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Chapter-15

Human Anatomy and Physiology

Reproductive system

- Anatomy of male and female reproductive system
- Physiology of menstruation
- Spermatogenesis and Oogenesis
- Pregnancy and parturition

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REPRODUCTIVE SYSTEM

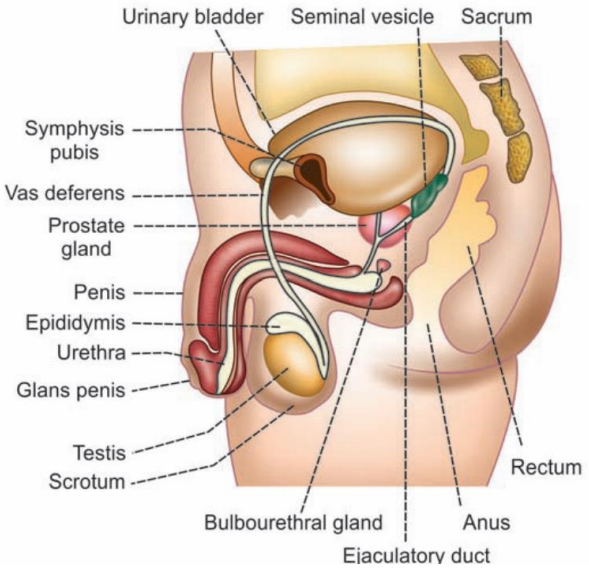
Reproductive system is one among the differs system in all, which maintains the continuation of the generation. In these primary and secondary organs are considered which are responsible for the gamete's production/transformation and transportation towards particular place where fertilisation and implantation occurs.

Gonads are the primary reproductive organs which produce the gametes (egg or ovum), a pair of testes produces sperms in male and a pair of ovaries produces ovum in females.

Anatomy of Male Reproductive system.

Reproductive organ includes

1. Primary sex organs— Testes are the primary sex organs or gonads in males.
2. Accessory sex organs.
    - Seminal vesicles.
    - Prostate gland.
    - Urethra.
    - Penis.



Also classified as

- External genitalia— Scrotum, penis, and urethra.
- Internal genitalia— Testis, epididymis, vas deferens, seminal vesicle, ejaculatory duct, prostate, Cowper's gland.

Testes are ovoid or walnut shaped bodies that are located and suspended in a sac-like structure called scrotum. Testis is enclosed by the three layers

- Tunica vasculosa— Innermost covering made up of connective tissue and it is rich in blood vessels.
- Tunica albuginea— It is the middle covering. It is a dense fibrous capsule.
- Tunica vaginalis— outermost covering formed by mesothelial cells. It is formed by the visceral and parietal layers, which allow the free movement of the testes.

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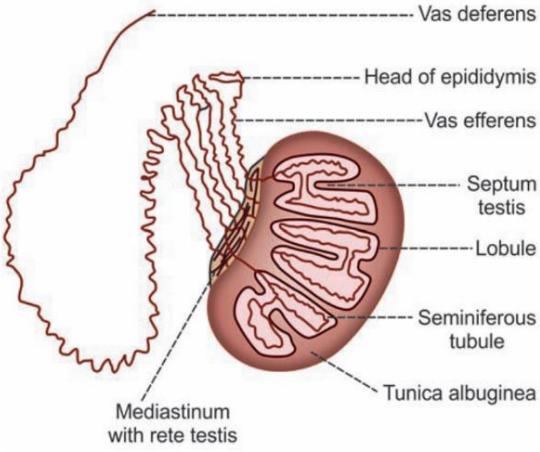
NOTE— Anterior and lateral surfaces of testis are covered by all the three layers. Posterior surface is covered by tunica albuginea only.

Structure present in the testes— Each testis has about 200 to 300 lobules.

