Male Reproductive System

Dr. Rajesh Prasad

Asst. Professor,
Dept. of Zoology,
Eastern Karbi Anglong College

Human Reproduction

- Human beings are **sexually dimorphic** organisms, *i.e.*, male and female are separately distinguishable. Reproductive system, whether in male or female is a collection of internal and external organs that work together to produce a new generation of living organisms similar to their parents.
- The external features which provide distinctiveness to the two sexes but have no role in sexual reproduction, are collectively called **secondary sex characters**.
- The specialised cells for reproduction or reproductive units are called gametes. Gametes are of two types : male gametes are **spermatozoa** and female gametes are **ova**. Gametes are formed in separate, paired organs of mesodermal origin, called **gonads**.
- Sperm producing gonads are called **testes** and ova producing gonads are called **ovaries**. Testes and ovaries are known as **primary sex organs**.

Major Reproductive Events

Gametogenesis
- Formation of gametes. It includes spermatogenesis (formation of sperms) and oogenesis (formation of ova or eggs).

Insemination
- Transfer of sperm into the genital tract of female.

Fertilisation
- Fusion of male and female gametes to form zygote.

Cleavage
- Rapid mitotic divisions of single celled zygote to develop multicellular blastocyst or blastula.

Implantation
- Attachment of blastocyst to the uterine wall.

Placentation
- Formation of placenta between fetus and uterine wall of the mother to exchange essential materials.

Gastrulation
- Development of blastocyst into gastrula with three primary germ layers.

Organogenesis
- Formation of specific tissues, organs and organ-systems from three primary germ layers.

Parturition
- Expelling of baby from mother's womb (uterus) *i.e.*, childbirth.

MALE REPRODUCTIVE SYSTEM

- Male reproductive system comprises of scrotum, a pair of testis, vasa efferentia, epididymes, vasa deferentia, ejaculatory ducts, urethra, penis and certain glands.

Scrotum

- It is a pouch or pigmented sac consisting of loose skin, muscles and connective tissue that hangs from the root, *i.e.*, attached portion of the penis. A **septum** divides the scrotum into two sacs. Each of these sacs contain one testis.
- The scrotum remains connected with the abdomen or pelvic cavity by two **inguinal canals** on each side of the scrotal septum.

