CLASS – 12

BIOLOGY

Chapter – 2

Reproduction in Flowering Plant

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PGT- Biology

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Human Reproduction:

- Human beings are sexually reproduce and viviparous animal.
- Human reproductive involve following process:

1. **Gametogenesis** in male (i.e. spermatogenesis which results formation of sperm) and female (i.e. oogenesis which results formation of ova).
2. **Fertilization –** internal fertilization occur after insemination at *ampullary-isthmic junction*.
3. **Formation and development of blastocyst**.
4. ***Implantation*** i.e. attachment of blastocyst in ***endometrium*** or uterine wall at about 6^{th} days after fertilization.
5. **Gestation** or embryonic development
6. **Parturition or delivery of the baby.**

Human Reproductive System

- In human, male and female reproductive system are show ***sexual dimorphisms*** (*i.e. different in structure and function*).
- It consists with ***primary sex organs*** and ***secondary sex organs***.

1) **Primary sex organs:**

- Under go number of changes during development and perform two basic functions.

a) ***Act as sex organs*** – to produce gametes (*i.e. testis produce sperm and ovaries produce ova*).

b) ***Act as endocrine gland*** – to secrete sex hormone (*i.e.* ***testis*** *- testosterone and* ***ovaries*** *- estrogen and progesterone*).

 # Sex hormone play important role in reproduction like – ***regulation of gametogenesis, maintain the structure and function of secondary sex organs and also responsible for the development of secondary sex characters*****.**

2) **Secondary sex organs:**

- It associated with primary sex organs and perform important function in reproduction.

Puberty

- It is age of maturity when reproductive system become functional like -

1. **Male** attain puberty at the *age of 13-16 years*.
2. **Female** attain puberty at the *age of 10-15 years*.

Home work: write the structure involve in human foetus that develop into male and female reproductive organs.

Male Reproductive System

- Located in pelvis region.
- Consist of following parts:

1. Pair of testis
2. Accessory glands
3. External genetilia

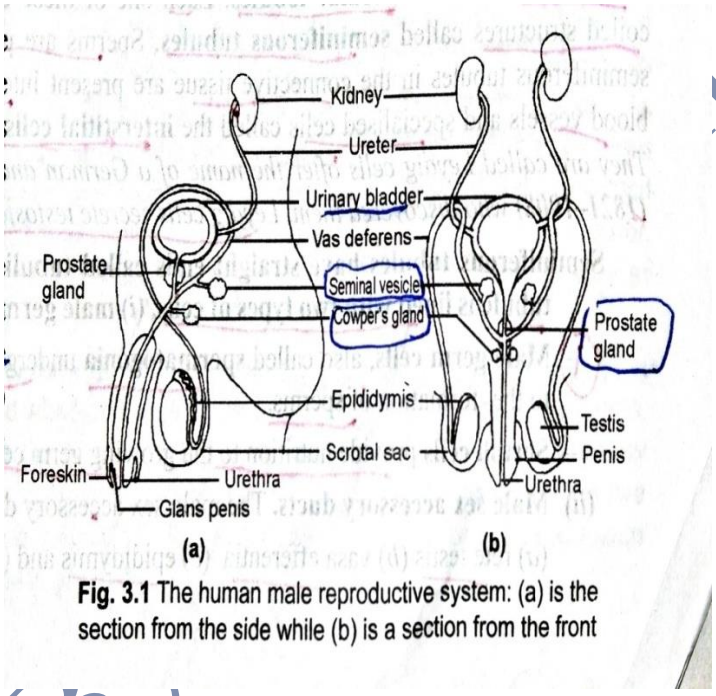


Fig. 3.1 The human male reproductive system: (a) is the section from the side while (b) is a section from the front

Testis:

- It produce **male gametes** (*i.e. sperms*) and secrete male **sex hormone** (*i.e. testosterone*)
- Located in **extra abdominal** (*outside the abdominal cavity*) **scrotum** (*i.e. help to maintain the temperature of testis 2-3 degree below the normal body temperature which help in spermatogenesis).*
- Testis formed within the **abdominal cavity** but before birth it descend through **inguinal canal** in t o the scrotum.
- **Cryptorchidism** occur due t o undescended testes in scrotum which cause sterility in the person.
- Testes are enclosed with **tunica vaginalis** (*outer covering*), **tunica albuginea** (*middle fibrous layer*) and **tunica vascularis** (inner *network of capillaries*).
- Each testis contain 250 **testicular lobules** (*i.e compartment*) which contain number of **seminiferous tubules** (*i.e highly coiled structure where spermatogenesis take place*).
- **Interstitial space** (space between the seminiferous tubules) contains **interstitial cells or Leydig cells** (*i.e. secrete testosterone*).
- Each seminiferous tubule contain two type of cells –

1. **Spermatogenic cells or spermatogonia** (*i.e. male germ cells which undergo meiotic division and form sperms*)
2. **Sertoli cells or supporting cells-** it provide nutrition to growing germ cells.

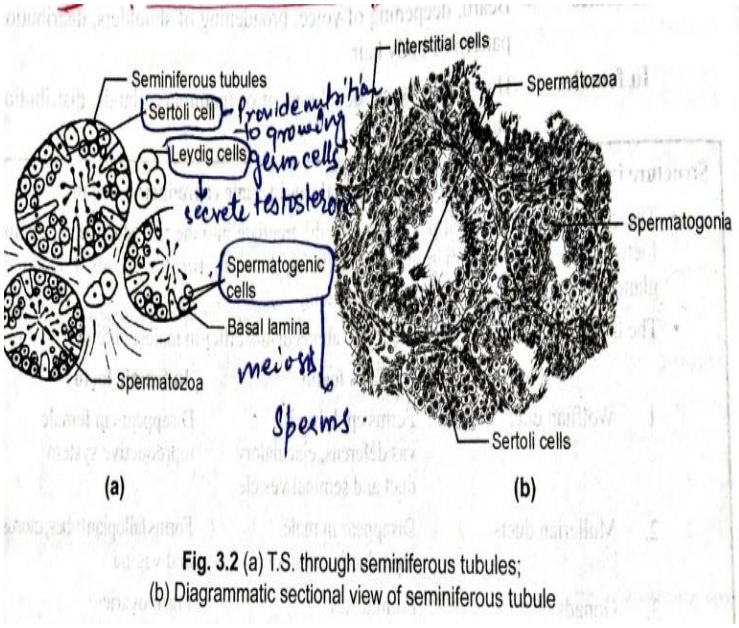


Fig. 3.2 (a) T.S. through seminiferous tubules;
(b) Diagrammatic sectional view of seminiferous tubule

 # sertoli cells secrete Androgen binding protein (concentrate testosterone in seminiferous tubules) and Inhibin (suppresses FSH of anterior pituitary).

Male accessory ducts

It include: Rete tetis, Vasa efferentia, Epididymis and Vas deferens.

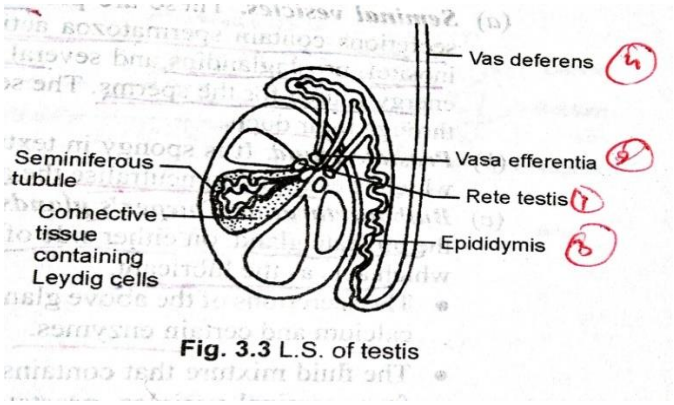


Fig. 3.3 L.S. of testis

1) **Rete testis:**

- Seminiferous tubules open into the rete testis (i.e space along with inner side of testis).

2) **Vasa efferentia:**

- Small tubular structure emerges from rete testis which opens into epididymis. Is known as vasa efferentia.

3) **Epididymis:**

- It is highly coiled tube present at *posterior surface of each testis*.
- Sperm are *stored in the epididymis which get concentrated and mature* before they release in vas deferens.
- It derives from the ***Wolffian duct of embryo***.

4) **Vas deferens:**

- It is short straight tube which ascends into abdominal cavity through inguinal canal and *open into the common urethra*.