- Seminiferous tubules— there are about 400 to 600 seminiferous tubules in each testis. Its wall is formed by three layers.
  a. Outer capsule or tunica propria.
  b. Homogeneous basement membrane.
  c. Complex stratified epithelium— it consists of two types of cells.
     1. Spermatogenic cells or germ cells— It presents in the seminiferous tubules are the precursor cells of spermatozoa. These cells lie between the Sertoli cells.
     2. Sertoli cells or supporting cells or nurse cells or sustentacular cells— it provides support, protection, and nourishment for the spermatogenic cells.



- Interstitial cells of Leydig
- Rete testis
- Vas efferens
- Epididymis
- Vas deferens
-

➢ **Pathway for the passage of sperms—**

Seminiferous tubules→ rete testis→ vas efferens→ epididymis→ vas deferens→ ampulla→ ejaculatory duct→ urethra.

Spermatogenesis.

Spermatogenesis is the process through which spermatogenic/germ cell undergo the development and transformation and form the spermatozoa or sperms cell in the testis. It takes 74 days for the formation of sperm from a primitive germ cell. Spermatogenesis occurs in four stages-

1. **Stage of proliferation.**
2. **Stage of growth.**
3. **Stage of maturation.**
4. **Stage of transformation.**

1. Stage of proliferation— Each spermatogonium contains diploid number (23 pairs) of chromosomes, In which 22 pairs of autosomal chromosomes and one pair of sex chromosomes. Sex chromosomes are one X chromosome and one Y chromosome. In this stage spermatogonia divides by mitosis and increase their number without any change in the chromosomal number which is called as primary spermatocyte.

2. Stage of growth— In this stage, the primary spermatocyte grows into a large cell. Apart from growth, there is no change in spermatocyte during this stage.

3. Stage of maturation— after completion of full growth cell undergoes meiotic or maturation division. It occurs into two phases.
   - First phase—During this phase primary spermatocyte divides into two secondary spermatocytes through meiotic division in that each secondary spermatocyte receives only the haploid or half the number of chromosomes. 23 chromosomes include 22 autosomes and a X or a Y chromosome.
   - Second phase— During this phase, each secondary spermatocyte undergoes second meiotic division, resulting in two smaller cells called spermatids. Each spermatid has haploid number of chromosomes.

4. Stage of transformation— In this stage no further division occurs, and spermatids get transformed into mature spermatozoa this transformation process is known as spermiogenesis. Finally mature spermatozoa released from Sertoli cell into the lumen of seminiferous tubule and this process is known as spermination.

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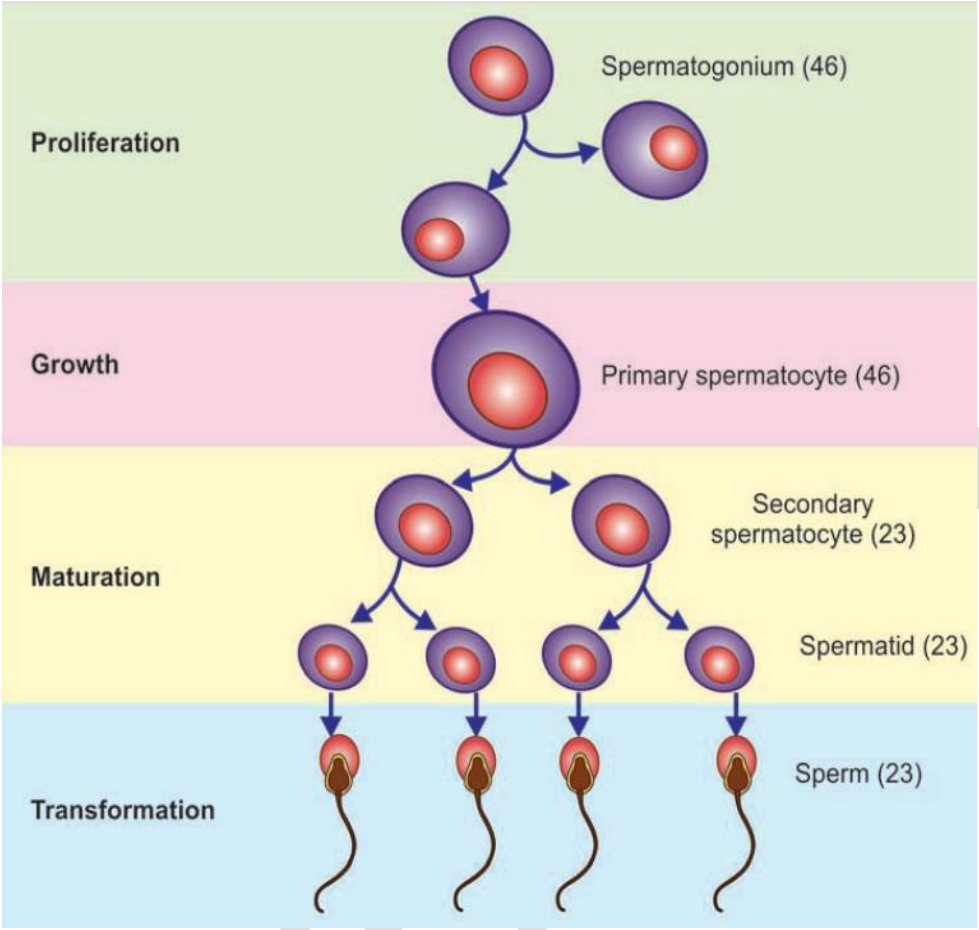


