Ch-3 Human Reproduction

The reproductive events in humans include :

(i) Formation of gametes (gametogenesis)

- Spermatogenesis (in males) → formation of sperms
- Oogenesis (in females) → formation of ovum

(ii) Transfer of sperm into the female genital tract (insemination)

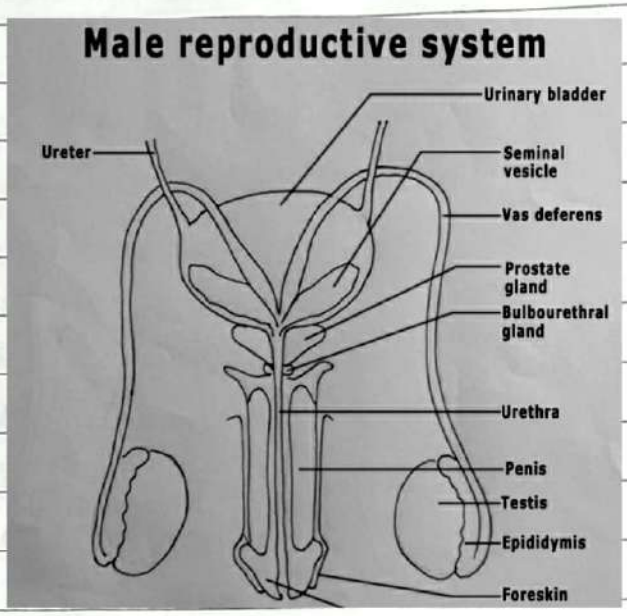
(iii) Fusion of sperm and ovum (fertilisation) leading to the formation of zygote.

(iv) Formation and development of blastocyst and its attachment to the uterine wall (implantation).

(v) Embryonic development (gestation period).

(vi) Delivery of baby (parturition)

The male Reproductive System



Male Reproductive System

Primary sex organ

- Testes
  - Testicular lobules
    - 2-3 Seminiferous tubules
      - Germinal epithelium (undergo spermatogenesis)
      - Sertolli cells (undergo spermiation)

Male accessory ducts

- Rete testis
- Vasa efferentia
- epididymis
- vasa deferns

Accessory glands

- Seminal vesicles
- Prostate gland
- paired bulbourethral glands

* Primary sex organ :

- The human male primary sex organ is a pair of testes. The testes are located outside the abdominal cavity within a pouch called scrotum.
- In adults, each testes is oval in shape.
- Each testis has about 250 compartments called testicular lobules. Each lobule contains one to three highly coiled seminiferous tubules in which sperms are produced.
- Each seminiferous tubule is lined on its inside by two types of cells called male germ cells (germinal epithelium) and sertolli cells.
- The male germ cells undergo meiotic division leading to sperm formation and sertolli cells provide nutrition to the germ cells.
- The regions outside the seminiferous tubules called interstitial spaces contains small blood vessel and interstitial cells (Leydig cells) which secretes androgens.

* Male accessory ducts :

- The male sex accessory ducts include rete testis, vasa efferentia, epididymis and vas deferns.
- The seminiferous tubules of the testis open into the vasa ~~deferns~~ efferentia through rete testis.
- The vasa efferentia leave the testis and open into epididymis located along the posterior surface of each testis.
- The epididymis leads to vas deferns that ascends to the abdomen and loops over the urinary bladder. It receives a duct from seminal vesicle and opens

into urethra as the ejaculatary duct.
- The urethra originates from the urinary bladder and extends through the penis to its' external opening called urethral meatus.

* Penis is the male external genitalia. It is made up of special tissues that helps in erection of penis. The enlarged end of penis is called the glans penis. It is covered by a loose fold of skin called foreskin.

* Male accessory glands :

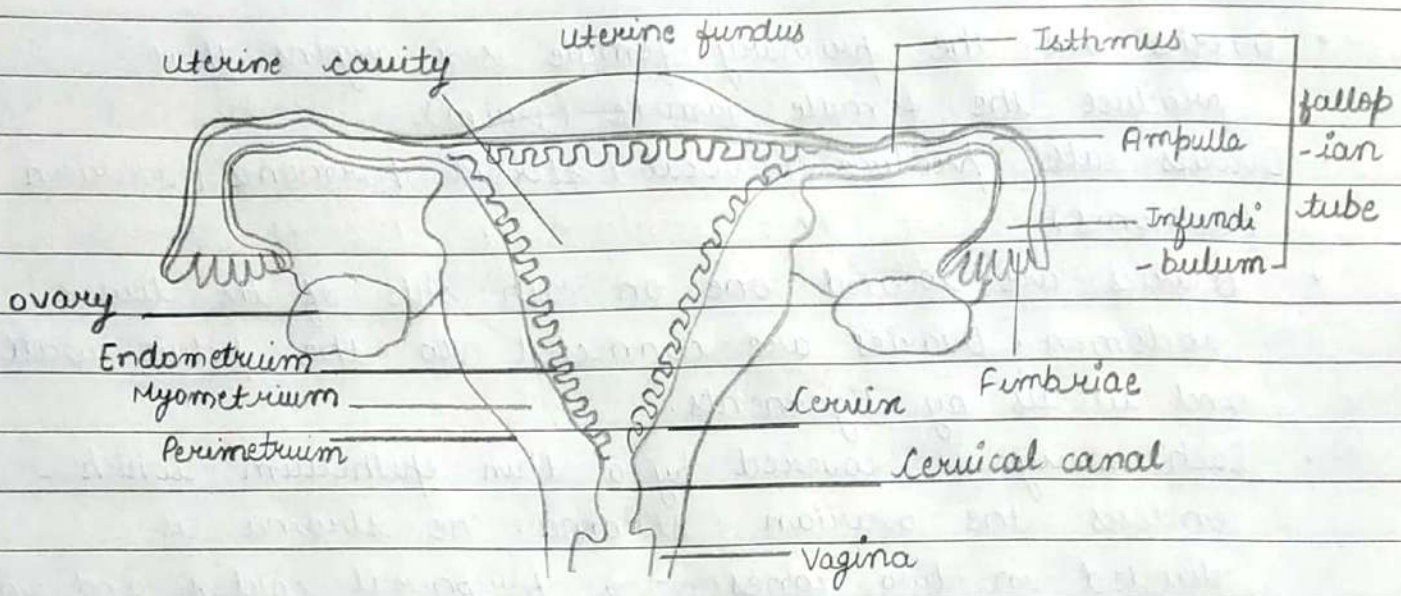
The male accessory glands includes seminal vesicles, a prostate gland and paired bulbourethral gland (cowpers glands).

