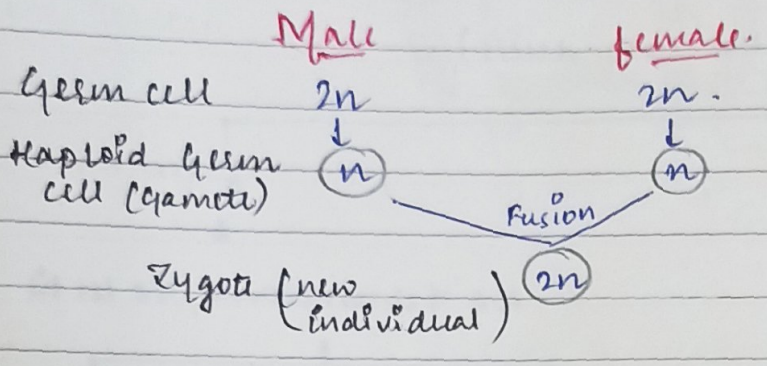
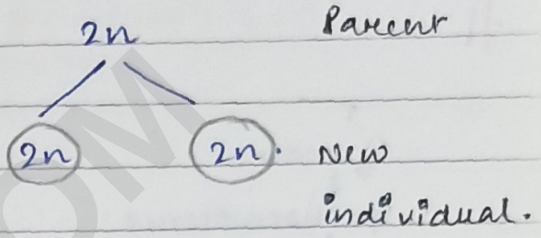
Sexual
- Biparental
- Gamete formation
- Gamete fusion
- Variation (✓)

Asexual
- Uniparental
- No gamete formation
- No gamete fusion.
- No vaciation.





Sex Organs (Plays role in Repsoduction)

Primary sex organ/ gonads. (forms the gamete)
- In male
  - Testis
  - forms gamete - sperm
- In female
  - ovary
  - forms gamete - ovum

Sec. sex organ (provide passage for gamete & help them in all way)
- In male
  - Epididymis
  - Vas-deferans
  - Seminal vesicle
  - Prostrate gland
  - Cowper's Gland
  - Penis

  (Seminal vesicle, Prostrate gland, Cowper's Gland → Accessory sex organs)
- In female
  - Uterus
  - Vagina
  - Fallopian tube
  - Bartholin's gland.

  (Bartholin's gland → Accessory sex organs)

* Parthenogenesis :- Development of embryo from unfertilised egg.
eg:- Honey bee drones

	Male	Female
Wolffian duct (Mesonephric duct)	Forms the sec. sex organs	Degenerate
Mullerian duct (Para-mesonephric duct)	Degenerate	forms the sec. sex organ.

#

Zygote (Has both ducts).

If male
↓
Y-chromosome
↓
SRY Gene
↓
TDF (Testis Determining Factor)
↓
formation of Testis.

- Leydig cells.
  ↓
  Release Testosterone (male sex hormone)
  ↓
  Development of Wolffian duct
  ↓
  Formation of sec. sex organ.
- Sertoli cells
  ↓
  Release AMH (Anti-Mullerian Hormone)
  ↓
  Degeneration of mullerian duct.

If female
↓
No Y chromosome, No testis

- Testosterone ✗
  ↓
  Development of Wolffian duct
  ↓
  Degeneration of Wolffian duct.
- AMH ✗
  ↓
  No degeneration of Mullerian duct
  ↓
  Development of Mullerian duct
  ↓
  Formation of sec. sex organs.

Testis :-

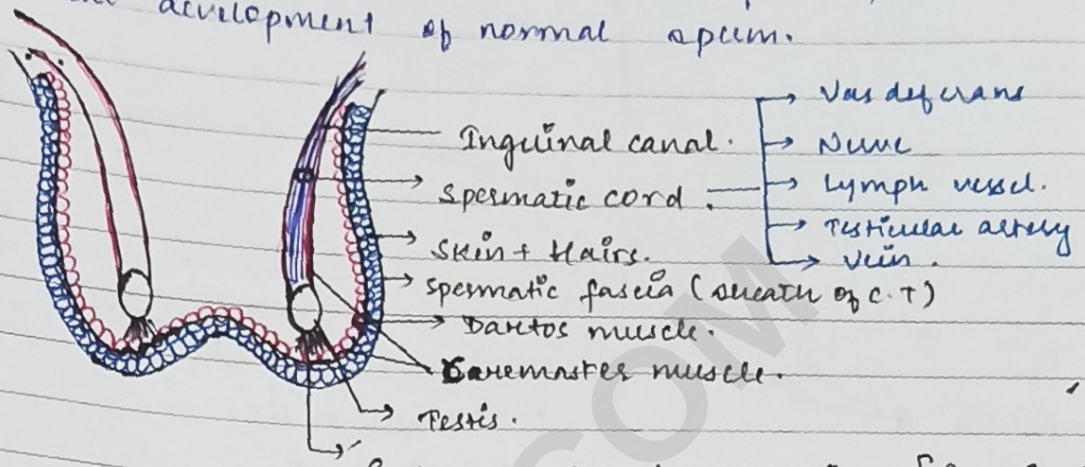
Mesodermal, length = 4 to 5 cm.
width = 2 to 3 cm.

- Soft, pinkish, oval shaped organ., paired.
- Extra abdominal organ ent in scrotum
- Develop from mesoderm in abdominal cavity
- Starts to descend down into scrotum at 7th month of pregnancy through inguinal canal & descend completely into scrotum on 8th month of pregnancy.

Scrotum :-

Temp. inside scrotum is 2-2.5°C less than body temp. which is suitable for the development of normal sperm.

∩ → Cremaster
∩ → Spermatic fascia
∩ → Dartos



Gubernaculum / mesorchium [Elastic fibre cord]

Muscles of scrotum

Dartos muscle
- contracts when ext. temp. is low.
- ↓ Shrinkage of scrotum
- ↓ Reduce surface area of scrotum
- ↓ Heat loss reduced. ⟶ Temp. of testis maintained.

Cremaster muscle.
- contracts when ext. temp. is low.
- ↓ Elevation of testis towards the abdomen.
- ↓ Temp. of testis maintained.

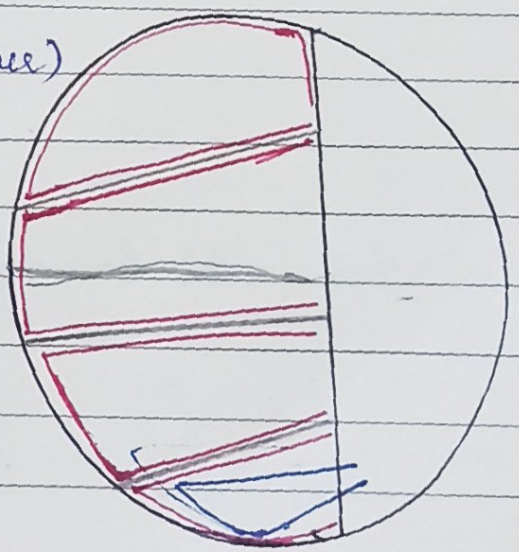
Internal structure of Testis :-

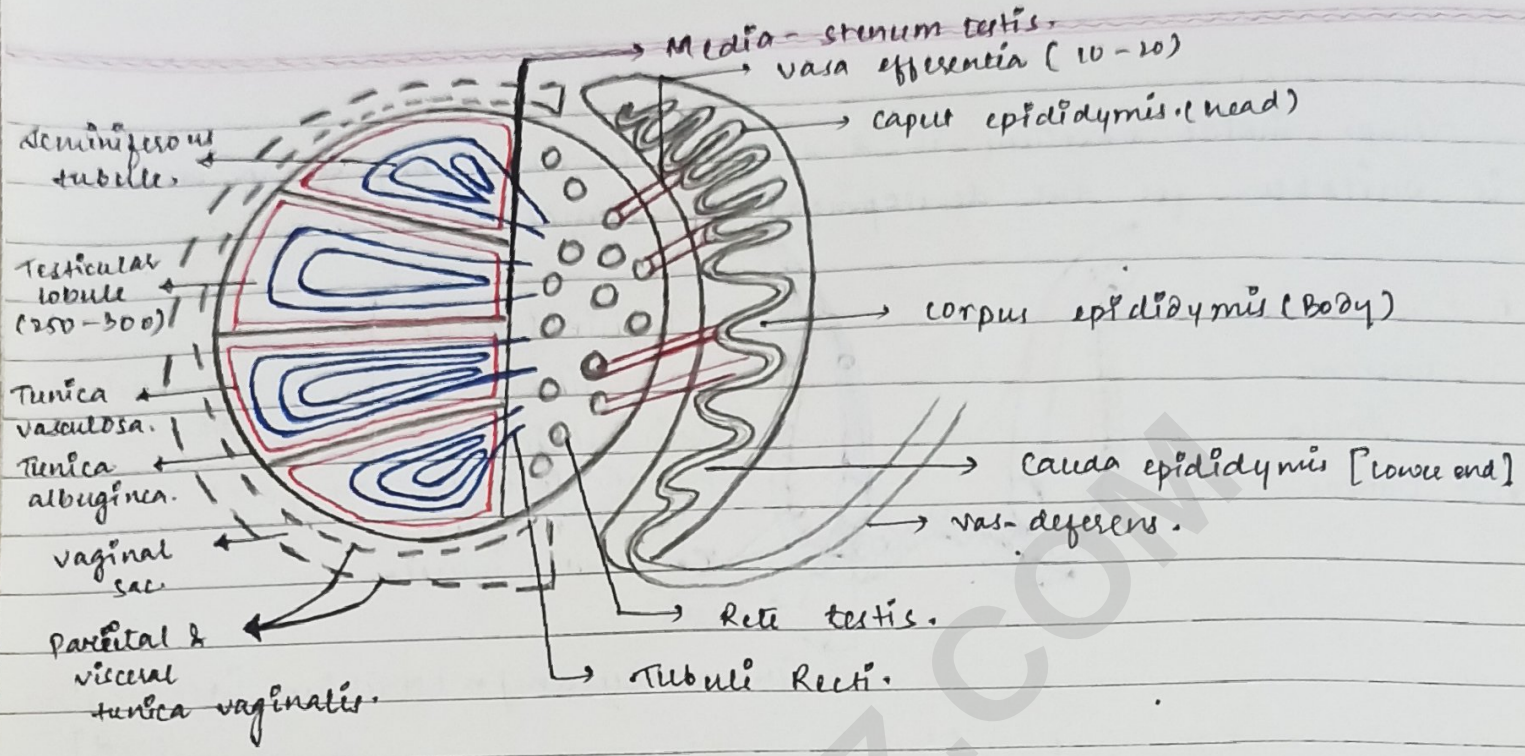
- Testis has 3 layers (outer to inner)

(i) Tunica vaginalis [Parietal, Visceral.

