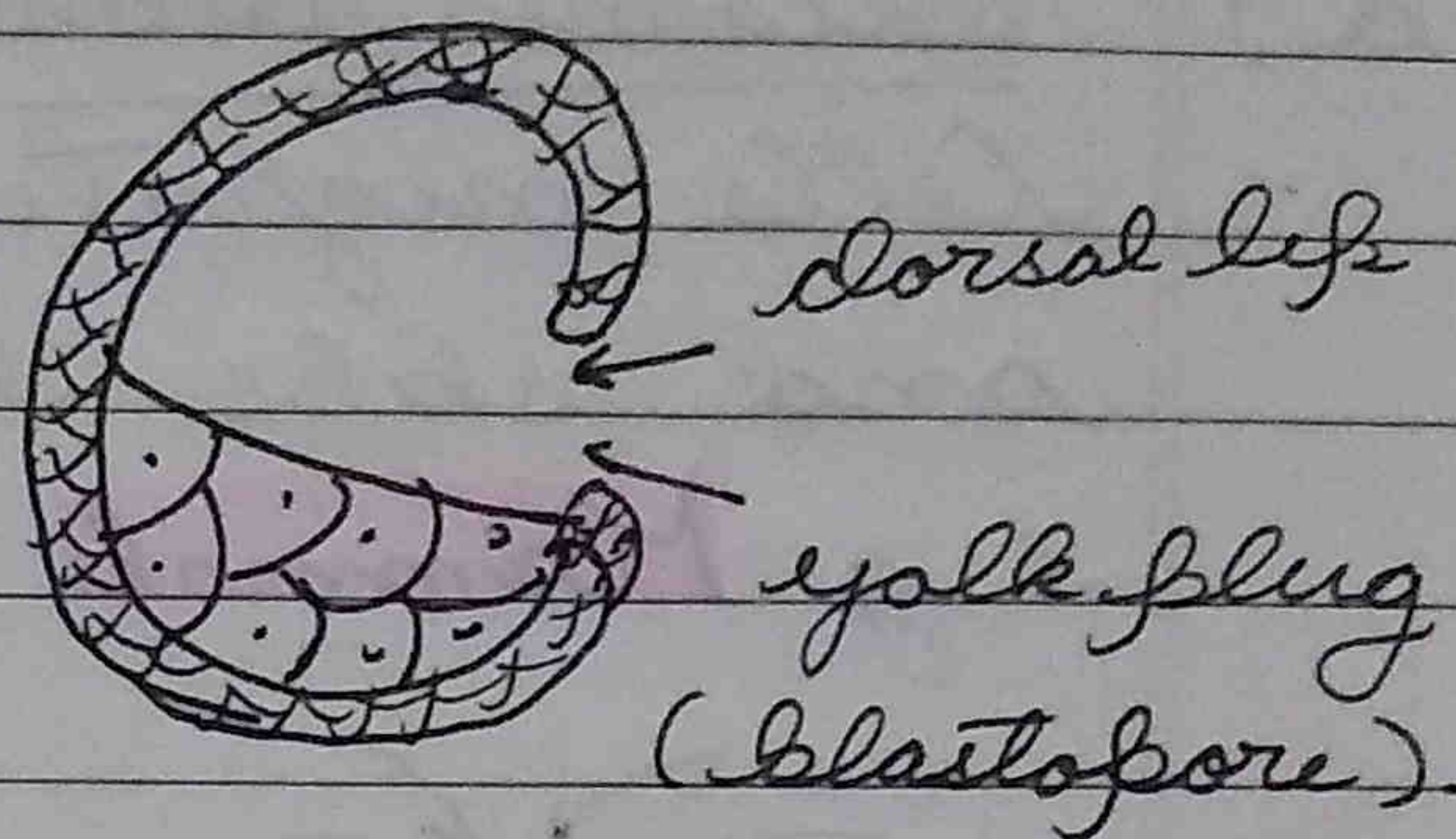
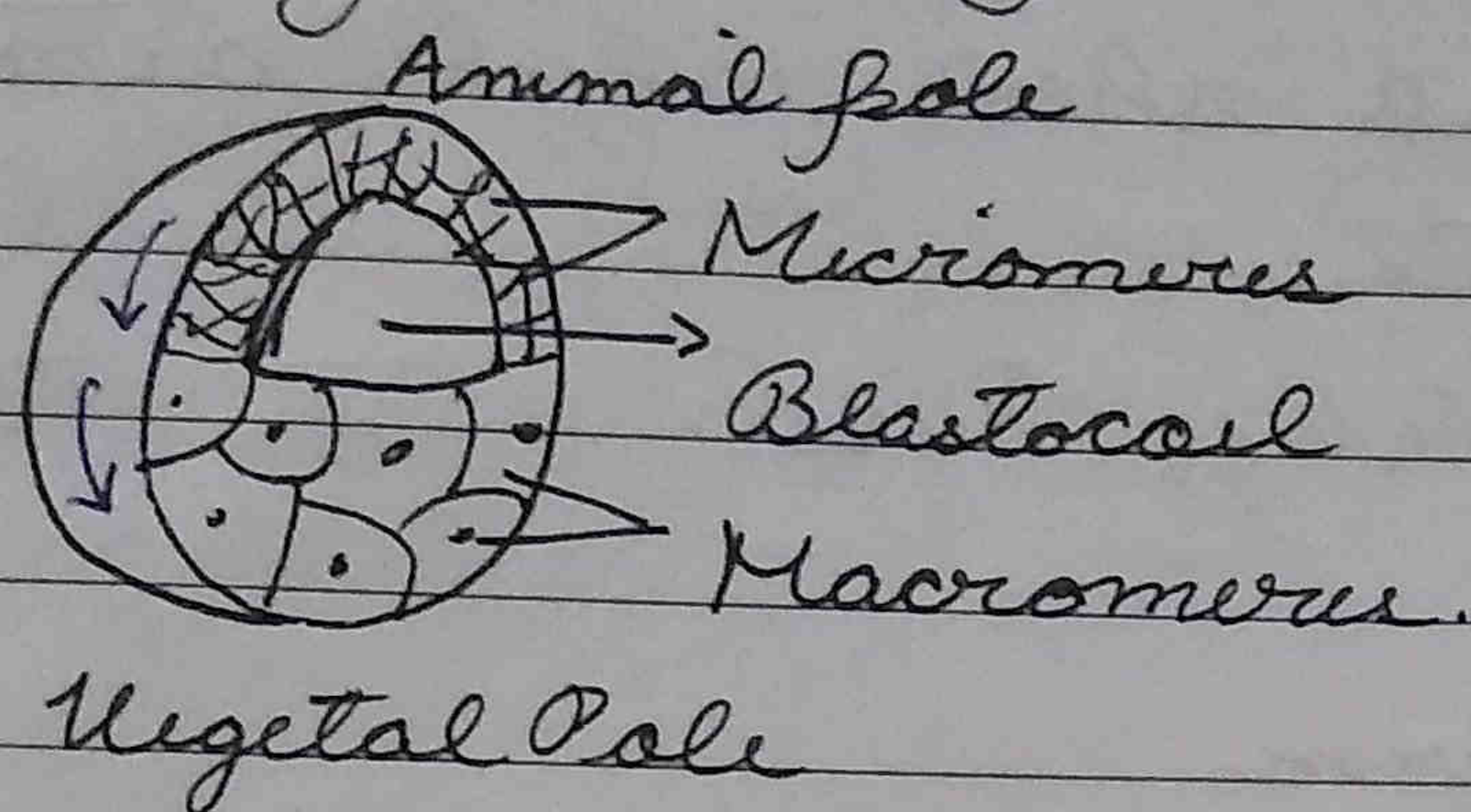
archenteron → embryonic gut