Urethra or Ejaculatory duct

- It is made up of spongy muscle tissue (i.e. when filled with blood cause the erection of organ.
- It open through ***urethral meatus*** (*i.e. external opening*)

 # during ejaculation the powerful contraction of urethra inhibits the passage of urine.

Accessory or Secondary gland

- These gland pour their secretions into urethra for :

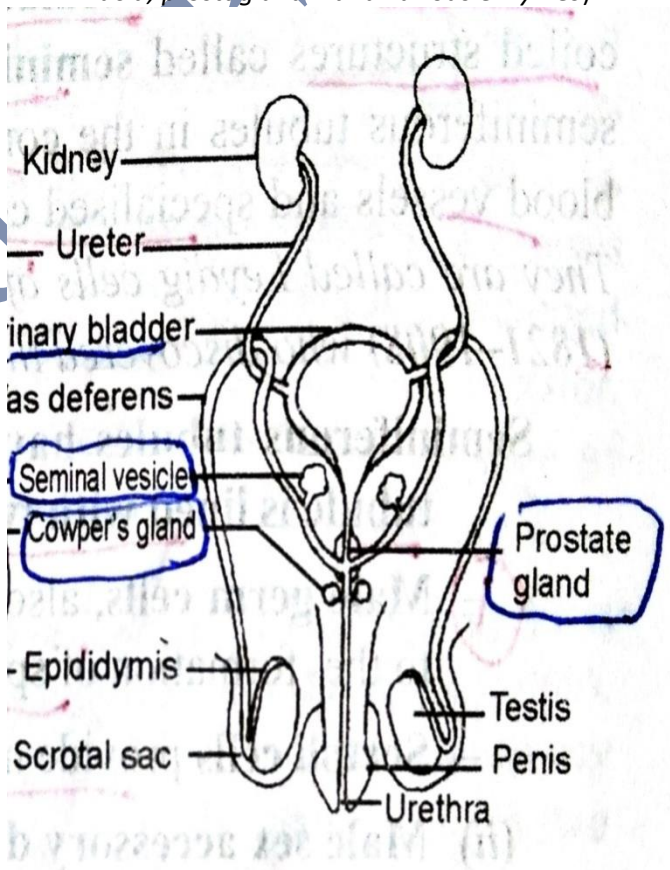
1) the *viability and mobility* of sperms

2) To provide proper *pH and ionic strength* of the medium.

- It include: pair of seminal vesicles, one prostate gland and pair of bulbourethral gland (*i.e. Cowper's glands*).
- Secretion of this gland constitutes the **seminal plasma**.

Seminal vesicle:

- Present *behind the urinary bladder* and poured their secretion in ***vas deferens***.
- Its secretion has ***pH 7.4*** and contains spermatozoa activating substance (*i.e. fructose- as a source of energy, citrate, inositol, ascorbic acid, prostaglandin and various enzymes*).



Prostate gland:

- Lies in pelvic cavity and consist of outer fibrous covering and layer of smooth muscle.
- Its secretions are ***slightly alkaline*** which essential to neutralize the acidic secretion present in vagina

- It secretion contain **albumin** - for sperm mobility and **fibrinolysin** and **fibrinogenase** (*i.e hydrolytic enzyme*).

Bulbo-urethral or Cowper's gland:

- Locate slightly below the prostate gland and either side of urethra.
- Their secretion is slightly ***alkaline*** which *neutralize any urine in urethra* and also ***act as lubricant*** for glans penis.

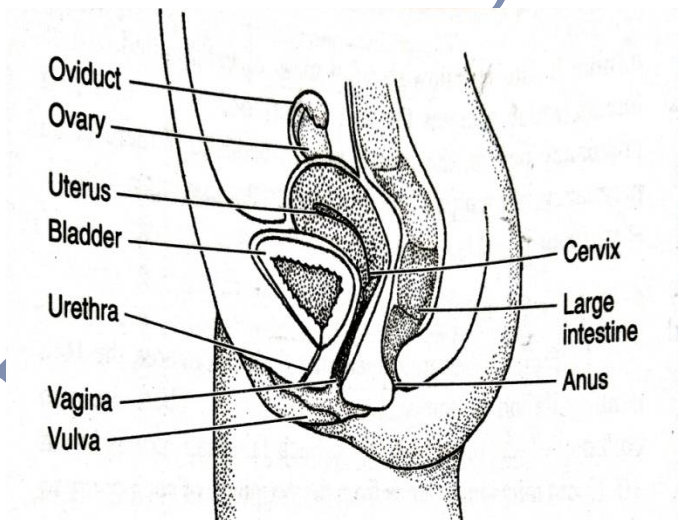
Semen:

- Fluid mixture that contains the secretion of all accessory glands and sperms is called **semen**.
- **FSH and LH** – *regulate the growth and function of seminiferous tubules and Leydig cells;* **testosterone** regulates the *functioning of secondary sex organs*.

Female reproductive system

- Located in pelvic region and consist of following parts:

1) A pair of ovaries
2) A pair of oviducts
3) Uterus
4) Cervix
5) Vagina
6) External genitalia



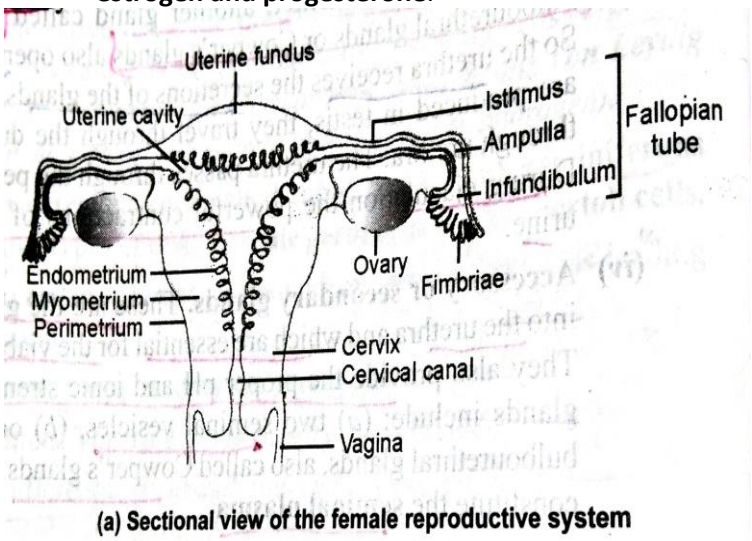
- All these part along with mammary gland involve in the process of ovulation, fertilization, pregnancy, birth and child care.

Ovaries

- It present on either side of the lower abdomen behind and below the fallopian tubes.
- Each ovary attached with abdominal wall by **mesovarium** i.e. ligament.
- It is covered by **tunica albuginea** (*i.e. cubical germinal epithelium with connective tissue*) and consist of outer dense layer **cortex** and inner loose layer ***medulla***.
- Inner surface of ovary covered with **germinal epithelium** (*i.e. made up of simple squamous or cubboidal epithelium*) which gives rise to ***follicles and ova***.
- Inner part of ovaries enclosed with epithelium known as **ovarian stroma** (*consist of connective tissue with blood capillaries*) which divide into two zone - ***peripheral cortex*** and ***inner medulla***.
- Stroma contain developing follicle with egg which develop into **graafian follicle**.
- Graafian follicle *repture and release mature egg into* **peritonial cavity.**

 # *Fimbriated opening of fallopian tube picked up the mature egg from peritonial cavity.*

- It produces **ovum** and ovarian hormone viz. **estrogen and progesterone**.



(a) Sectional view of the female reproductive system

Female accessory duct system

- It includes pair of *fallopian tube, uterus, and vagina*.

1) Fallopian tubes or oviducts:

- It is 10-12 cm, long tube which *carries the egg from the ovary to uterus*.

- It has funneled shaped structure near the ovary known as **infundibulum**.
- The edges of the infundibulum are called **fimbriae** (*i.e. finger like projections*) which contain **fimbriated opening** (*to receive the mature egg*).
- Infundibulum lead in to **ampulla** (i.e. *wider part of oviduct*) which lead into isthmus (*i.e. narrow part of oviduct*) that joins the **uterus**.
- Each fallopian tube contains **cilia** which *help egg move towards the uterus* (if sperm are present).

Fertilization takes place in the upper end of the fallopian tubes and embryo develop here up to blastocyst stage.

Uterus or womb:

- It is inverted pear shaped which situated *above and behind the urinary bladder* and *attached with pelvic wall by ligament*.
- Lower tip of uterus is called **cervix** that have **cervical canal (***i.e. cavity of cervix*).
- Wall of uterus consist of three layer:

1) **Perimetrium** (i.e. outermost thin memrane)

2) **Myometrium** (i.e. middle, thick smooth muscle layer, *undergo strong contraction during the delivery of the baby*).

3) **Endometrium** (i.e. *innermost glandular layer with blood vessels, lies at the cavity of uterus*).

- *Cervical canal along with vagina* forms the **birth canal**.

Embryo gets implanted and develops for nine month during pregnancy in uterus.

Endometrium involve in cyclic change during menstrual, its secretion nourishes the blastocyst for few days before implantation.

Vagina:

- It is large muscular tube which receives sperm during mating and serves birth canal.
- Two fold of tissue is called vulva which protect vaginal and urethral opening.

