

Human reproductive system



CHAPTER - 3

BIOLOGY

Class -12



SEXUAL DIMORPHISM IN HUMAN BEINGS

Human beings, like most of mammals, are **unisexual** or **dioecious** (sexes are separate) sexually reproducing and viviparous. Each human being has only either male or female gonads, reproductive ducts and accessory genital structures. Out of these reproductive structures, gonads (testes in male and ovaries in female) are called **primary sex organs** and produces the gametes and sex hormones. All other genital structures (reproductive ducts and associated glands) are collectively called **secondary sex organs**. These include epididymis, vas deferens, prostate, seminal vesicles and penis in male, and the Fallopian tubes, uterus, vagina and mammary glands in females. Two sexes are also different in their certain external morphological features, called **secondary or accessory sexual characters**, while this phenomenon is called **sexual dimorphism**. (Table 3.1).

BASIC PHASES OF PHYSIOLOGY OF REPRODUCTION

1. **Gametogenesis**. It involves the formation of haploid sex cells or gametes, called **sperms** and **ova**, from diploid primary germ cells, called **gametogonia**, present in the reproductive organs called **gonads** (testes in male and **ovaries** in female).

Gametogenesis is of **two types** :

(a) **Spermatogenesis** : Formation of haploid **sperms** from diploid spermatogonia of the testes of male organism.

(b) **Oogenesis** : Formation of haploid **ova** from diploid oogonia of the ovaries of female organism.

2. **Insemination (Ejaculation)**. It involves release of seminal fluid of male in the vagina of female at the end of copulatory act.

3. **Fertilization**. It involves the fusion of haploid male and female gametes to form diploid **zygote**. The fusion of gametic nuclei is called **karyogamy** while mixing of two sets of chromosomes of two gametes is called **amphimixis**.

4. **Cleavage**. It includes the rapid mitotic division of zygote to form a single-layered hollow spherical larva called **blastula** (called **blastocyst** in mammals) so is also called **blastulation**.

5. **Implantation**. It is the process of attachment of blastocyst on the endometrium of the uterus.

6. **Placentation**. It involves the formation of an intimate mechanical and physiological connection, called **placenta**, between the foetal and maternal tissues for the nutrition, respiration, excretion, etc., of the foetus.

7. **Gastrulation**. It is the process by which blastocyst is changed into **gastrula** larva with three primary germ layers.

8. **Organogenesis**. It includes the formation of specific organ systems from three primary germ layers of gastrula

during the gestation period (period of pregnancy and embryonic development). It involves **morphogenesis** and **differentiation**.

9. **Parturition**. It involves expelling of fully formed baby from the mother's uterus after the gestation period (of about 280 days in human female).

HUMAN MALE REPRODUCTIVE SYSTEM (FIGS. 3.1-3.5)

It is that system which is concerned with sperm formation. It is located in the pelvis region. It is formed of a pair of **testes** along with their **accessory ducts** (i.e. rete testis, vasa efferentia, epididymis and vas deferens), **gland** and the **external genitalia** :

1. **Testes**. These are one pair, small sized (4-5 cm × 2.5 cm × 3 cm), oval-shaped, pinkish coloured **primary sex organs of male**. These are present in thin walled skin pouches called **scrotal sacs** or **scrotum** (so are **extra-abdominal**) hanging from lower abdominal wall between the legs. Scrotal sac is filled with tissue fluid called **hydrocoel**. Testis is held in position in scrotum by a small, thick, white fibrous **gubernaculum** and **spermatic cord**. The cavity of scrotal sac is called **vaginal coelom** and is connected to abdominal cavity through **inguinal canal**. Scrotal sacs act as **thermoregulators** and keep the testicular temperature 2-2.5°C lower than body temperature for normal spermatogenesis, as high abdominal temperature kills the spermatogenic tissue. Thermoregulation is maintained by spermatic cord and smooth muscles of scrotum.

Each testis is externally covered by a white fibrous capsule, the **tunica albuginea** (Fig. 3.1) which is produced inside the testis as fibrous **septa**. The septa divide the testis into a number of **testicular lobules** (about 250 in number). Each lobule has one to three convoluted **seminiferous tubules**, also called **crypts**, which on inner side become straight (called **tubuli recti**) and open into a network of tubules called **rete testis**. Tunica albuginea is externally covered by a peritoneal layer of flat cells called **tunica vaginalis**, while inner to it and adhering to testis, there is another peritoneal layer called **tunica vasculosa**.

