Lecture 31&32
Spermatogenesis

Items to know

- Definition & Steps of spermatogenesis.
- Hormonal control of the spermatogenesis.
- Abnormal spermatozoa.

●Definition of spermatogenesis:

It is a series of changes by which a male primitive germ cell – the spermatogonia is converted into a spermatozoon.

●Site and time:

Spermatogenesis is initiated in the male testis with the beginning of puberty and remains in continuity till death. It is a continuous process. The gonadal cords that are solid up till then in the juvenile testis develop a lumen with the start of puberty. They then gradually transform themselves into spermatic canals (convoluted seminiferous tubules).

●Duration: The entire process of spermatogenesis takes **74 days**. Including the transport on ductal system, it takes 3 months. Testes produce 200 to 300 million spermatozoa daily

Steps of spermatogenesis (Fig. 1):

The process of spermatogenesis can be divided into three phases :

1-Spermatocytosis (proliferation and differentiation of spermatogonia).

2-Meiosis

3-Spermiogenesis

The development of germ cells begins with the spermatogonia (an undifferentiated male germ cells) at the periphery of the seminal canal and advances towards the lumen over spermatocytes **I** (primary spermatocytes), spermatocytes **II** (secondary spermatocytes), spermatids and finally to mature sperm cells.

1-Spermatocytosis

►The spermatogonia lie within the seminiferous tubules of the testis forming the basal layer of germinal epithelium. They divide repeatedly by mitotic division to renew themselves.

- There are 2 types of spermatogonia: type A and type B.

The type A spermatogonia acts as a stem cell which divides to forms its own and to give rise to type B spermatogonia. Type B spermatogonia give rise to primary spermatocytes by simple mitotic division (Fig. 2).

Thus the process of spermatocytosis maintains a pool of spermatogonia and gives rise to primary spermatocytes also.

2-MEIOSIS:

The primary spermatocytes (2n) move into the middle zone of the seminiferous tubules, divide to form two **haploid** (n=23) secondary spermatocytes (23 doubled structured chromosomes). This is a reduction division (First meiotic division) (meiosis I) where in the number of chromosomes becomes half.

- Each secondary spermatocyte further divides to form two spermatids (n) (23 single chromosomes) by second meiotic division.

