MSC: Ali Talib Ahmed Al aaraji

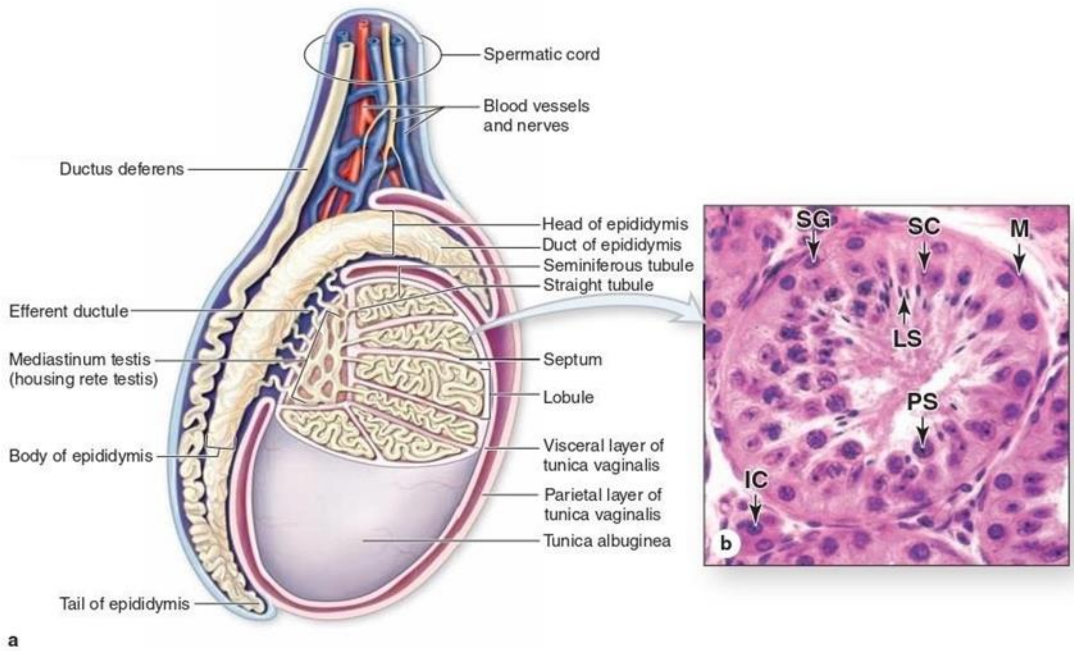
**Lec.** **Male Reproductive System**

The male reproductive system consists: of the testes, genital ducts, accessory glands, and penis (Figure 21–1).
Testes produce sperm but also contain endocrine cells secreting hormones such as testosterone, which drives male reproductive physiology. Testosterone is important for spermatogenesis, sexual differentiation during embryonic and fetal development, and control of gonadotropin secretion in the pituitary.
A metabolite of testosterone, dihydrotestosterone, also begins to act on many tissues during puberty (eg, male accessory glands and hair follicles).

The genital ducts and accessory glands produce secretions required for sperm activity and contract to propel spermatozoa and the secretions from the penile urethra. These secretions provide nutrients for spermatozoa while they are confined to the male reproductive tract. Spermatozoa and the secretions of the accessory glands make up the semen (L, seed), which is introduced into the female reproductive tract by the penis.

**Testes**
Each testis (or testicle) is surrounded by a dense connective tissue capsule, the tunica albuginea, which thickens on the posterior side to form the mediastinum testis. From this fibrous region, septa penetrate the organ and divide it into about 250 pyramidal compartments or testicular lobules ( Figures 21–2 and 21–3 ). Each lobule contains sparse connective tissue with endocrine interstitial cells (or Leydig cells) secreting testosterone, and one to four highly convoluted seminiferous tubules in which sperm production occurs.