Spermatogenesis stages

Anatomy of Female Reproductive system.

Female reproductive system also comprises of primary sex organs and accessory sex organs

1. Primary sex organs— Primary sex organs are a pair of ovaries, which produce eggs or ova and secrete female sex hormones, the estrogen and progesterone.
2. Secondary/accessory sex organs— It helps to carrying the ova and fertilisation.
    1. Fallopian tubes.
    2. Uterus.
    3. Cervix.

4. Vagina (labia majora, labia minora and clitoris).

Mammary glands are not the female genital organs but are the important glands of female reproductive system, which secretes the hormones and provide the nourishment to growing baby after birth.

1. Fallopian tubes— Fallopian tube divided into four parts.
    - Isthmus— It communicate the uterus.
    - Ampulla— A lumen/space where commonly fertilisation takes place
    - Infundibulum— fimbriated part communicate
    - Fimbriae—It catch the ovum from the abdominal cavity during the ovulation.
2. Uterus/womb— It is pyriform in shaped and dimension about 7.5 cm in length, 5 cm in breadth, and 2.5 cm in thickness. It is divided into three portions fundus, body, cervix. Uterus is made up of three layers.
    - Serous or outer layer
    - Myometrium or middle muscular layer
    - Endometrium or inner mucus layer.
3. Cervix— It is the lower constricted part of uterus. It has two orifices.
    - Internal orifice/supravaginal portion— which communicates with body of uterus.
    - External orifice/lower vaginal portion— which communicates with vagina.
4. Vagina— Vagina is a short tubular organ. It is lined by mucus membrane, which is formed by stratified epithelial cells. Vagina includes-
    - labia majora.
    - labia minora.
    - clitoris.