During reproductive life it contain Lactobacillus acidophilus that produce lactic acid from glycogen (maintenance of acid pH -4.9 to 3.5) which inhibit the growth of most microbe which inter in it from perineum.

Female have separate urinary and vaginal opening unlike male.

External genitalia:

- it include:

1. **Mons pubis:** outer structure of external genitalia which covered by skin and pubic hair.

2. **Labia majora:** it is fleshy fold of skin which extends fom mons pubis and surrounds the vaginal opening.

3. **Labia minoa:** it is paired fold of tissue under the labia majora.

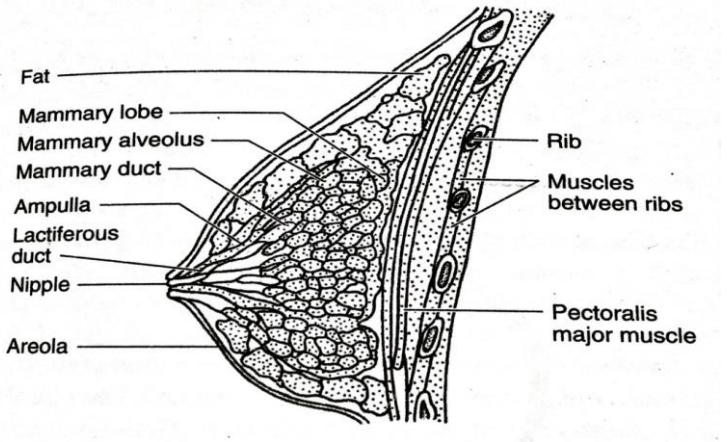
4. **Hymen:** mucous membrane which partially cover the vagina known as hymen.

Generally broken by active participation in sport like horse riding, cycling etc.

- Presence or absence of hymen is not a reliable indicator of virginity or sexual experience.

5. **Clitoris:** it is a tiny structure that lies at upper junction of labia minora or above the uretharal opening.

Mammary gland



- It contains **glandular tissue** and a large amount of **adipose tissues**.
- Each mammary gland consists of **20- 25 mammary lobule** with own lactiferous **duct** that emerges in the nipple.

- Mammary lobule contains **mammary alveoli lined** with milk producing cells, each lobule separate from other by **fibrous and adipose tissue**.
- Milk secreted by cells of alveoli stored in the **cavities of alveoli**.
- Alveoli open into mammary tubule.
- The *tubule of each lobe joined* and form **mammary duct** that joined and form **wider mammary ampulla which** is connected to **lacteferous duct through** which milk ejects out.

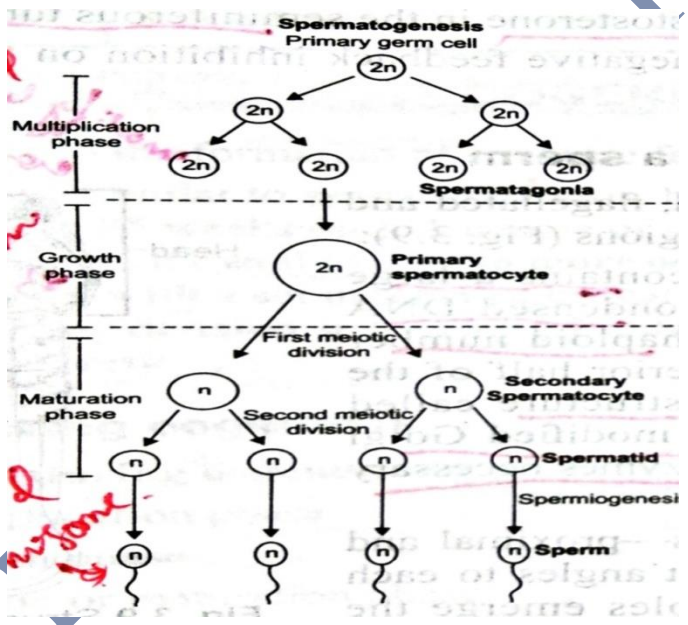
Gametogenesis

- It is process of *formation of gamete from germ cell in* male testis (i.e. spermatogenesis) and female ovary (oogenessis).
- During the gametogenesis the cells of germinal epithelium undergo following process:

1. **Multiplication phase**
2. **Growth phase**
3. **Maturation phase or meiotic phase**

- It is controlled by gonadotrophic hormone of anterior pituitary.

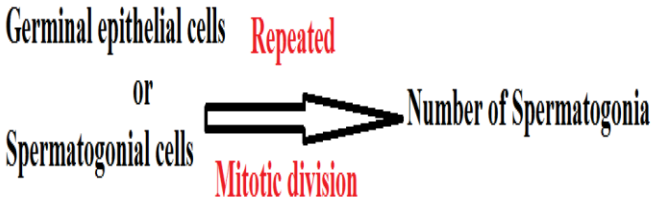
Spermatogenesis



- It is process of *production of spermatozoa or sperm* in the seminiferous tubules of testes.
- It completed into four stages:

1. **Multiplication phase**
2. **Growth phase**
3. **Maturation phase or meiotic phase**
4. **Spermiogenesis**

Multiplication phase



- In this phase the **epithelial or primary germ cells of seminiferous tubule** (*i.e. spermatogonial cells*) undergo repeated ***mitotic division*** and form number of **spermatogonia (2n).**

Growth phase

- Here some ***spermatogonia*** increase in size (*i.e. almost double in volume*) by accumulating nourishing materials from **germinal cells** are called ***primary spermatocytes (2n)***.

***It is preparatory phase for initiation of meiosis.***

Meiotic phase or Maturation phase

- In this phase the *primary spermatocyte (2n)* undergo first ***meiotic division*** and result two **secondary spermatocytes (n).**
- The *secondary spermatocytes* undergo ***second meiotic division*** (*i.e. equational division*) and form **four haploid spermatids** (i.e. *unspecialized cells having separated nuclear matter and remain connected by the cytoplasm*).

Spermatogenesis

- In this unspecialized ***spermatid*** transform into ***spermatozoa*** (*i.e. sperm*) by :

1. *Losing a great deal of cytoplasm*
2. *Condensation of nucleus into a head*
3. *By formation of flagellated tail*

- During development the flagellated *tail of sperm projected* into **lumen** while *head is embedded* in the **Sertoli cells** which get

detached and released in the lumen of the **seminiferous tubule** at the maturation.

Spermiation: is process when mature spermatozoan *gets detached and released in the lumen of the seminiferous tubule*.

Hormonal control of spermatogenesis

- Spermatogenesis start at the age of puberty (i.e. 3-16 years) .
- At this stage the gonadotropin releasing hormone (GnRH) is released by hypothalamus and stimulate anterior pituitary to produce two gonadotropins:

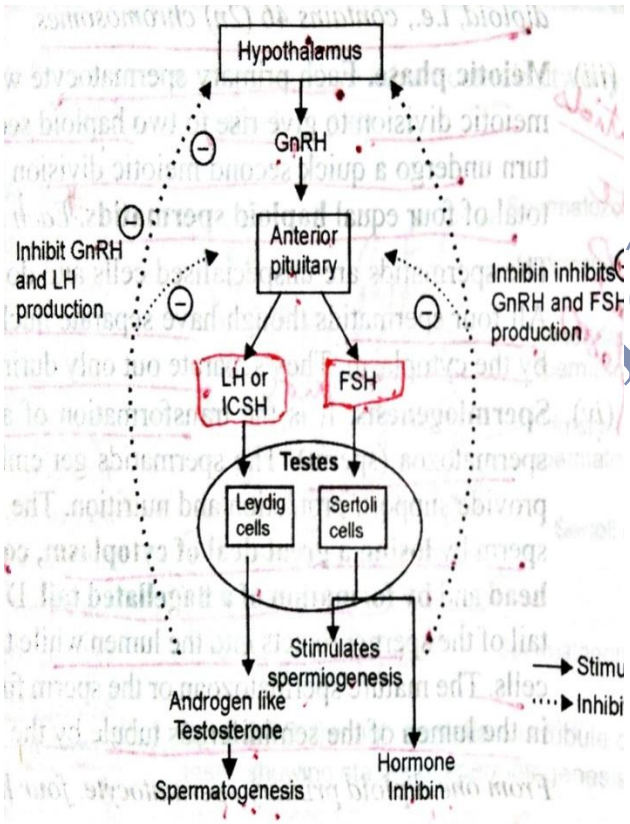


Fig. 3.8 Hormonal control of spermatogenesis (interaction between testes and anterior pituitary)

1. **Luteinising Hormone (LH)** or **Interstitial Cells Stimulating Hormone (ICSH):** it stimulates ***leydig cells or interstitial cells*** to secrete androgen like **testosterone** (*i.e. involve in process of spermatogenesis*).

2. **Follicle Stimulating Hormone (FSH):** it stimulate the ***sertoli cells*** to facilitate **sperm development** or **spermatogenesis** and to produce a peptide hormone **inhibin** (*i.e. inhibits FSH secretion*).