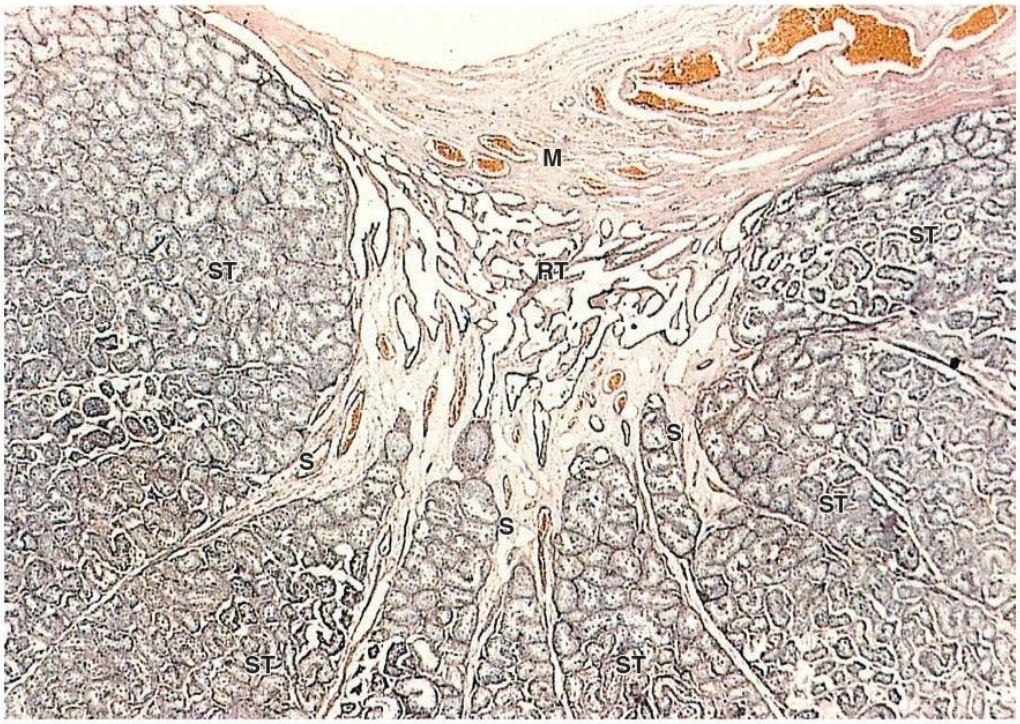
FIGURE 21–2 Testes and seminiferous tubules.




The anatomy of a testis is shown. **(a)** The diagram shows a partially cutaway sagittal section of the testis. **(b)** A seminiferous tubule cross section shows spermatogonia (**SG**) near the periphery, near nuclei of Sertoli cells (**SC**), primary spermatocytes (**PS**), and late spermatids (**LS**) near the lumen, with interstitial cells (**IC**) in the surrounding connective tissue. X400. H&E.

The testes develop retroperitoneally in the dorsal wall of the embryonic abdominal cavity and are moved during fetal development to become suspended in the two halves of the scrotal sac, or scrotum, at the ends of the spermatic cords (Figure 21–2).

FIGURE **21–3** **Lobules converging at rete testis.**




The dense capsule of the testis, the tunica albuginea, thickens on the posterior side as the mediastinum (**M**) testis, from which many thin septa (**S**) subdivide the organ into about 250 lobules. Each lobule contains one to four convoluted seminiferous tubules (**ST**) in a sparse connective tissue interstitium.

Each tubule is a loop attached by means of a short straight tubule to the rete testis (**RT**), a maze of channels embedded in the mediastinum testis. From the rete testis the sperm move into the epididymis. X60. H&E.

During migration from the abdominal cavity, each testis carries with it a serous sac, the tunica vaginalis, derived from the peritoneum. This tunic consists of an outer parietal layer lining the scrotum and an inner visceral layer, covering the tunica albuginea on the anterior and lateral sides of the testis (Figure 21–2 )

**Interstitial Tissue**

The interstitial tissue of the testis between the seminiferous tubules consists of sparse connective tissue containing fibroblasts, lymphatics, and blood vessels including fenestrated capillaries. During puberty interstitial cells, or Leydig cells, develop as large round or polygonal cells with central nuclei and eosinophilic cytoplasm rich in small lipid droplets (Figures 21–2b and 21–4). These cells produce the steroid hormone testosterone, which promotes development of the secondary male sex characteristics. Testosterone is synthesized by enzymes present in the smooth ER and mitochondria similar to the system in adrenal cortical cells.