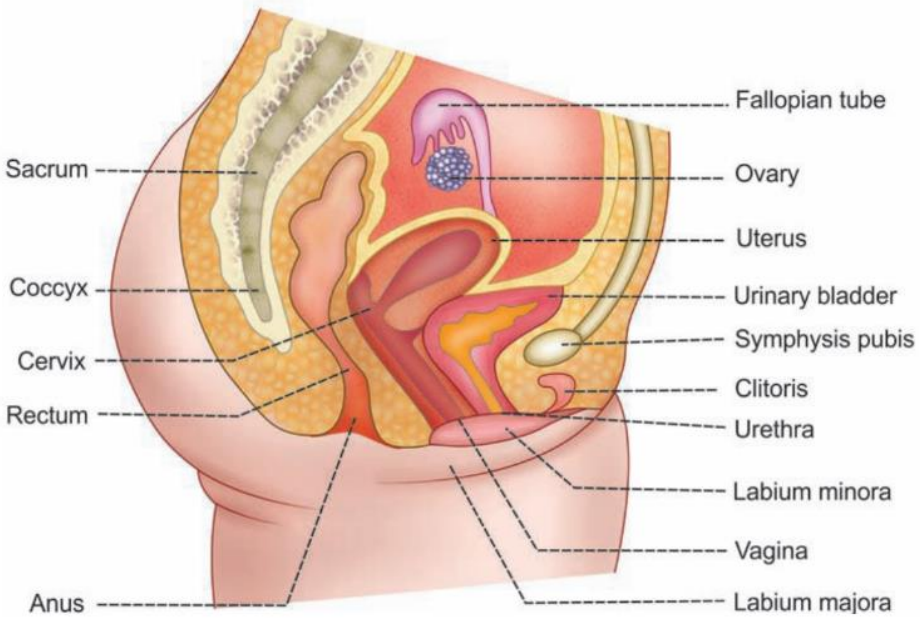
OVARY

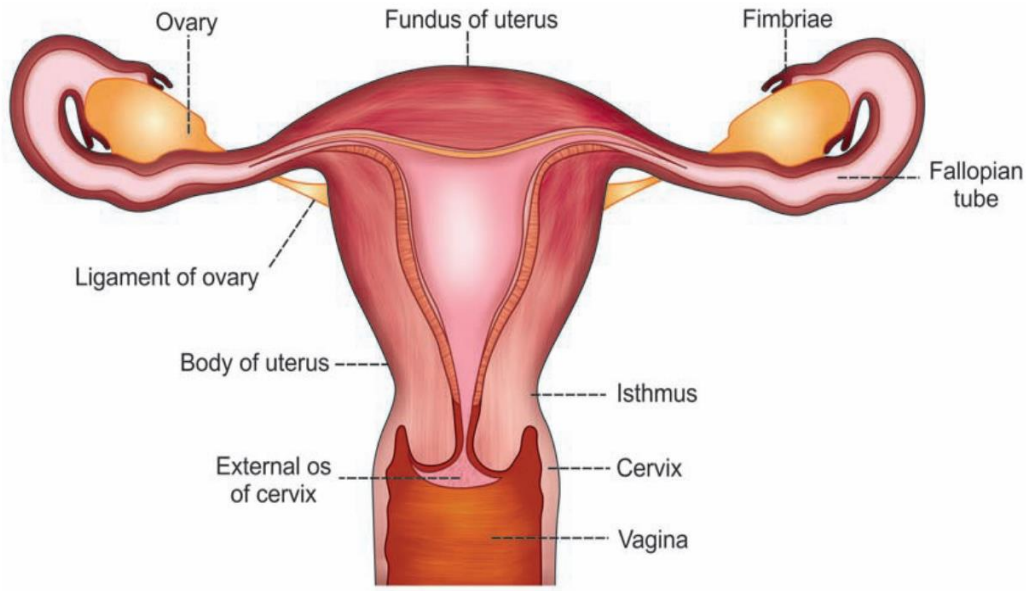
Ovary is the gonad or primary sex organs in females. A woman has two ovaries. Ovaries is responsible for the production and development for the female gamete (reproductive cell). It also acts as endocrine function in female by releasing the female hormones. It is oval in shape and attached at hilum by the ovarian ligament and mesovarium ligament. Each ovary has two portions-

- Medulla— it is the deeper portion of the ovary. It has the stroma of loose connective tissues, blood vessels, lymphatics, nerve fibres etc.

- Cortex— it is the outer broader portion and has compact cellular layers. Cortex consists of the following structures

1. Glandular structures, which represent ovarian follicles at different stages
2. Connective tissue cells
3. Interstitial cells, which are clusters of epithelial cells with fine lipid granules formed mainly from theca interna.