(ii) Tunica albuginea.

(iii) Tunica vasculosa.





- **Functions of Epididymis**

(i) Temporarily store the sperms [Ampulla of vas-deferens also stores]

(ii) Functional maturation of sperm (sperm gains motility here)

(iii) Decapacitation of sperms

layer of cholesterol on acrosome of sperm

↓

Acrosome will not burst in male body

layer of inhibitory proteins on sperm

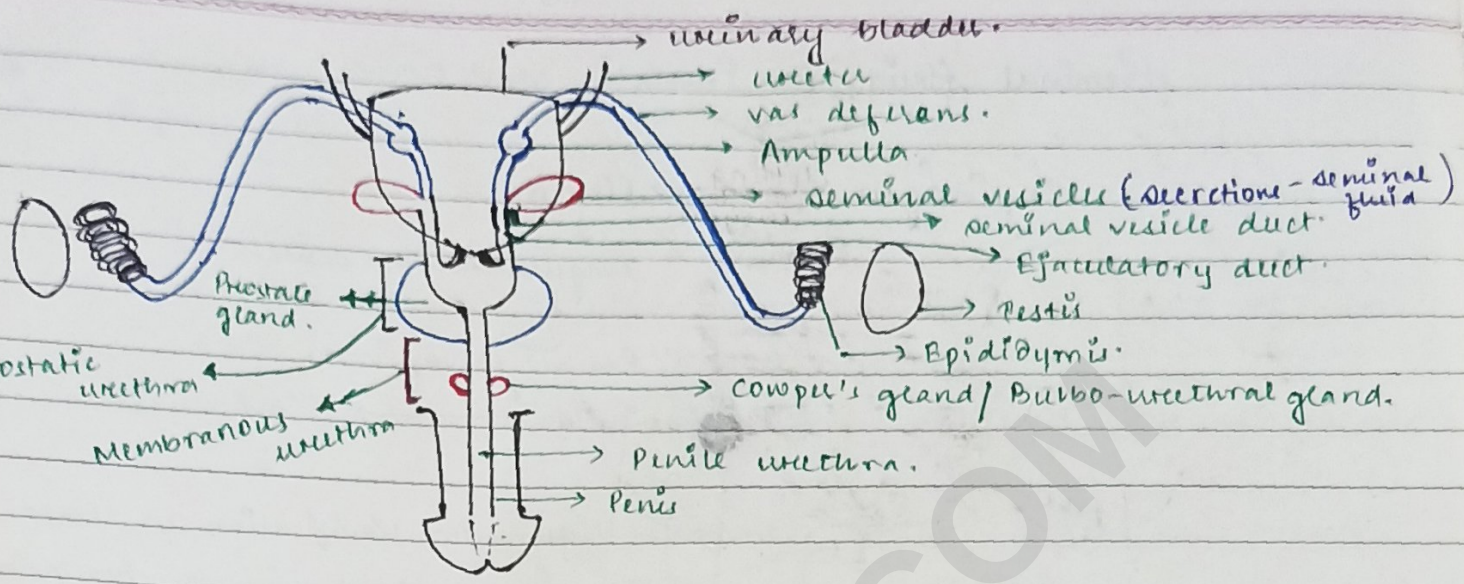
↓

Motility of sperms will be suppressed.

↓

Energy of sperm will be conserved in male body

* Capacitation occurs in vagina by cervical mucus secretions



Seminal Vesicle

- Secrete seminal fluid
- a pair
- located on dorso-lateral side of urinary bladder
- pH = 7.3 (Alkaline)
- forms 60-70% part of semen

Contents :-

1. fructose (fuel for sperm)
2. Prostaglandin — light contraction in vaginal muscle
3. Fibrinogen — i.E → fibrin - causes coagulation of semen.
4. Inositol
5. citrate.

Prostate Gland

- forms 30% part of semen
- Located just below the U.B.
- pH = 7.2
- unpaired, made of 5 lobes
- Helps in sperm activation in female vagina

Contents :-

- clotting enzyme
- Probibrinolysin — causes lysis of fibrin in vagina.
- citric acid (fuel)
- Ca^{+2}
- PO_4^{-2}

Cowper's Gland

- Present on membranous urethra, pours secretion into penile urethra.
- pH = 7.2
- functions :-

(1) lubrication for copulation

(2) cleans the urethra (destroy the acidity)

Seminal fluid + Prostatic secretions.

Fibrinogen $\xrightarrow[\text{enzyme}]{\text{clotting}}$ Fibrin.

↓

coagulation of semen.

↓

Reaches to vagina.

↓

Profibrinolysin ⟶ Fibrinolysin

↓

~~liquification~~ liquification of semen after 15-20 min of ejaculation.

Semen = Sperm + Seminal fluid + (Prostatic secretion + Cowper's secretion)
10% 60% 30%

→ Semen = Sperm + Seminal plasma
(secretions of accessory sex glands)

→ Semen = 3-4 ml / ejaculation

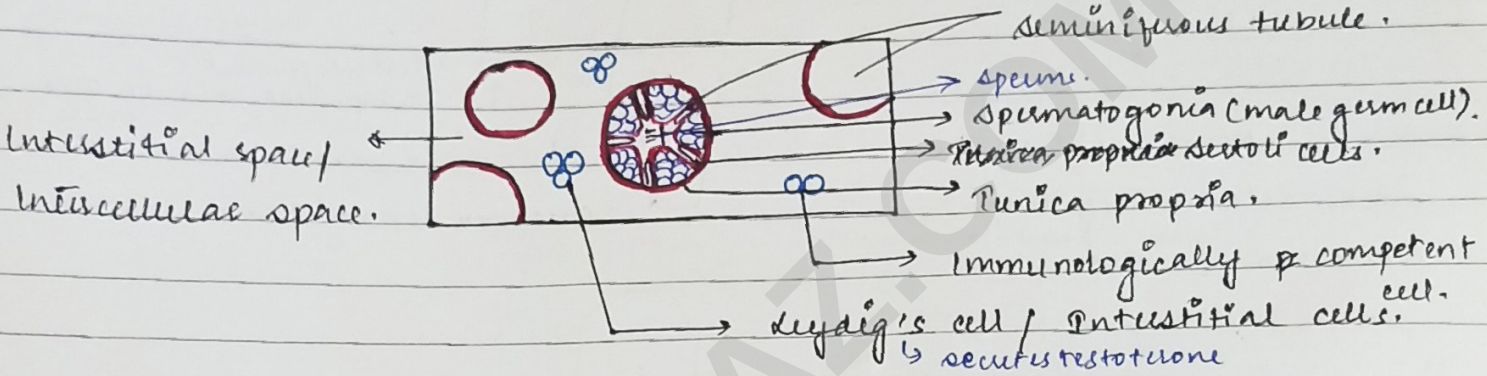
→ Sperm count in semen = 200 - 300 million / ejaculation
20 - 180 million / ml of semen.

*** For normal fertility, 60% sperms must have normal size & shape, & out of them 40% sperms must be motile i.e., must have vigorous motility.

- Oligospermia :- < 20 million sperms / ml of semen
- Azoospermia :- Almost absence of sperms in semen
- Necrospermia :- dead or non-motile sperms in semen
- Teratozoospermia :- Abnormal size & shape of sperms in semen
- Asthenozoospermia :- Less motility of sperms.

Histology of Seminiferous tubules :-

- Highly coiled.
- 1 - 3 in each testicular lobule.
- (750 - 1000) in each testis
- forms the sperm - structural & functional unit of ~~sperm~~ testis.
- [outer layer - Tunica propria (WFCT).
  Inner layer - cuboidal germinal ~~epidermis~~ epithelium (has spermatogenic cells)



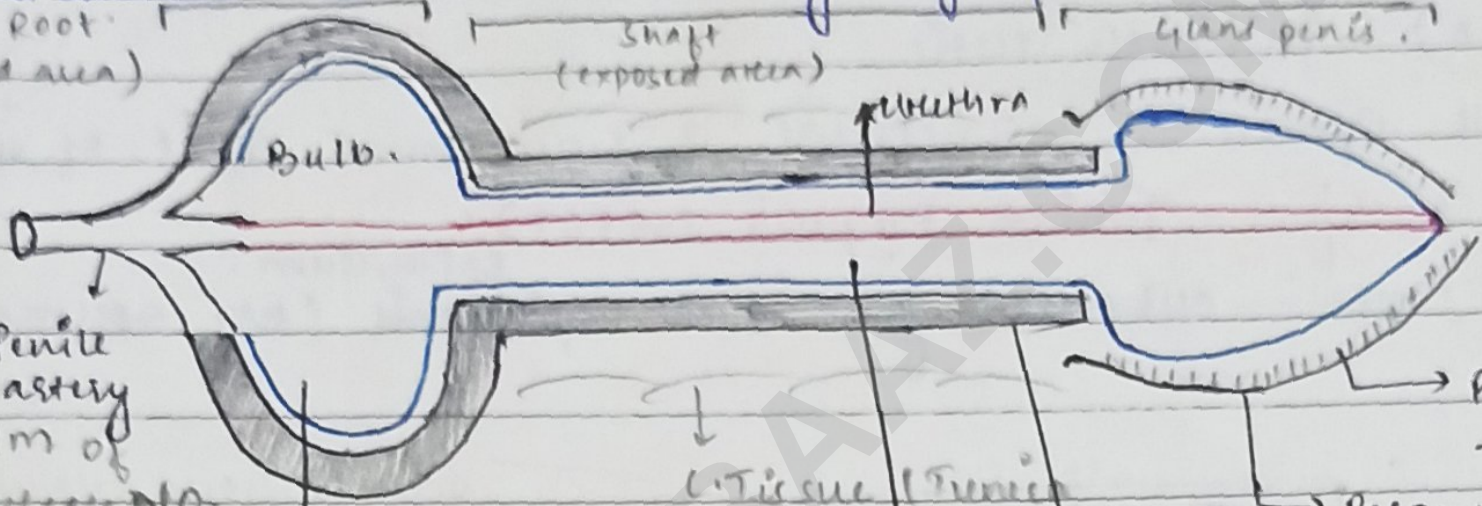
Sertoli / Nurse / sustentacular / sub tintacular cells:-

- Provides nourishment to growing ~~germs~~. sperms.
- Forms blood testic barrier.
- Phagocytose the dead or degenerated sperms.
- Secrete hormones:-
  (1) AMH [suppress mullerian duct]
  (2) Inhibin (supress the FSH)
  (3) ABP - Androgen Binding Protein - concentrate the testosterone into seminiferous tubule.
  4) can change testosterone into oestrogen. with the help of Aromatase enzyme.