\# ***Rising level of testosterone suppress the release of GnRH from hypothalamus.***

\# ***In the hormonal control of spermatogenesis both testosterone and inhibin exert negative feedback inhibition on the secreation of LH, FSH and GnRH.***

Structure of spermatozoan or a sperm

- It is elongated, flagellated and motile cells.
- It consists of following parts: head, neck, middle piece and tail or flagellum.

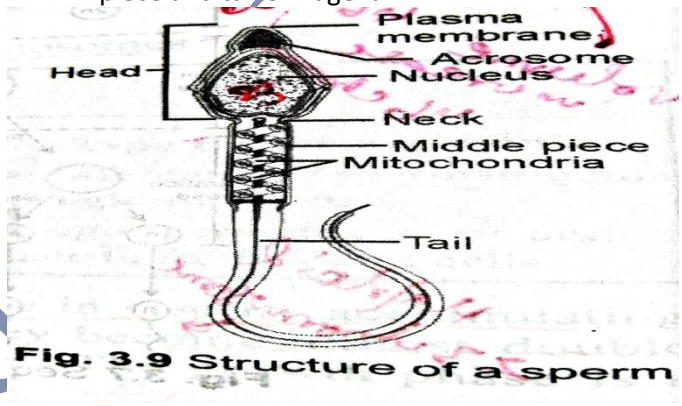


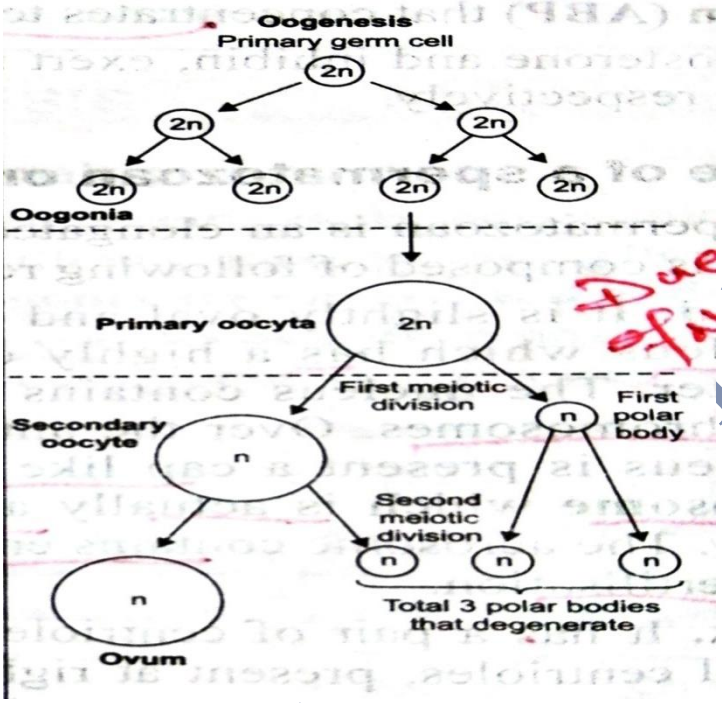
Fig. 3.9 Structure of a sperm

Part of sperm	Structure present	Function
Head	Large nucleus	Contain condense DNA and haploid number of chromosome.
	Acrosome (modified Golgi body)	Form the cap over the nucleus and contain hydrolytic enzyme (i.e. hyaluronidase) which enable the sperm to penetrate into the cytoplasm of the egg.
Neck	Proximal centriole (locted in the neck)	Play important role during the first cleavage division of the zygote.
	Distal centriole	The axial filament (i.e. form the tail piece of the sperm) is attached to the distal centriole.
Middle piece	Spiral mitochondria	Contain respiratory enzyme and supply the energy for the movement of the sperm.
Tail piece	Axial filament which surround by cytoplasm and enclosed by a tail sheath	It is modified flagellum which help in propelling the spermatozoa in liquid medium and in female reproductive tract.

Oogenesis

- It is process of formation of mature female gamete.
- It started early in the embryonic stages.
- A couple of million oogonia (*i.e. gamete mother cells*) are formed with in foetal ovary and ***no more oogonia are formed and added after birth***.

When a baby girl is born is has set of primary oocytes (*i.e. present in prophase I – diakinesis stage of meiotic division****) in the ovary and the further development (****i.e. primary oocytes****) remain suspended till puberty.***



- Oogenesis completed in the following stages:

1. **Multiplication phase** -*the germinal epithelium of ovary undergo* ***repeated mitotic division*** *which results increase in number of* ***oogonia*** **(2n)**.

2. **Growth phase-** *some of oogonia* ***increase in size and undergo growth phase*** *which result the formation of* ***primary oocytes (2n)***.

3. **Meiotic or maturation phase-** the primary oocytes undergo first meiotic division and produce two unequal size of cells (n) (i.e. due to unequal division of the cytoplasm) :

I. **Secondary oocytes:** large and receive most of the cytoplasm.

II. **First polar body:** very small.

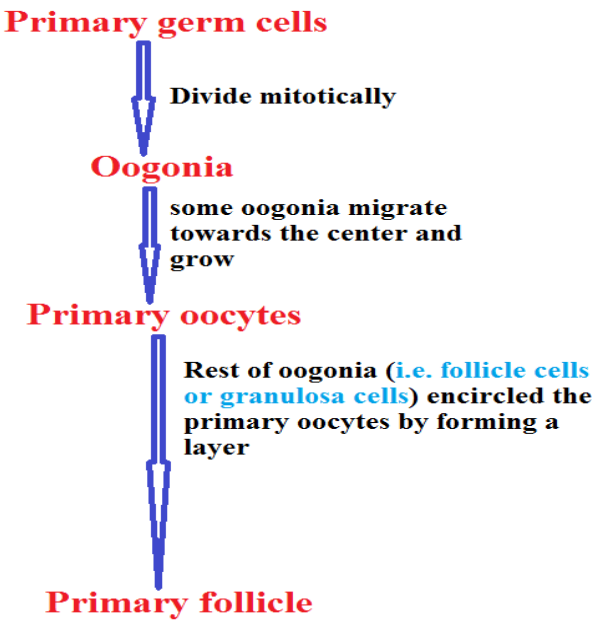
- **During second meiotic division- secondary *ooocytes and first polar body*** undergoes the division simultaneously which results formation of **large ootid or ovum** and **two small polar bodies** respectively. That mean primary oocytes gives rise to one ovum and three polar body.

in human first polar body does not undergo meiosis II and disintegrate (i.e. only one functional gamete or ova remain).

- **During ovulation – *egg release from graafian follicle*** (*i.e. secondary oocytes*) undergo ***meiosis I and till metaphase stage of meiosis II*.**
- Rest of meiosis take place ***at the time of fertilization*** (*i.e. entry of sperm restarts the cell cycle by breaking down the* ***metaphase breaking factor*** *and turning on the* ***anaphase promoting factor*** *and lead the completion of meiosis II*) and convert the secondary oocytes into ovum (*i.e. fused with sperm and form zygote*).

Development of ova in ovary (oogenesis)

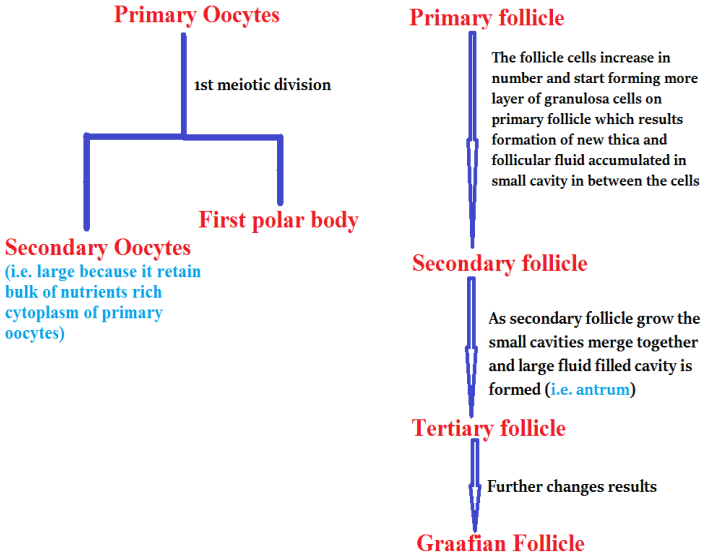
In ovary -



Follicle cells are *protective and nutritive in function* ***due to that during the phase from birth to puberty large number of follicle cells degenerate and only***

about 60,000 – 80,000 primary follicle are left in ovary.