1. Seminal vesicle - It is 5 cm long, muscular and opens into vas deferns.
   Its' secretion helps in activation of sperm and contraction in female reproductive tract.

2. Prostate gland - It is a single donut shaped gland
   It pores its' secretion into urethra
   Its' secretion contains bicarbonate ions, lipids.
   It provides nutrition to sperms and proper basic PH.

3. Cowper's gland - It is also called bulbourethral gland.
   It is a paired gland which secretes muccus which helps in lubrication.

Female Reproductive System



Female Reproductive Tract

- **Primary sex organs**
  - **Ovary**
    - oogenesis takes place
- **Female accessory ducts**
  - **Oviduct**
    - Infundibulum with fimbrae
    - Ampulla
    - Isthmus (fertilisation takes place here)
  - **Uterus**
    - Perimetrium
    - Myometrium
    - Endometrium
  - **Vagina**

* Female primary sex organ

- Ovaries are the primary female sex organs that produce the female gamete (ouum).
- Ovaries also produce several steroid harmones (ovarian harmones).
- Ovaries are located one on each side of the lower abdomen. Ovaries are connected to the pelvic wall and uterus by ligaments.
- Each ovary is covered by a thin epithelium which encloses the ovarian stroma. The stroma is divided in two zones - a peripheral cortex and an inner medulla.

* Female accessory ducts

- **Ouiducts:** The ouiducts (fallopian tubes) is about 10 - 12 cm long and extends from the periphery of each ovary to the uterus.

→ The part closer to the ovary is the funnel-shaped infundibulum.

→ The edges of the infundibulum posses finger-like projections called fimbrae, which helps in collection of ouum after ouulation.

→ The infundibulum leads to a wider part of the ouiduct called ampulla.

→ The last part of the ouiduct is isthmus. It joins the uterus and it is the place where fertilisation takes place.

• **Uterus**: The uterus is single and is also called womb. The shape of the uterus is like an inverted pear.

→ The uterus opens into vagina through a narrow cervix. The cavity of the cervix is called cervical canal.

→ The wall of the uterus has three layers of tissues:

(i) Perimetrium - It is the external thin membrane.

(ii) Myometrium - The middle thick layer of smooth muscles

(iii) Endometrium - Myometrium and inner glandular layer is called the endometrium. It lines the uterine cavity. It undergoes cyclic changes during menstrual cycle.

* The female external genitalia includes mons pubis, labia majora, labia minora, hymen and clitoris.

→ Mons Pubis - It is a cushion of fatty tissues covered by skin and pubic hair

→ Labia majora - They are fleshy folds of tissues which extends down from the mons pubis and surrounds the vaginal opening.

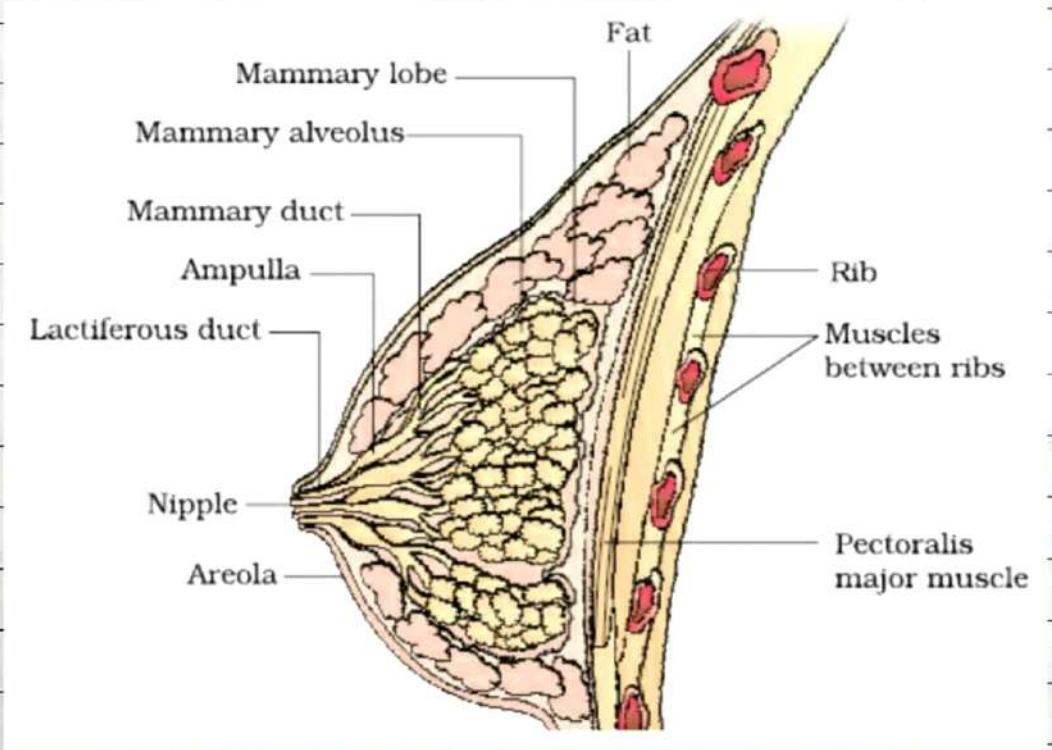
→ Labia minora - They are paired folds of tissue under labia majora.

→ Hymen - The opening of vagina is partially covered with a membrane is called hymen.

→ Clitoris - The clitoris is a tiny finger - like structure which lies at the upper junction of the two labia minora above the urethral opening.

* Mammary glands

- The mammary glands are paired structures that contains glandular tissues and variable amount of fat.
- The glandular tissue of each breast is divided into 15 - 20 mammary lobes containing clusters of cells called alveoli.
- The cells of alveoli stores milk which is stored in the cavities of alveoli.
- The alveoli opens into mammary tubules. The tubules of each lobe join to form a mammary duct. Several mammary ducts join to form a wider mammary ampulla which is connected to lactiferous duct through which milk is sucked out.