Penis:-

- Single, cylindrical shaped main copulatory organ.
- composed of three cylindrical masses of erectile tissues i.e, two right & left corpora cavernosa & one middle corpus spongiosum.
- At terminal, corpus spongiosum bulge out to forms glans penis

- Urethra passes through spongiosum
- Erection of penis is controlled by parasympathetic N.S.
- Ejaculation is controlled by Sympathetic N.S.



endothelium of artery releases NO which relaxes smooth muscle & dilates it

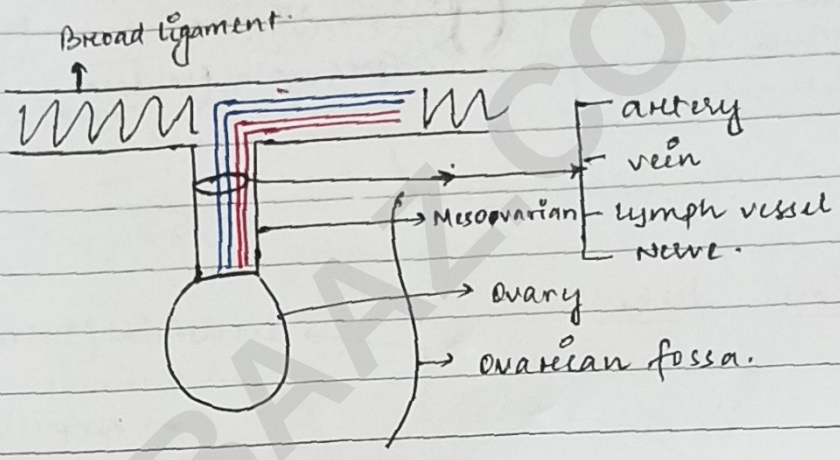
Corpus muscle

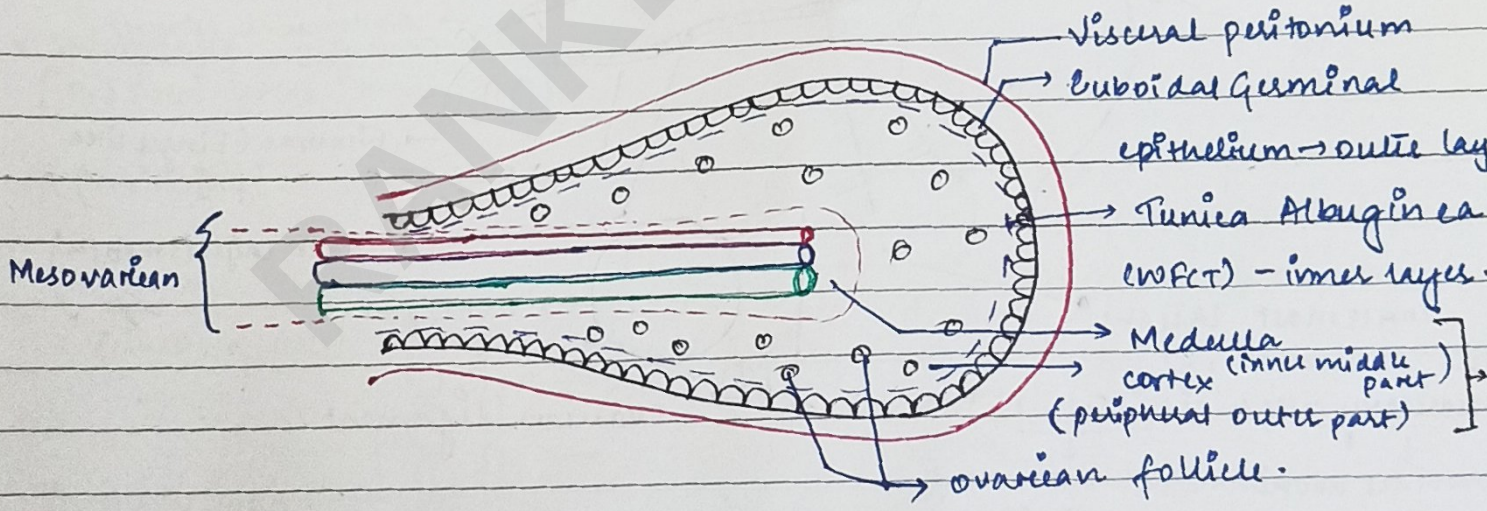
Normally they are contracted. They relax when erected.

Female Reproductive System:-

- Ovary (one pair)
- Fallopian tube (one pair)
- Uterus (single)
- Vagina (single)
- Vulva / external genitalia / pudendum
- Bartholin gland (1 pair)