Each **seminiferous tubule** (Fig. 3.2) is lined by a **germinal epithelium** formed of two types of cells—**germ or spermatogenic cells** and **sertoli or nurse or subtentacular cells**. Germ cells are cuboidal and form bulk of epithelium. These undergo spermatogenesis

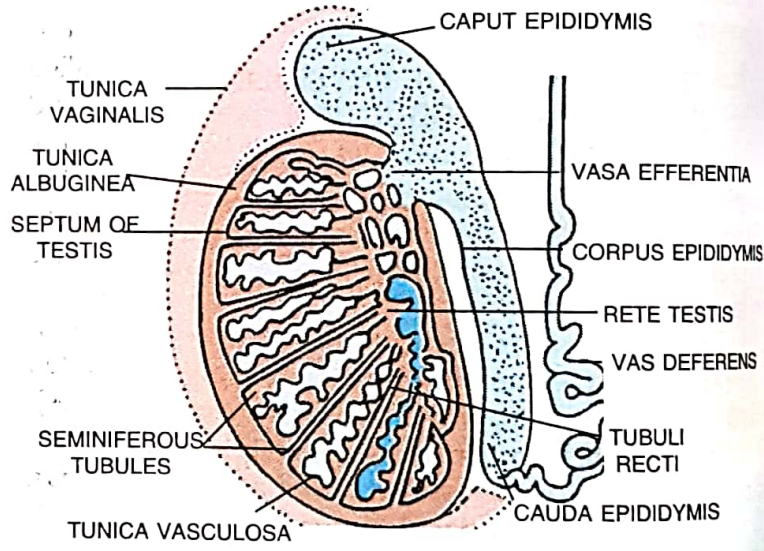


Fig. 3.1. L.S. of Testis of man.

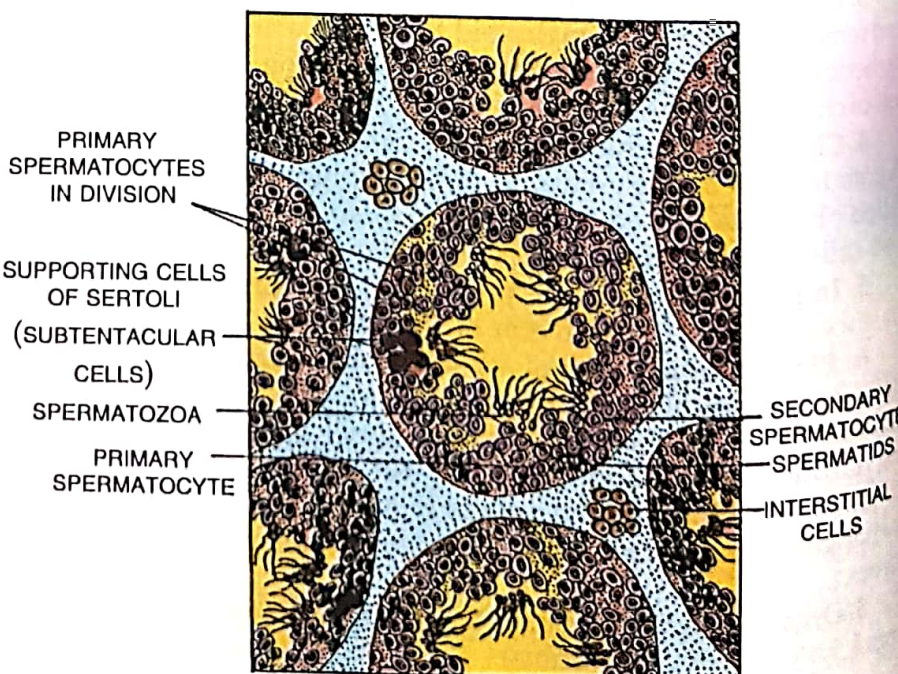


Fig. 3.2. T.S. seminiferous tubules of testis (Diagrammatic).

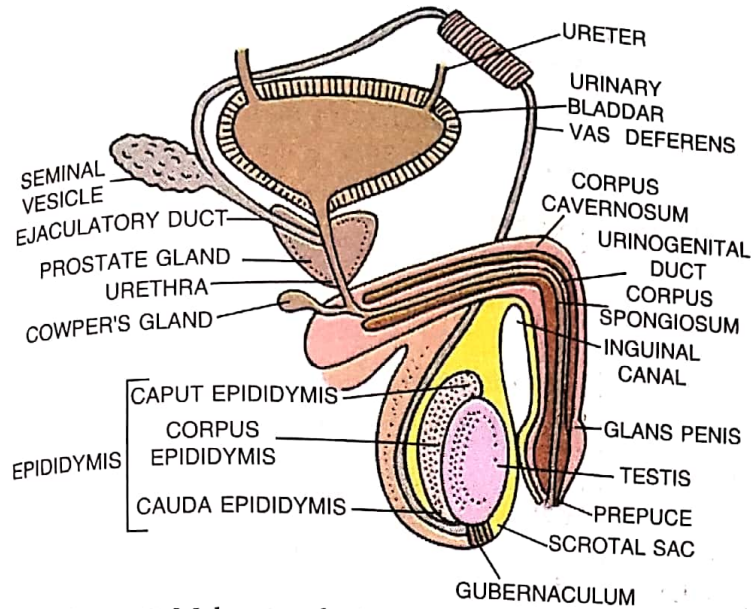


Fig. 3.3. Male reproductive system (Diagrammatic) (Lateral view).

and form haploid and motile male gametes called **spermatozoa**. Sertoli cells are a few pyramidal-shaped cells which provide nutrition to developing sperms.

Scattered in interstitial spaces between seminiferous tubules, there are groups of polyhedral endocrine cells called **interstitial** or **Leydig's cells** (Fig. 3.2). These secrete steroid male sex hormones called **androgens**, most important of which is **testosterone** which controls the development of secondary sexual characters in male and spermatogenesis.