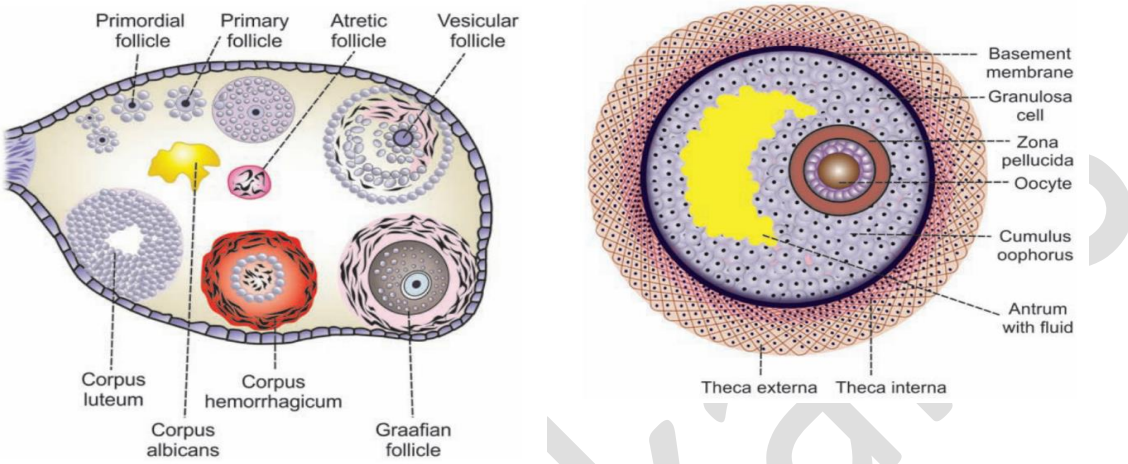




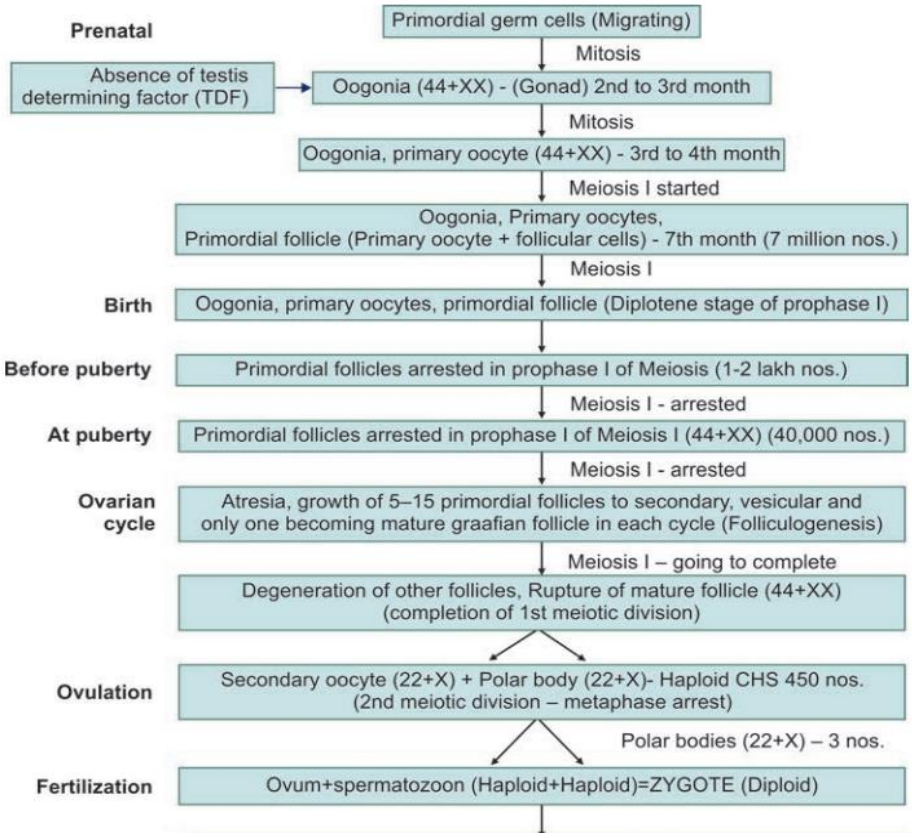
FEMALE REPRODUCTIVE SYSTEM

Oogenesis.