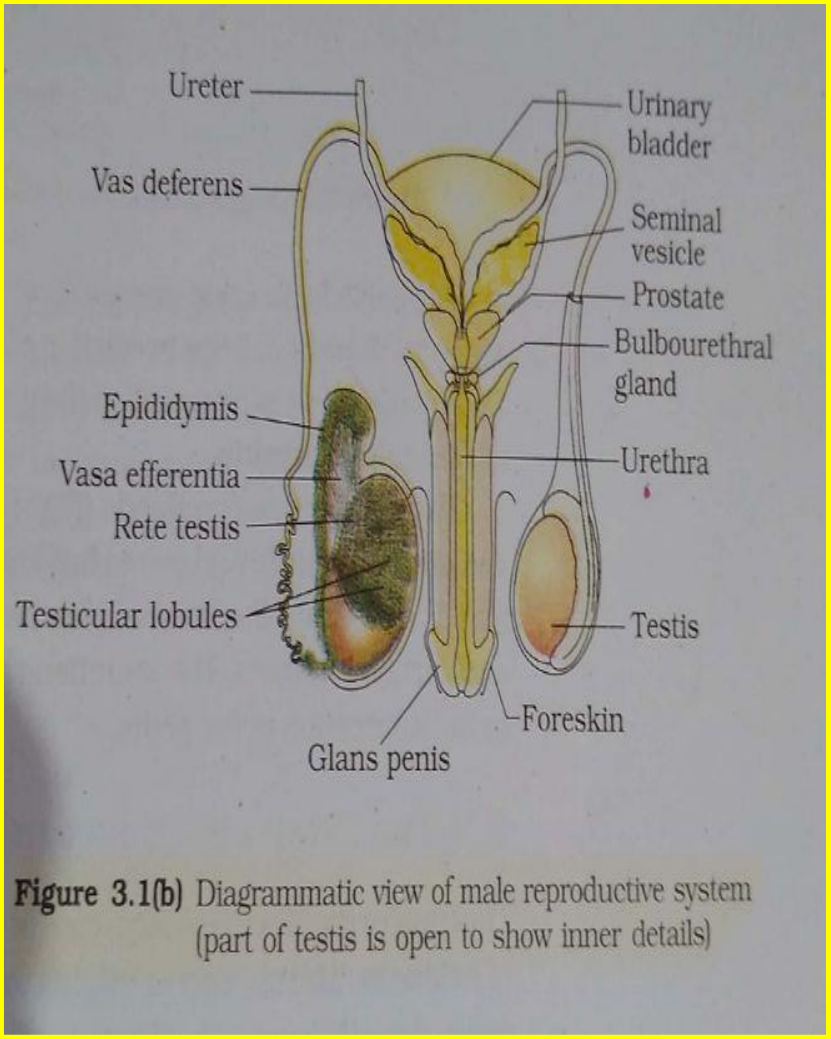


Figure 3.1(b) Diagrammatic view of male reproductive system (part of testis is open to show inner details)

- Scrotum acts as a thermoregulator and maintains testes at a temperature 2°C lower than the body which is optimal for sperm production.

Testes

- There is a pair of testes that are suspended in the scrotum by the spermatic cords. The testes develop in the abdominal cavity just below the kidneys during early fetal life and then they descend into the scrotum.
- A fibrous cord that extends from the caudal end of the testis to the scrotal wall is called **gubernaculum**.

Testis is surrounded by three layers : (i) **Tunica vaginalis** - Serous covering of testis, (ii) **Tunica albuginea** - A layer made of fibrous or collagenous connective tissue. (iii) **Tunica vasculosa** - Delicate, loose connective tissues lining testicular lobules, has rich supply of blood capillaries.

- Each testis has around 250 compartments called **testicular lobules** each of which contains several sperm producing coiled tubules called **seminiferous tubules**.
- The lining of seminiferous tubules called germinal epithelium has two types of cells, **spermatogenic cells** and **supporting cells** or **Sertoli cells**.
- In between the seminiferous tubules, in the connective tissue, there are present small groups of rounded endocrine cells, called **interstitial** or **Leydig's cells.**
- Under the influence of luteinising hormone (LH) or interstitial cell stimulating hormone (ICSH), Leydig's cells produce androgens *e.g.*, **testosterone**.
- Testes perform two functions : (a) production of sperms and (b) secretion of male sex hormones.

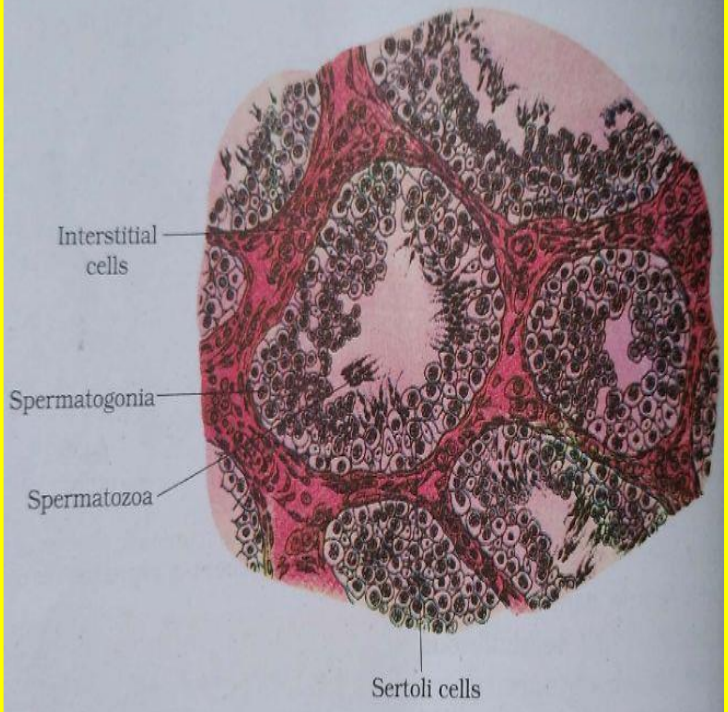


Figure 3.2 Diagrammatic sectional view of seminiferous tubule

Male Accessory Ducts

- **Rete testis, vasa efferentia, epididymes** and **vasa deferentia, (**or **vas deferens)** are called the male accessory ducts. These ducts store and transport the sperms from the testis to the outside through urethra.
- The seminiferous tubules join at one end to form a network or **rete testis** from where vasa efferentia arise.
- Epididymis is a mass of long narrow closely coiled tubule which lies along the inner side of each testis.
- At the anterior end of the testis epididymis is called **caput epididymis**, in which the vasa efferentia opens. The middle part of the epididymis is known as **corpus epididymis**. The posterior end of the epididymis is called as **cauda epididymis**.
- The vas deferens is a continuation of the cauda epididymis. It leaves the scrotal sac and enters the abdominal cavity through the inguinal canal.
- The **vas deferens** curves over the urinary bladder where it is joined by duct from the seminal vesicle to form the ejaculatory duct. Vasa deferentia carry sperms.