Function. Testes are involved in spermatogenesis and secretion of testosterone.

2. Epididymis. On the posterolateral side of each testis, there is an elongated and flattened structure called **epididymis**. It is formed of a long (about 6 metres), highly coiled tube. It is differentiated into **three parts** :

(a) **Head or Caput epididymis or globus major.** It is a swollen part present on cranial (Head) side of the testis. It receives the sperms from rete testis by 10-12 fine, ciliated ductules called **vasa efferentia** or **ductuli efferentes**.

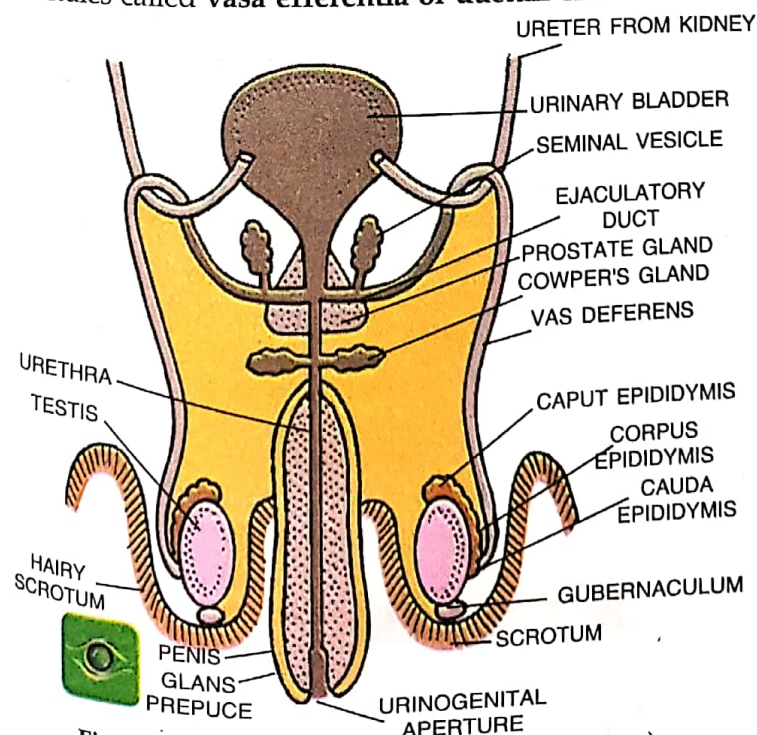


Fig. 3.4. Male reproductive system (Front view).

(b) **Body or Corpus epididymis or globus normal.** It lies on lateral side of testis and stores the sperms temporarily.

(c) **Tail or Cauda epididymis or globus minor.** It is lower part and lies on caudal side of testis.

Function. Epididymis is involved in storage (for 18 to 24 hours), nutrition and physiological maturation and motility of the sperms by removing the decapacitation factors (so initiates capacitation of sperms). It also shows peristaltic and segmenting contractions to move the sperms.

3. **Vasa deferentia (Seminal ducts).** A vas deferens or **ductus deferens** is a long (about 30 cm), narrow, muscular and tubular structure which starts from the tail epididymis, ascends, passes through inguinal canal, passes over the urinary bladder in the abdomen and finally dilates to form **ampulla** which joins the duct of seminal vesicle to form **ejaculatory duct** (2 cm long). It passes through prostate gland and joins the urethra.

Function. Conduction of sperms by peristalsis.

4. **Urethra.** It arises from the urinary bladder and joins the ejaculatory duct to form **urinogenital canal** as it carries urine, sperms and secretions of seminal vesicles, prostate and Cowper's glands. It passes through penis and is differentiated into **prostatic part** (2.5 cm), **membranous part** (2.5 cm) and **penile part** (15.0 cm). It finally opens at the tip of penis as **urethral maetus**.

Function. Conduction of sperms, secretions of accessory reproductive glands and urine.

Rete testis, ductus epididymis, vas deferens and urethra collectively form the **accessory genital ducts** which conduct the sperms towards the **urethral maetus**.

5. **Penis (Fig. 3.5).** It is a cylindrical, erectile and copulatory organ. It forms the **external genitalia** of male. It is supported by three erectile tissues : two posterior, yellow fibrous ligamentous **corpora cavernosa** and one anterior, highly vascular and spongy **corpus spongiosum** which surrounds the urinogenital canal. Tip of penis is highly sensitive and is known as **glans penis**. It is covered by a retractile skin fold called **foreskin** or **prepuce**. Glans is with a slit-like opening of urinogenital canal called **urethral maetus**.

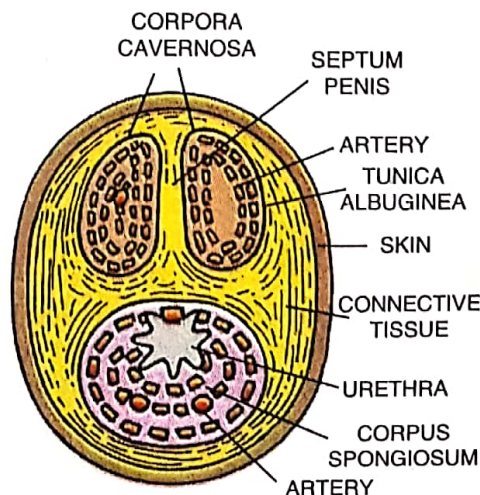


Fig. 3.5. T.S. Penis.