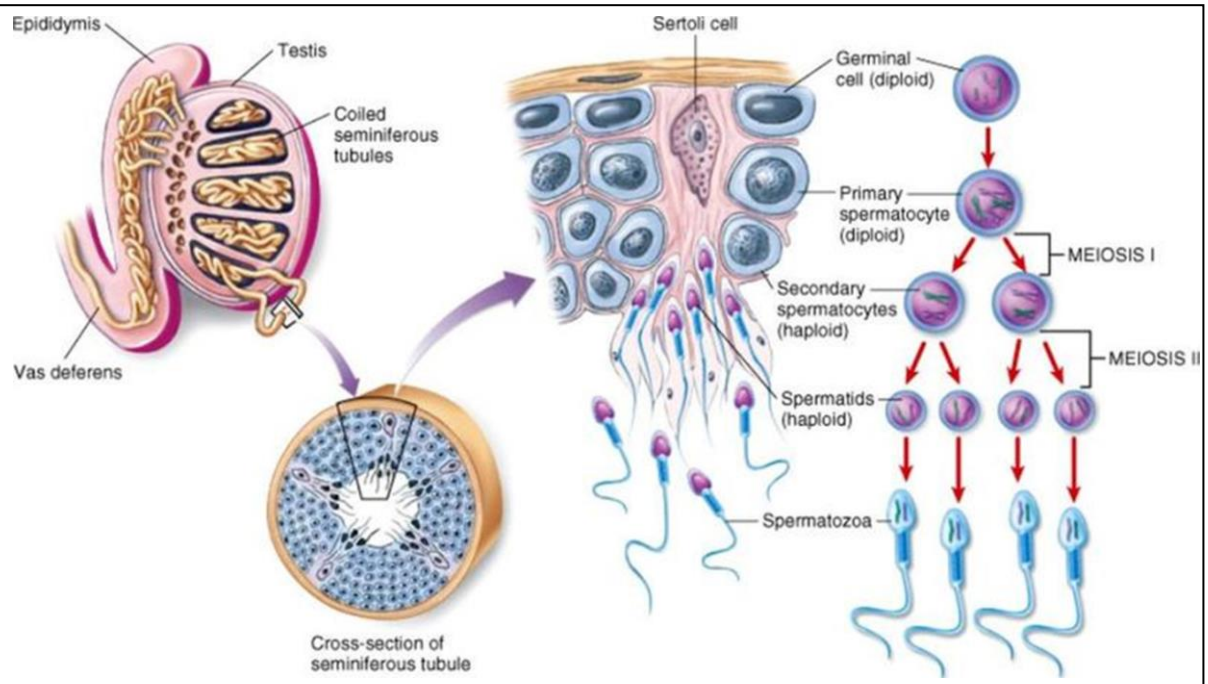

Fig. 1: Spermatogenesis

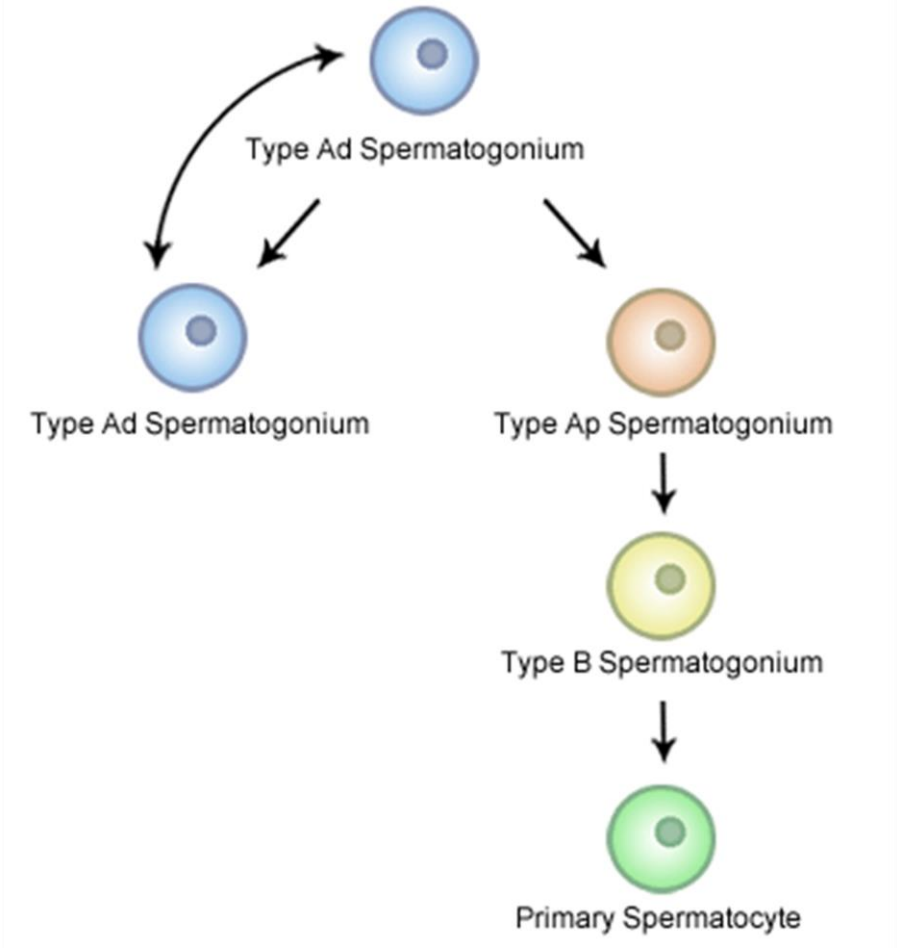

Fig. 2: SPERMATOCYTOSIS

• Each secondary spermatocyte further divides to form two spermatids by second meiotic division.

3-Spermiogenesis (Fig. 3):

• It is the series of changes resulting in the transformation of spermatids into spermatozoa.

• A spermatid is almost like a circular cell having nucleus, mitochondria, Golgi bodies and centriole.

• **<u>These changes are as follows:</u>**

1-The centriole divides into two parts, the axial filament grows from one while the other forms the annulus (end ring).

2-The nucleus forms head of the spermatozoon and the Golgi bodies cover it forming acrosomal cap.