Ejaculatory Ducts

- They are formed by union of ducts from seminal vesicle and vas deferens. They pass through the prostate gland and join the prostatic part of urethra.
- They carry sperms mixed up with secretion of seminal vesicle.

Urethra

- It is the urinary duct which originates from neck of urinary bladder and opens out, at the tip of penis. It also receives secretions of prostate and Cowper's glands.

Penis

- The penis is a male copulatory organ used during mating.
- The penis contains three cylindrical masses of erectile tissue — two dorsal **corpora cavernosa** and one ventral **corpus spongiosum**. These bodies are surrounded by fibrous tissue.
- The corpus spongiosum, through which the urethra extends, enlarges at its distal end to form a sensitive cone-shaped **glans penis**.
- During sexual arousal, the three bundles of tissue in the penis become engorged with blood.

Male Accessory Glands

- **Seminal vesicle :** These are paired, glandular, sac-like structures near the base of the bladder, secreting fluids which constitute approximately 60% of the volume of semen. It also contains **fructose** and **prostaglandins**.

Fructose, which is present in seminal fluid and is not produced anywhere else in the body is used for confirmation of sexual intercourse/rape during forensic test.

- **Prostate gland :** It is a single large gland surrounding urethra. It produce a milky secretion which forms 25% of the volume of semen.
- The secretions of prostate gland also contain glycoprotein **prostate specific antigen (PSA)** which liquefies the clotted semen.
- **Bulbourethral (Cowper's) gland :** These are a pair of glands present on either side of membranous urethra. They secrete an alkaline fluid that neutralises acids from urine in the urethra.

Semen is a collection of secretions from the seminal vesicles; prostate gland; Cowper's glands; sperms from testes. It is ejected from the penis during ejaculation.

Questions

1. What is the function of Leydig's cells and Sertoli cells in male reproductive system?
2. Write two major functions of testis.
3. What are the major functions of male accessory glands?

GAMETOGENESIS

- The primary sex organs- the testis in the males and the ovaries in the females-produce gametes, *i.e.*, sperms and ovum, respectively, by the process called **gametogenesis.**
- The cells producing gametes are called **germ** or **germinal cells.** They are generally diploid.
- The gametes differ from all other cells (=somatic cells) of the body in that their nuclei contain only half the number of chromosomes found in nuclei of somatic cells.
- Meiosis forms the most significant part of gametogenesis. Gametogenesis for the formation of sperms is termed **spermatogenesis,** while that of ova is called **oogenesis.**
- Both spermatogenesis and oogeneis are accomplished in three phases:
  - **Multiplication phase :** Here multiplication of the germ cells occurs through mitosis so as to increase their number.
  - **Growth phase :** The germ cells increase in size.
  - **Maturation phase :** Germ cells undergo meiosis to produce haploid gametes.

Spermatogenesis

- Spermatogenesis (spermioteleosis) is the process of formation of haploid spermatozoa (sperms) from diploid spermatogonia inside the testes of the male.
- It occurs in the seminiferous tubules of the testes.

- The seminiferous tubules are lined by **germinal epithelium.**
- The germinal epithelium consists largely of cuboidal **primary or primordial germ cells (PGCs)** and elongated pyramidal or columnar polygonal cells called **Sertoli cells.**

Formation of spermatids

- It consists of three phases : multiplication, growth and maturation phase.

Multiplication phase

- At sexual maturity, the undifferentiated primordial germ cells divide several times by mitosis to produce a large number of spermatogonia (diploid, containing 46 chromosomes) or sperm mother cells.

Growth phase

- Each spermatogonium actively grows to a larger **primary spermatocyte** by obtaining nourishment from the nursing cells.
- The phenomenon of formation of primary spermatocytes from spermatogonia, is called spermatocytogenesis.