Oogenesis is the process through which the female gametes going to develops and transform into ovum. It happens into many stages.



Development of ovum and Graafian follicle



Stages of Oogenesis

Physiology of menstruation.

Menstrual cycle is defined as the natural cyclic changes occurs in the female life during the reproductive period. Menstrual cycle starts after the puberty called **menarche** (at the age of 12 to 15 years it varies individual to individual). Menstrual cycle stops/ceases in old age called menopause (at the age 45 to 50 years it also varies individual to individual). Menstrual cycle is usually 28 days but it varies between 20 to 40 days under the physiological conditions. Four types of physiological changes happen during the menstrual cycle—

- **Ovarian changes.**
- **Uterine changes.**
- **Vaginal changes.**
- **Changes in cervix.**

1. Ovarian changes— It occurs into two phases-
   A. Follicular phase— it is also known as maturation phase. It extends from the 5th day of the cycle until the time of ovulation. In this phase gamete cell going to development and transformation into ovarian follicle/glandular structure. Follicle development further divide into four stages.
      I. Primordial follicle— At the time of puberty, both ovaries contain about 400,000 primordial follicles, which is incompletely surrounded by the granulosa cells. At the onset of puberty, under the influence of FSH and LH the primordial follicles starts growing through various stages.
      II. Primary follicle— Primordial follicle becomes the primary follicle, when ovum is completely surrounded by the granulosa cells. During this stage both follicle and ovum increase their size.
      III. Vesicular follicle— Under the influence of FSH, about 6 to 12 primary follicles start growing and develops into vesicular follicles. In this stage a follicular cavity or antrum is formed in these liquor folliculi serous fluid is present.
         - Ovum is pushed to one side and it is surrounded by granulosa cells, which forms the germ hill or cumulus oophorus. Further these cells become columnar and form corona radiata.
         - A narrow cleft appears between ovum and zona pellucida called perivitelline space.
         - Follicular sheath/theca folliculi/capsule is formed and it divided into two layers - **theca interna and theca externa**.

- Theca interna is the inner vascular layer with loose connective tissue and secrete the female sex hormones (mainly estrogen and less amount of progesterone).

IV. Matured follicle or Graafian follicle (A Dutch physician and anatomist, Regnier De Graaf)— After about 7th day of menstrual cycle, one of the vesicular follicles outgrowths and develops into Graafian follicle and follicles degenerate by means of apoptosis. In this stage ovum attain maximum size and zona pellucida, corona radiata, theca interna becomes thicker and more prominent.

Ovulation— On the 14th day of menstrual cycle Graafian follicle ruptures and discharge the ovum. It is influenced by the LH

B. Luteal Phase— luteal phase extends between 15th to 28th day of menstrual cycle. During this stage, corpus luteum is developed and hence this phase is called luteal phase.