Gametogenesis

(i) Spermatogenesis:

The process of formation of sperm within male gonads i.e testes is known as spermatogenesis. The process of spermatogenesis begins at puberty.

→ Within the male gonads i.e testes the male germ cells (spermatogonia) produces sperms at puberty.
→ Each spermatogonia cells behave as primary spermatocytes which undergoes meiosis to form two equal haploid cells known as secondary spermatocytes.
→ The secondary spermatocyte will undergo second meiotic division to form four equal haploid spermatids.
→ Spermatids will undergo spermiogenesis and get transformed into spermatozoa.
→ Then, it is followed by spermiation

* Spermiation - Sperms head becomes embedded in the sertolli cells to get nutrition and are finally released from one seminiferous tubule by the process called spermiation.

• Sperm transport in males

• The sperms are produced within the seminiferous tubules of the testes and are finally released from it by the process of spermiation.
• From the testicular lobule finally through the rete testis sperm enters to vasa efferentia.
• From vasa efferentia the sperm is deposited into

epididymis that ascends to the abdomen and loops over the urinary bladder.

- It receives a duct from seminal vesicle and opens into the urethra as the ejaculatory duct. The urethra originates from the urinary bladder and extends through the penis to it's external opening called urethral meatus.

- **Harmonal control of spermatogenesis :**

The secretion of GnRH by hypothalamus increases significantly during puberty.
GnRH will act upon anterior pituitary and stimulates the secretion of two gonadotropins and also Intestitial cell stimulating harmone (ICSH). The two gonadotropins secreted are LH (Leydig cells) and FSH (Follicle Stimulating harmone).
LH acts on leydig cells of testes and stimulates them to secrete androgens. Androgens, in turn stimulates the process of spermatogenesis
FSH acts on sertolli cells to secrete some factors which helps in the process of spermiogenesis.

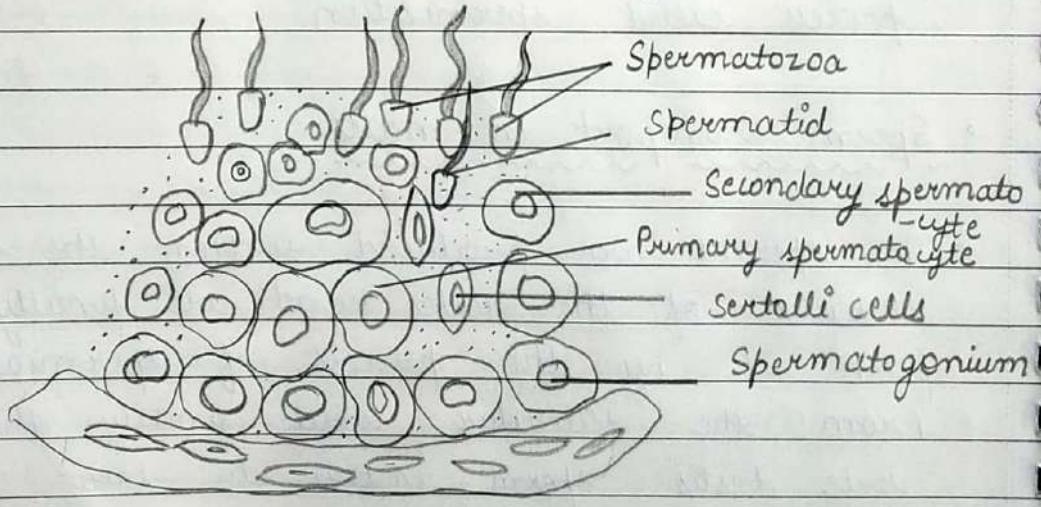


Fig - Sectional view of a seminiferous tubule (enlarged)