Maturation phase

- Each primary spermatocyte undergoes two successive divisions, called **maturation divisions.**
- The first maturation division is reductional or meiotic. Hence, the primary spermatocyte divides into two haploid daughter cells called **secondary spermatocytes (23 chromosomes).**
- Both secondary spermatocytes now undergo second maturation division which is an ordinary mitotic division to form four haploid spermatids, by each primary spermatocyte.

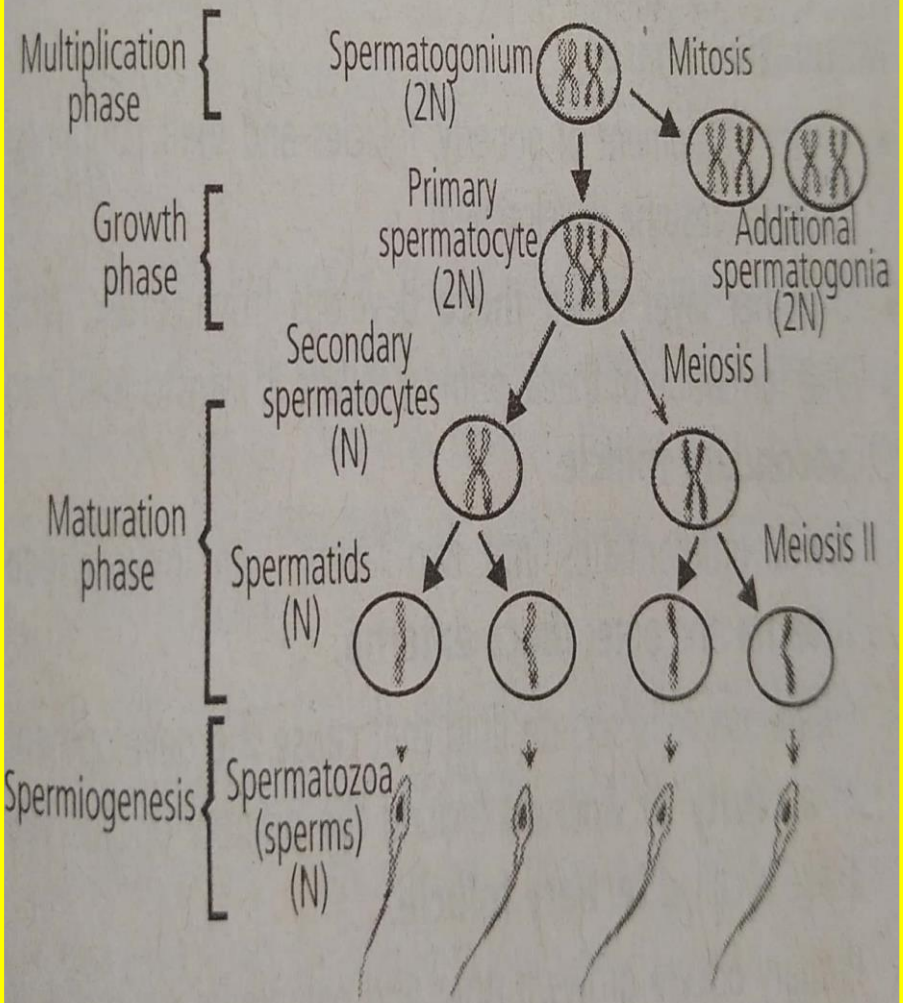


Fig.: Stages in spermatogenesis

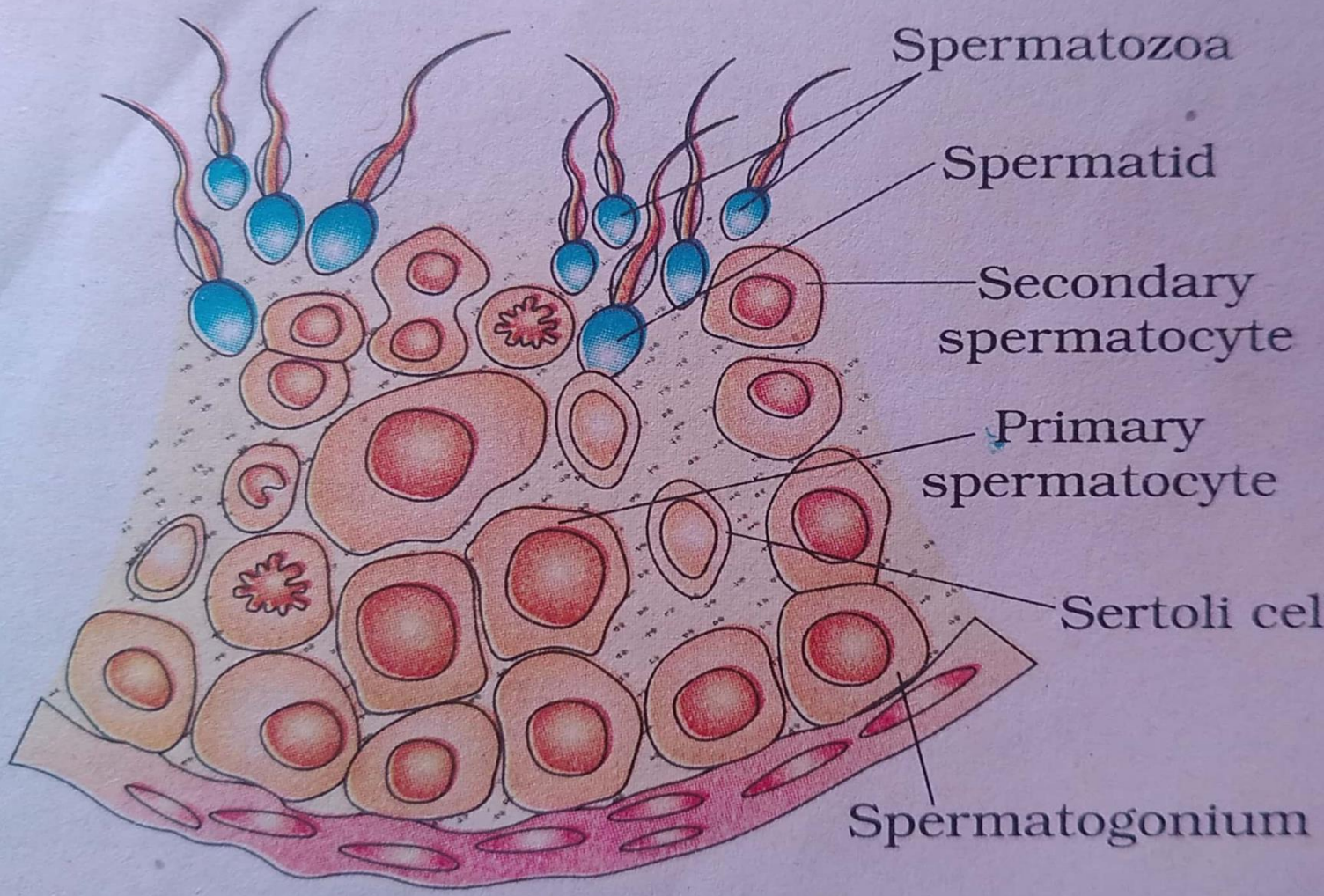
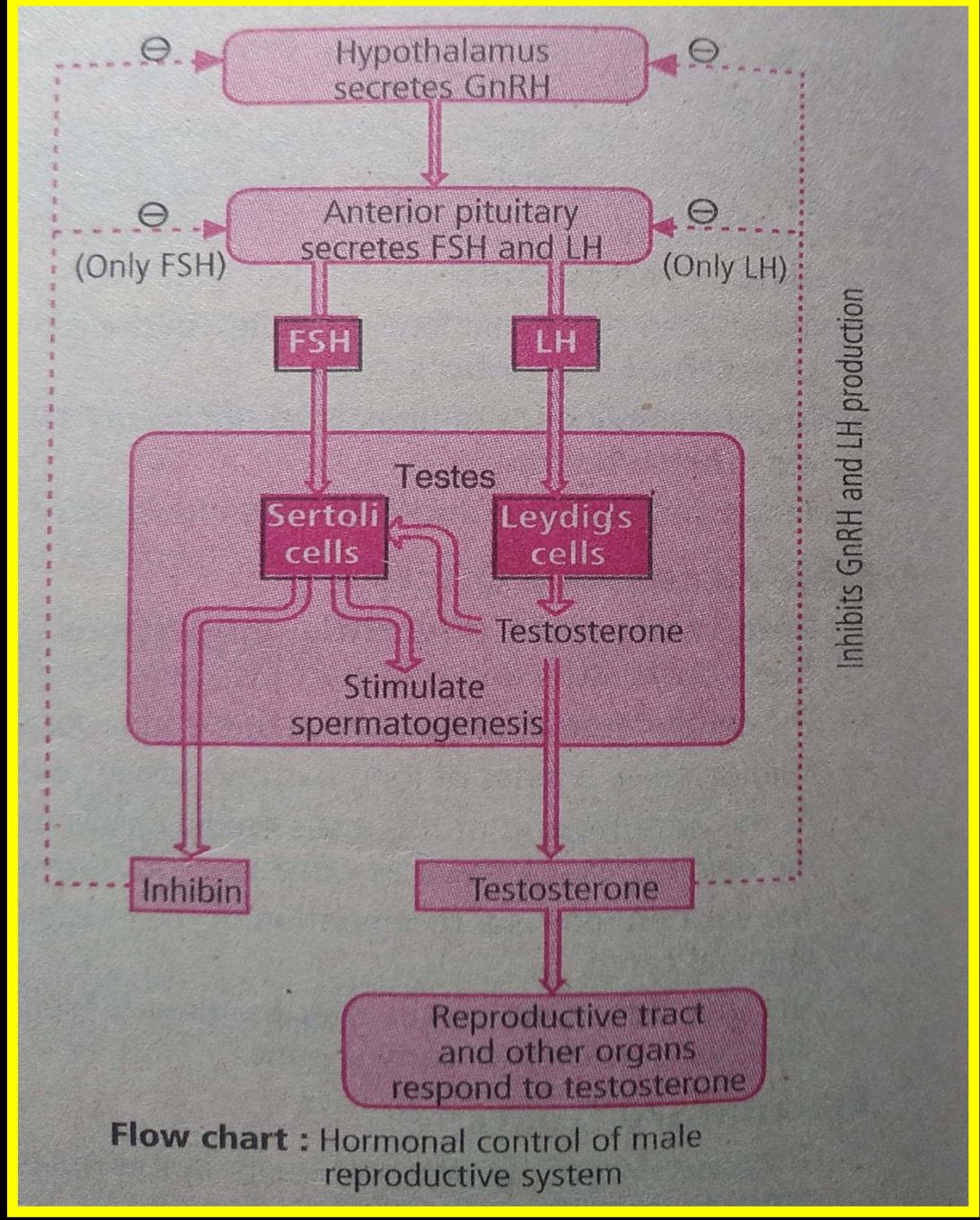