Function. Penis helps in insemination. Erection of penis is due to rush of arterial blood (about 10 times more) into the sinuses of corpus spongiosum aided by contraction of erector penis muscles.

ACCESSORY OR SECONDARY GENITAL GLANDS OF MALE

These are of **three types** :

1. Seminal Vesicles. These are one pair of elongated (5 cm), muscular and sacculated glands present in the pelvis between the bladder and rectum. Their ducts join the vasa deferentia.

Function. Secretion of seminal vesicles forms about 60-70% of semen and is mainly formed of fructose (energy source), citrate, several proteins and **prostglandins** which activate the spermatozoa and stimulate vaginal contractions to help in fusion of gametes.

2. Prostate Gland. It is a large, chestnut-shaped, spongy and lobulated tubulo-alveolar gland which surrounds the proximal part of urethra. It pours its alkaline secretion into urethra by 20-30 openings. It contains some lipids, small amount of citric acid, bicarbonate ions and a few enzymes e.g. **fibrinolysin**.

Functions. Prostatic secretion forms about 20% part of semen, activates the sperms, provides nutrition to sperms and neutralises the acidity of urine and adjusts vaginal pH.

3. Cowper's or Bulbourethral glands. These are one pair, white, pea-seed sized tubulo-alveolar glands present at the base of penis.

Function. These secrete a mucus-like alkaline substance prior to ejaculation that lubricates the penis for frictionless movements of penis during copulation.

Secretion of accessory sex glands is called **seminal plasma**. It is rich in fructose (source of energy), citrate,

prostglandins, calcium and certain enzymes. Seminal fluid along with the sperms is called **semen** or **seminal fluid** or **ejaculate**. It also maintains the viability and motility of sperms as it provides proper pH (**approximately pH 7.5**) and ionic strength. Sperms form **10%** of the volume of semen.

MAJOR FUNCTIONS OF MALE REPRODUCTIVE SYSTEM

1. **Spermatogenesis** by the germ cells of seminiferous tubules.
2. Secretion of male hormone, **testosterone**.
3. **Transfer of sperms** into vagina of female during copulation.

HORMONAL CONTROL (FIG. 3.6)

The growth, maintenance and functioning of secondary sex organs (epididymis, vasa deferentia, accessory glands and penis) are under the control of **testosterone hormone** secreted by Leydig's cells of testis, while those of seminiferous tubules and Leydig's cells are controlled by Follicular Stimulating Hormone (**FSH**) and Interstitial Cells Stimulating Hormone (**ICSH**)/ **Luteinising hormone (LH)** of anterior pituitary lobe respectively.

Sertoli cells also secrete two proteins : (i) **Activin** or **Androgen Binding Protein (ABP)** that concentrates testosterone in the seminiferous tubules; and (ii) **(Inhibin) protein** which suppresses FSH secretion. Release of FSH, LH or ICSH, in turn, are controlled by release of **hypothalamic gonadotropin releasing hormone (GnRH)**.