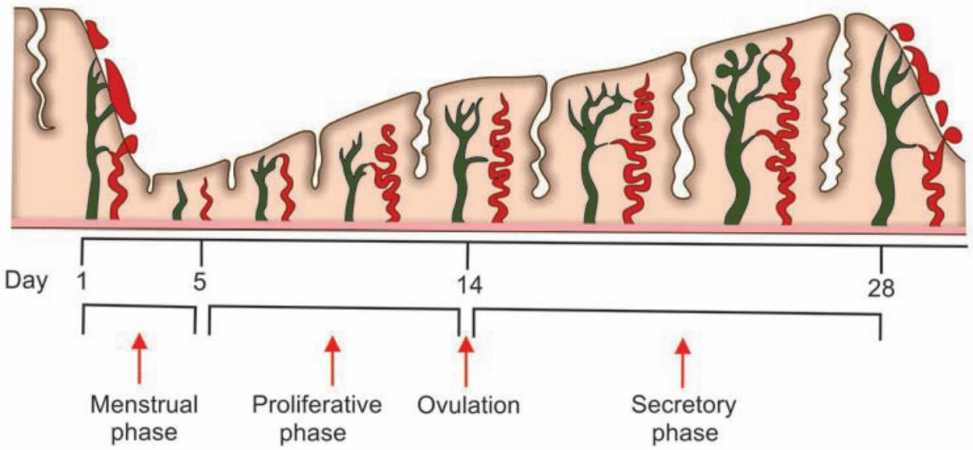
2. Uterine changes—Uterine changes occurs in three phases
   - Menstrual phase/period— After ovulation, if pregnancy does not occur then thick endometrium going to shed or destruction and expelled out through the vagina along with blood and tissue fluid this process is called menstruation or menstrual bleeding. During normal menstruation 35ml of blood and 35ml of serous fluid is expelled and it lasts for about 4 to 7 days. **The day when bleeding starts is considered as the first day of the menstrual cycle.**
   - Proliferative phase— Proliferative phase extends usually from 5th to 14th day of menstruation that is between the day when menstruation stops and the day of ovulation. It corresponds to the follicular phase of ovarian cycle.
   - Secretory phase— It extends between 15th to 28th day of the cycle that is between the day of ovulation and the day when menstruation of next cycle commences. After ovulation, corpus luteum is developed in the ovary. It secrets the large quantity of progesterone (responsible for enlargement of endometrial stroma and growth of glands) and small amount of estrogen (responsible for proliferation of cells in uterus so that endometrium become thicker).
3. Vaginal changes—During proliferative phase, mucus membrane thinner and more alkaline due to influence of estrogen and helps in the survival and motility of spermatozoa.
   - During secretory phase mucus membrane thicker and more adhesive due to the action of progesterone.

4. Change in cervix— During proliferative phase, epithelial cells of vagina are cornified due to influence of estrogen
    - During secretory phase epithelium of vagina proliferates due to action of progesterone.

Regulation of menstrual cycle—

Regulation of menstrual cycle is a complex process that is carried out by a well organised hormonal system. Hormone involved in the regulation of menstrual cycle are-

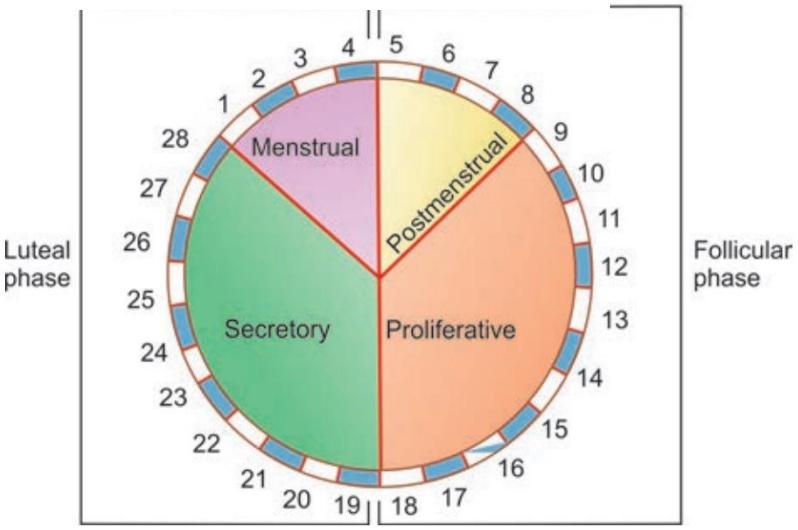
- Hypothalamic hormone (GnRH).
- Anterior pituitary hormone (FSH and LH).



Change in Endometrium

- Ovarian hormone (Estrogen and Progesterone).

Phases of Menstrual cycle.