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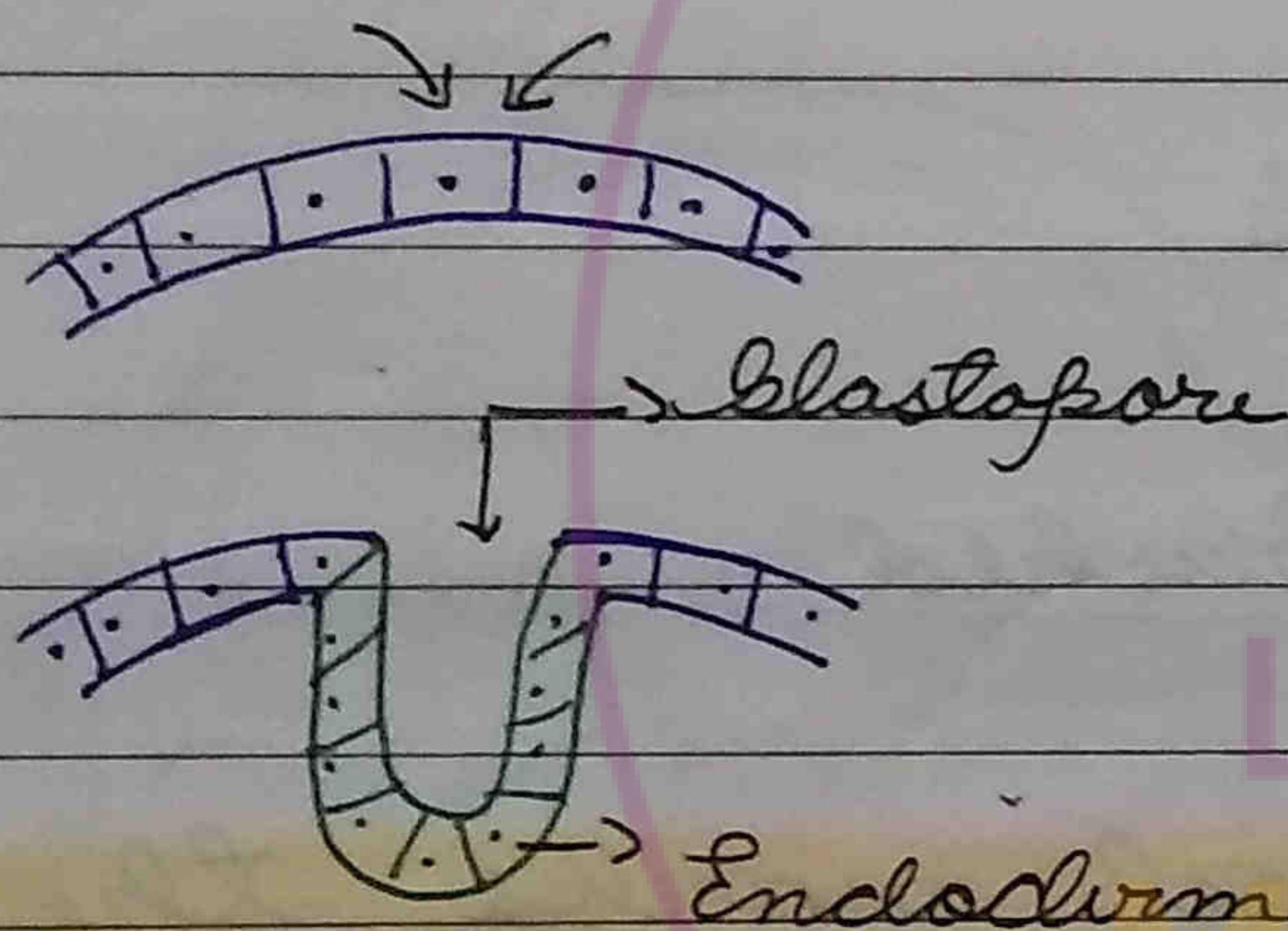
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Epiboly in Frog



Emboly

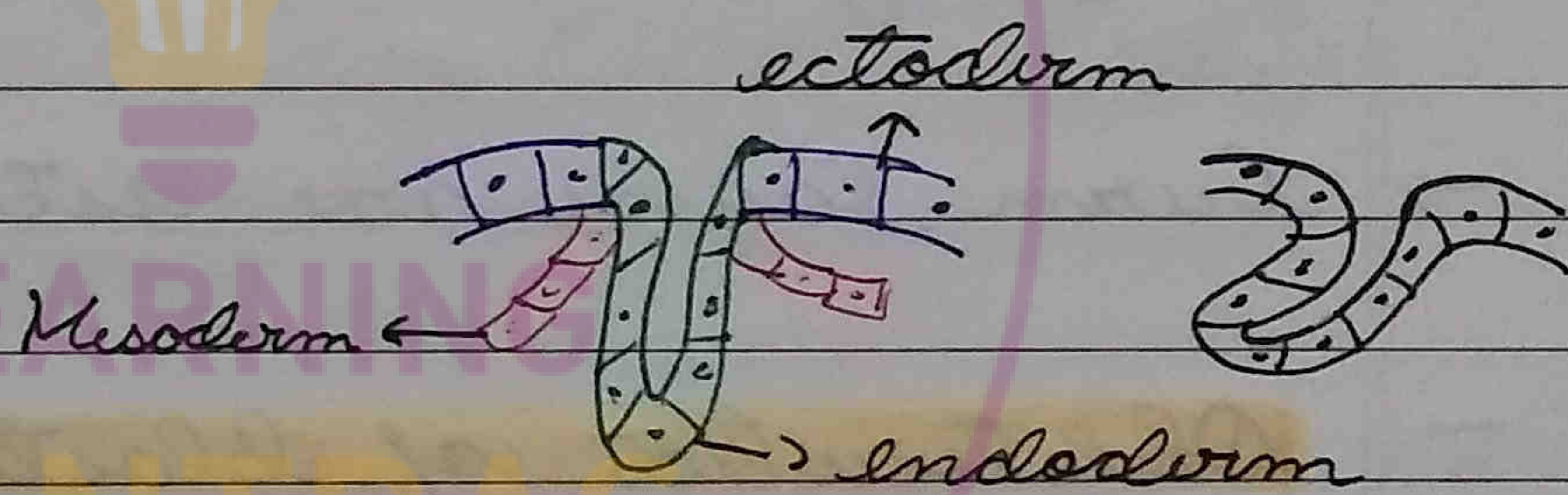
1 Ingression



Presumptive endodermal cells move in to form gut.
e.g. Frog

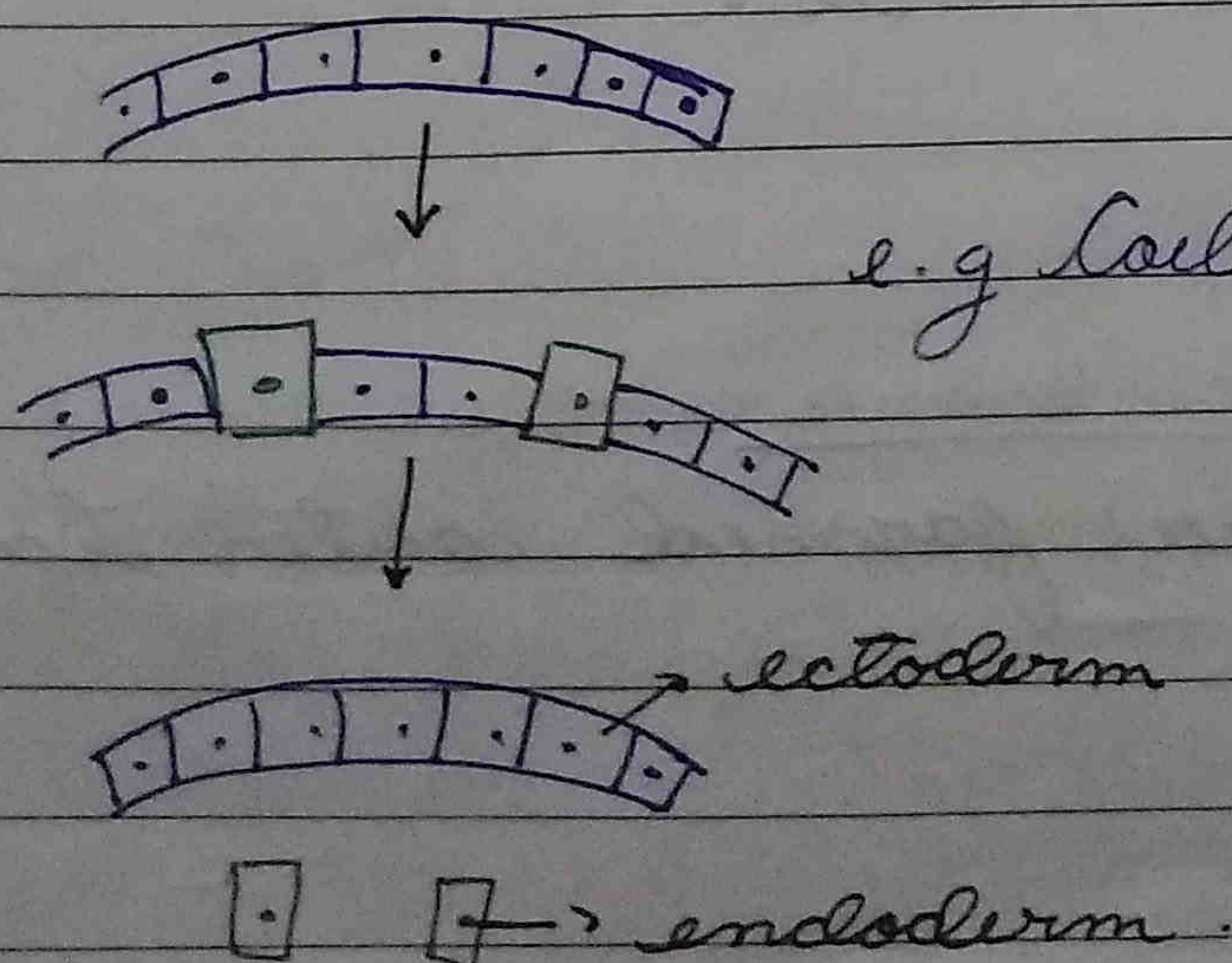
2 Involution (to roll in)