- **As primary oocytes grow further:**



- When secondary oocytes on a slender stalk cells projecting into cavity that whole structure is called ***Graafian follicle***.
- **At ovulation –** *secondary oocytes released in follicular fluid* and finally *Graafian follicle rapture and release the ova*.
- **After ovulation -** the granulosa cells of ruptured follicle transform into **corpus luteum** (*i.e. release progesterone hormone*)

Structure of Graafian follicle

- Following structure are present in graafian follicle:

1. **Antrum** (i.e. fluid filled cavity)
2. **Liquor folliculi** (i.e. fluid present in the antrum)
3. **Cumulus oophorus** (i.e. antrum by a stalk of cells called cumulus oophorus; formed by granulosa cells)

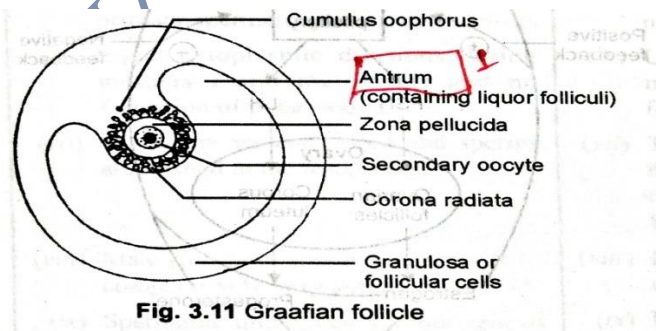


Fig. 3.11 Graafian follicle

4. **Zona pellucida** (i.e. thick area surrounds the secondary oocyte; composed of glycoprotein and synthesized by both follicle cells and oocytes.
5. **Corona radiata**(i.e. it is radiating layer of granulosa cells out side zona pellucida; it surround the secondary oocytes at the time of ovulation)

Hormonal control of Oogenesis

- Various hormone play important role in the control of oogenesis:

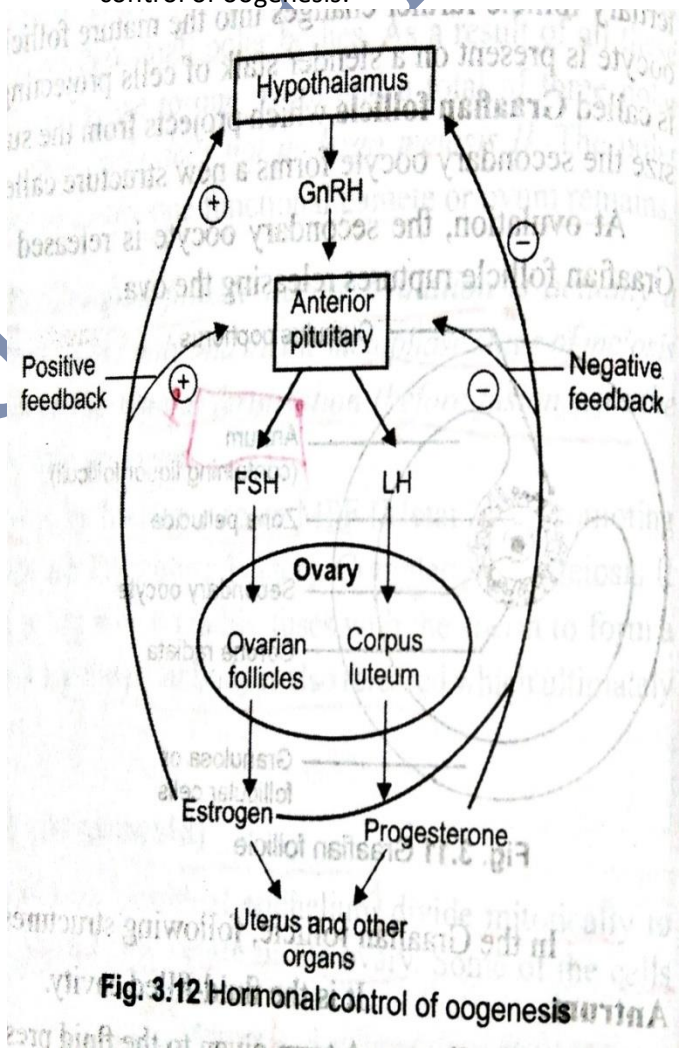


Fig. 3.12 Hormonal control of oogenesis

1. Hypothalamus release ***gonadotropin releasing hormone (GnRH)*** which stimulate anterior pituitary to release its hormone :

a) **LH (lutenising hormone) :** act on *corpus luteum* that secrete **estrogen** and **progesterone** (*i.e.*

increase the thickening of endometrium for implantation of blastocyst).

b) **FSH (follicle stimulating hormone):** stimulate the *maturation of primary, secondary and Graafian follicles* which produce the hormone **estrogen** (*i.e. responsible for the development of secondary sexual characteristics of mature women*).

rising level of estrogen causes the endometrium to become thicker and more rich supplied with blood vessel and gland.

high level of estrogen and progesterone inhibit the release of GnRH by negative feedback mechanism.

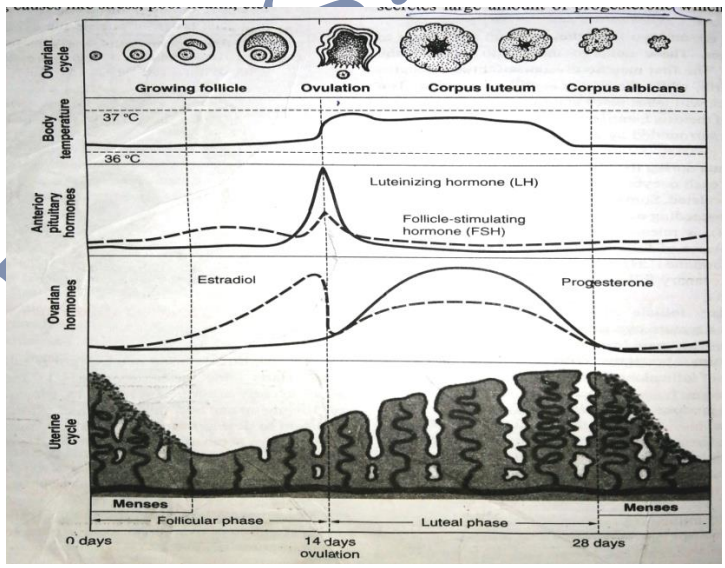
Menstrual cycle

- It involve number of cyclic changes in **ovary** and **uterus** under the influence of ***FSH*** and ***LH*** from anterior pituitary.
- Being at puberty at the age of ***10-15 year or menarche*** and goes till agents ***45- 55 years or menopause***.

it last about 28days in which ovulation occurs at 14^{th} day.

it consist of three phase:

1. ***Menstrual phase***
2. ***Proliferative phase***
3. ***Secretory phase.***



Menarche

- It is beginning or commencement of menstruation at puberty.

OR

The ***first monthly period or menstruation*** is menarche.

- It occurs between **11-13 years**.

Menstrual Phase

- Last out ***3-5 days***.
- Signed by *breaking down of the mucous membrane and gland from lining of uterus* (i.e. endometrium).
- In this phase *epithelial lining , connective tissue and blood vessels get slashed off and discharged as menstruation*.

Lack of menstruation is indication of pregnancy and it also occurs some time due to – stress, poor health and effect of some medicine.

during menstruation phase – level of estrogen and progesterone are very low in blood.

Follicular or Proliferative phase

- Last for *9-10 days (i.e. 5^{th} day to 14^{th} day or up to ovulation)*.
- In this *repairing of damage endometrium* and *ruptured blood vessels uterus* occurs through proliferation.
- Follicular induced by *raising the level of FSH* which causes the maturation of primary follicle into Graafian follicle so it also termed as follicular phase.
- ***As the ovarian follicle develop***, it start to secrete **Estrogen** due to that estrogen level uplift gradually and reach maximum about three day before ovulation.
- Estrogen cause the *ticking of endometrium* which have rich supply of blood vessels and endometrial gland i.e. endometrium become double in thickening.

Luteal or Secretary Phase

- Last up to *12-14 days (i.e. 14^{th} day to 28^{th} days)*.
- Induced by *secretion of LH* so it also called luteal phase.

- LH along with FSH stimulates ovulation (i.e. release of ova from graafian follicle).

during ovulation concentration of LH and FSH is high.

when LH concentration is high during mid cycle is called LH surge (i.e induced the rapture of graafian follicle and release of ovum).

- Now *rapture graafian follicle transform into corpus luteum* which release **progestrone**.
- Progesterone – *maintain the endometrium of uterus for implantation of the blastocyst* and *Inhibit the further maturation of any new follicle or ovulation* from the ovary.

If fertilization is absent:

- ***Corpus luteum start their own degradation*** *because the high level of progesterone inhibit the release of GnRH* which in turn **inhibit** the release of **FSH** and **LH** and results the degradation of corpus luteum and level of progesterone and estrogen also decreases.
- As corpus lueum degenerate it transform into **corpus albicans** and consequently start the breakdown and uterine contraction increases.
- **At the 28th Days:** *progesterone level falls , blood vessels constrict which prevent the blood supply to endometrium* and diminished supply of oxygen and nutrient so that all these lead the breakdown of endometrium along with blood vessels and is the beginning of menstrual cycle.