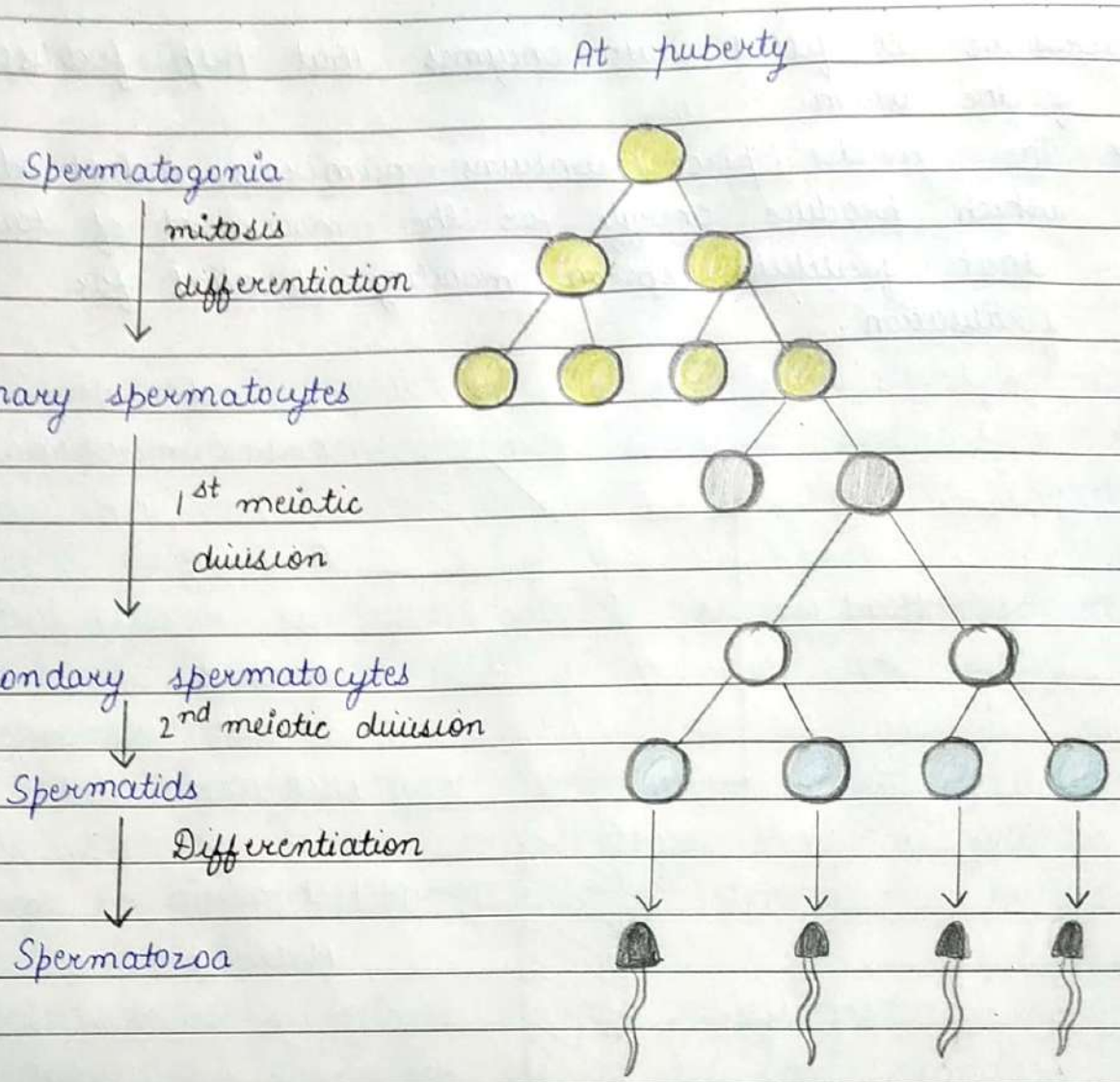


Fig- Schematic representation of spermatogenesis

- **Structure of a human sperm**

→ A human sperm is composed of a head, neck, a middle piece and a tail.
→ A plasma membrane envelops the whole body of sperm.
→ The sperm head contains an elongated haploid nucleus, the anterior portion of which is covered with a cap-like structure called acrosome. The

acrosome is filled with enzymes that help fertilisation of the ovum.

→ The middle piece contains numerous mitochondria which produce energy for the movement of tail. that facilitate sperm mobility essential for fertilisation.

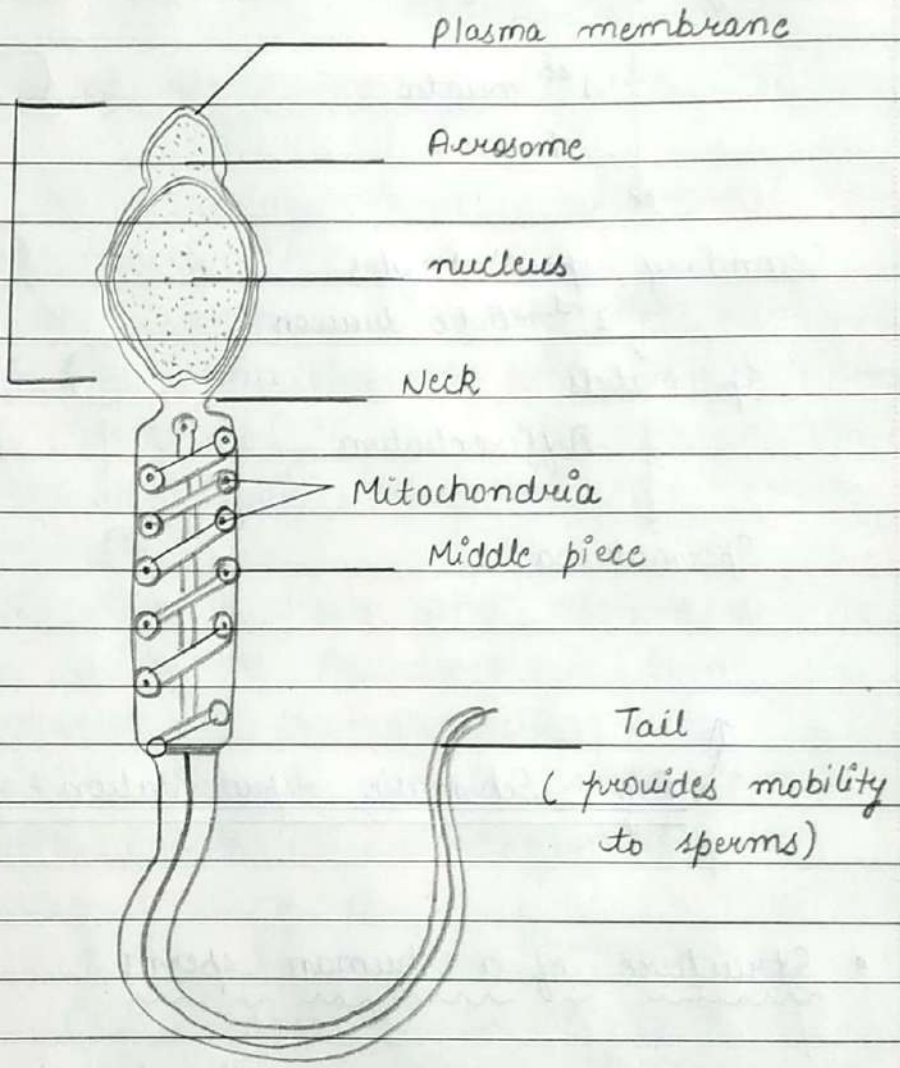


Fig - Structure of a sperm

(ii) Oogenesis:

The process of formation of ova within female gonads i.e ovary is known as oogenesis.
It starts at foetal stage in females.

→ Oogenesis is initiated during embryonic developmental stage when millions of oogonia are differentiated in each ovary and no more oogonia are formed after birth.
→ The oogonia undergoes meiosis but is suspended at prophase I of meiosis I. These cells are called primary oocytes.
→ Each primary oocytes becomes surrounded by a layer of granulosa cells and become primary follicles. Many primary follicles degenerate during the period of birth to puberty.
→ When primary follicles becomes surrounded by more number of granulosa cells and forms secondary follicle.
→ After the development of a fluid filled cavity called antrum around the primary oocyte, the secondary follicle transforms into tertial follicle.
→ The granulosa layer become organised into two layers.
(a) Theca interna
(b) Theca externa
→ At this stage, the primary oocyte completes meiosis I and forms a large secondary oocyte and tiny first polar body. The tertiary follicles grows further and grows into grafian follicle.
→ The secondary oocyte develops a new membrane around it's plasma membrane called zona pellucida.

It starts meiosis II which is suspended at metaphase stage. At this stage the follicle ruptures to release secondary oocytes which moves into fallopian tube.