Figure 3.5 Diagrammatic sectional view of a seminiferous tubule (enlarged)

Formation of spermatozoa from spermatids (Spermiogenesis)

- The transformation of spermatids into spermatozoa is called spermiogenesis or spermateleosis or differentiation phase.
- The different changes which occur during spermiogenesis are :
  - Formation of acrosome by Golgi apparatus. The latter then degenerates.
  - Elongation and condensation of nucleus.
  - Separation of centrioles.
  - Formation of axial filament from distal centriole.
  - Development of mitochondrial spiral around upper parts of axial filament.
  - Differentiation of a limiting membrane and formation of flagellum. This produces a spermatozoon.
- Sertoli cells act as phagocytes too. They consume the residual cytoplasm discarded during spermiogenesis.
- After their maturation, spermatozoa detach from Sertoli cells. The process is called spermiation.
- The released sperms are stored in epididymis and first portion of vasa deferentia for upto one month.
- Here they gain motility. Nutrition is provided by epithelium of epididymis.

- Spermatogenesis starts at the age of puberty due to significant increase in the secretion of Gonadotropin releasing hormone (GnRH).
- The increased levels of GnRH then acts at the anterior pituitary gland and stimulates secretion of two gonadotropins- Luteinising hormone (LH) and follicle stimulating hormone (FSH).
- LH acts on Leydig cells and stimulates synthesis and secretion of testosterone hormone.
- FSH acts on Sertoli cells and stimulates secretion of some factors which help in spermiogenesis.



Flow chart : Hormonal control of male reproductive system

Sperm or Spermatozoon

- A spermatozoon consists of four parts : **head, neck, middle piece** and **tail.**
- A plasma membrane envelops the whole body of a sperm.
- The sperm head contains an elongated **haploid nucleus,** the anterior portion of which is covered by a cap-like structure, **acrosome.**
- The acrosome is filled with enzymes that help in fertilization of the ovum.
- Acrosome contains proteolytic and lysosomal enzymes popularly called sperm lysins, *e.g.*, hyaluronidase, corona penetrating enzyme, acrosin or zona lysin.
- The surface of head contains adhesions (decapacitation factors) which have to be removed before it becomes capable of fertilizing an ovum.
- **Neck** is very short and is present between the head and middle piece.
- It contains the **proximal centriole** towards the nucleus which plays a role in the first cleavage of the zygote and the **distal centriole** which gives rise to the axial filament of the sperm.