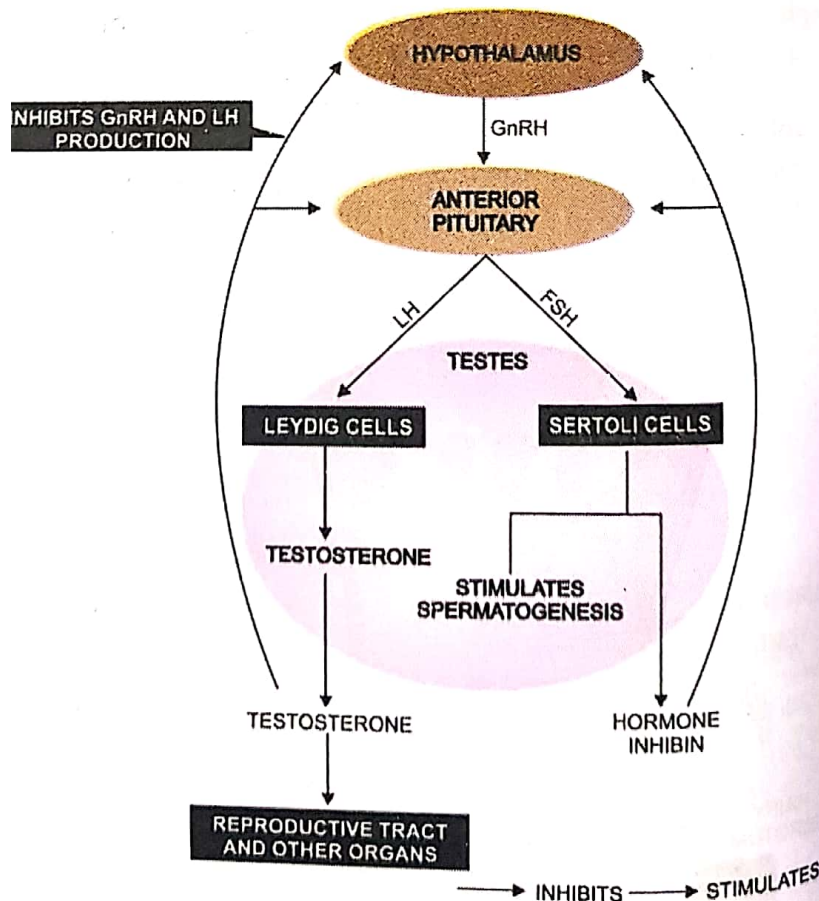


Fig. 3.6. Hormonal control in male reproductive system

PUBERTY IN MALE

1. **Definition.** Puberty is the period of sexual maturity when reproductive organs become functional.

In male, the puberty is characterized by the onset of spermatogenesis in the testes.

2. **Period.** Between 13-16 years.

3. **Control.** Puberty in male is controlled by male sex hormone called **testosterone** which is secreted by **interstitial** or **Leydig's cells** of testes under the stimulation of **interstitial cells stimulating hormone (ICSH)/ LH** secreted by anterior pituitary.

4. **Characters at Puberty**

(a) The seminiferous tubules start producing sperms.

(b) The development and maturation of secondary sex organs (prostate, scrotum, penis).

(c) The development of secondary sexual characters like growth of hair on face, chest, pubis and axillae; broadening of shoulders; deepening of voice due to enlargement of voice-box etc.

(d) Increase in height due to rapid growth of muscles and bones.

HUMAN FEMALE REPRODUCTIVE SYSTEM

It is concerned with formation of ova, fertilization, foetal development and child-birth. It is also located in the pelvis region. It is formed of a pair of **ovaries** along with their **oviducts, uterus, cervix, vagina** and the **external genitalia**. Fallopian tubes, uterus and vagina collectively form the **female accessory ducts**.

1. **Ovaries.** Ovaries are the **primary sex-organs** of female.

These are one pair, small sized (2-4 cm × 1.5 cm × 1 cm), almond-shaped structures present in the pelvis, one on either side of uterus. Each ovary is suspended from dorsal abdominal wall by a mesentery called **mesovarium**. Each ovary is attached to the pelvic wall and uterus by a double fold of peritoneum, **ovarian ligament**. So ovaries, unlike the testes, are abdominal in position.

Each **ovary (Fig. 3.7)** is solid internally and is lined by a cuboidal **germinal epithelium**. Inner **stroma** or **matrix** is differentiated into outer **cortex** of reticular connective tissue and inner **medulla** of areolar connective tissue. Outer to ovarian cortex and inner to germinal

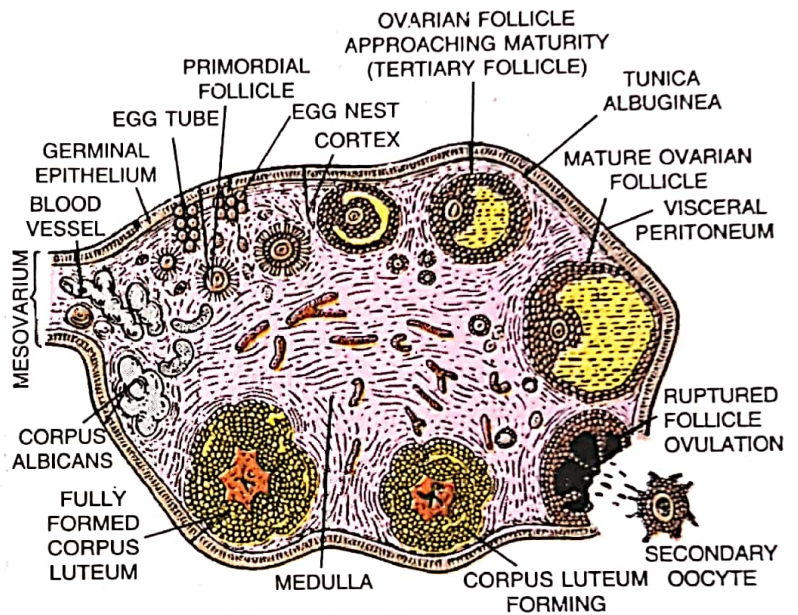


Fig. 3.7. L.S. Human ovary.

epithelium, there is a weakly developed connective tissue layer, called **tunica albuginea**.

There are a number of small, oval or rounded developing **primary** or **ovarian follicles** in different stages of oogenesis in the medullary region of the ovary. Every month, a primary follicle transforms into **mature** or **Graafian follicle** under the stimulation of **FSH (Follicular Stimulating Hormone)** of anterior pituitary.

A **Graafian follicle (Fig. 3.8)** is about 2.5 cm in diameter and has a secondary oocyte surrounded by a few layers of follicular cells, the **discus proligerous**. It is suspended in a small cavity, the **antrum** by a stalk of follicular granulosa cells, the **germ hill** or **cumulus oophorus**, from a multilayered **membrana granulosa** of follicular granulosa cells whose outermost layer is called **theca externa**, inner to which is **theca interna**. Antrum is filled with a semi-viscous fluid called **liquor folliculi** secreted by the follicular cells. The follicular cells are endocrine in function and secrete female sex hormones, **estrogens**, in the blood.