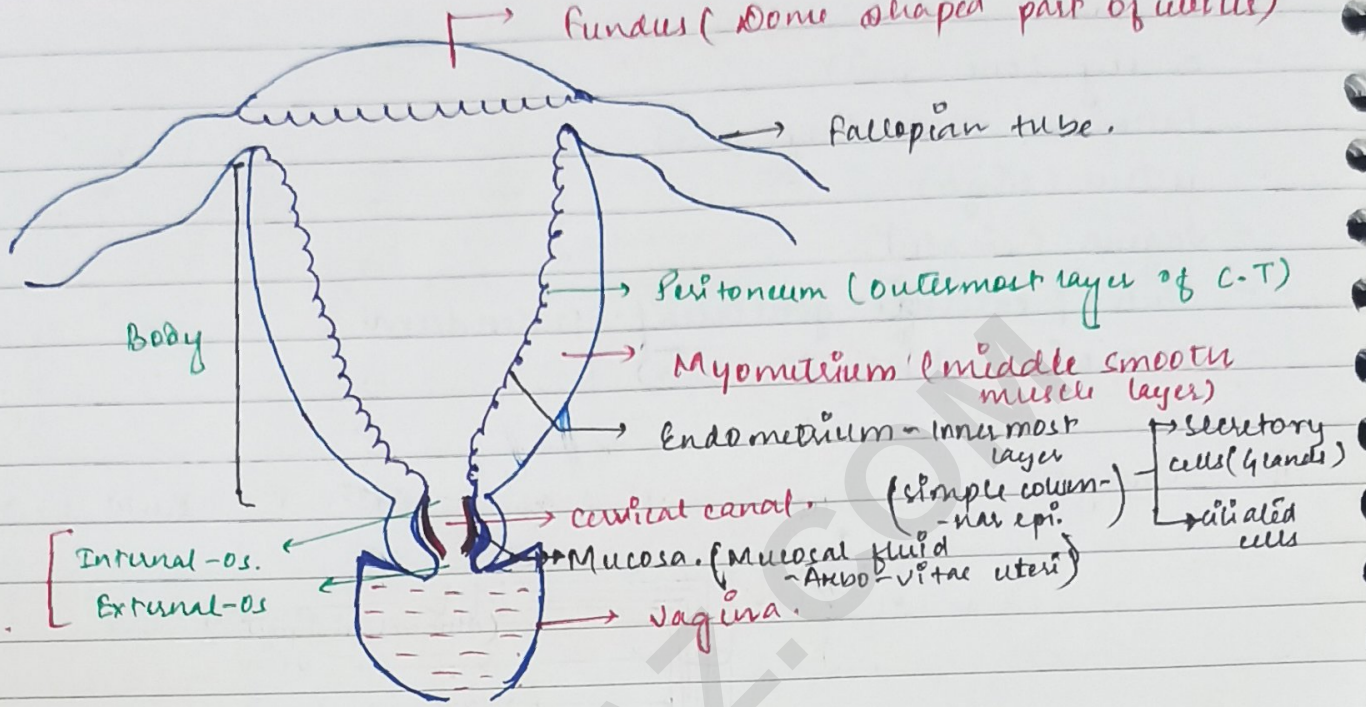
Ovary:-



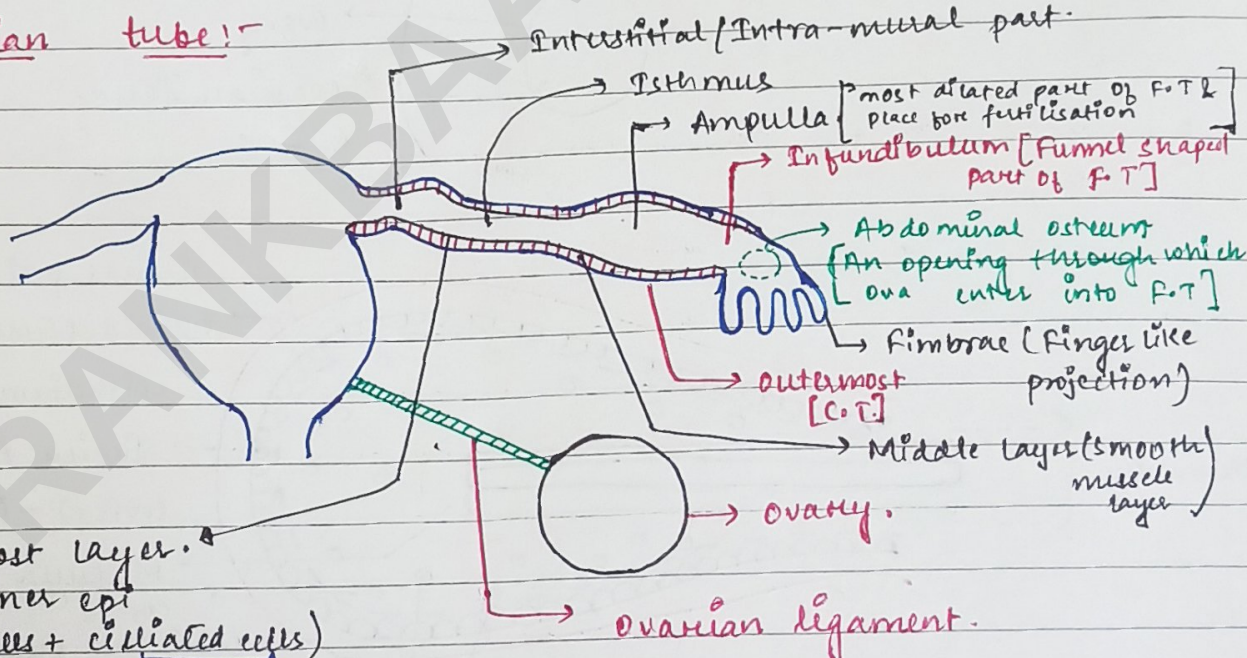


Uterus:-

- Single, piriform shaped (inverted pear shape)
- Birth canal = cervical canal + vagina.



Fallopian tube :-



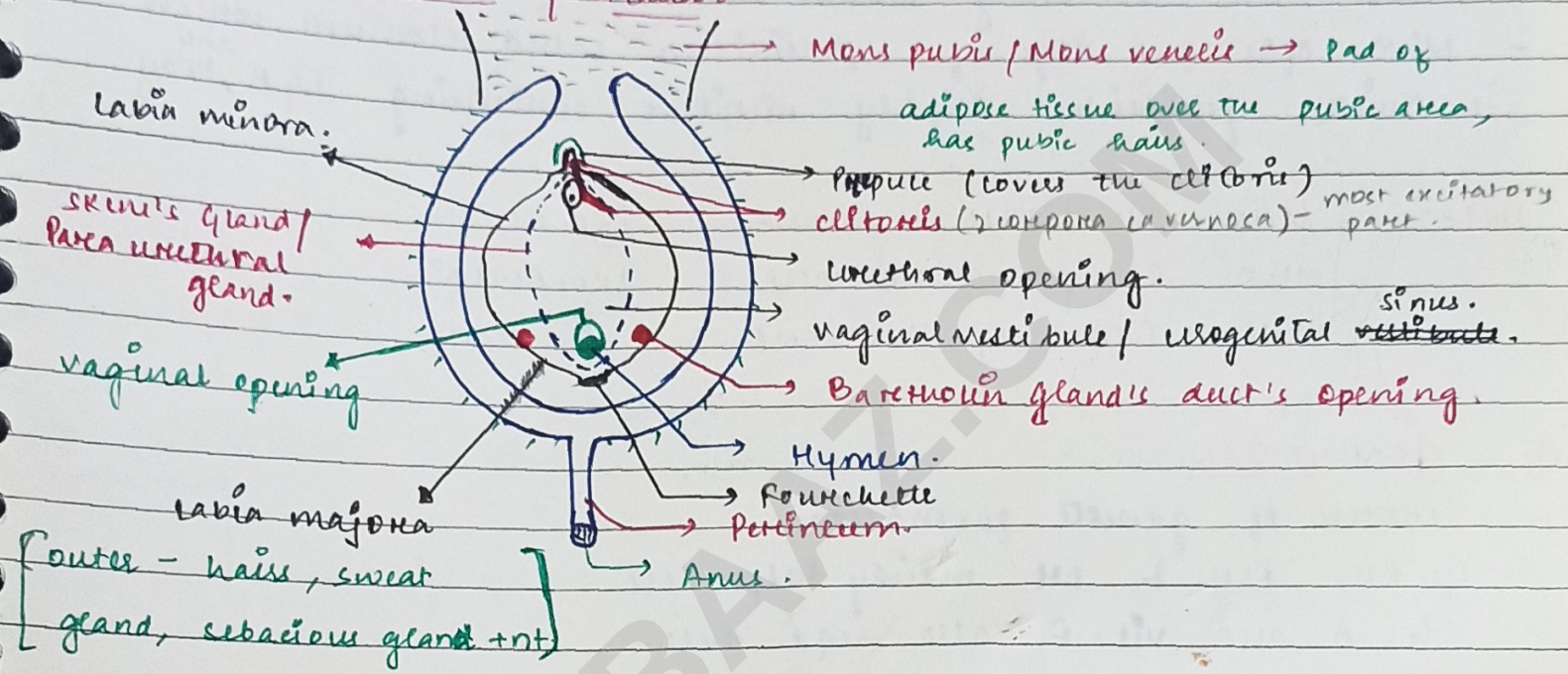
Innermost layer.
Simple columnar epi
- (Secretory cells + ciliated cells)
↓ provides nourishment to zygote
↓ movement of egg is facilitated.

* coelomic egg = Human egg.
- Fertilisation takes place in ampulla.

Vagina:-

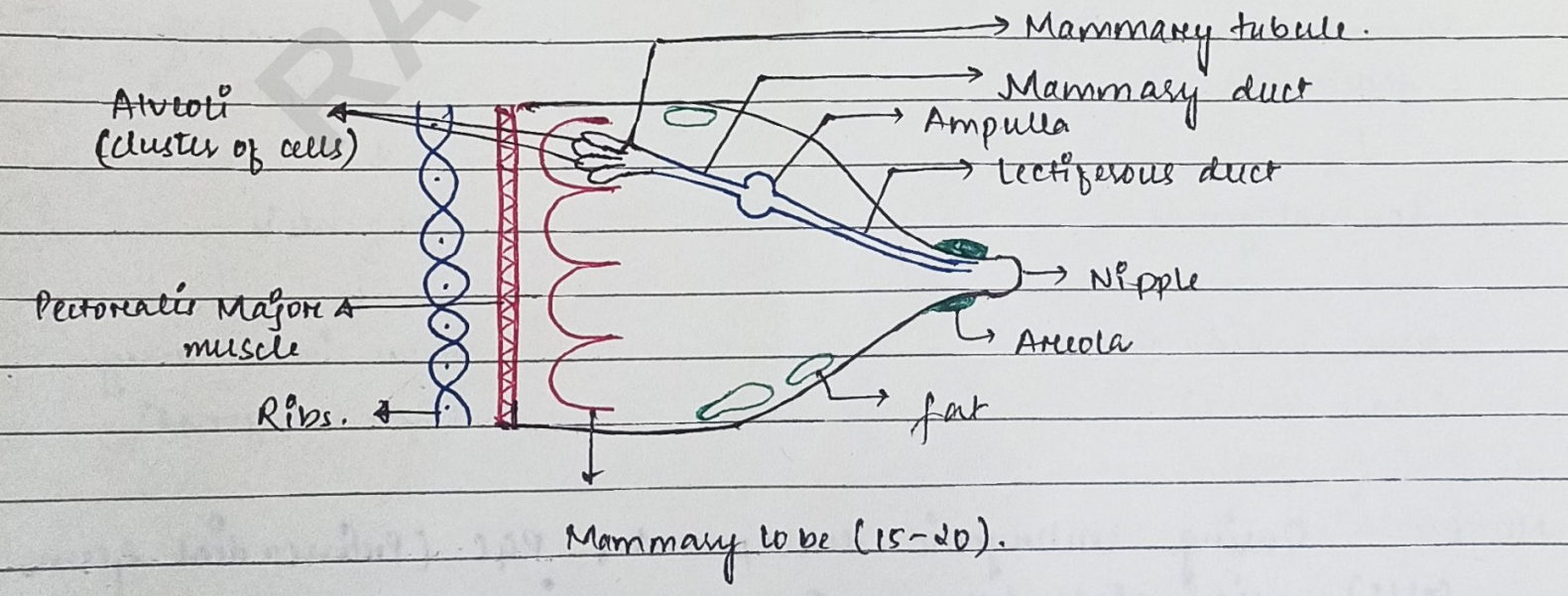
It is single, tubular, non-glandular, fibromuscular, copulatory organ.

Vulva / External genitalia:-



- Normally vagina has acidic pH (4-5)

Breast:-



- Presence of mammary gland is the characteristic feature of mammals.

- Presence of active mammary gland is the characteristic feature of female mammal
- In prototheria these glands are active in both male & female
- Mammary glands are apocrine, exocrine, modified sweat glands.
- Breast are secondary sexual character of female.
- Milk after few days of parturition called colostrum which is thick, yellowish, highly nutritive containing IgA antibody

NOTE:- MILK SYNTHESIS HORMONE = PROLACTIN
MILK SECRETING HORMONE = PROLACTIN
MILK EJECTING HORMONE = OXYTOCIN.

GAMETOGENESIS:-

- Process of gamete formation
- GnRH, FSH & LH mainly helps here
- Vit. A and vit. E also reqd. here.