Presumptive mesodermal cells roll inside



e.g. Frog

c Ingression / Polyinvasion

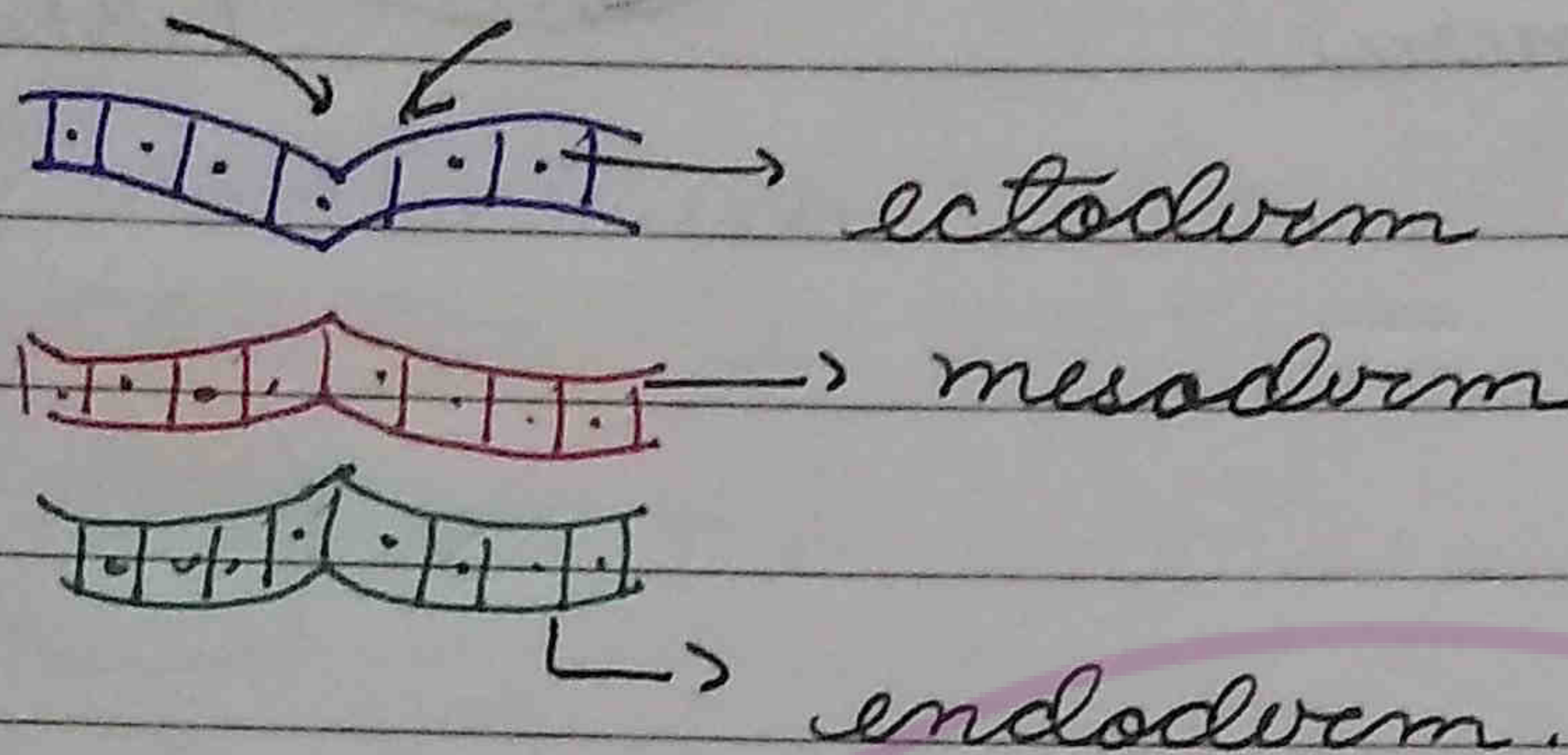


e.g. Coelenterates

d) Delamination

Cells migrate as a sheet which detaches and slips beneath.

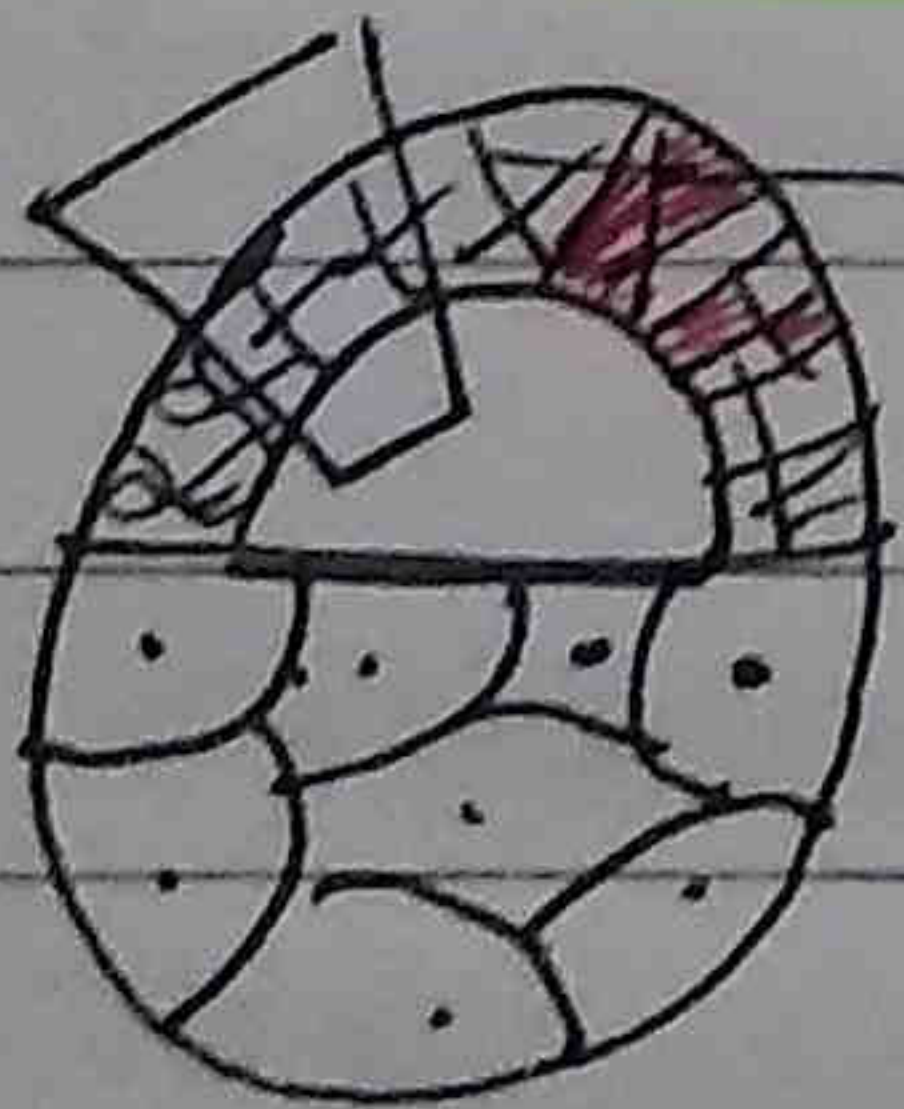
e.g. Mammals, Reptiles, Bird.

• Gastrula

- Morphogenetic movements

- Germ layers are established

- Obliteration of blastocoel marks the end of gastrula.

• Fate maps

stained

with vital
dye

Fate maps show the prospective fate of the blastomeres.

• Extra-embryonic Membranes

- Membranes which are formed outer to the embryo.

Blood cell formation in humans.

yolk sac → liver and spleen → bone marrow.