Cortex of ovary may also have yellowish, conical endocrine gland, **corpus luteum (yellow body)** or a degenerating corpus luteum, **corpus albicans (white body)**.

Functions. Ovaries are concerned with formation of ova and secretion of female sex hormones — **estrogen** and **progesterone**.

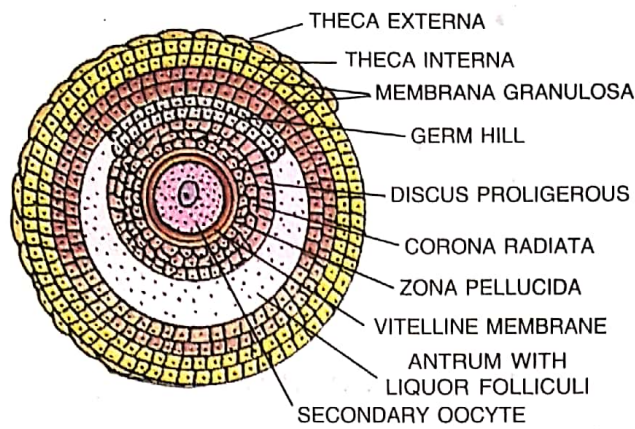


Fig. 3.8. Mature or Graafian follicle.

2. Fallopian Tubes (Oviducts). These are one pair, long (10-12 cm), ciliated, muscular and tubular structures which extend from the periphery of ovaries to uterus. Each fallopian tube is differentiated into **three parts** :

(a) **Ampulla.** It is outer, wide (3 mm in diameter), funnel-shaped part which opens in abdominal cavity close to ovary by a fimbriated aperture called **ostium**. Ostium receives the ovum released from the ovary. To increase the catching area, it is with a number of finger-like ciliated processes, **fimbriae**. Its outer expanded and fimbriated part is called **infundibulum**.

(b) **Isthmus.** It is middle, narrow and ciliated.

(c) **Uterine part.** It is inner and narrow part which opens in the upper part of uterus.

Functions. It is involved in the **conduction of ovum or zygote** towards the uterus by peristalsis and ciliary action. It is also the **site of fertilization**.

3. Uterus (womb). It is a large (8 cm × 5 cm × 2 cm), hollow, muscular, highly vascular and inverted pear-shaped structure present in the pelvis between the bladder and rectum. It is formed of **three parts** (Fig. 3.9):

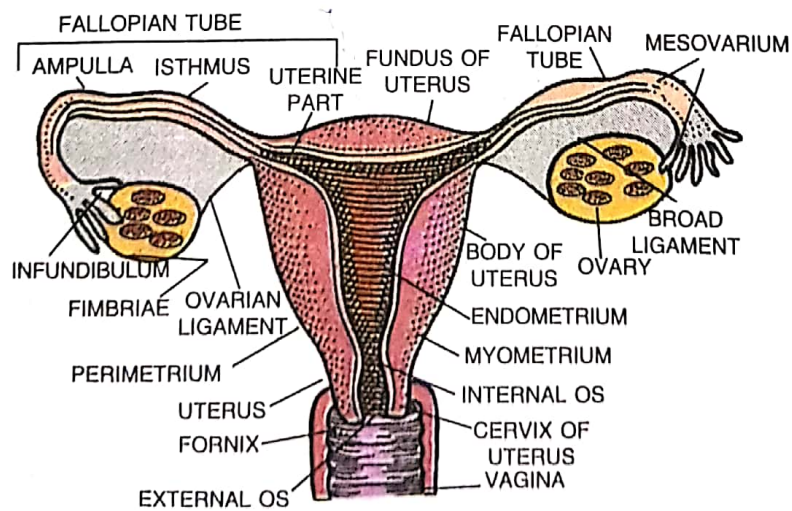


Fig. 3.9. Female reproductive system.

(a) **Fundus.** It is upper dome-shaped part.

(b) **Body or Corpus.** It is middle and main part of uterus. Its wall is formed of outer peritoneal layer, **perimetrium**; middle muscular coat or **myometrium**

of smooth muscle fibres and inner highly vascular and glandular mucosa or **endometrium**.

(c) **Cervix**. It is lower, narrow part which opens in body of uterus by **internal os** and in vagina below by **external os**. The cavity of cervix is called **cervical canal** and forms a part of birth canal.

Functions. Endometrium of uterus is the site of implantation and foetal growth during pregnancy. It also takes part in placenta formation. Myometrium helps in expelling of the baby during parturition.

4. Vagina. It is a long (7.5 cm), fibro-muscular tube. It extends backward in front of rectum and anal canal from cervix to the vestibule. It is highly vascular tube internally lined by mucous membrane and is raised into transverse folds called **vaginal rugae**. It finally opens in the vestibule by **vaginal orifice**.

Functions. Vagina acts both as **copulation canal** as it receives the sperms from penis during copulation and **birth canal** (Cervical canal + vagina) during parturition.