Gametogenesis

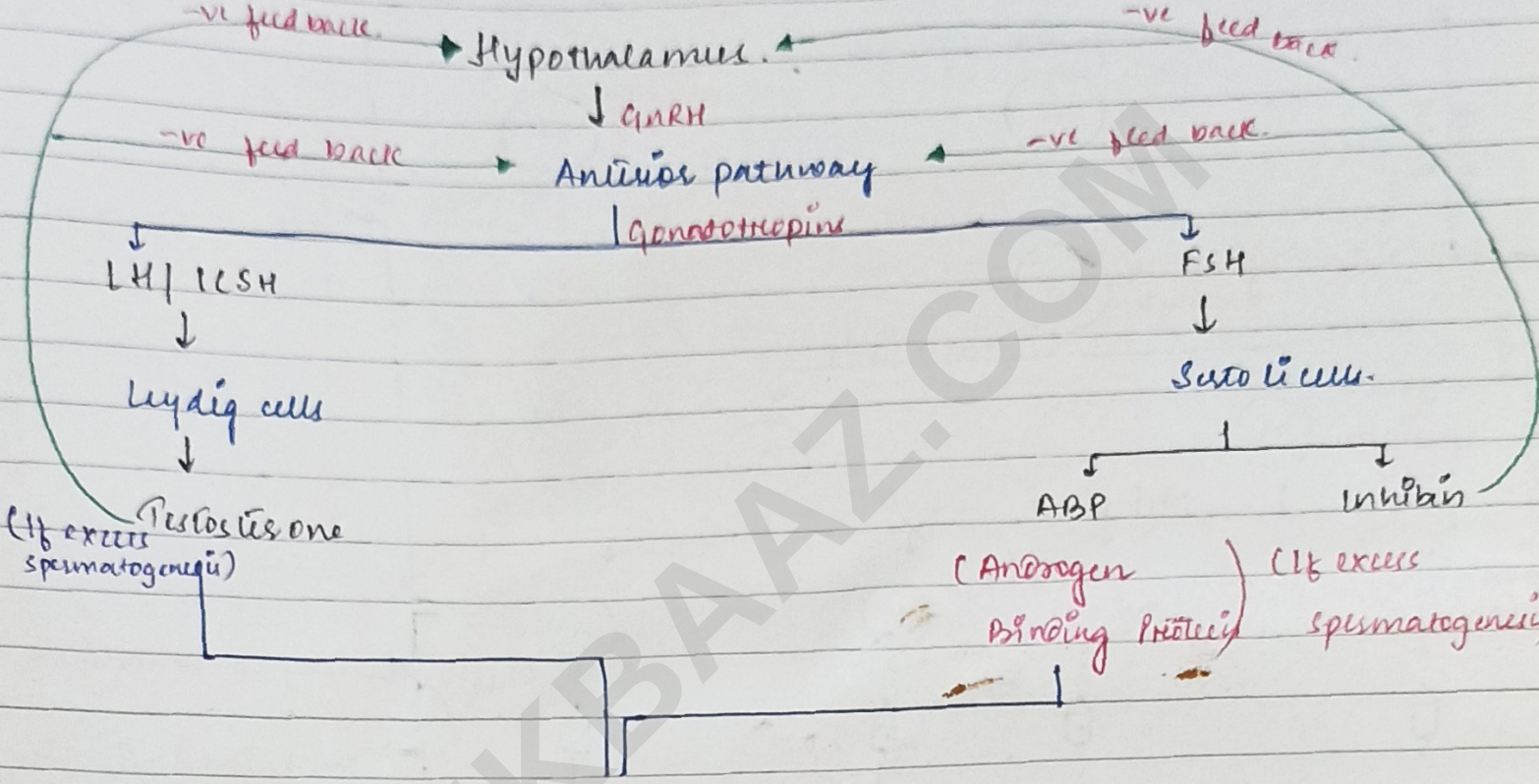
In male → Sperm (male gamete) formation → Spermatogenesis → occurs inside testis (Male Gonad)

In female → Ovum (female gamete) formation → Oogenesis → occurs inside ovary (female gonad)

NOTE:- During embryonic development, PGC (Primordial Germ cells) originated from extra embryonic mesoderm. Later on PGC give rise to spermatogonia & then sperm in female, while give rise to oogonia & then ovum

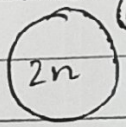
in female.

Spermatogenesis :-



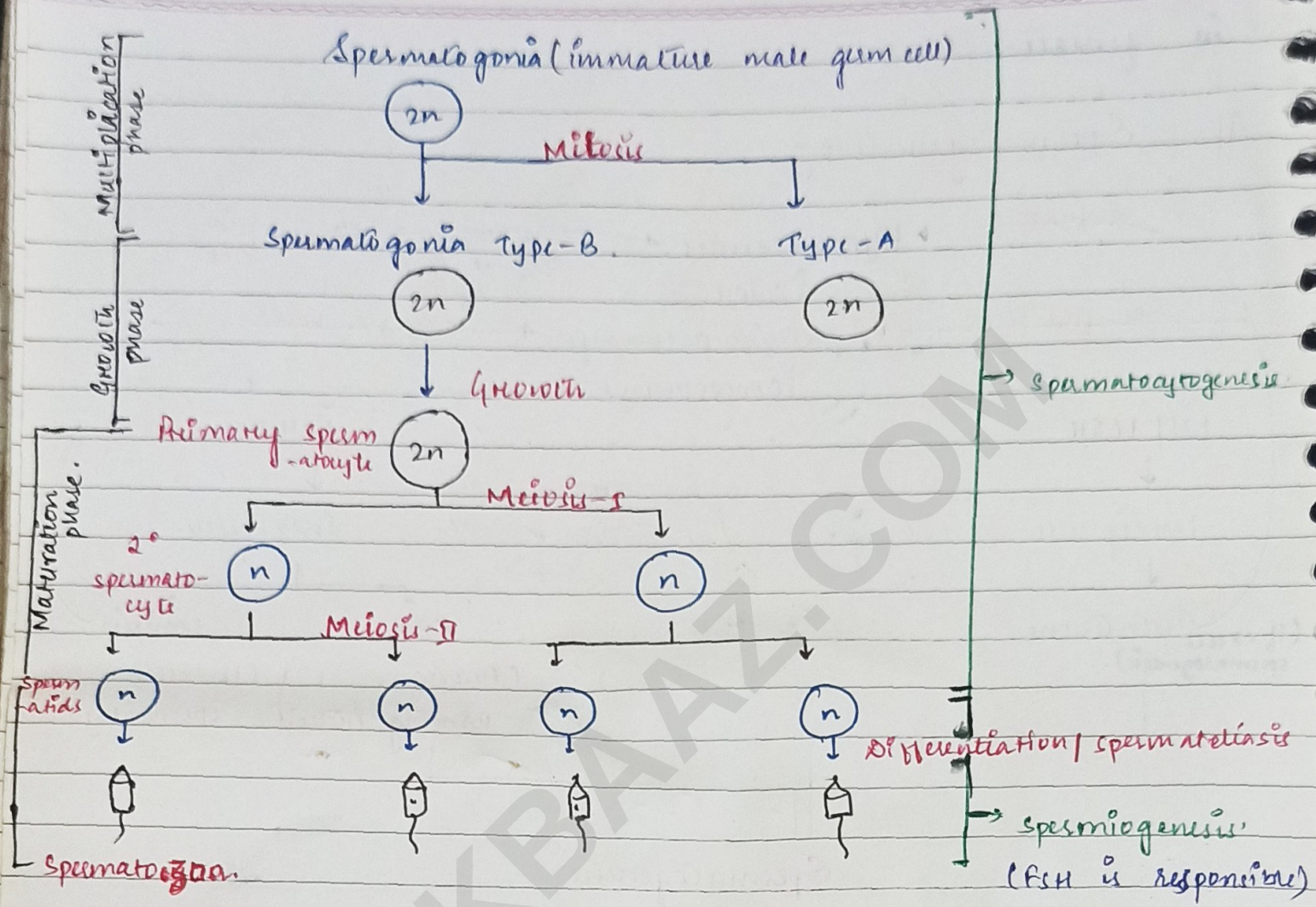
- Site - Seminiferous tubules of testis
- Begins - At Puberty
- Reason - Due to significant rise in level of GnRH, FSH & LH

Spermatogenesis



- ** FSH stimulates sertoli cells, sertoli cells release growth factors which help in spermiogenesis / sperm differentiation.

Oviparous mein → Growth phase bahut lamba hota hai.



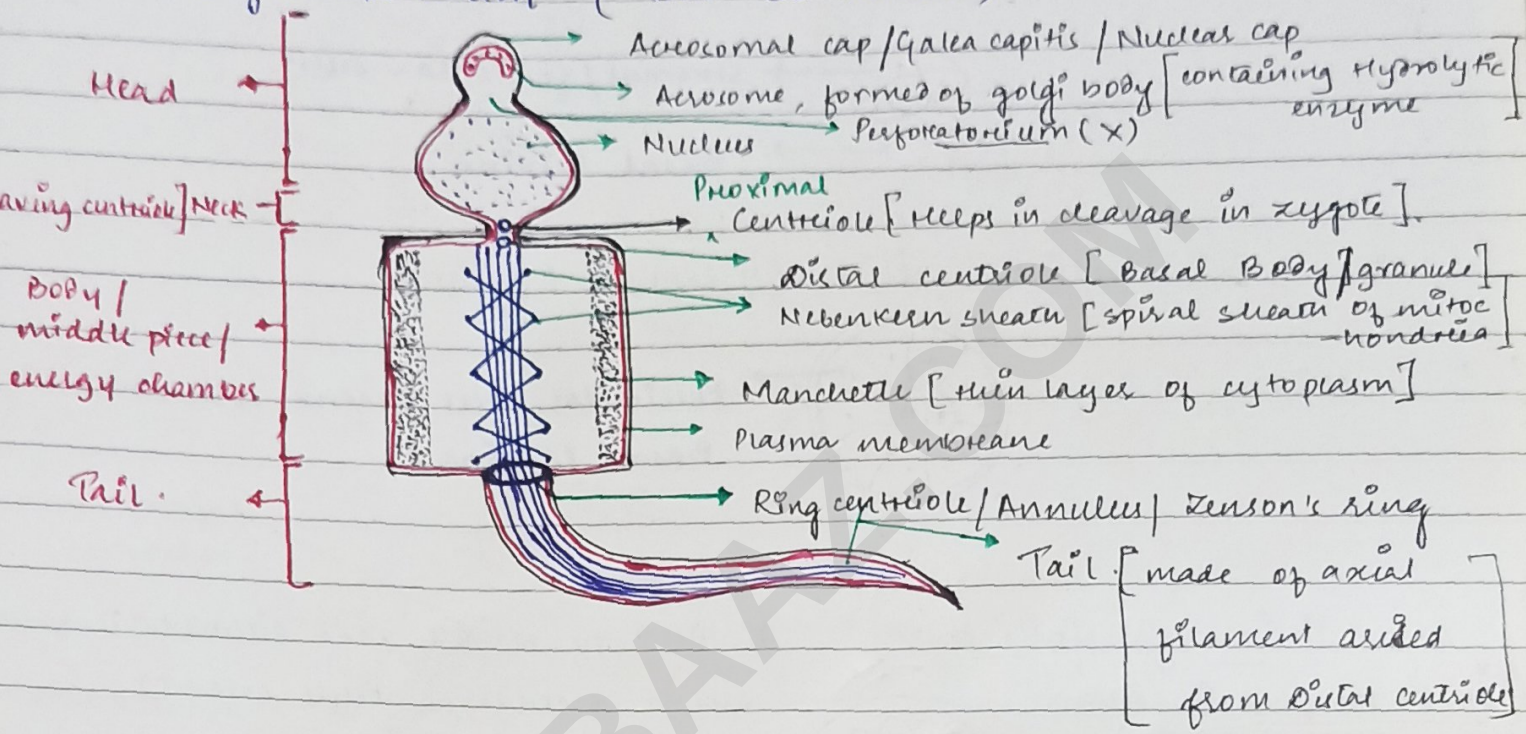
- **Spermatogenesis = Spermatocytogenesis + Spermiogenesis**
- Maturation phase → longest phase.
- 2° spermatocyte – 1st haploid of spermatogenesis.
- Spermiation – Liberation of sperms from sertoli cells & seminiferous tubules
- Semination :- Liberation of sperm from testis
- Ejaculation :- Liberation of sperm from male body.
- Insemination :- Entry of sperm into vagina