3-Part of the axial filament (between the head and the annulus) becomes surrounded by the mitochondria forming mitochondrial sheath.

4-Most of the cytoplasm is extruded and the cell membrane remains as a covering of the spermatozoon.

5-Axial filament elongates to form the tail or principal piece.

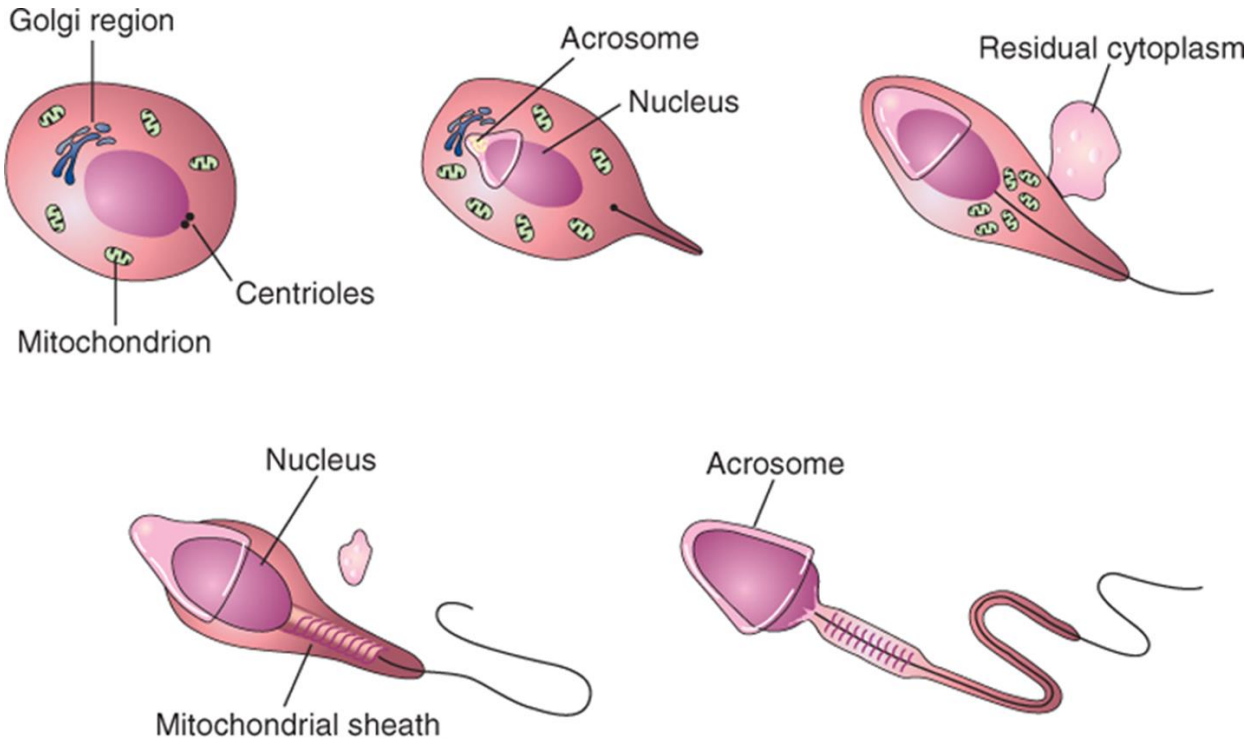

Fig. 3: Spermiogenesis

❖ **<u>Mature sperms (Fig. 4):</u>**

- Mature sperms are free-swimming, actively motile cells consisting of a head and a tail. The neck of the sperm is the junction between the head and tail.
- The head of the sperm forms most of the bulk of the sperm and contains the haploid nucleus.

- The anterior two thirds of the nucleus is covered by the acrosome, an organelle containing several enzymes facilitate sperm penetration during fertilization.
- Maturation of sperms takes place in the epididymis, the store house for spermatozoa.
- The tail of the sperm consists of three segments: middle piece, principal piece, and end piece.
- The tail provides the motility of the sperm that assists its transport to the site of fertilization.
- The middle piece of the tail contains mitochondria, which provide the adenosine triphosphate necessary for activity.