- Harmonal contral of oogenesis :

→ The hypothalamus, anterior pituitary and ovary interact to regulate female reproduction.
→ Harmones of hypothalamus, anterior pituitary and ovary maintains menstrual cycle.
→ The human female produces ova at regular intervals within their ovarian follicles.
→ The mature follicle ruptures to liberate the ovum. This process is called ovulation. Ovulation takes place in about the middle of menstrual cycle (on 14th day). This is due to the surge of LH secreted by anterior pituitary.
→ The granulosa cells of the developing ovarian follicles synthesise estrogens, while the corpus luteum synthesise both estrogen and progesterone.
→ Estrogen are group of steroids and are responsible for developing secondary sexual characters in females. The synthesis and secretion of estrogens in high level supress the release of Gonadotropin releasing harmone providing a negative feedback control of harmone level.
→ Progesterone is a steraid and has numerous affects in the body. It's production is secreted by LH and it's secretion is controlled by hypothalamus

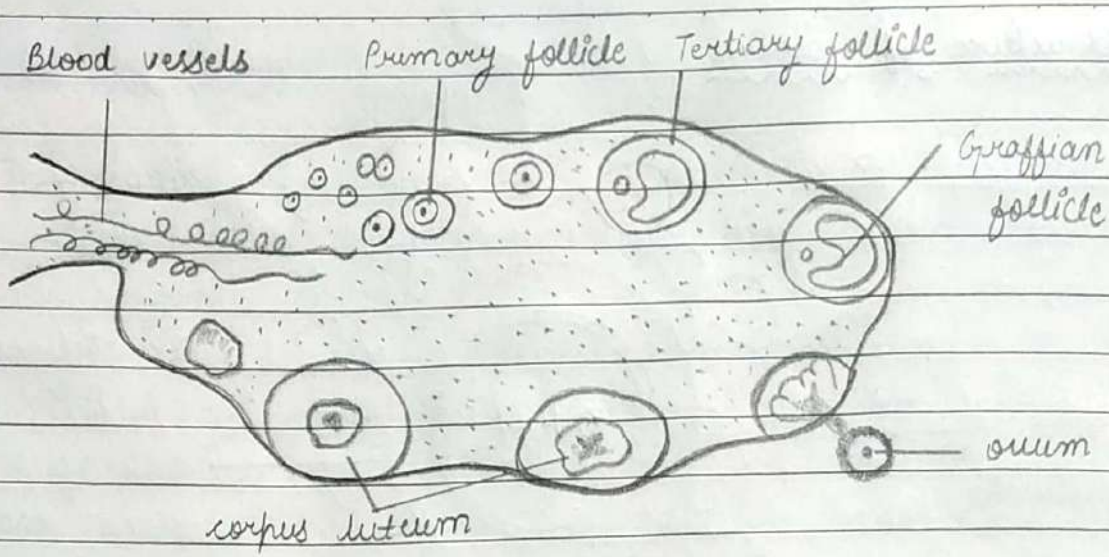


Fig - Diagrammatic sectional view of ovary

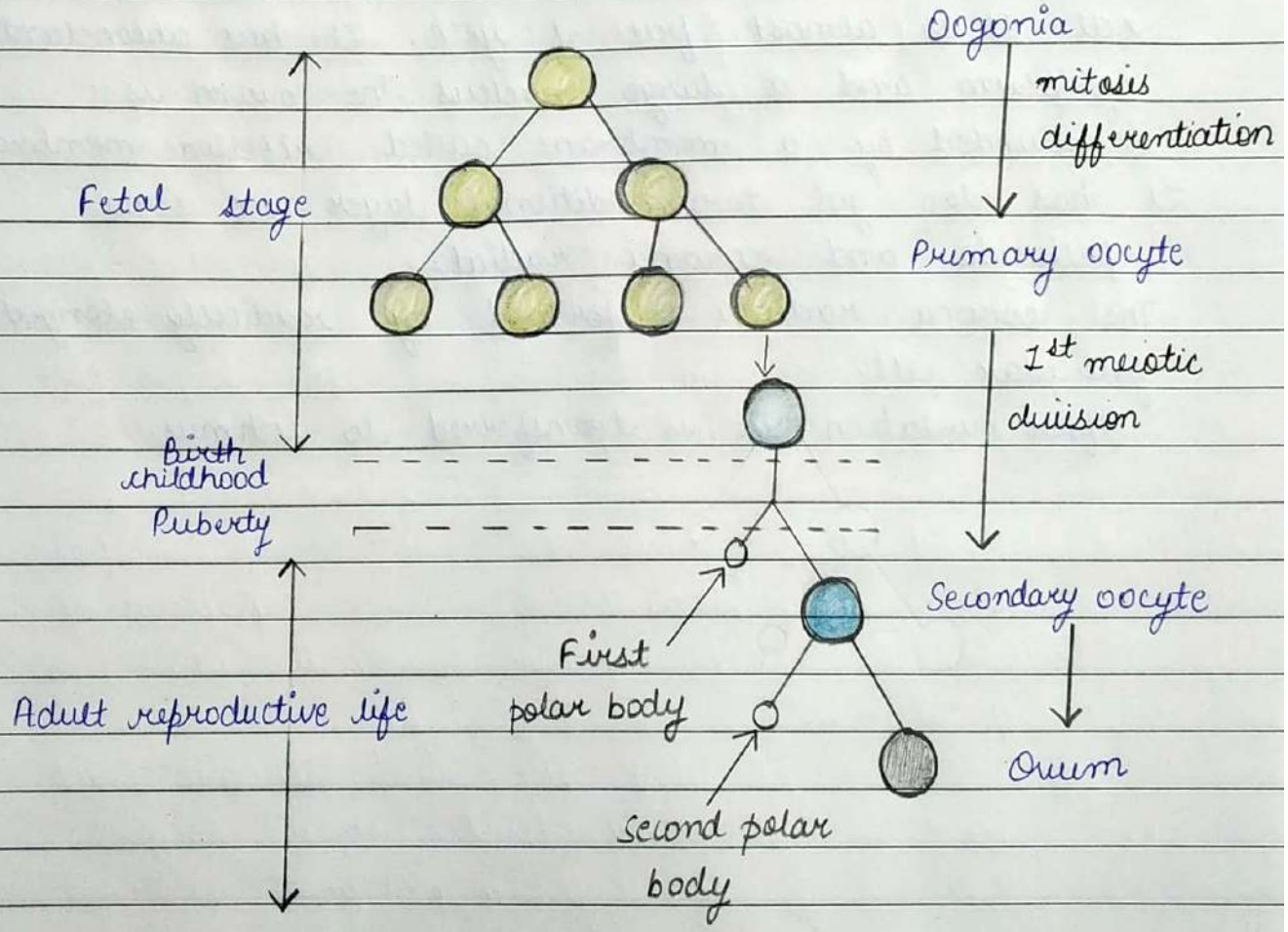
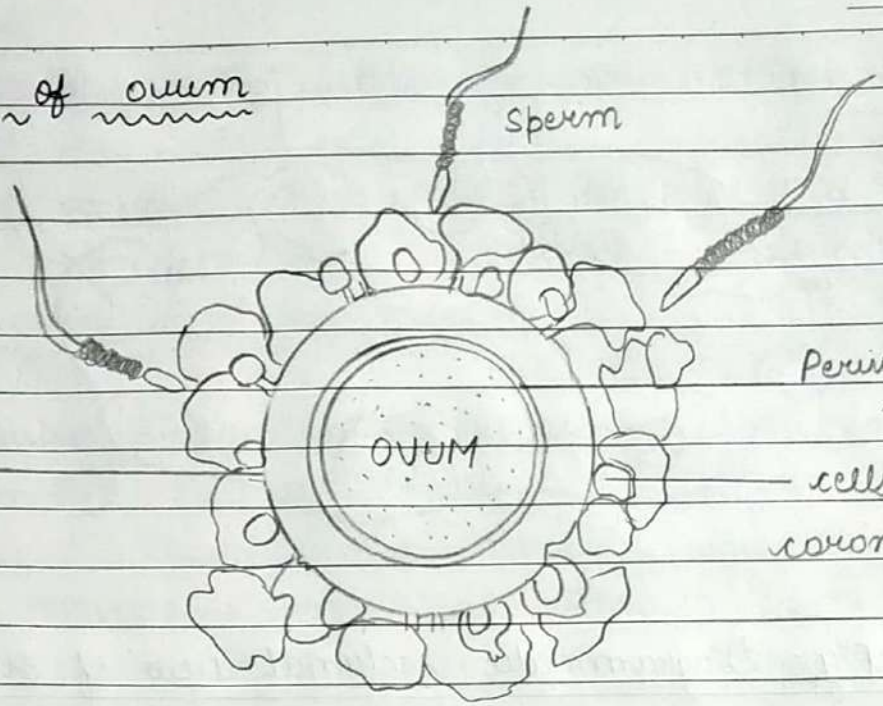