* **Duration of spermatogenesis = 64 to 75 days.**

Imp.
components of cell : Genetic material, cytoplasm, plasma membrane.
* Mitochondria comes from mother] in zygote
Centriole comes from father

Human Sperm :-

- Elongated, haploid cell, motile through the tail, spoon shaped head, length = 60 micron (tail = 55 micron)



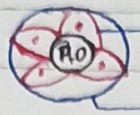
Oogenesis :-

Oogonia (2n) [All oogonia formed till 28 weeks of intra-uterine life]
↓ Growth
Primary oocyte (2n) → Meiosis-I starts & arrested at diplotene of Prophase-I. ---- till birth
→ Meiosis-I completes after puberty ---- After puberty
↓ (n)
Sec. oocyte (n) → Meiosis-II starts & arrested at metaphase. (Ovulation occurs)
→ Meiosis-II completes at fertilisation when sperm touches ovum. → 1st Polar body (Degenerate) (negligible cytoplasm)
↓ (n)
mature ovum / ootid. (n)
2nd polar body (Degenerate)

- No. of Sec. polar body = No. of child
- Maturation phase = longer phase.

Development of Ovarian follicle :-

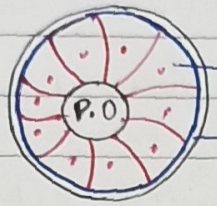
1. Pre-Primordial follicle (7 million) - In embryonic stage.



→ Stromal / follicular cells.

→ Basal lamina.

2. Primordial follicle. (4 lakhs) (Puberty)

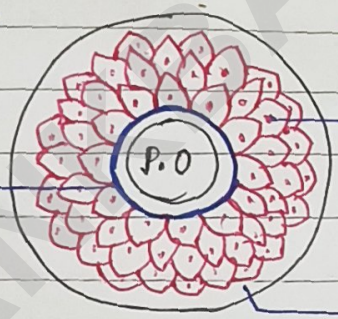


→ Follicular cells become columnar

→ Basal lamina.

3. Primary follicle :-

(** 60-80 thousand in each ovary at puberty)



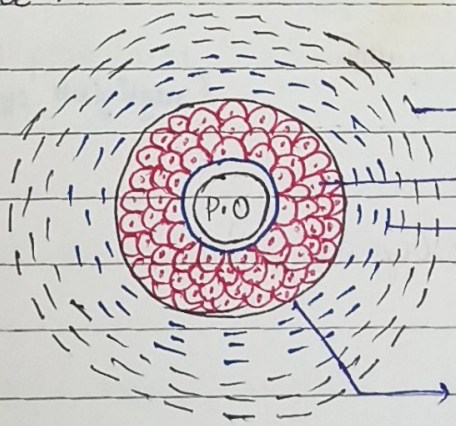
Zona Pellucida [Glycoprotein layer]

→ Membrana Granulosa [Multilayer] contain Granulosa cells.

→ Basal lamina

* Acc^n to NCERT Zona Pellucida is formed around secondary oocyte (NEET)

4. Secondary follicle :-



→ Theca externa.

→ Membrana Granulosa.

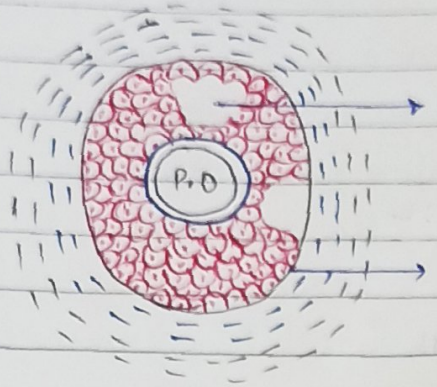
→ Theca interna.

↓

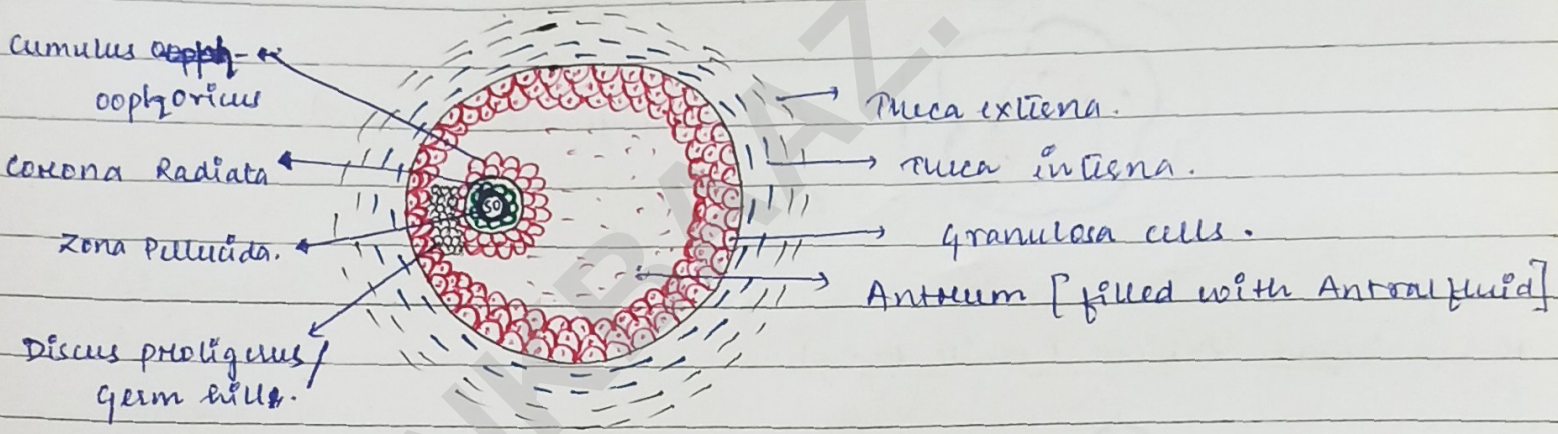
Secretes oestrogen.

→ Basal lamina.

5. Early tertiary follicle,

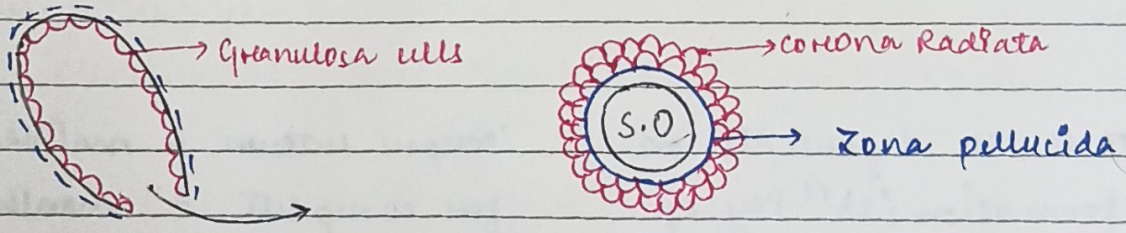


6. Late Tertiary / Mature tertiary / Mature Graafian follicle :-



** completion of Meiosis-I & formation of sec- oocyte occurs in tertiary follicle.

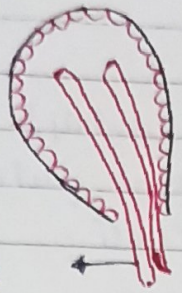
7. Ovulation due to LH :-



8. Corpus Haemorrhagicum [Red Body]

Granulosa cells start secreting yellow pigment & convert into corpus luteum

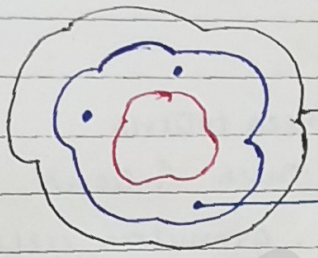
New blood vessels enter into ruptured follicle.



Ovulation occurs at 14th day. Corpus luteum is formed at the 15th day of menstrual cycle & starts to degenerate at the 23rd day of menstrual cycle i.e., 9th day of its formation & completely degenerates at 28th day of menstrual cycle i.e., 14th day of its formation

LH

9) Corpus Luteum [Yellow body].



10. Corpus Albican (white body).

Corpus Luteum.

If no fertilization

Corpus luteum starts to degenerate on 9th day of its formation (23rd day of MoC) & completely degenerate on 28th day of MoC (14th day of its formation)

If fertilization

Corpus luteum is maintained for complete 9 months of pregnancy [C.L. is maintained by HCG - Human Chorionic Gonadotrophin hormone of zygote / embryo]

Menorrhoea - excessive discharge

During pregnancy → 9 MoC are missed [9 months]
& lactation period → 6 MoC are missed [6 months]
Total 15 months / MoC are missed.