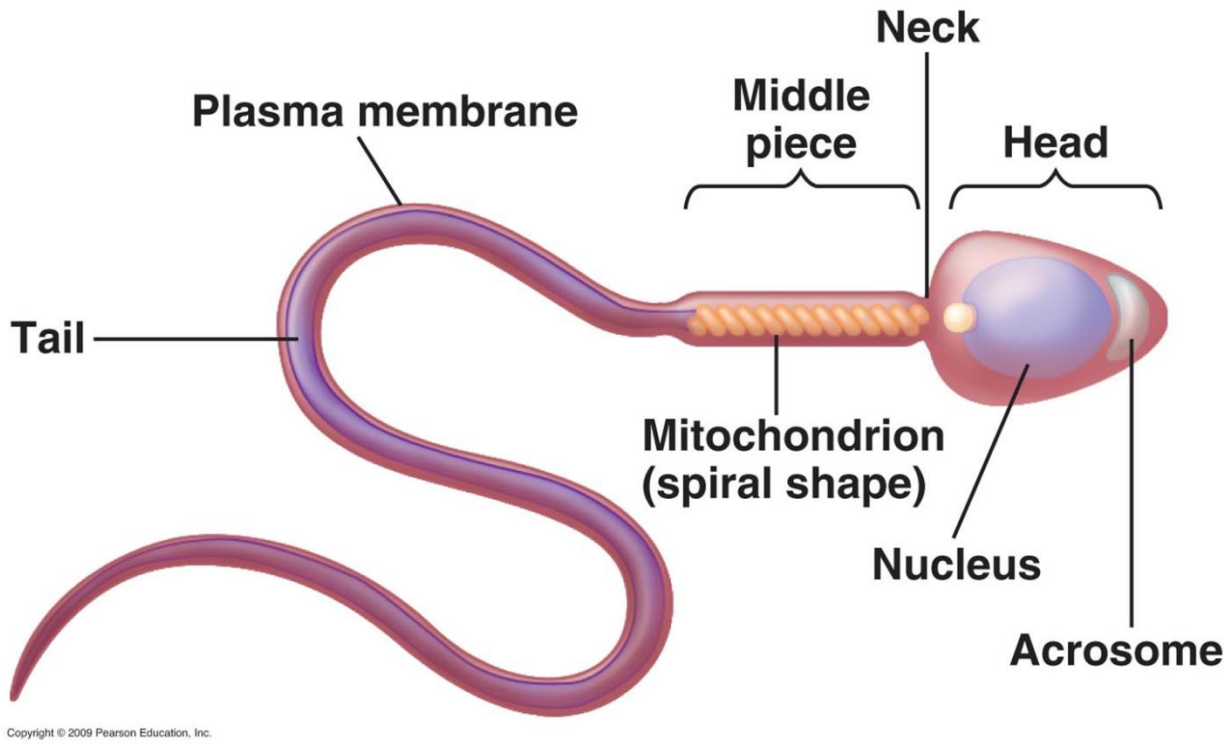

Fig. 4: Mature sperms

- A fully developed spermatozoon acquires the ability to fertilize the ovum only when it has travelled through the female genital tract. This is called capacitation. The average viable period of spermatozoa is about 3 to 4 days.

• A single ejaculate is about 2 to 3 ml. in volume and contains approximately 200 to 300 million sperms. If the concentration of sperms is less than 20 milion it usually leads to sterility. Poor motility can also cause sterility.

❖ **Hormonal control of spermatogenesis**

Spermatogenesis is regulated by luteinizing hormone (LH) production by the pituitary. LH binds to receptors on Leydig cells and stimulates testosterone production, which in turn binds to Sertoli cells to promote spermatogenesis.

Follicle stimulating hormone (FSH) is also essential because its binding to Sertoli cells stimulates testicular fluid production and synthesis of testosterone receptors.

❖ **Abnormal sperms (Fig. 5)**:

- Abnormal spermatozoa are seen frequently, and up to 10% of all spermatozoa have observable defects.
- The head or the tail may be abnormal; spermatozoa may be giants or dwarfs; and sometimes they are joined.
- Sperm with morphologic abnormalities lack normal motility and probably do not fertilize oocytes.