★

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All substances entering the embryo pass through chorion and are filtered hence chorion = ultra filter

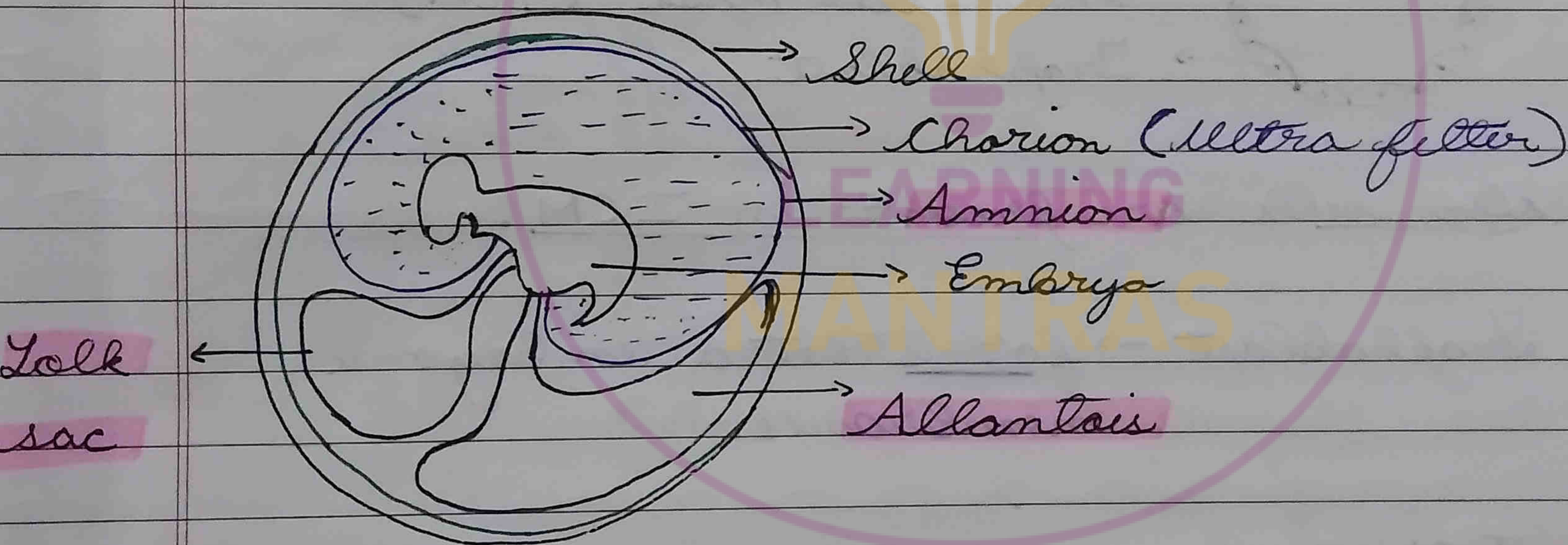
4 extra-embryonic membranes

Chorion	formed only in	Reptiles, birds and mammals.
Allantois		
Amnion		
Yolk sac		

- Amniotes: animals in which amnion is formed.

- Anamniotes: animals in which amnion is not present.

e.g. Amphibians, Fish.



• Amnion: Amniotic fluid protects the embryo from drying and from mechanical shocks.

• Chorion: ★ ultra-filter
Contributes to placenta in mammals.

• Yolk sac: In reptiles and birds, its function is to provide nourishment.

Mammals - No yolk in yolk sac

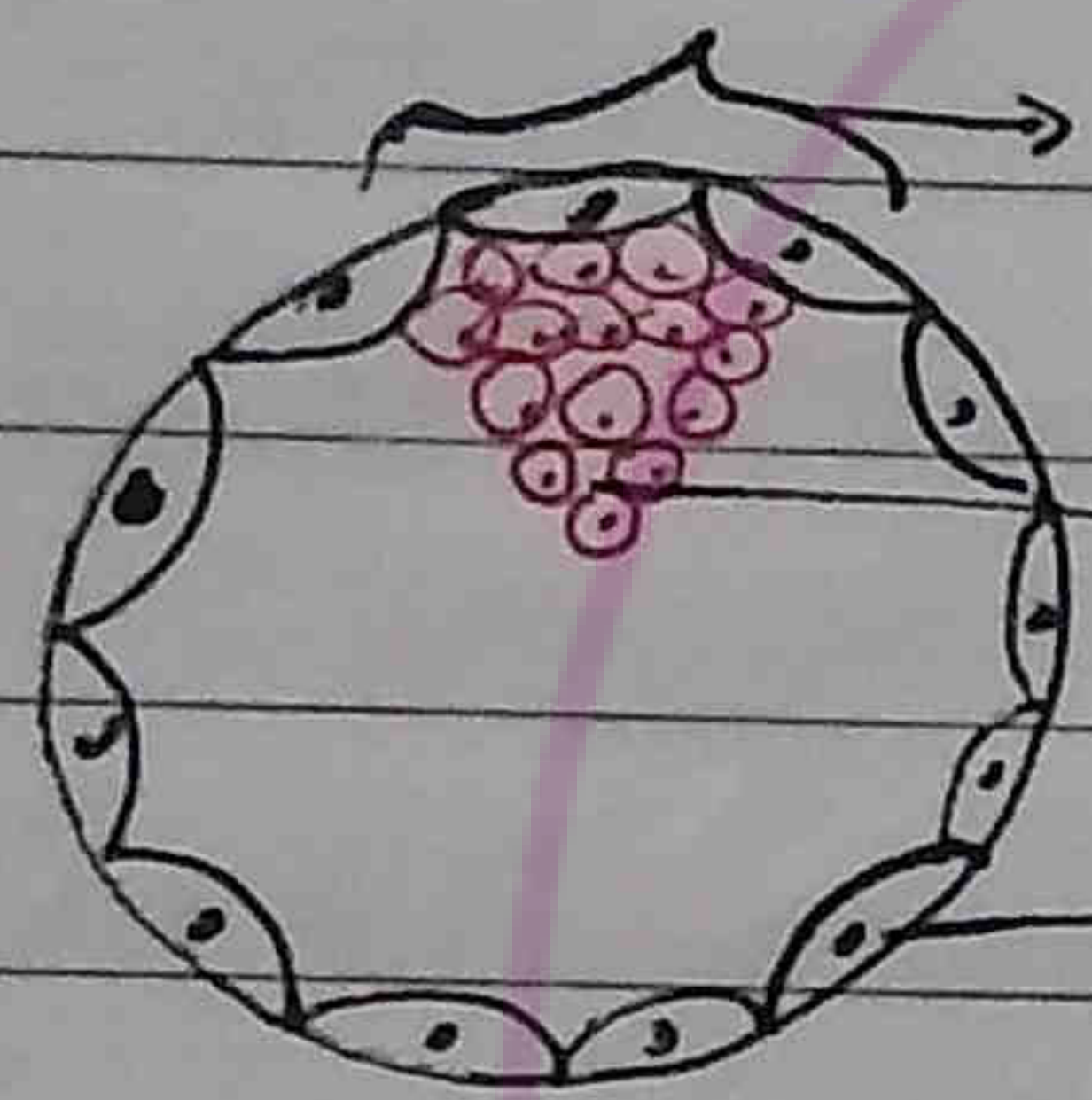
→ Stem cells which give rise to blood cells.

- Allantois → Nitrogenous wastes produced by embryo sac are deposited in reptiles and snails.

In mammals - nitrogenous wastes are removed via placenta.

- Chorion + Allantois form placenta in case of mammals.

Human Embryonic Development

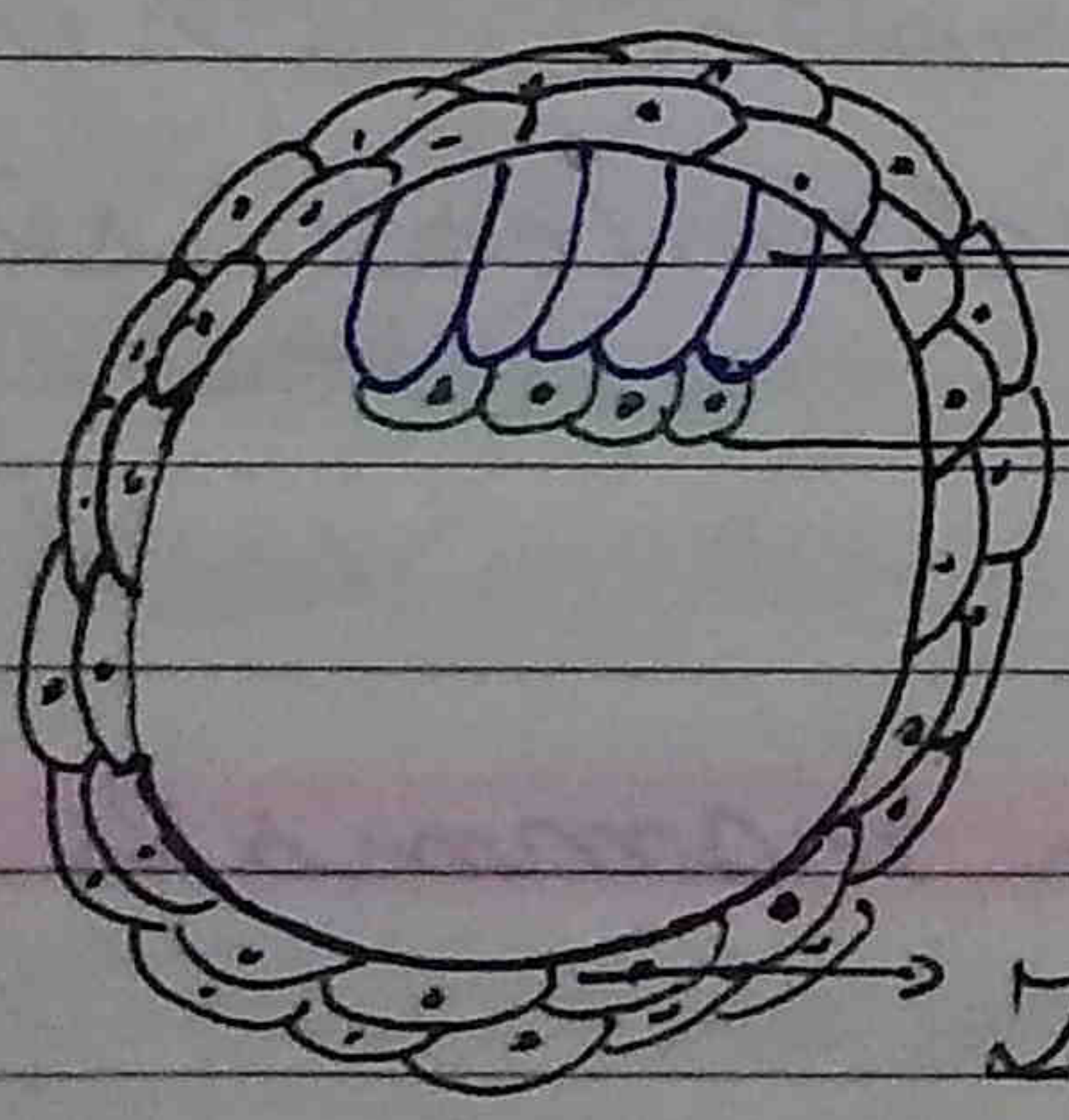


Cells of Rauber (sticky cells towards inner cell mass.)