5. Vulva (Fig. 3.10). It is external genitalia of female. It has a depression, the **vestibule** (or **urinogenital sinus**), in front of anus. Vestibule has two apertures — **upper external urethral orifice** of urethra and **lower vaginal orifice** of vagina. In the virgin female, vaginal orifice is partially covered by a membranous fold, called **hymen**, which is often torn during the first coitus (intercourse) or due to vigorous physical activity during horse back riding, bicycling, sudden jerk, etc. but may persist even after coitus. So the presence or absence of hymen is not a reliable indicator of virginity or sexual experience.

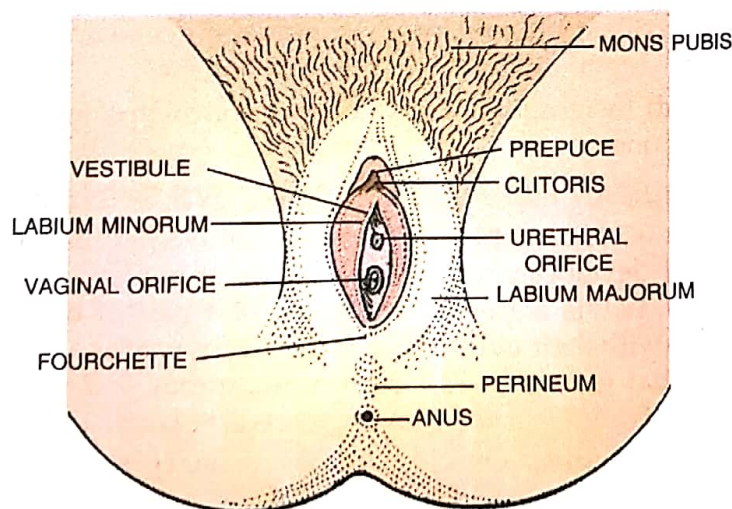


Fig. 3.10. Female external genitalia—vulva.

Vestibule is bounded by two pairs of moist skin folds with sebaceous glands—inner smaller pair called **labia minora** and outer larger pair called **labia majora**. Labia minora fuse anteriorly to form a skin fold called **prepuce** in front of a small erectile organ, the **glans clitoridis** which is **homologous to penis** as both are supported by corpora cavernosa. Labia minora also fuse posteriorly to form a membranous fold called **fourchette**. There is a fleshy elevation above the labia majora and is known as **mons pubis** which has pubic hair.

The oviduct, uterus, vagina, clitoris, the accessory genital glands and mammary glands are collectively called **secondary sex organs of female**.

ACCESSORY SEX GLANDS OF FEMALE

1. **Bartholin's glands (Bulbivestibular glands).** These are one pair, small sized glands present one on either side of vaginal orifice. These secrete mucus to lubricate the vagina at the time of mating and parturition.

2. **Breasts (Fig. 3.11).** These are one pair, rounded structures present on ventral thoracic wall. Each is convex anteriorly and has an erectile **nipple** in its middle. The nipple has 15-25 openings of **lactiferous ducts** which carry milk from mammary glands to nipple. Lactiferous ducts dilate and form **lactiferous ampullae** just beneath the nipple to store the milk. The base of nipple is deep pink to light brown in colour and is called **areola**.

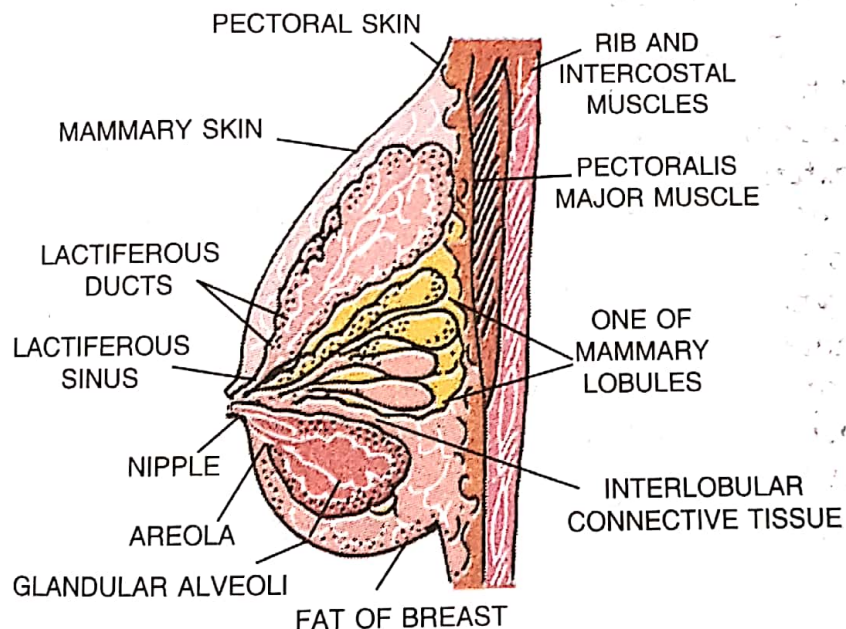


Fig. 3.11. Sagittal section of breast.