FIGURE **21–2** **Testes and seminiferous tubules.**

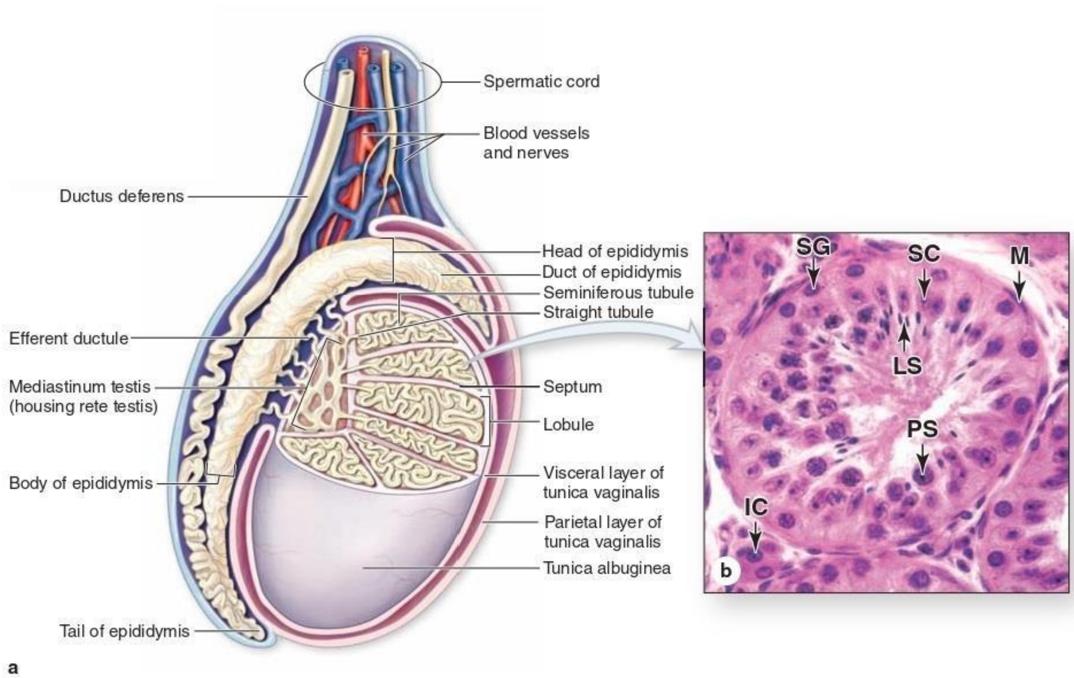



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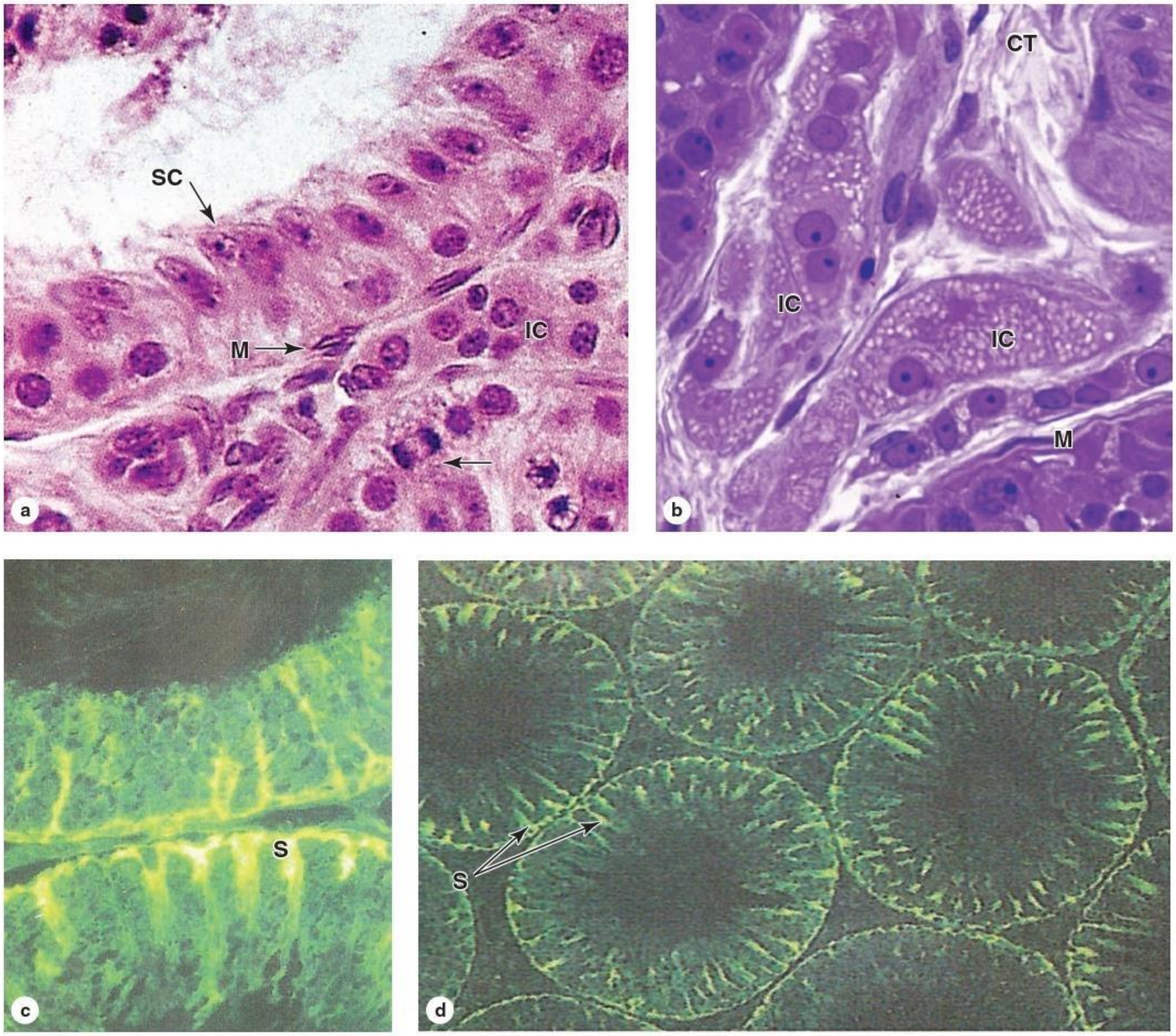
FIGURE **21–4** **Seminiferous tubule and interstitial cells.**




**(a)** Seminiferous tubules are surrounded by connective tissue containing many large interstitial cells (**IC**) that secrete androgens. The tubule wall is a unique epithelium composed of columnar Sertoli cells (**SC**), with oval or pyramidal nuclei and distinct nucleoli, and dividing spermatogenic stem cells with round nuclei (**arrow**). Also numerous are flattened peri-tubular myoid cells (**M**) whose contractions help move fluid in the tubules. X400. H&E.

**(b)** A plastic section shows lipid droplets filling the cytoplasm of the clumped interstitial cells (**IC**), or Leydig cells, in the connective tissue (**CT**) between tubules. Such cytoplasm is typical of steroid-secreting endocrine cells. The epithelium of a nearby seminiferous tubule is immediately surrounded by myoid cells (**M**). X400. PT.

**(c)** Immunohistochemistry of seminiferous tubule wall shows the full height of Sertoli cells (**S**) and the dendritic nature of their cytoplasm. Spermatogenic cells are intimately associated with Sertoli cell surfaces. 400X.

**(d)** Lower magnification of the same preparation shows the distribution and density of Sertoli cells (**S**) in the seminiferous tubules. 100X. Both with fluorescent antibody against sulfated glycoprotein-1 (prosaposin).

*(Figure 21–4c, d used, with permission, of Dr Richard Sharpe, Medical Research Council/University of Edinburgh Centre for Reproductive Health, UK.)*

Testosterone secretion by interstitial cells is triggered by the pituitary gonadotropin, luteinizing hormone (LH), which is also called interstitial cell stimulating hormone (ICSH). Testosterone synthesis thus begins at puberty, when the hypothalamus begins producing gonadotropin-releasing hormone.