Pregnancy and parturition

Pregnancy is the developmental stage of embryo or foetus in the uterine cavity after fertilisation in the female body. After the fertilisation, fertilised egg implanted in the lining of the uterus and develops into placenta and embryo or foetus.

NOTE- Ectopic pregnancy is one in which the fertilised egg implants in the tissue outside of the uterus and the placenta and foetus begins to develop there.

Changes occurs during pregnancy—

- During the pregnancy ovulation or ovarian changes does not occurs. Corpus luteum enlarges and secretes a large quantity of progesterone and little estrogen, which are essential for maintaining the pregnancy (up to 3 month).
- During three-month, endometrium becomes more thicker and going to develops into placental connection. Placenta develops by the trophoblastic cell of the morula (Foetal part) and decidua area of uterus (Maternal part). After three month fully developed placenta form and secretes the female hormone.
- During the pregnancy, due to influenced of the hormone uterus, vagina, cervix, fallopian tube undergoes changes in the volume, size, glandular nature etc.
- Size of the mammary glands increase because of development of new ducts and alveoli, deposition of fat and increase vascularization. Pigmentation of nipple and areola occurs.

Foetal growth during Pregnancy—

- 12 weeks.
  - Finger and toes are distinct.
  - Placenta is complete.
  - Foetal circulation is complete.
  - Organ system are complete.
- 16 weeks.
  - Sex is differentiated.
  - Heart beat is present.
  - Nasal septum and palate close.
  - Rudimentary kidneys secrete urine.
- 20 weeks.
  - Lanugo covers entire body.

- Foetal movement felt by the mother.

➢ 24 weeks.
- Skin appears wrinkled.
- Eyebrow and fingernails develop.

➢ 28 weeks.
- Skin appears red colour
- Pupillary membrane disappears from eyes.
- The foetus has an excellent chance of survival.
- Eyes open and close.

➢ 32 weeks.
- Eyelids open.
- Fingerprint are set.
- Vigorous foetal movement occurs.

➢ 36 weeks.
- Lanugo disappears.
- Amniotic fluid decrease.

➢ 40 weeks.
- Skin is smooth.
- Eyes are uniformly slate coloured.
- Bones of skull are ossified and nearly together at sutures.

Gestation period— It refers to the pregnancy period. In human female average gestation period is about 280 days or 40 weeks from the last menstrual period (LMP).

Pregnancy test— Test is used to detect or confirm pregnancy. The basis of pregnancy tests is to determine the presence of the Human Chorionic Gonadotropin (HCG) in the urine of suspected woman.

Procedure.

- One drop of HCG antiserum is taken on a glass slide. One drop of urine from the suspected woman is added and mix well.
- Now, one drop of latex particles is added to this and mixed.
- Finally observing the agglutination of latex particle added to mixer of HCG antiserum and women urine. If agglutination occurs then pregnancy negative otherwise pregnancy positive.
- Now a day, pregnancy card or strips are available in the market for detecting the pregnancy.

Parturition is the expulsion or delivery of the foetus from the mother body. It occurs at the end of pregnancy (after 9 month). The process by which the delivery of foetus occur is called labor. It involves various activities such as contraction of uterus dilation of cervix and opening of vaginal canal. Parturition occurs in three stages.

- First stage— Initially strong uterine contraction called labor contractions commence. It arises from fundus and move downwards so that the head of foetus is pushed against cervix and results in dilation of cervix and opening of vaginal canal.
- Second stage—In this stage, foetus is delivered out from uterus through cervix and vaginal canal. This stage lasts for about 1 hour.
- Third stage— during this stage, the placenta is detached from the decidua and is expelled out from uterus. It occurs within 10 to 15 minutes after the delivery of the child.

Hormones involved in the process of parturition.

Maternal Hormones

- Oxytocin
- Prostaglandins
- Cortisol
- Catecholamine
- Relaxin

Foetal Hormones.

- Oxytocin.
- Cortisol.
- Prostaglandins

Placental Hormones

- Estrogen
- Progesterone
- prostaglandins