Fig - Schematic representation of oogenesis

- Structure of ovum



Human ovum is rounded, non-motile (non-volatile) cell. It is almost free of yolk. It has abundant cytoplasm and a large nucleus. The ovum is surrounded by a membrane called vitelline membrane. It has also got two additional layer i.e zona pellucida and corona radiata.

The corona radiata is formed by radially elongated follicular cell.

After ovulation, it is transferred to isthmus.

Menstrual cycle:

The cycle in which there is a discharge of blood and fragments of endometrium at intervals of 28 days from the vagina of a mature woman.

- **Menarche** - It is the onset of menstrual cycle in human female after attainment of puberty.
- **Menopause** - It is the pause in the menses after the age of 50 years. It is usually uneventful but in some women complications like flushing, excessive bleeding and nervous disorders are observed.

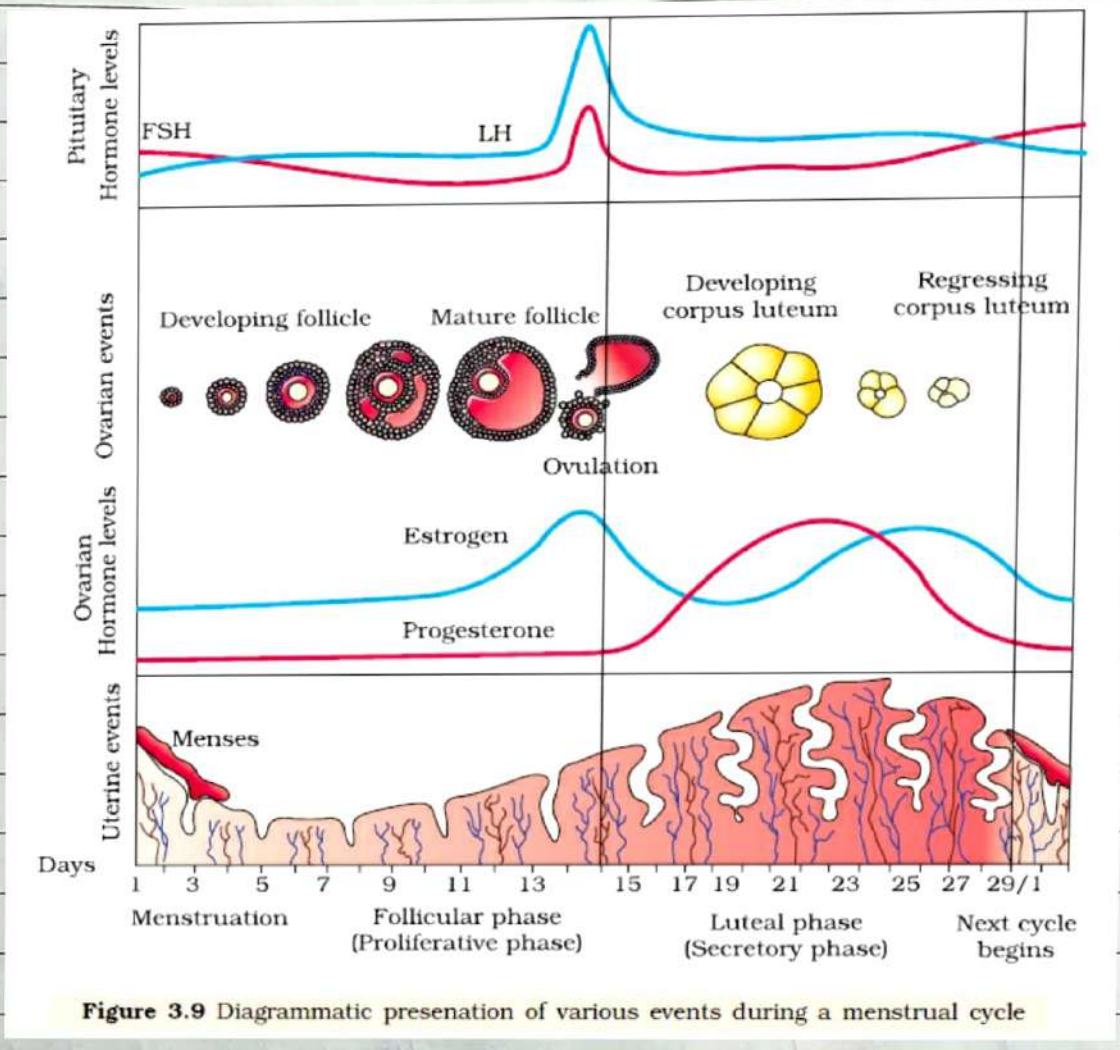


Figure 3.9 Diagrammatic presenation of various events during a menstrual cycle

Menstrual cycle is divided into four events (phases):

(i) Menstrual phase - It occurs from day 1 to day 5 of a new cycle. There are some individual variations however.
During this period, parts of mucous membrane and glands are broken down and lost from endometrium through vagina.

(ii) Follicular phase - It is also called folliferative phase. On day 2 of the cycle, the pituitary gland releases FSH. This stimulate the development of several ovarian follicles.
At 6th day one of the follicle ~~stimulates~~ dominates and start secreting estrogens and the other follides degenerates. The remaining one follicle develops into graffian follicle and continues to secrete estrogen until the 14th day of cycle. As a result blood estrogen level rises. Estrogen causes proliferation of the endometrium to replace the layer lost during the previous cycle.

(iii) Ovulatory phase - It is the rupture of mature grafian follicle with expulsion of ovum into the pelvic cavity that occurs on day 14 in a 28 day cycle.
→ On 12 to 13 day the blood estrogen level reaches a threshold level which trigers sudden surge of LH harmone from anterior pituitary. This rapid increase triggers ovulation around 14th day. The ovum lives for 14 - 36 hours.