Atresia - follicular degeneration. (From embryonic stage till menopause)

Even after menopause some theca cells retain in some women which produce testosterone - responsible for producing some male characters (aggressiveness, hair growth on chin, coarse voice)

Menstrual cycle:-

Cyclic event occurs in rythmic fashion in female primate every month from puberty till 50 years of age (menopause)
(ovarian change + uterine change)

- Usually of 28/29 days

Female Primates

- Ape
  - Gibbon ✓
  - Gorilla ✓
  - Chimpanzee ✓
  - Orangutan ✓
- Human [✓] MoC
- Monkey.
  - Old world monkey [✓]
  - *AIIMS New world monkey [×]
    - Estrous cycle

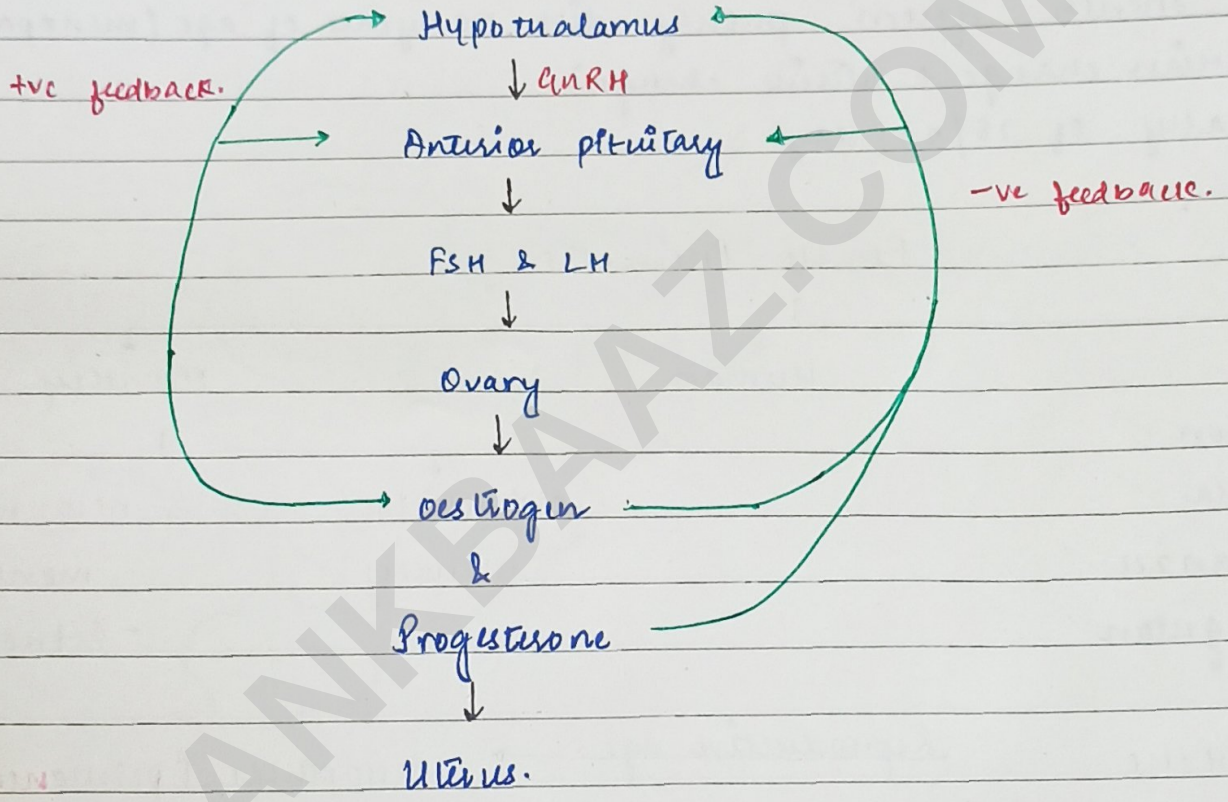
Menarche (1st menstrual cycle on puberty)

Reproductive age. → Menopause (permanent stopping at 50 years of age)

1 menstrual cycle = 1 ovulation = 1 ovum = 1 first polar body

** GnRH, LH, FSH, estrogen, progesterone regd. in M. Cycle.

	Oestrogen	Progesterone	GnRH	FSH	LH.
-ve feedback.	↑ ↓	↑ ↓	↓ ↑	↓ ↑	↓ ↑
+ve feedback.	↑↑↑		↑↑	↑↑	↑↑↑



Oestrogen
- Endometrial proliferation
- Endometrial thickness ↑↑
- wall thickness ↑↑

Progesterone.
- Maintain thickness
- ↑se Glandularity
- ↑se secretory nature
- Inhibits uterine contraction

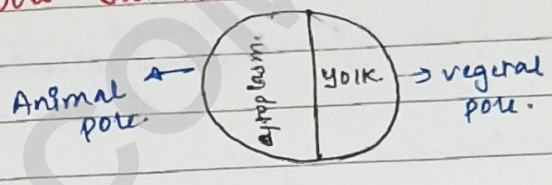
Hyperplasia - ↑ cell no.
Hypertrophy - ↑ cell size.

1. Bleeding / Menstruation phase = 3-5 days.
1 year = 13 menstrual cycle.
1 child/abortion = 1 second polar body.

NOTE:- Human egg is Alecithal (yolk is negligible amount),
Homo/Isolecithal → yolk is equally distributed & non-cleidoic egg shell is -nt.

Movement of sperm – Random movement.

NOTE:- Sperm enters through animal pole but not in Human.

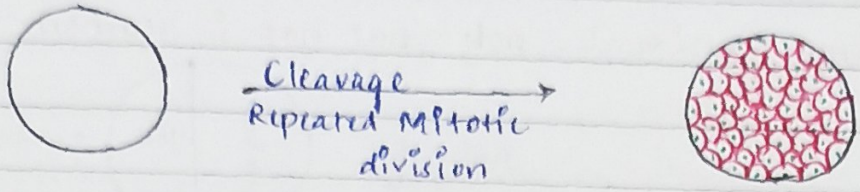


Fertilisation :-
- At Ampulla part – Life
Internal fertilisation - Type.
n + n = 2n.
Sperm Ovum Zygote.
Completes in 4 steps :-
1. Syngamy - Fusion of both gametes.

Types of ovum :-
(A) Amount of yolk (formed on vegetal pole)
(i) MICROLECITHAL (OLIGO) :- Eutherian, echinodermata, marsupials, cephalochordata
(ii) Mesolecithal → Cyclostomata, amphibian.
(iii) Megalecithal/Macrolecithal → lizard, insect, bird, fish, prototheerians.

(B) Location of yolk
(i) Homolecithal → Dark membrane of yolk (pigmental). Eg:- microlecithal
(ii) Centrolecithal → Insects. (centre)
(iii) Telolecithal → Reptilia, Birds, fish, cyclostomes, amphibians. (towards vegetal pole)

Cleavage / Segmentation / Cellulation / closed Mitosis :-

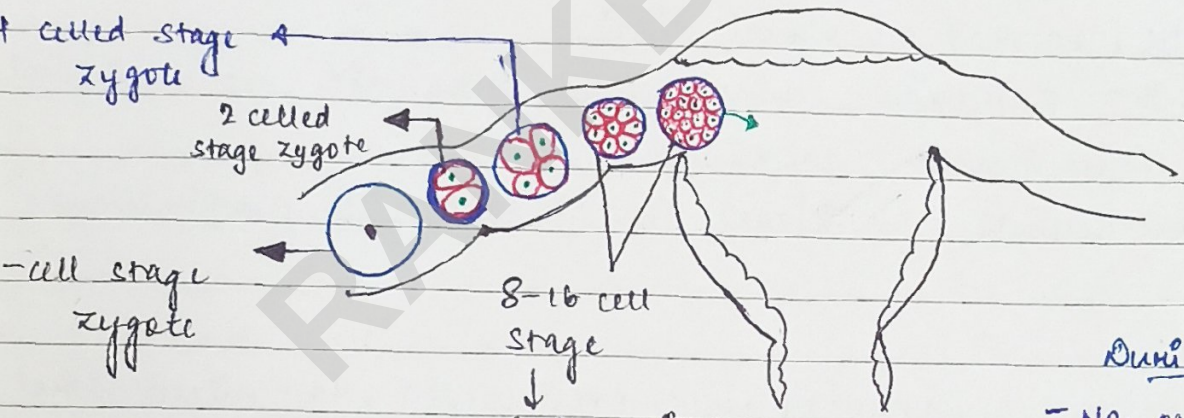


Unicellular zygote

Multicellular embryo.

In cleavage :-

1. Interphase is short [Because $G_1 - G_2$ absent, only S phase present]
2. So during division only DNA duplicates, but no new cytoplasm is formed.
3. Begins just after fertilization & stoped at the end of gastrula



solid ball like structure

↓

Morula

↓

enters into uterus.

During cleavage :-

- No. of blastomere - ↑↑
- Size " " - ↓↓
- Size of zygote - const.
- Karyoplasmic index - ↑↑ ($\frac{\text{Nucleus}}{\text{cytoplasm}}$)

* The type of cleavage in human egg is Unequal Holoblastic.

Twin

↓ Monozygotic twin / Identical twin

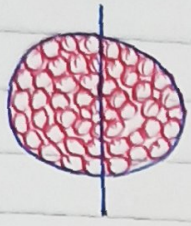
↓ develop from 1 sperm & 1 ovum.

↓ Their face, external feature & sex same

↓ Dizygotic / Fraternal twin

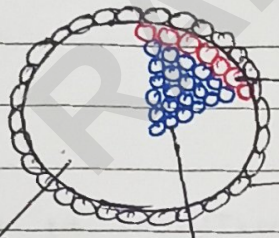
↓ develop from 2 sperm & 2 ova

↓ sex may be similar or dissimilar



BLASTULA :-

- 32 - 64 celled stage.
- Human blastula is called blastocyst.
- covered by zona pellucida
- ** Implantation occurs in blastocyst stage.