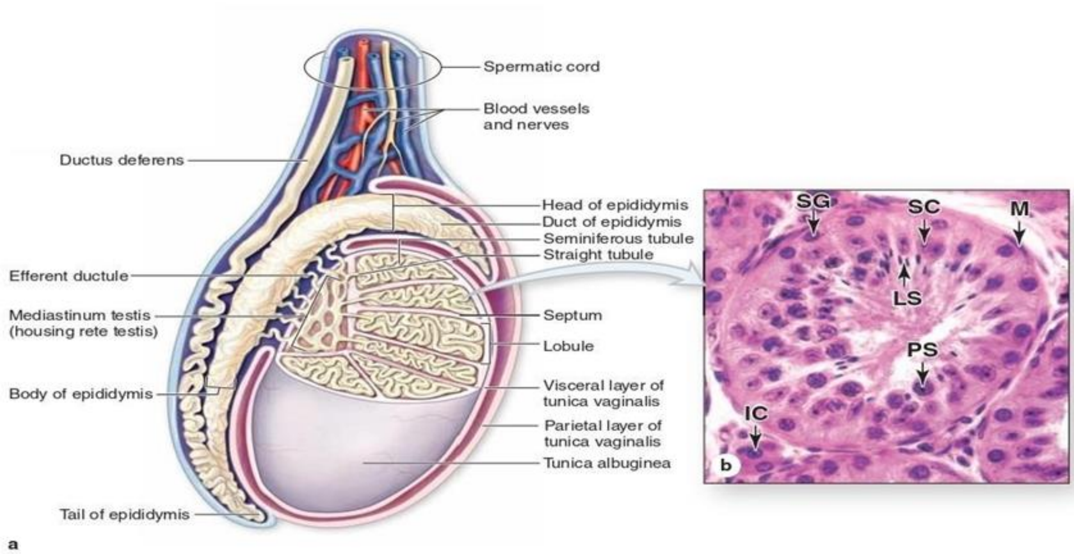
In the late embryonic testes gonadotropin from the placenta stimulates interstitial cells to synthesize the testosterone needed for development of the ducts and glands of the male reproductive system. These fetal interstitial cells are very active during the third and fourth months of pregnancy, then regress and become quiescent cells resembling fibroblasts until puberty when they resume testosterone synthesis in response to the pituitary gonadotropin.

**Seminiferous Tubules**

Sperm are produced in the seminiferous tubules at a rate of about 2 × 108 per day in the young adult. Each testis has from 250 to 1000 such tubules in its lobules, and each tubule measures 150 to 250 µm in diameter and 30 to 70 cm in length.

The combined length of the tubules of one testis totals about 250 m. Each tubule is actually a loop linked by a very short, narrower segment, the straight tubule, to the rete testis, a labyrinth of epithelium-lined channels embedded in the mediastinum testis (see Figures 21–2a and 21–3). About 10-20 efferent ductules connect the rete testis to the head of the epididymis (Figure 21–2a).

FIGURE 21–2 Testes and seminiferous tubules.

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Each seminiferous tubule is lined with a complex, specialized stratified epithelium called germinal or spermatogenic epithelium (Figure 21–2b).

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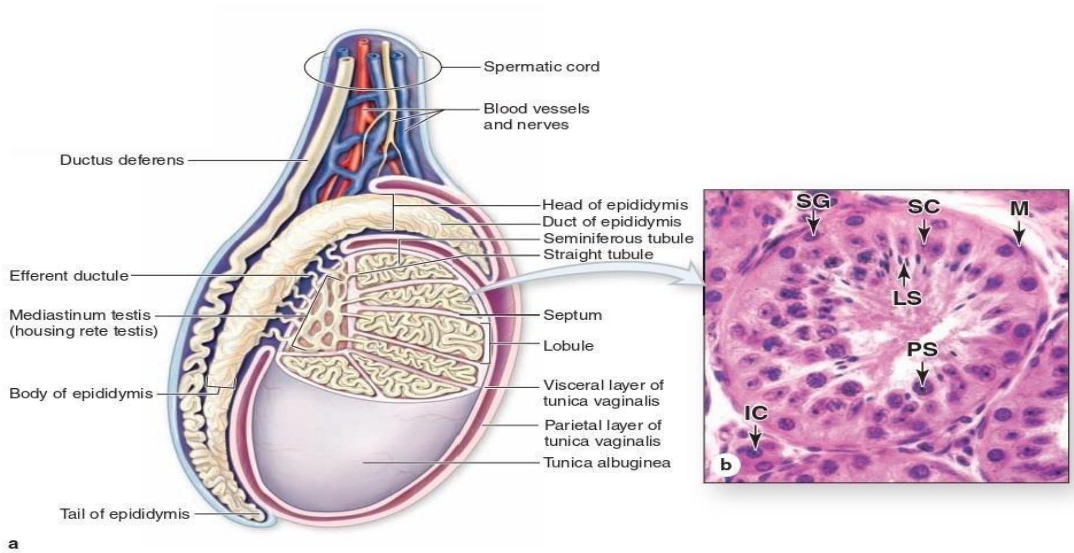