(iv) Luteal phase - It is also called secretory phase. LH cause graffian follicle to form corpus luteum (yellow body). The name comes from yellow colour of secretory cells that develops inside the remaining Grafian follicle.

- Role of different harmones in menstrual cycle:

1. Luteinising harmone (LH):-

→ It stimulates ovulation
→ It causes graafian follicle to develop into corpus luteum. It stimulates the synthesis of progesterone by corpus luteum.

2. Role of Progesterone:-

→ It causes spiral shaped blood vessels to grow into endometruim of uterus so that endometruim begin secreting mucus and nutrients.
→ High level of progesterone inhibits FSH, no new follicles are stimulated
→ It prevents maturation of any other graafian follicle.

3. Role of estrogen:-

→ It maintains the uterine lining.
→ On 12-13 day estrogen reaches peak and a sudden surge of LH takes place which causes ovulation.

Fertilisation and implantation:

* Fertilisation:

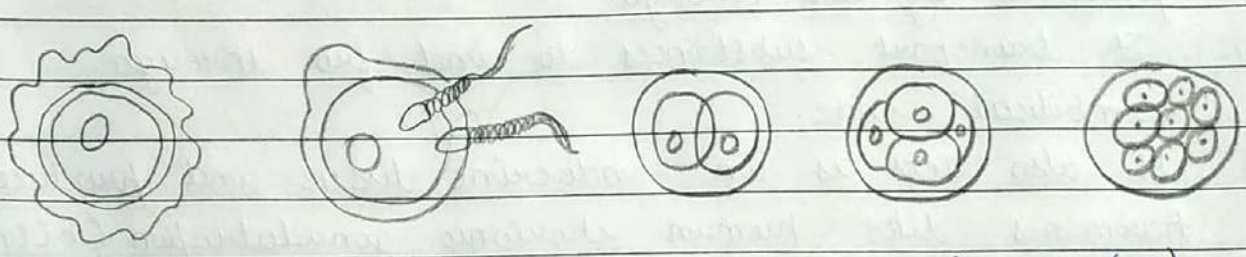
- During coitus semen is released by the penis into the vagina. This process is called insemination.
- The motile sperms pass through the cervix, enter the uterus and reach to the fallopian tube. Ovum is also released by the ovary and fertilisation takes place in the isthmus part of the fallopian tube.
- The process of fusion of sperm with an ovum is called fertilisation. During fertilisation, a sperm comes in contact with the zona pellucida layer of the ovum and induce changes in the membrane that block the entry of other sperms. Thus, only one sperm can fertilise the ovum.
- The secretions of the acrosome help the sperm to enter into the cytoplasm of the ovum through the zona pellucida and the plasma membrane. This indicates the completion of the meiotic division of the secondary oocyte.
- The second meiotic division is also unequal and result in the formation of second polar body and a haploid ovum.
- Soon the haploid nucleus of the sperms and that of the ovum fuse together and form a diploid zygote.

* Implantation:

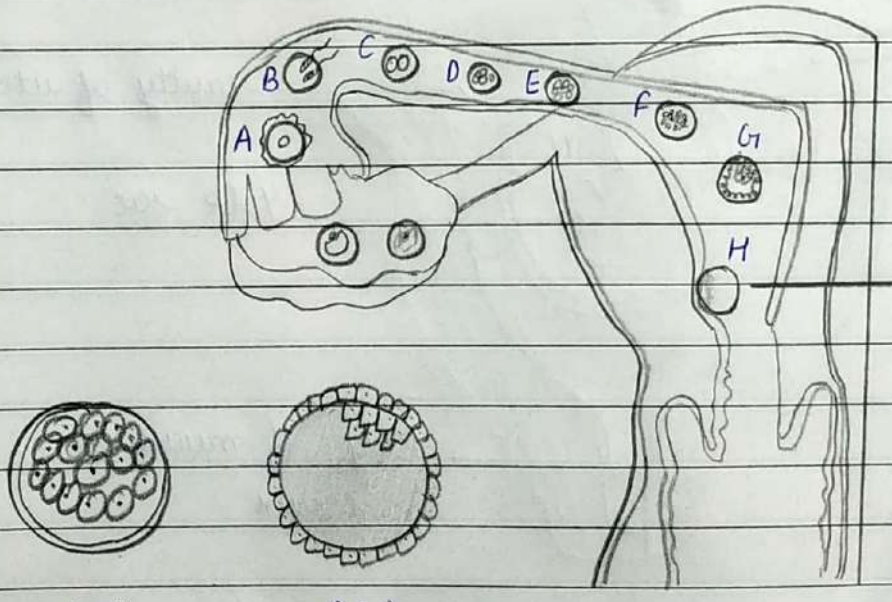
- Fertilisation is followed by a phase of rapid cell division called cleavage. As a result 2, 4, 8, 16 daughter cells called blastomers are formed.
- The embryo with 8 to 16 blastomers is called a

morula.