Mammary glands are compound tubulo-alveolar and modified sweat glands. A breast is with about 15-20 lobes of milk glands. Each lobe is formed of many lobules, each of which contains groups of secretory cells called **alveoli**. These are functional in female but vestigial in male.

Size. Size of breasts varies. In the female, the breasts are small sized upto puberty. Their size increases after puberty under the stimulation of estrogens secreted by follicular cells of Graafian follicle of ovary. Size of breasts is further increased during pregnancy and after child-birth under the stimulation of **prolactin** hormone of anterior pituitary and **progesterone** hormone of corpus luteum.

MAJOR FUNCTIONS OF FEMALE REPRODUCTIVE SYSTEM

1. **Oogenesis** by the germ cells of ovary.
2. Vagina receives the seminal fluid during copulation.
3. **Fertilization** of gametes to form zygote.
4. **Implantation** followed by **prenatal growth** of embryo.
5. **Parturition**.

HORMONAL CONTROL (FIG. 3.12)

Ovary is regulated by pituitary gonadotropins or GnTH. Anterior pituitary secretes Follicular Stimulating Hormone (FSH) which controls the transformation of young primary follicle into Graafian follicle; maturation of ovum and secretion of estrogens by its follicular cells. The Luteinizing Hormone (LH) of anterior pituitary regulates the ovulation from the Graafian follicle; transformation of empty Graafian follicle into yellowish, conical corpus luteum and secretion of progesterone hormone from the corpus luteum.

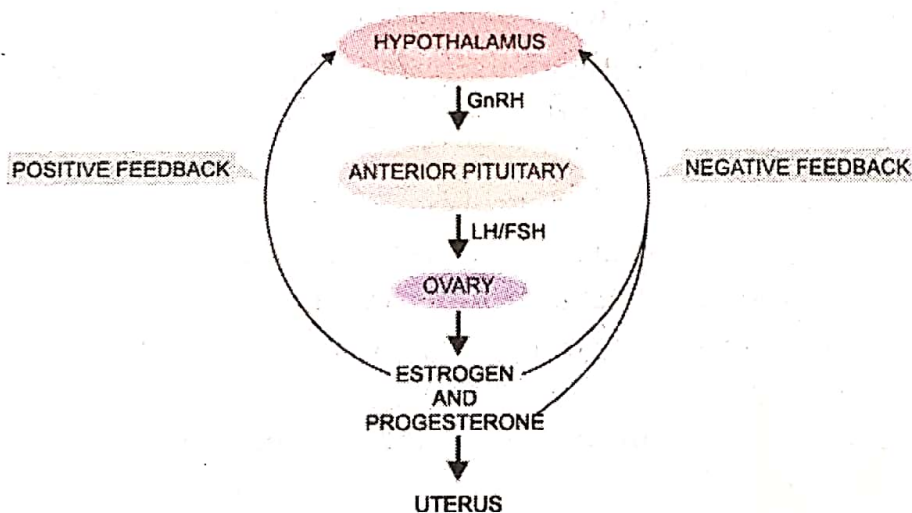


Fig. 3.12. Hormonal control of female reproductive system.

Growth and function of secondary sex organs are regulated by estrogens and progesterone. **Estrogens** control the growth, maintenance and functioning of secondary sex organs of female. **Progesterone** suspends ovulation during pregnancy, promotes implantation of foetus on the endometrium and development of foetus in the uterus.

At the end of pregnancy, the corpus albicans secretes **relaxin** which broadens the pelvis for easy parturition.

PUBERTY IN FEMALE

Puberty in female is characterized by the beginning of ovulation and menstrual cycle. Puberty in female comes between 10 to 14 years.

Control. Puberty in female is initiated by **estrogen** hormones.

Characters. A number of physical and psychological changes occur in female at the onset of puberty :

1. The enlargement of breasts.
2. The ovulation and menstrual cycle begin.
3. The broadening of hip region due to widening of pelvis.
4. Pubic and axillary hair grow.
5. Increase in subcutaneous fat in thighs, buttocks and face.
6. Stoppage of growth of long bone and height.

Table 3.3. Distinguish between Primary and Secondary sex organs.

Characters	Primary sex organs	Secondary sex organs
1. Function	These form the gametes (sperms and ova).	These help in conduction of gametes.
2. Hormones	These secrete sex hormones.	These do not secrete sex hormones.
3. Control	Their growth, maintenance and functions are controlled by gonadotropins of anterior pituitary.	Their growth, maintenance and functions are controlled by sex hormones secreted by gonads.

HOME TASK

1. Define : Semen, puberty, glans penis, insemination, Graffian follicle,

2. Short answer questions :

a) Give the location of testes in man.

b) Name the endocrine cells of the testes.

c) Name the external genitalia of male & female.

d) Name the innermost glandular epithelium of uterus.

e) Name the hormone regulating puberty in male and female.

3. Differentiate :-

a) Primary Sex Organs & Secondary Sex Organs.

b) Vasa Efferentia & Vasa Deferentia.

c) Puberty in male & female.

d) Accessory genital glands in male & female.

4. Write notes on hormonal control in male & female reproductive systems.

5. Write the major functions of male & female reproductive system.