If fertilization occurred:

- The coupus luteum keep growing and level of **progesterone** also increases.
- The lining of endometrium thickens further which enable the implantation of blastocyst and menstrual cycle remain suspended.

Implantation of ova occurs in about a days after fertilization.

Monopause

- It is period of life when ***menstruation naturally stop*** in women.
- It occue between the age of **45-50** years.
- After monopouse *ovaries become small, Graafian follicle disappear and replaced by fibrous tissue, ova corpora lutea and internal secretion* of ovary are no longer. (*I.e. female lose the ability to reproduce*).

there is no male monopause but function of the male testes decline slowly with advancing the age.

Structure of ova

- It is **small** (*i.e. 0.15 mm in diameter*), **non-motile and alecithal** (*i.e. almost without any yolk*).
- It draw the nourishment from the mother through the placenta.

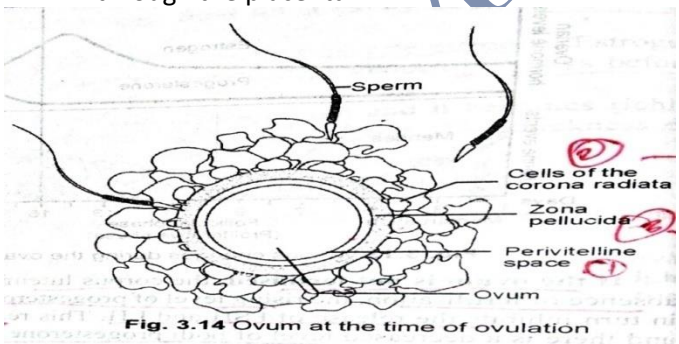


Fig. 3.14 Ovum at the time of ovulation

- At ovulation the ova is at **secondary oocyte stage**.
- It surrounded by radiating row of follicle cells called **corona radiata** (*i.e. it protect the ova till fertilization*) and get beak down only by the acrosomal enzyme released by the sperm.
- Inner to corona radiata clear transparent zone is present that called **zona pellucida (***secrete by corona cells, undergoes significant changes and thinking after fertilization to stop the entry of other sperms*).
- Next to zona pellucida**, vitelline membrane** is present which surround the cytoplasm of the egg.
- Ovum is said to have polarity that mean it have two region :

1. **Animal pole:** region where the polar body are released
2. **Vegetal pole:** region opposite to animal pole

Fertilization

- It is the fusion of sperm nucleus and egg nucleus which results zygote.
- In human fertilization is ***internal*** and occurs **at ampullary –isthmic junction**.

- **After the insemination** (*i.e. deposition of sperm into vagina*) sperm remain fertile for 12-24 hours in female reproductive part.
- Mobility of sperm tiger through vagina by ***muscular contraction of wall of uterus and oviducts*** as well a by the ***various liquid secretions from secretary cells of oviduct mucosa***.
- After ejaculation the spermatozoa are not capable to fertilizing the oocytes so that they must undergo the **capacitation period** which last about **7 hours** .

Capacitation period: during this the glycoprotein coat and seminal protein coat are remove from the surface of sperm acrosome by the action of substance secreted by uterus or uterine tube).

- It involve 3 major steps:

1. **Penetration of sperm into ovum.**
2. **Activation of ovum.**
3. **Fusion of sperm and egg nucleus.**

Penetration of sperm into ovum

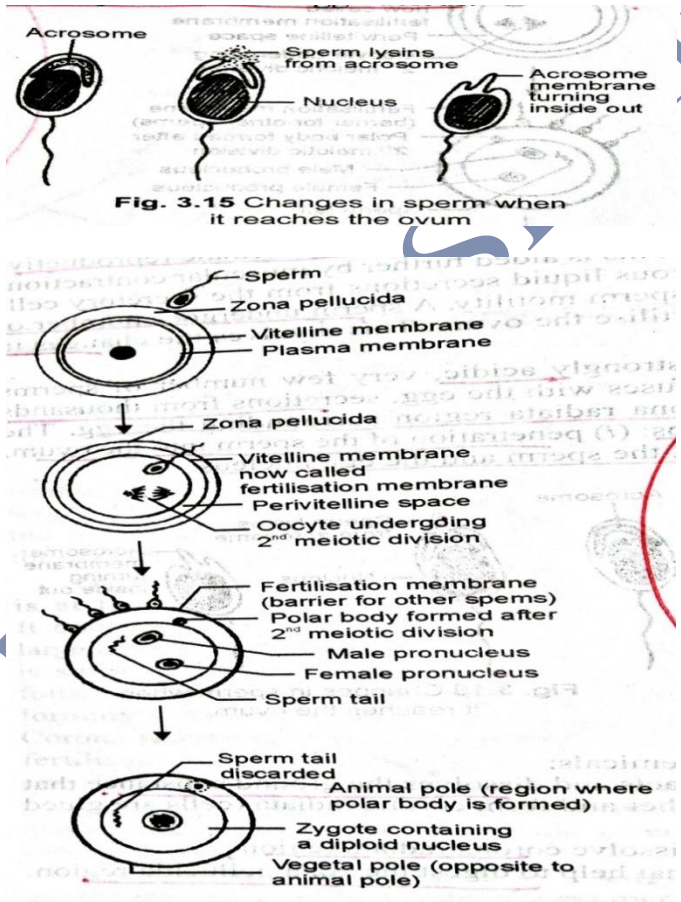


Fig. 3.15 Changes in sperm when it reaches the ovum

Fig. 3.16 Changes in ovum during fertilisation

- As the sperm reach the ovum it undergo **acrosomal reaction** (*i.e. breakdown of membrane covering of acrosomal region and release the chemical substance or enzyme from acrosome viz. sperm lysins*).

Sperm lysine: contain **Hyaluronidase enzyme** (*i.e. disperse the cells of the corona radiata*), **Acrosin** (*digest the zone pellucida region*) and **Neuraminidase**.

Fertilin proteins (*i.e. present on sperm*) act as ***egg recognition protein*** to recognize *gamete of same species*.

- As the sperm come in contact with zona pellucida the acrosome turn ***inside out*** and release *chemical to dissolve the viteline and plasma membrane of egg*.
- ***After the entry of sperm into egg cytoplasm*** - the **cortical reaction** and **zona reaction** occures to ensure **monospermy** (*i.e. fertilization of egg with only one sperm*) or to prevent the **polyspermy** (*i.e. entry of more than one sperm into ovum*).

Cortical Reaction:

Cortical granule (*i.e. located just below the egg membrane*) fuse with membrane and release their content into *space between egg membrane and vitelline membrane* which results the ***hardening of vitelline membrane and transform into fertilization membrane*** *(i.e. act as barrier for the entry of other sperm)*.

Zona reaction: the **zona pellucida** along with **vitelline membrane** becomes thick and separate from plasma membrane.

Activation of ovum

- As the sperm enter the ovum get activated and ***secondary oocytes*** undergo second meiosis which results **ovum or ootid** and a **polar body** (*viz. get degenerates*).

Fusion of egg and nucleus

- Its results formation of **zygote** (*i.e. contain parental and maternal chromosome*).

*# **After fertilization zygote undergo first mitotic division or cleavage division.***

Sex of child

- Sex of child decides as *zygote is formed* and it is determining by *chance fusion of an egg and a sperm*.
- **Female** – XX – meiosis - gamete (*i.e. Contain X-Chromosome*).
- **Male** – XY – meiosis – formed two gamete (*i.e. one contain X-Chromosome while other contain Y-Chromosome*).

Scientifically sex of the child is determine by the father and not by mother.

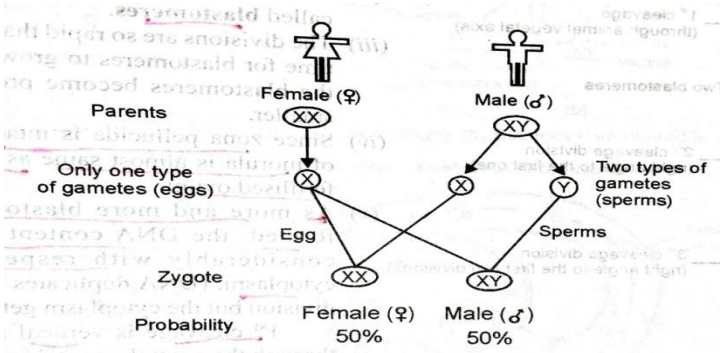


Fig. 3.17 Equal probability of a male and a female child in humans

Cleavage or segmentation

- ***After fertilization*** zygote undergo repeated division called ***cleavage division***.
- In this large cytoplasmic mass convert into number of small cells clustered together and formed ***morula***.
- Human egg shows complete division or ***holoblastic cleavage***.