- The morula continues to divide and transforms into blastocyst as it moves further in the uterus. The blastomers in the blastocyst are arranged into an outer layer called trophoblast and an inner group of cells attached to tropoblast called the inner cell mass.
- The tropoblast layer then gets attached to the endometrium and the inner cell mass gets differentiated as the embryo.
- Then the blastocyst gets attached to the wall of uterus at the start of pregnancy. This process is called implantation



(A) (Ovum) (B) (Fertilisation) (C) (Cleavage) (D) (E) (Morula)



(F) (Blastula cavity develops) (G)

Fig - Transport of ovum, fertilisation & passage of growing embryo through fallopian tube.

Pregnancy and embryonic development

After implantation, the chronic villi and uterine tissue become interdigitated with each other and jointly form a structural and functional unit between developing embryo and maternal body called placenta. It is a disc - shaped structure.

→ Functions of placenta

(a) Provides oxygen and nutrients to the embryo.
(b) Removes carbon dioxide and excretory material produced by the embryo.
(c) It transport substances to and fro through umbilical code.
(d) It also acts as an endocrine tissue and produces harmones like human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogens etc.

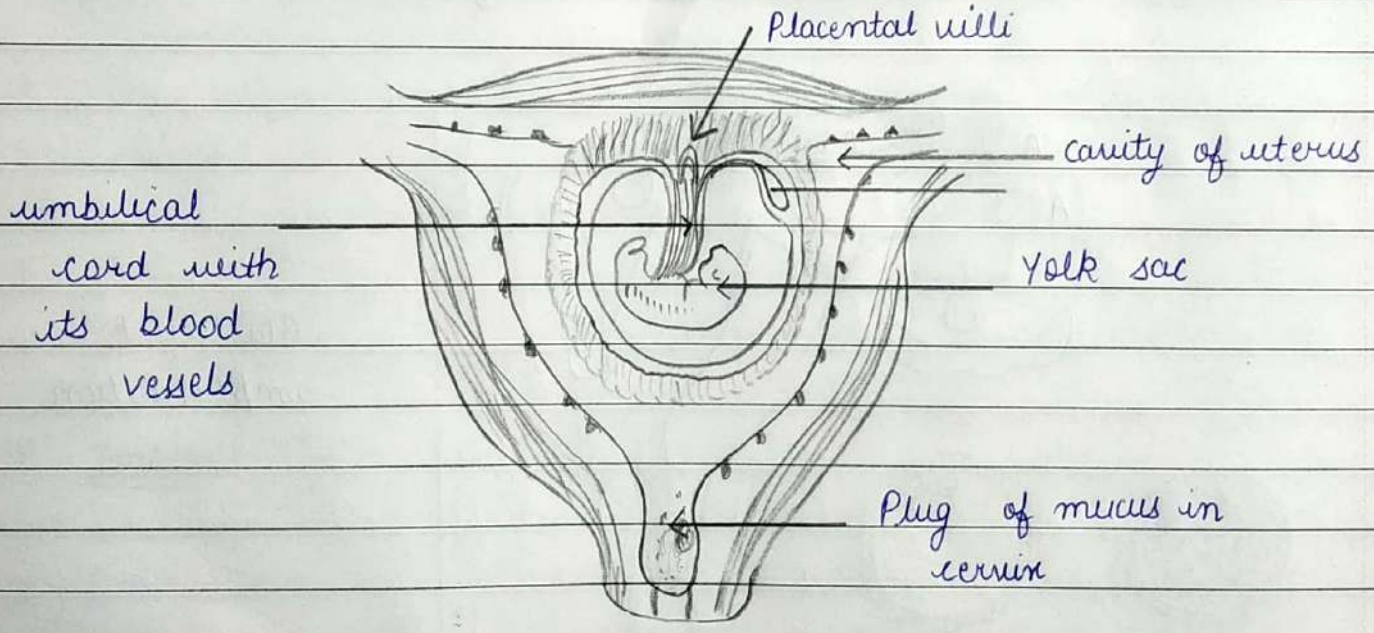


Fig - the human foetus within the uterus

- Immediately after implantation, the inner cell mass (embryo), differentiates into an outer layer called ectoderm, an inner layer called endoderm and mesoderm soon appears between ectoderm and endoderm. These three layers give rise to tissues & organs.

- Human pregnancy lasts for nine months.
- After one month of pregnancy the embryos heart is formed.
- By the end of second month, the foetus develops limbs and digits.
- By the end of three months, most of the major organs are formed. such as the limbs and external genital area.
- Appearence of hair on the head is observed during the fifth month.
- After the end of 6 months, the body is covered with fine hair, eye-lids and eyelashes are formed.
- By the end of nine months of pregnancy, the foetus is fully developed and ready for delivery.

Parturition

- The average duration of human pregnancy is 9 months which is called the gestation period.

The process of delivery of foetus is called partwrition.

- Parturition is induced by a complex neuroendocrine mechanism.
- The signals for parturition originate from the fully developed foetus and the placenta which induce mild uterine contractions called foetal ejection reflex. This triggers release of oxytocin from the maternal body.

- Oxytocin acts on the uterine muscle and causes stronger uterine contractions, which in turn stimulates further secretion of oxytocin.
- This stimulatory reflex between the uterine contraction and oxytocin secretion continues resulting in stronger and stronger contraction. This leads to expulsion of the foetus out of the uterus through the birth canal.

Lactation:

- The mammary glands of the female undergo differentiation during pregnancy and start producing milk towards the end of pregnancy. This process is called lactation.
- This helps the mother feeding the new born.
- The milk produced during the initial days of lactation is called colostrum which contains several antibodies essential for the health of new born baby.