Inner cell mass (ICM)

Trophoblast

- ★ stem cells are present in ICM.
- ★ Trophoblast → forms extra embryonic membranes.
- ★ ICM : forms embryo.



Epiblast (Germ Disc)

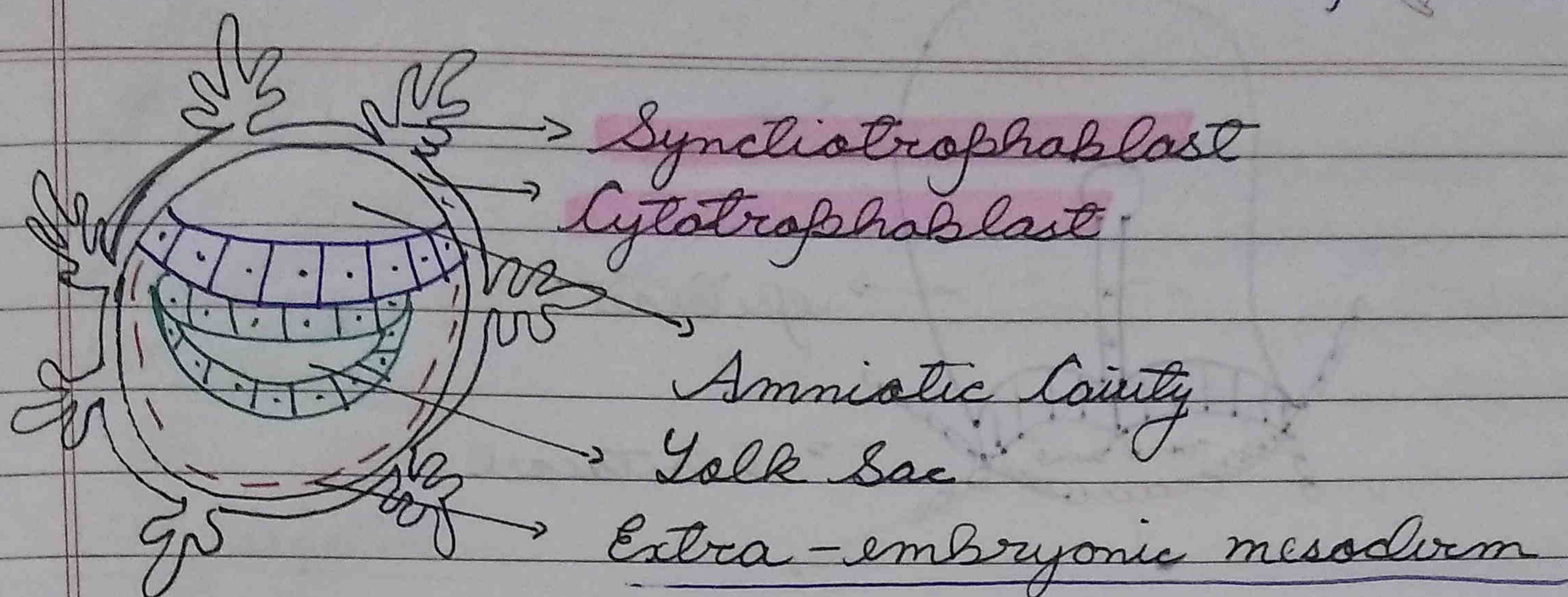
Hypoblast

Trophoblast

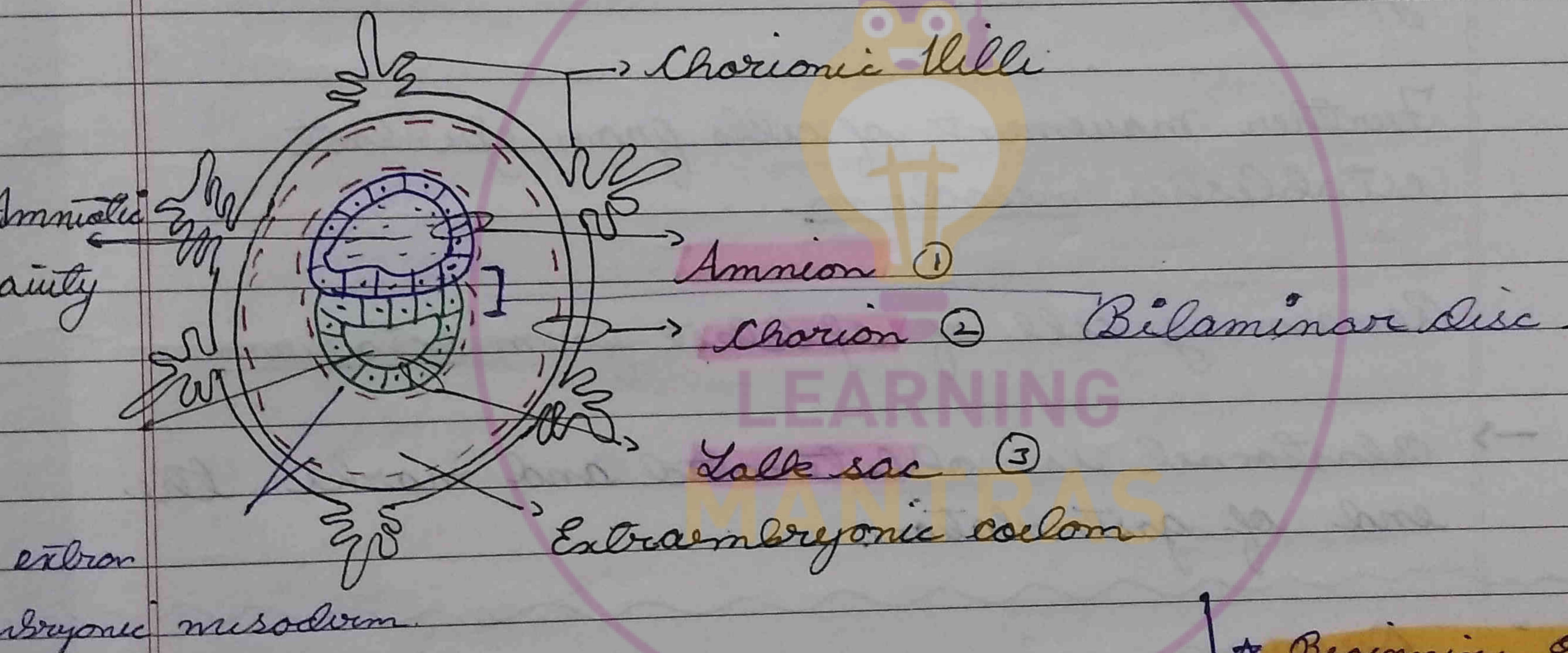
Epiblast : give rise to 3 germ layers

Hypoblast : Primitive endoderm (extra embryonic) layers

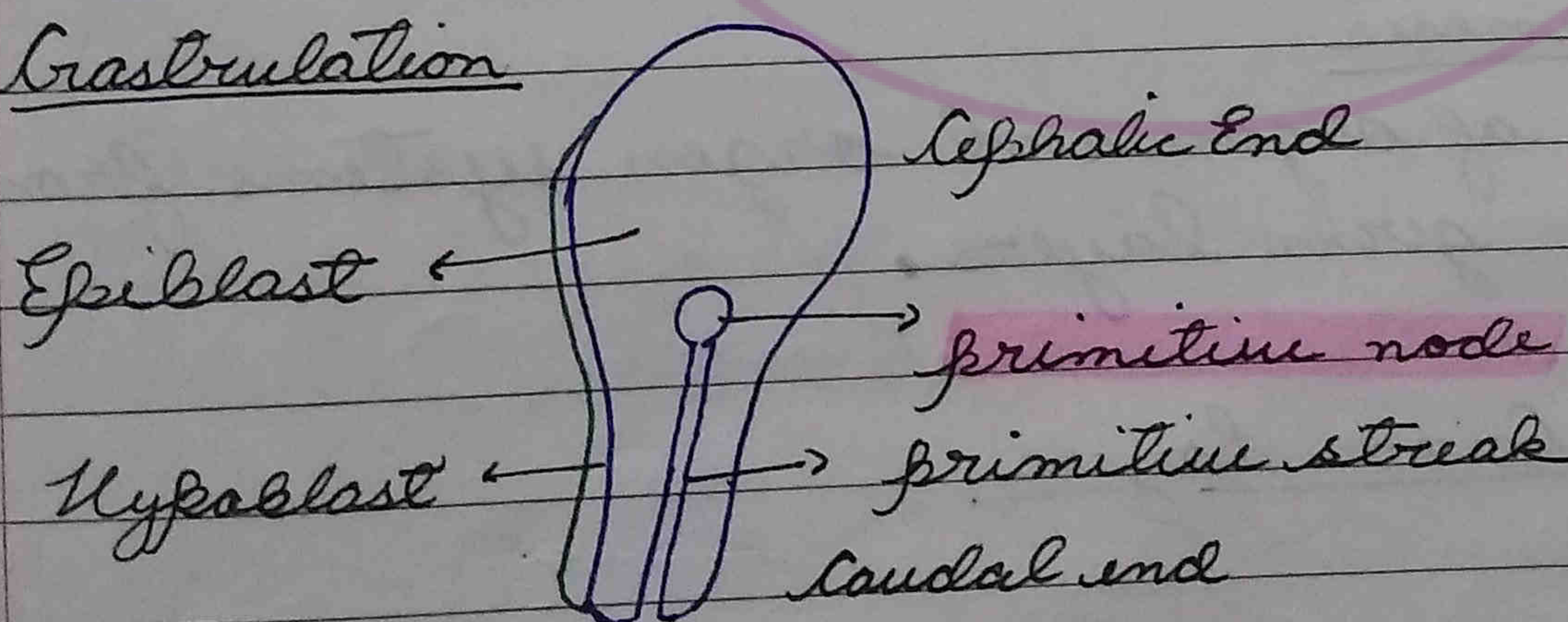
Amnion = Extraembryonic mesoderm + ectoderm
 Yolk sac = " " + endoderm
 Chorion = " " + Trophoblast



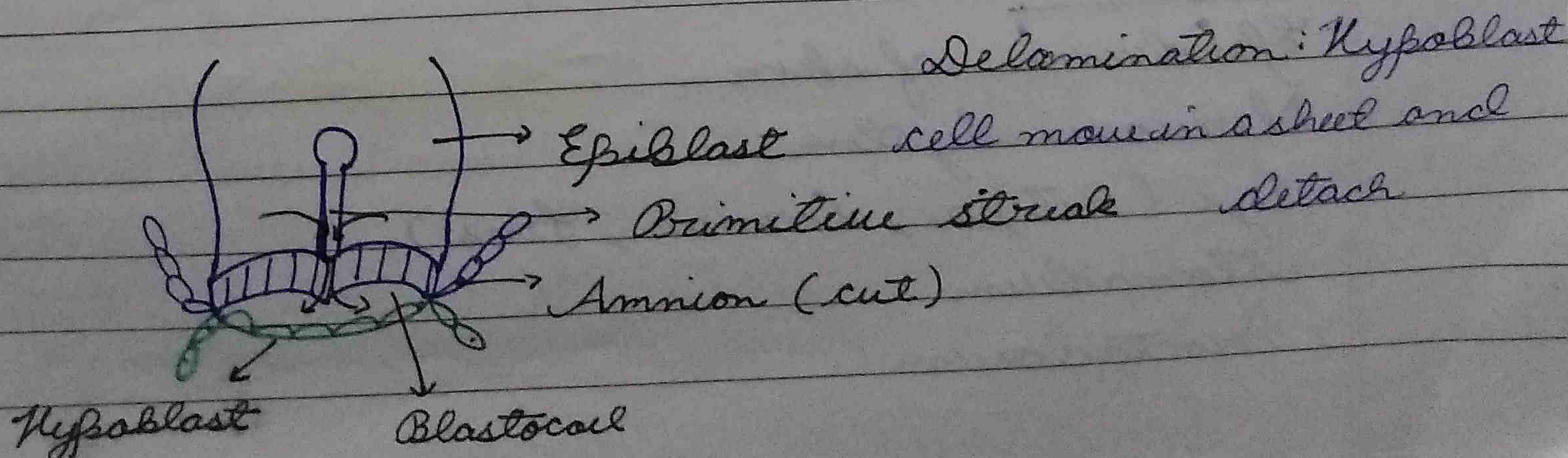
Cavitation: The epiblast layer forms a cavity → Amniotic cavity.