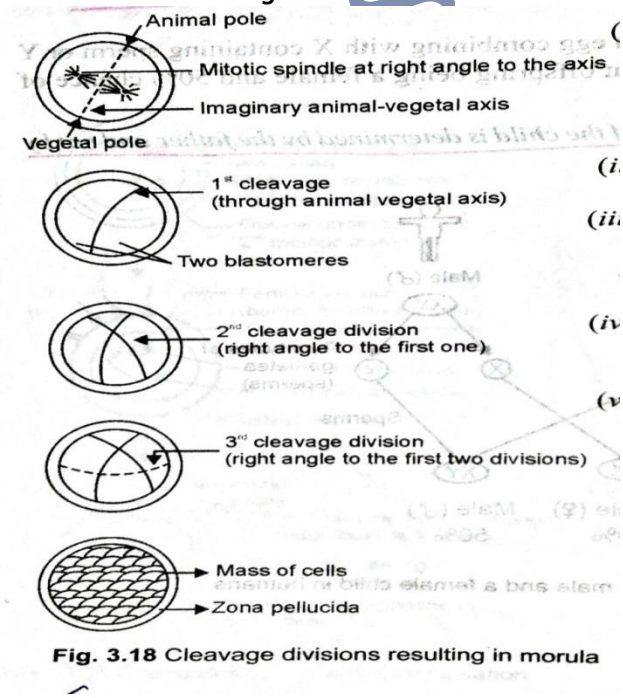


Fig. 3.18 Cleavage divisions resulting in morula

- **First cleavage** is vertical which pass through animal – vegetal axis and divide the zygote into two blastomeres (*i.e. 30 hours after fertilization*).
- In **second division** is again vertical at right angle to the first one and divides blastomeres in 4 cells.
- **3rd division** is horizontal at right angle to the first two and form 8 cell stage.
- Successive division occurs and produces a spherical mass of cell called the morula (*3 days after fertilization*).

Blastulatio

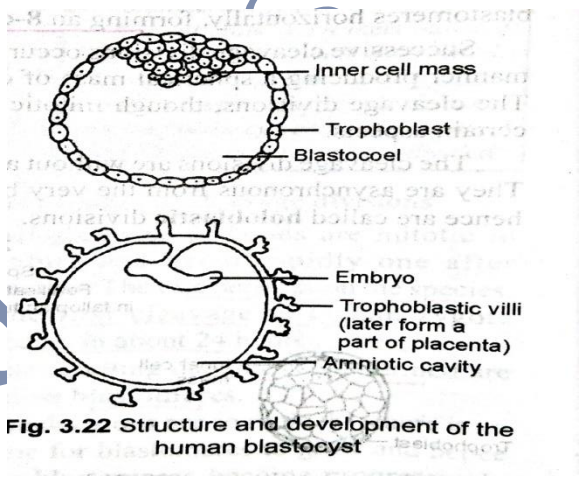


Fig. 3.22 Structure and development of the human blastocyst

- Due to arrangement of cells a fluid filled cavity appear in the center of morula is called ***blastocoel or segmentation cavity*** (*i.e. filled with liquid secreted by trophoblast cells and cells of oviducts*).
- Embryo with blastocoel is known as **blastula or blastodermic vesicle or blastocyst**.
- **During blastulation** – zona pellucida disintegrated and allows the blastula to increase in size and volume.
- One week after fertilization ***implantation or pregnancy*** occurred *i.e. blastocyst stage embedded into thickened wall of uterus* (i.e. endometrium).

Pregnancy and embryo development

- Blastocyst has ***trophoblast or trophoectoderm*** (*i.e. outer layer of cells*) ***and inner cells mass***.

Trophoblast: form outer layer of blastomeres and *help to make contact with uterine endometrium and implantation in the uterus*.

Inner cell mass or embryoblast: cluster of cells at one pole of blastocyst which *give rise to embryo and differentiated into 3 primary germ layer* (i.e. *differentiate to various tissue of embryo*).

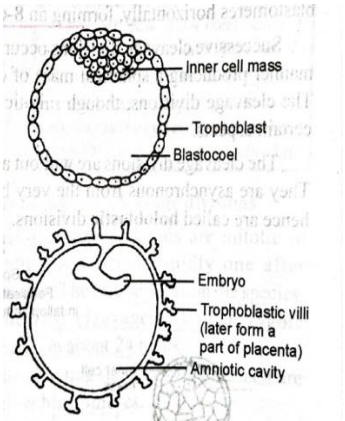
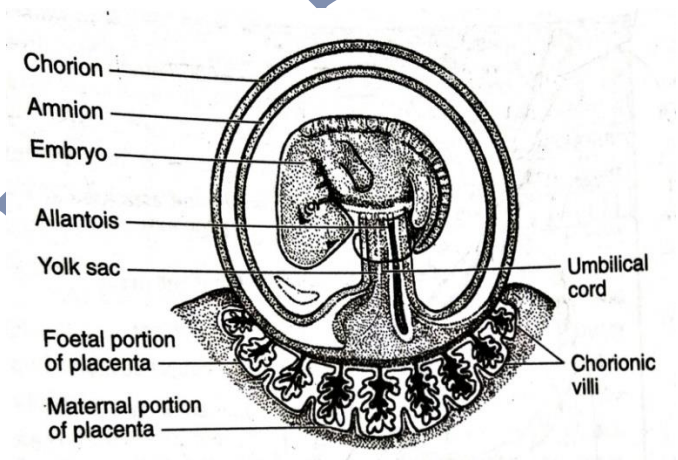


Fig. 3.22 Structure and development of the human blastocyst

- **After implantation** chorionic villi (*i.e. finger like projection*) appear in the trophoblast and are surrounded by uterine tissue and internal blood.
- Uterine tissue and chorionic villi become integrated and form placenta.

in human being embryonic stage last up to 6-8 week after fertilization (i.e. embryo is about an inch long) and later development of embryo takes the characteristics human form and termed as foetus till birth.

Placenta



- Special tissue develops between the embryo and uterine wall called ***placnta***.

OR

Disc shaped temporary connection between the mother and foetus.

- **It** consists of ***chorion (****i.e. foetal part*) and paternal part ***decidua***.

Decidua basalis: after implantation *chorion villi of blasocyst grow into endometrium* and endometrial tissue undergo changes is known as ***decidua baalis***.

- Chorion villi burro deeper in endometrium (*i.e. ressults breakdown of mucosa epithelium, connective tissue and endometrium lining*) and come close with contact of maternal blood so that blood vessels of chorionic villi are bathed into mother blood. This type of placenta is ***called haemochorial placenta***.

Function of placenta

1. It allows the blood system of foetal and mother to *come close contact without mixing*.
2. Exchange of *respiratory gases, nutrients, excretory waste*
3. Transport of *drugs*
4. Endocrine *organs*
5. Also act as **ultra filter** for *soluble inorganic and organic substance, hormone antibodies against disease also pass from mother to foetus*.

Protein and hormone secreted by placenta

- It synthesis and secrete number of protein and hormone.

1. Human chorionic gonadotrophin (hCG):

- It secreted by *chorionic membrane*, it keep level of *estrogen and progesterone high* and *prevents menstruation and ovulation*.

It is hormone that tested for in all pregnancy.

2. Relaxin:

- Secrete from ***placenta***, facilitates child birth by *softening the connective tissue of the pelvis*.

3. **Progesterone**
4. **Human placental lactogen (HPL)**
5. **Estrogen.**

hCG , HPL and relaxine produce in women only during pregnancy.

Increase level of estrogen, progesterone, cortisol, prolactin and thyroxin in maternal blood is essential for the foetal growth as well as for metabolic changes in mother mentanence of pregnancy.

Umbilical cord

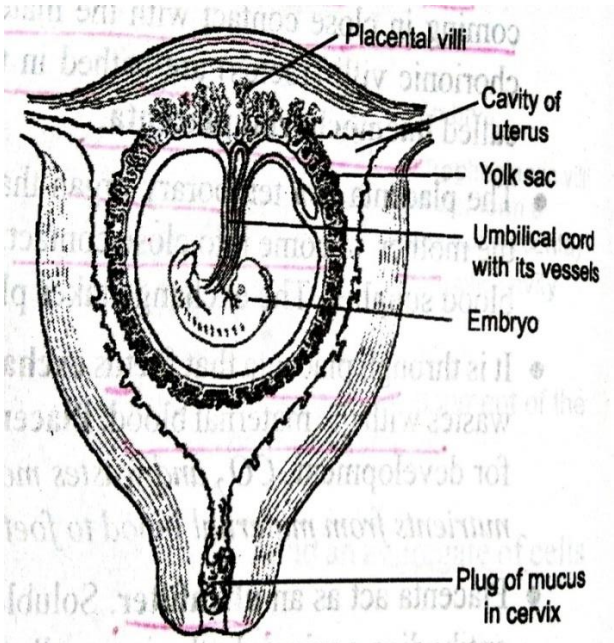


Fig. 3.24 The human foetus

- It is long and thick cord that between the foetus and the placenta.
- It attached to belly of the foetus on side and to the placenta on other side.
- It contains **blood vessels** taking foetus blood to and from the placenta.