→ Amniogenic cells / cells of Rauber (forms Amnion)

→ Trophoblast (phagocytic & sticky in nature)

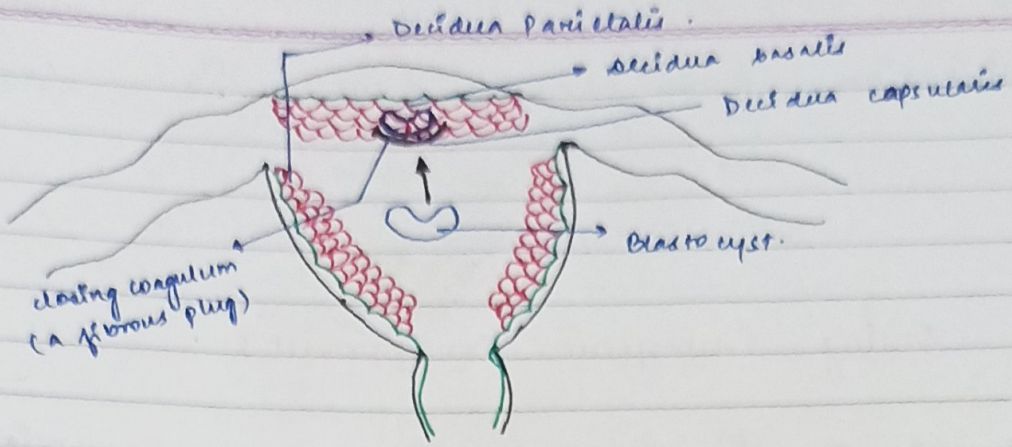
↓ Helps in implantation & formation of extra embryonic membranes.

Blastocoel (cavity)

Inner cell mass / embryonal knob

↓ contains stem cells.

↓ forms the complete embryo.



1. Blastocyst comes closes to implantation site
2. Trophoblast of blastocyst release hydrolytic enzymes which destroy the endometrial cells at point of contact.
3. Blastocyst completely embedded into endometrium.

↓

Adjacent endometrial cells proliferate to cover the blastocyst.

↓

A fibrous plug (closing coagulum) seal the implantation site.

Decidua - endometrium after implantation.

Gastrula stage :-

- Differentiation of blastomeres → formation of 3 primary germ layers [Ectoderm, Mesoderm, Endoderm]

↓

They will form the organs.

- Preparation / planning for differentiation occurs in late blastula.
- Archenterone (cavity) formed in gastrula.
  old intestine. → forms alimentary canal.
- BMR, respiration, energy requirement low during Gastrula stage.
- Cleavage slows down.

- Morula enters into uterus.
- Implantation at blastula.

Zona- Hatching

Fluid enters into Blastocoel.

↓

extension of Blastocyst.

↓

Pressure exerted on zona-pellucida

↓

Rupturing of zona- Pellucida

↓

Blastocyst escape out from zona

↓

Zona Hatching

↓

Implantation of Blastocyst.

→ Zona pellucida prevents the implantation of zygote at unwanted site (ectopic pregnancy).

Ectopic pregnancy :-

Implantation at abnormal unwanted site.

- It leads to abortion.

Implantation :-

Site :- fundus part / mid- dorsal wall of endometrium of uterus.

Begins :- at 7th day of fertilization

Completed :- at 12th day of fertilization.

Type :- Interstitial implantation (complete blastocyst enters into endometrium)

1st differentiated organ - Brain.

After fertilization, 0 - 7th day - zygote
8th day - 8 week - embryo
9th week - till delivery - foetus.

Events during Embryonic Development :-

(i) At the end of 1st month :- Heart become functional
- 1st differentiated (formed) organ in embryo - Brain
- 1st functional organ - Heart.

(ii) At the end of 2nd month :- Limbs & digits formed (Now onwards embryo is called foetus)

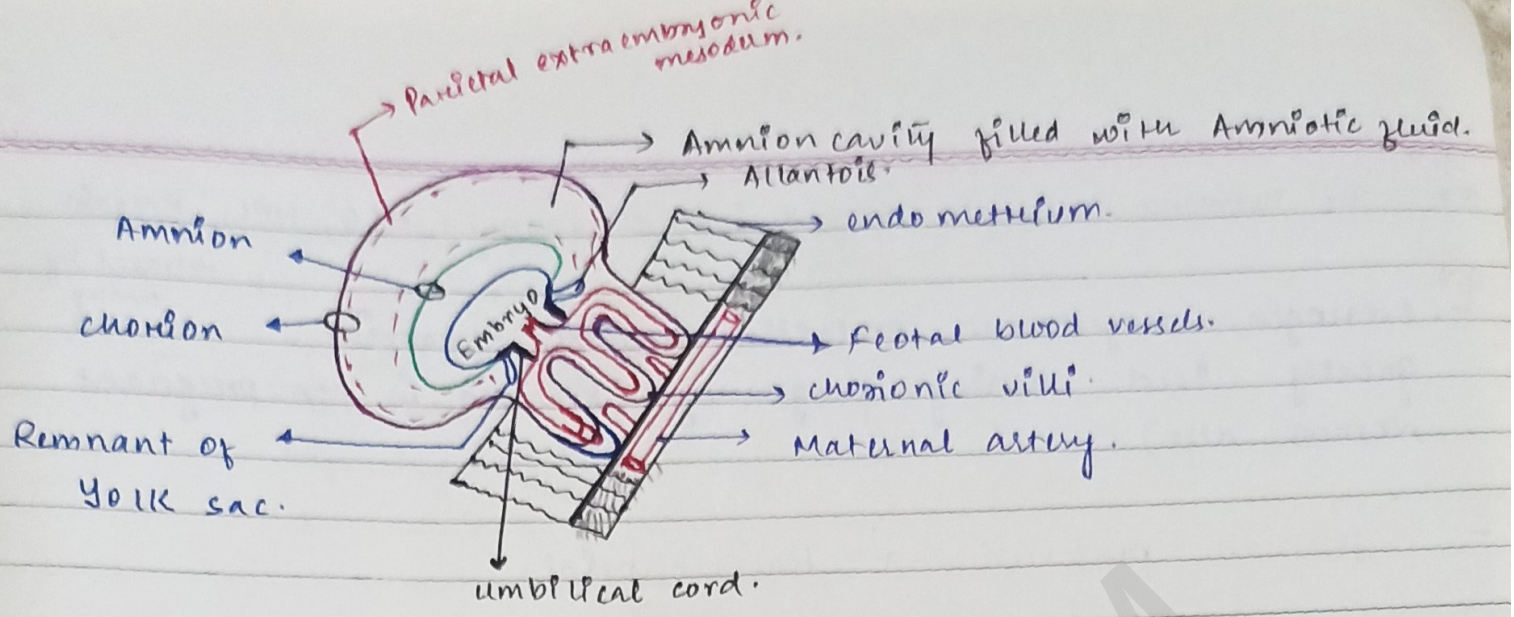
(iii) At the end of 3rd month / 1st trimester :-
All major organ system is formed. (Organogenesis completed)

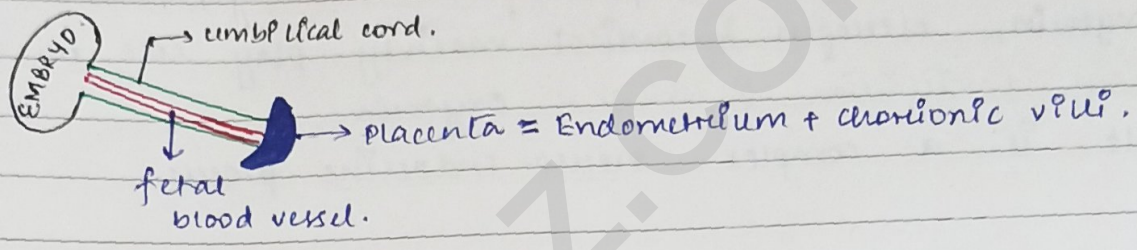
(iv) During 5th month :-
- First foetal movement.
- Hairs appear on head

(v) At the end of 6th month :-
- Eyelids separated, eyelashes formed.
- Fine hairs on body

(vi) At the end of 9th month :- Delivery of fully developed foetus.

Extra Embryonic Membranes :-
1. Amnion
2. Chorion
3. Yolk sac
4. Allantois.





Placenta :-

- Disc shaped, endocrine structure
- It is structural, functional, mechanical, physiological connection b/w foetus & mother.

Placenta

Foetal part
- chorionic villi
[chorionic frondosum]

Maternal part.
- endometrium.
[Decidua Basalis]

Placental hormones :-

- estrogen (estradiol)
- Progesterone.
- HCG [Human chorionic Gonadotropin]
- HPL [Human Placental Lactogen] → ① converts fat to fuel for baby. (noncarb/glycogen → glucose)
  HCS [Human chorionic Somatotropin] ② insulin resistance.
  ③ carbohydrate into to mother.

** The hormone released only during pregnancy - HCG, HPL, Relaxin (released by ovary)

** - estrogen, progesterone, prolactin, cortisol, thyroxine greatly raised during pregnancy. (Released in non-pregnant women also)

- Human placenta → Haemochorial.

Parturition (Labour / Vaginal Delivery)

Oxytocin, estrogen & cortisol mainly play role in parturition

- Main parturition hormone = oxytocin
- It is a complex neuro-endocrine process.

LMP - Last Menstrual Period
EDD - Expected Date of Delivery

EDD = LMP + 9 months + 7 days.

eg:- 1 January + 9 months + 7 days = 8th Oct [EDD]

** Signal for parturition originates from fully developed foetus & Placenta **

↓ Foetal ejection reflex

Mild contraction in myometrium

↓ +ve feedback. (signals. to CNS for release of oxytocin)

oxytocin is released from maternal pituitary

↓

More uterine contraction

↓ +ve feedback.

oxytocin secretion increased

↓

more & more intensed, frequent & long contractions

↓

Expulsion of foetus from uterus via birth canal.