Gastrulation



★ Beginning of gastrulation is marked by formation of primitive streak.

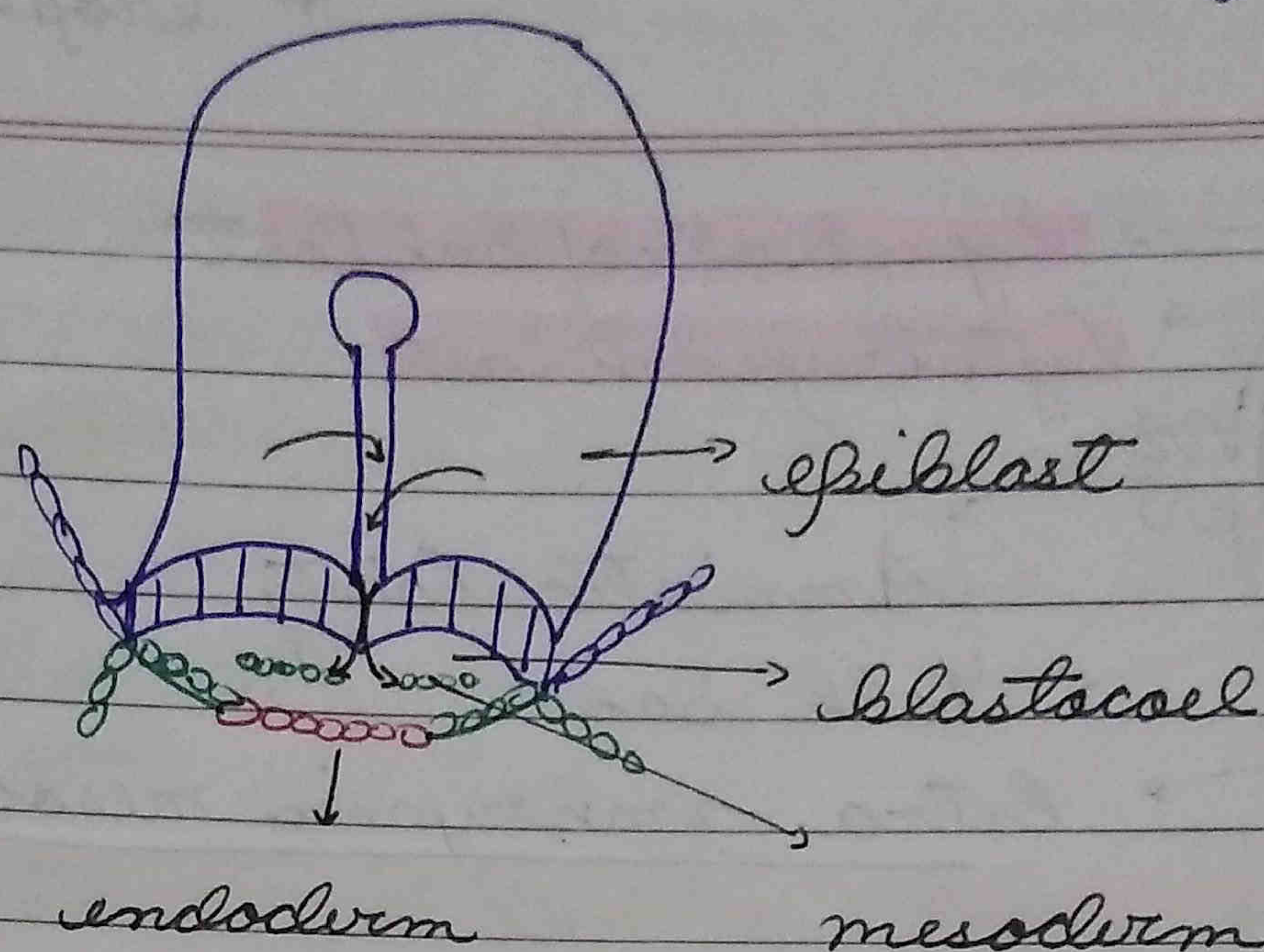




Endoderm is the first layer to be established followed by mesoderm and lastly ectoderm.

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• Endoderm is established when migrating cells displace hypoblast cells.

Further movement of cells from epiblast establishes mesoderm.

Remaining cell of epiblast form ectoderm.

→ Blastocoel is obliterated and marks the end of gastrulation.

Organogenesis

Formation of organ and organ systems from the three germ layers.