Foetal membrane or extra embryonic membrane

- Peripheral membrane of blastocyst or trophoblast forms the extra embryonic or foetal membrane.
- It include following:

1. **Amnion:**

- It is inner membrane that surround embryo.
- Between the amnion and embryo – amnion cavity is present which is filled with amnion fluid (i.e. prevent desiccation of the embryo and act as shock absorber).

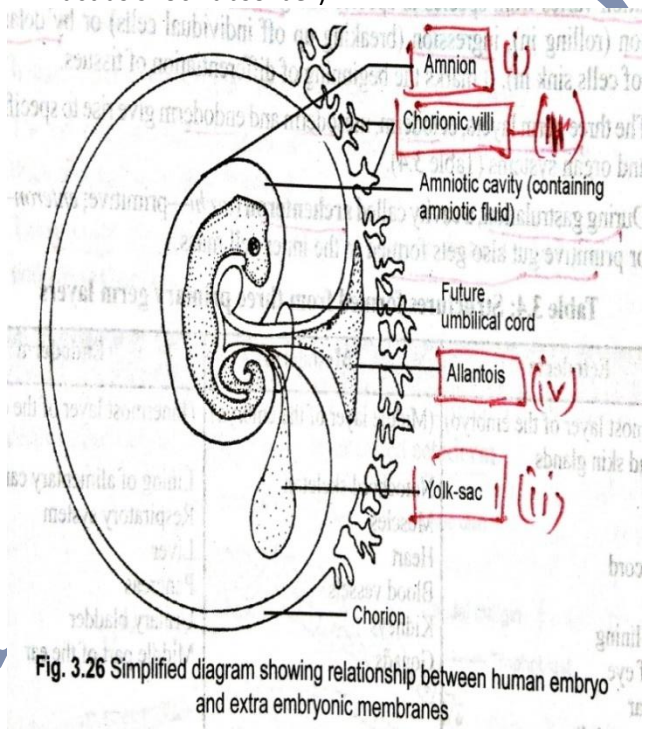


Fig. 3.26 Simplified diagram showing relationship between human embryo and extra embryonic membranes

2. **Yolk sac:**

- It is very *small* and *degenerate and shrinks*.
- In birds and reptile it nourishes the embryo but not in human being.
- In human it provides *foetal blood cells* and is modified to form *part of umrical cord*.

3. **Chorion:**

- It also called **serosa** and develop from cells of trophoblast.
- It form foetal portion of placenta.

4. **Allantois:**

- It forms ***blood vessels*** that run between foetal and uterus wall in umbrical cord.
- Allantois come in contact with chorion and form ***allanto-chorion*** *(vascular structure)* which form the foetal part of placenta.

Due to participation of allantois and chorion in formation of human placenta is called chorioallantoic placenta.

Gastulation

- In this cells of blastocyst (*inner cell mass*) differentiated and undergo various movement or *morphogenetic movement* and resultant of that they rearranged into **primary germ layers**.
- Primary germ layer in double layer structure called **gastula**.
- Gastula formed, by **invagiinaion, involution** (*rolling in*), i**ngression** (*breaking up of individual cells*) or **delamination** (*sheets of cells sink in*).
- Three germ layer give rise specific organ and organ system.

Ectoderm	Mesoderm	Endoderm
Outer most layer of embryo	Middle layer of embryo	Innermost layer of embryo
Hair, Brain , Spinal cord, Nerves, Mouth lining , Lens of eye, Inner ear Adrenal medulla	Notochord or skeleton, Muscles, Heart, Blood vessels, Kidneys Gonads	Lining of alimentary canal, Respiratory system, Liver, Pancreas, Urinary bladder, Middle part of ear

Neurulation

- After gastulation process of tissue differentiation started and during neurulation development of neural tube takes place.
- Later neural tube gives rise to nervous system in which interiorly it differentiates into brain and posterior into spinal cord.

Development of Human Embryo

- Embryo takes about ***9 month or 40 weeks*** from fertilization till birth and these time divide into three periods (i.e. each period of *3 months called trimester*).

First Trimester (First 3 month):

- It is period of rapid division, cell differentiation and organogenesis.
- **After first month –** *embryo heart is formed* (the first sign of growing foetus is noticed by listening of the foetal heart sound through the stethoscope).
- **End of 2nd month –** *foetus develop limbs and digit*.
- **End of 3rd month –** *major organ system are formed like limb and external genital organ are well develop and basic structure of the baby is formed.*

during this period foetus is very sensitive because the proper course of event can be disrupted easily like viral infection of rubella may lead to spontaneous abortion or malformation in the embryo.

Second Trimester (3-6 months):

- It is period of *tremendous growth and development*.
- ***During 5th month –*** first *movements of the foetus and appearance of hair on the head* are observed.
- ***End of 6th months –*** *body covered with fine hair , upper and lower eyelids separate and eyelashes are formed*.

During seventh month eyes open and the bones begin to ossify.

Third Trimester (6-9 months)

- It is mainly the period *of growth rather than development*.
- Foetus has develop sufficiently (*with respect to circulatory and respiratory systems*) to potentially survive if born prematurely.
- ***During the 9th month –*** *foetal weight become double*.
- **End of 9th month** *foetal is fully developed and is ready for birth*.

Birth

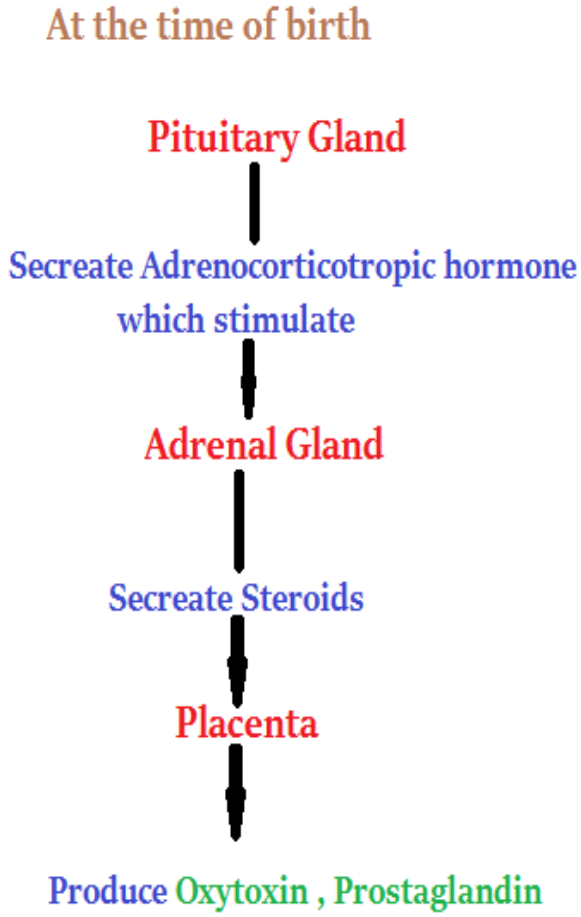
- A *vigorous contraction of uterus* at the end of pregnancy requires expelling the foetus called **labour**.

The level of progesterone rises from 12th week of pregnancy (i.e. inhibits uterine contractions) and start fall from the 38th week .

- The duration of pregnancy is about **280 days or 40weeks** (*viz. is calculated from 1st day of the last menstrual cycle*).
- New born healthy child has about **3.5 kg weight**.

Parturition

- *Process of delivery of foetus* is called **parturition**.
- It induces by a complex **neuro-endocrine mechanism** in which single for parturition originates from *fully develops foetus and placenta*. Which induce mild uterine contraction called **foetal-ejection reflex**.
- **During foetal-ejection reflex,** pituitary gland secrete ***Adrenocorticotropic hormone (ACTH)*** (*i.e. stimulate adrenal gland to secrete steroid*).



- Due to release of **oxytoxin** and **prostaglandin** cause strong contraction which results *dilation of cervix and amniotic sac rapture* and baby is expelled out of the uterus through birth canal.
- Labour can be also induces artificially by *injections of oxytocin or by the injection of prostaglandin into vagina*.
- If women does not want to go through the labour pain so she can opt for surgical procedure i.e. **Caesarean.**

Lactation

- *Production and release of milk* is called **lactation**.
- Initial 2-3 days mother produce **colostrums** (*i.e. thick, yellow and high protein fluid which contain maternal antibodies i.e. help in strength the body immune system*).
- Milk production after parturition stimulate by **prolectin** (*i.e. hormone of anterior pituitary*).

High level of estrogen acts directly on mammary gland to block their stimulation by prolectin.

If a women does not wish to breast feed her baby than she may take oral estrogen to inhibit prolactine secretion.

- Breast feeding during the initial period of infant growth recommended by doctors to *bringing up a healthy body*.