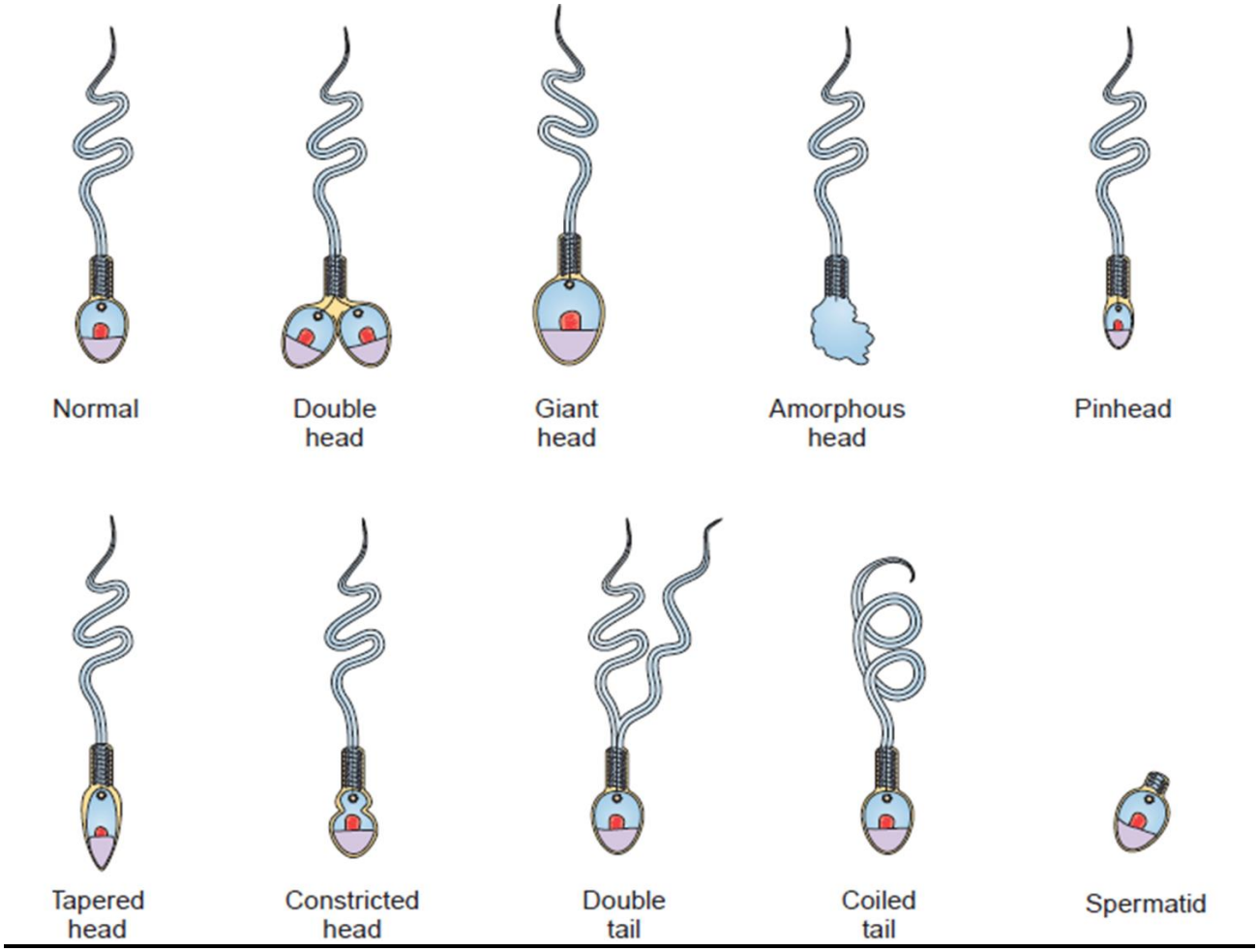

Fig. 5: Abnormal sperms

Important Terms

- **Aspermia**: absence of semen
- **Azoospermia**: total absence of spermatozoa in semen.
- **Oligozoospermia:** refers to a reduced number of spermatozoa in semen and is usually used to describe a sperm concentration of less than 20 million/ml.
- **Asthenozoospermia:** sperm which are immotile or have reduced motility, compared to the WHO reference values.
- **Teratozoospermia:** sperm carry more morphological defects than usual.