• Fate of Germ Layers

Ectoderm

Epidermis of skin

Nervous System

Eye (Retina, Cornea, Lens)

Stomach

Proctodaeum

Pineal

Pituitary

★ Adrenal Medulla

★ Enamel.

Mesoderm

Dermis of skin

Teeth (except enamel)

Blood vascular system

Heart

Cartilage, Bone

★ Adrenal cortex

Kidney

Gonads

Endoderm

Lungs

Alimentary Canal

Thyroid

Parathyroid

Liver

Pancreas

Inner lining of urethra

urinary bladder.

Placenta

- Temporary endocrine gland
- Formed by both foetal and maternal tissues.
- Fulfills the nutritive, respiratory (foetal lung), excretory requirements of the foetus.

Maternal — Decidua basalis

Foetal — Chorion and Allantois

— Placental Hormones

— Progesterone

— Estrogen

— HCS (human chorionic somatotropin)

→ causes growth and makes blood sugar high so that foetus has continuous supply.

— Human Chorionic Thyrotropin: stimulates maternal thyroid to release thyroxine (for physical and mental development of the foetus).

Cretinism: if HCS ↓

— Human chorionic corticotropin: stimulates maternal adrenal cortex.

— hPL (human placental lactogen): prepares mammary glands for lactation.

— Relaxin — secreted by corpus luteum of pregnancy. ∴ it is secreted in ovary.
• Loosens / softens the pubic symphysis.

If ovary is removed after 3 months \Rightarrow no effect

In umbilical chord there is 100:1 - fetal blood.

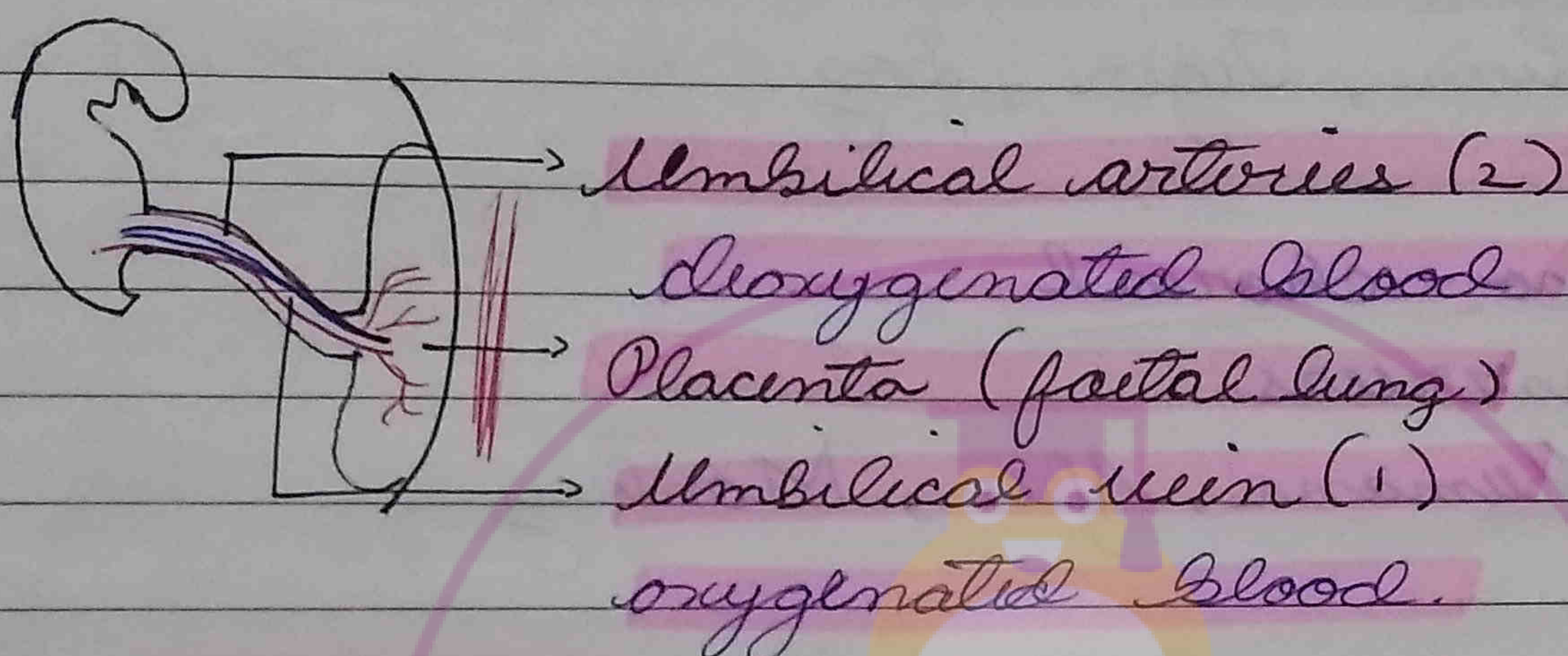
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Placenta is established by the 6th week of pregnancy.

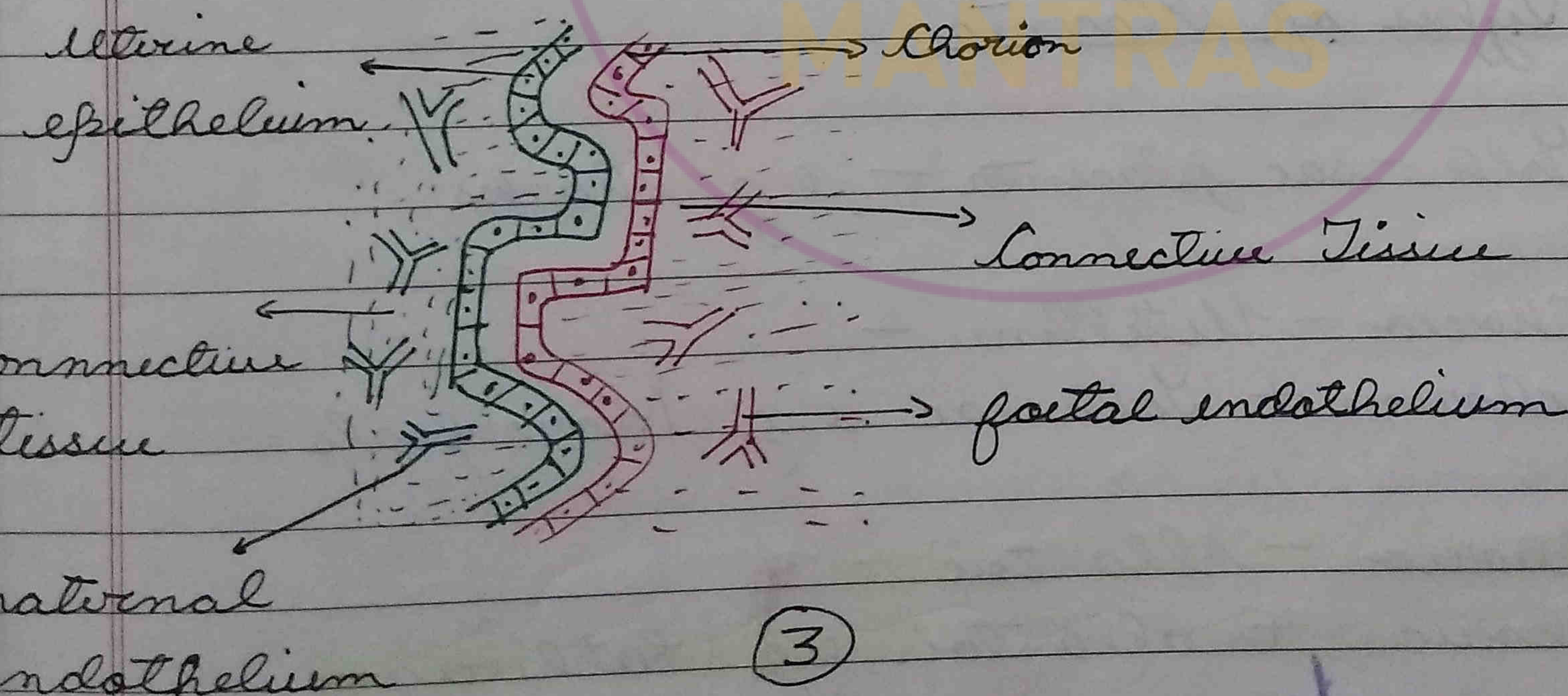
It takes over the function of corpus luteum.

- Placenta is connected to foetus through umbilical cord.



Placental Barriers

- do not allow mixing of foetal and maternal blood.



(3)

(3)

Epithelio-chorial: all 6 barriers present.
e.g. Horse, Pig.

2 Syndesmo-chorial
5 barrier
e.g. Cow, Buffalo, Goat

3 Endothelio-chorial
4 barrier
e.g. Lion, Tiger, Dog

4 Haemo-chorial
3 barriers
e.g. Humans, Apes, Monkey.

5 Haemo-endothelial \Rightarrow Advanced
Only 1 barrier (fetal endothelium)
e.g. Rat, Rabbit.

• Types of Placenta

a) Yolk-sac placenta - e.g. Sharks.

b) Chorio-vitelline -
chorion + Yolk sac e.g. Marsupials

c) Chorio-Allantoic -
chorion + allantois e.g. Eutherians.