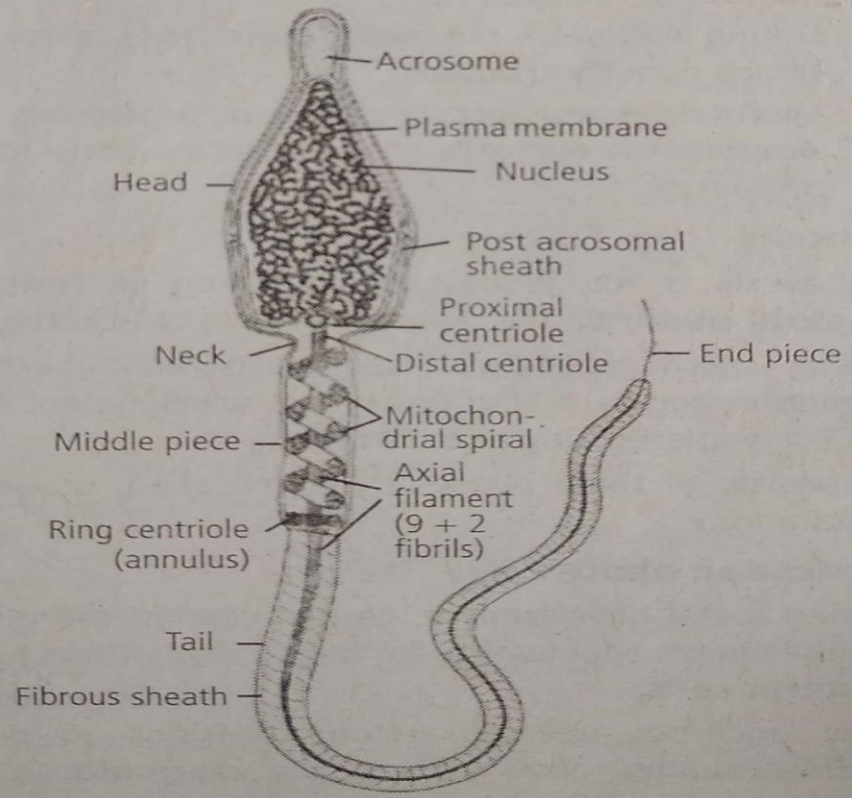


Fig.: A mammalian spermatozoon as seen under electron microscope.

- **Middle piece** is a long cylindrical part of sperm which lies between the neck and tail.
- **Axoneme** or **axial filament** of microtubules runs through it. The same is covered by a **mitochondrial spiral** (nebenkern) of 10-14 turns.
- A sheath of cytoplasm and plasmalemma lie on the outside. Reserve food is limited. Mitochondrial activity helps in providing energy for the movement of tail that facilitate sperm motility essential for fertilization.
- The **middle piece** possesses numerous **mitochondria,** which produce energy for the movement of tail that facilitate sperm motility essential for fertilization.
- **Tail** is very long, slender and tapering, and is formed of cytoplasm. **Axoneme** or **axial filament** occurs throughout. Tail is vibratile part of sperm.

Significance of spermatogenesis

- The significances of spermatogenesis are given below:
  - During spermatogenesis, one spermatogonium produces four sperms.
  - Sperms have half the number of chromosomes. After fertilization, the diploid chromosome number is restored in the zygote. It maintains the chromosome number of the species.
  - During meiosis I **crossing over** takes place which brings about **variation.**
  - Spermatogenesis occurs in various organisms. Thus it supports the evidence of the basic relationship of the organisms.

Questions

1. List the names of the hormones, endocrine glands along with functions of the hormones that are crucial in causing spermatogenesis.
2. During which stage of cell division are spermatids formed from the secondary spermatocytes?
3. Mention the differences between spermiogenesis and spermiation.
4. Where is acrosome present in humans? Write its function.
5. Draw and label the parts of a human sperm.
6. Schematically represent and explain the events of spermatogenesis in humans.