↓
mammals \rightarrow Humans

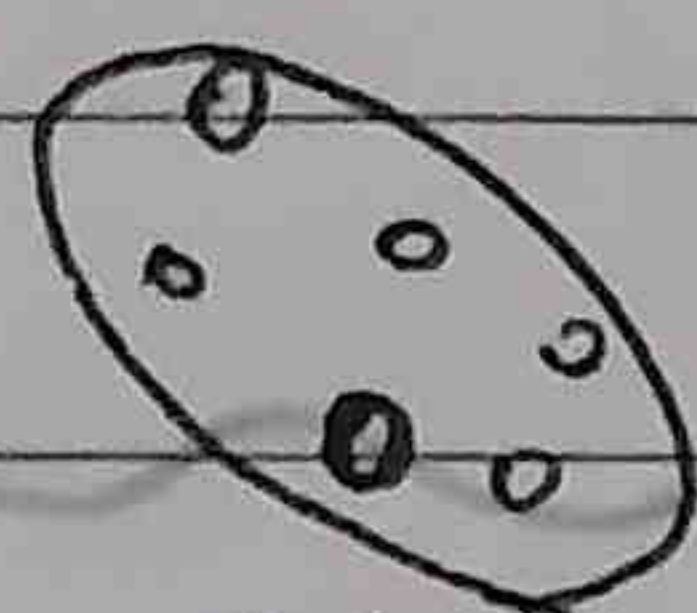
Placenta Types

Non-deciduate

Only foetal part is delivered.

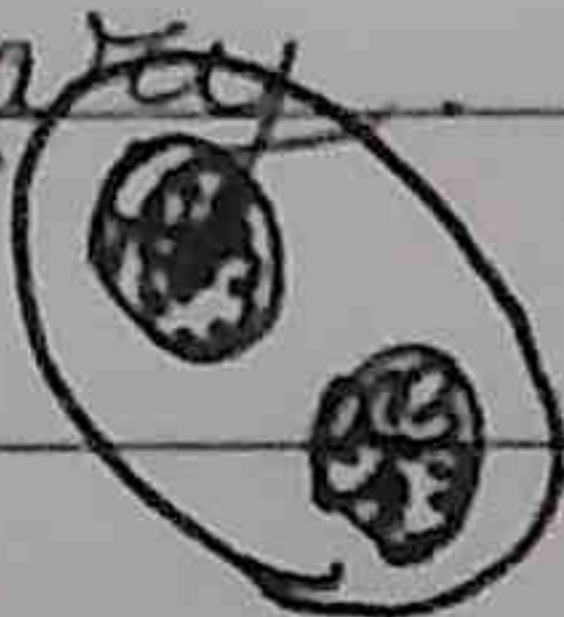
Diffuse

e.g. Horse, Pig



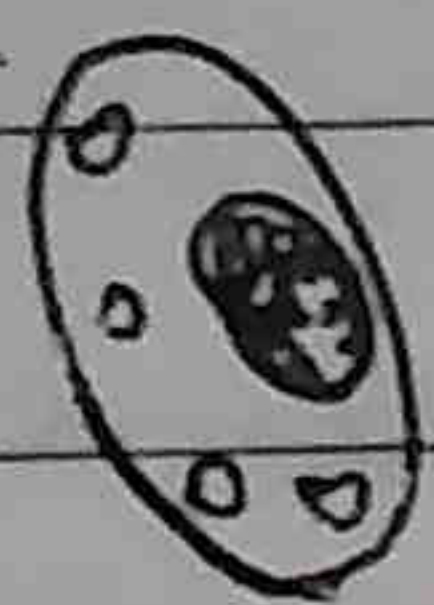
Stylodonary

e.g. Cow, Goat



Intermediate

e.g. Giraffe



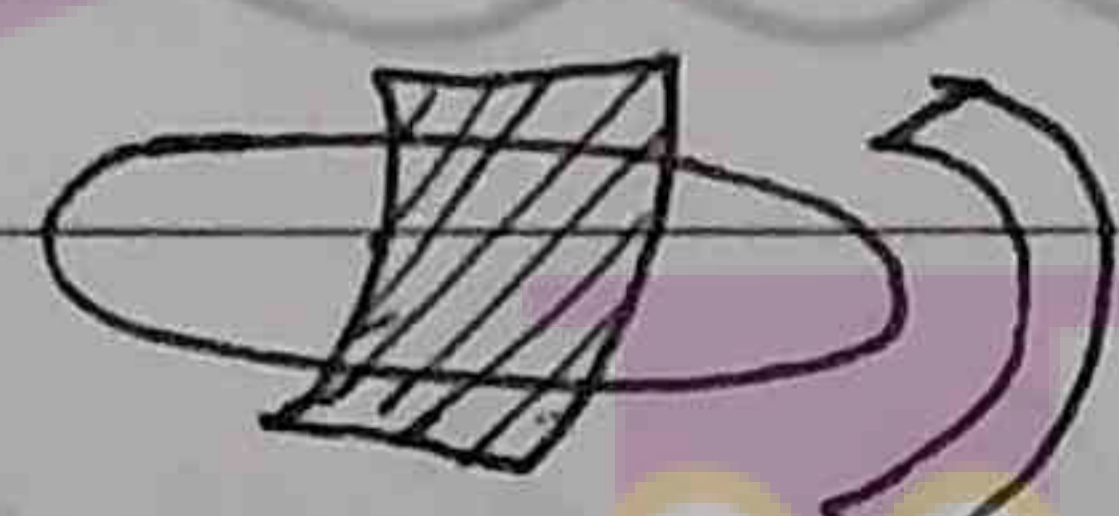
Deciduate

Both foetal & maternal part are delivered.

Zonary

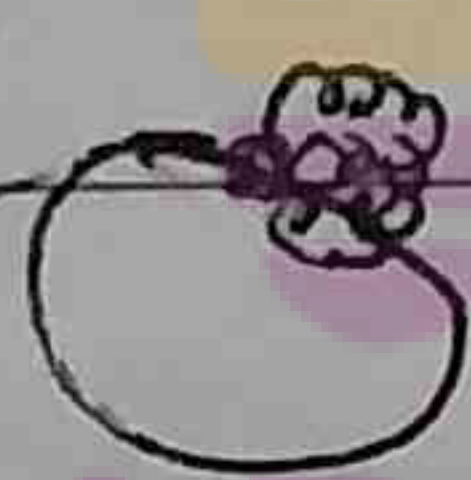
e.g.

Carnivorous, Elephant



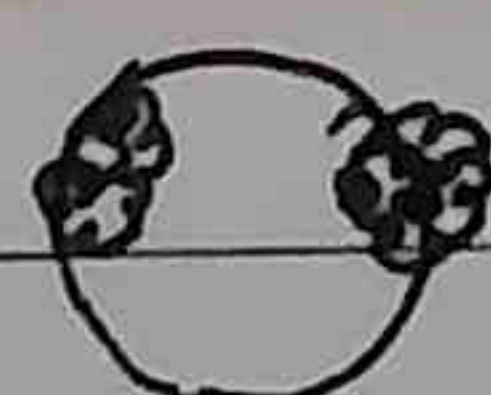
Discoidal

e.g. Rabbit, Rat



★ Metadiscoidal

e.g. Human



Contra-deciduate

Both foetal and maternal part are absorbed.

e.g. Peromyscus

(Bandicoot)

Talpa (mole)

Gestation period

Time period from conception till parturition.

Humans : 266 days from fertilisation

280 days from last menstrual period.

Elephants : 22 months (longest)

Cows : 9 months

Buffaloes : 10 months

4th week — Heart

1st trimester (3 months) all organ systems are formed.

→ Thalidomide (Drugs)

Phocomelia (feet failed to develop)

Teratogen (drugs causing abnormality)

• Parturition (Child-birth)

Fully formed foetus + placenta

↓
Foetal ejection reflex

Mild contraction occur in uterine muscles.
(Labour pains)

Release of Oxytocin hormone from posterior pituitary.

★ Estrogen from placenta rises and progesterone declines.

More contractions, cervix dilates (+) the feed back for oxytocin.

— Expulsion of foetus.

In foetal life IgG cross placental barriers.

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(NO) → under its effect pulmonary vessels dilate
switchover from placental to pulmonary
respiration.

Lactation: Release of milk from mammary
glands to nurse the child.

Prolactin - synthesis and secretion.

Oxytocin - release, Milk let down

Colostrum: thick, yellowish secretion
having IgA

Inhibitory peptide - inhibits milk formation
when child is not suckling.

Archenteron cavity is found in gastrula.

Calcaneous eggs are favourable for respiration.

Extrusion of second polar body from egg
nucleus occurs after entry of sperm before
completion of fertilisation.