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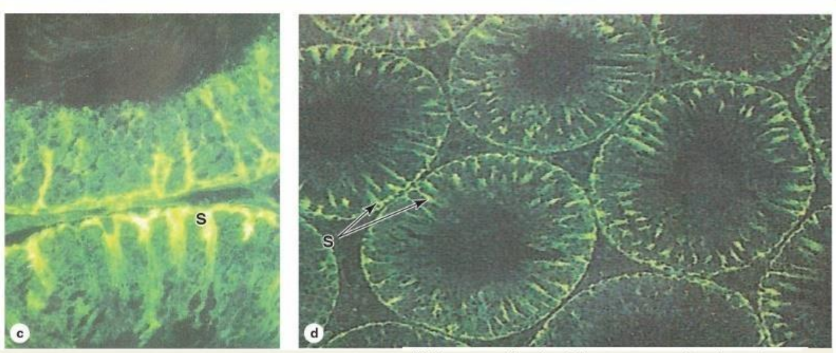
The basement membrane of this epithelium is covered by fibrous connective tissue, with an innermost layer containing flattened, smooth muscle-like myoid cells (Figure 21-2b), which allow weak contractions of the tubule. The germinal epithelium consists of two types of cells:

■ Large nondividing Sertoli cells (Figure 21–4c,d), which physically and metabolically support developing sperm cell precursors.

FIGURE **21–4** **Seminiferous tubule and interstitial cells.**

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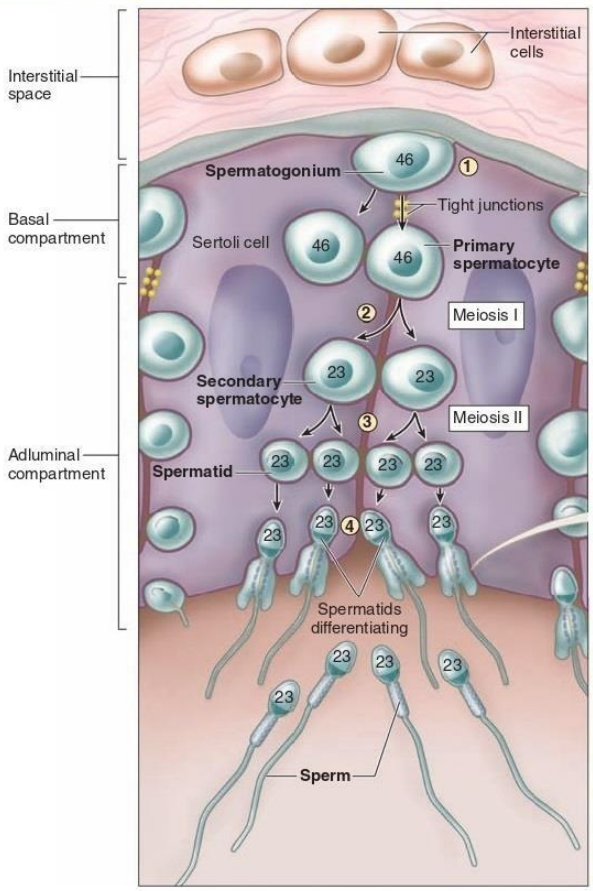
■ Dividing cells of the spermatogenic lineage (Figure 21–5a).

FIGURE **21–5** **Spermatogenesis and spermiogenesis.**



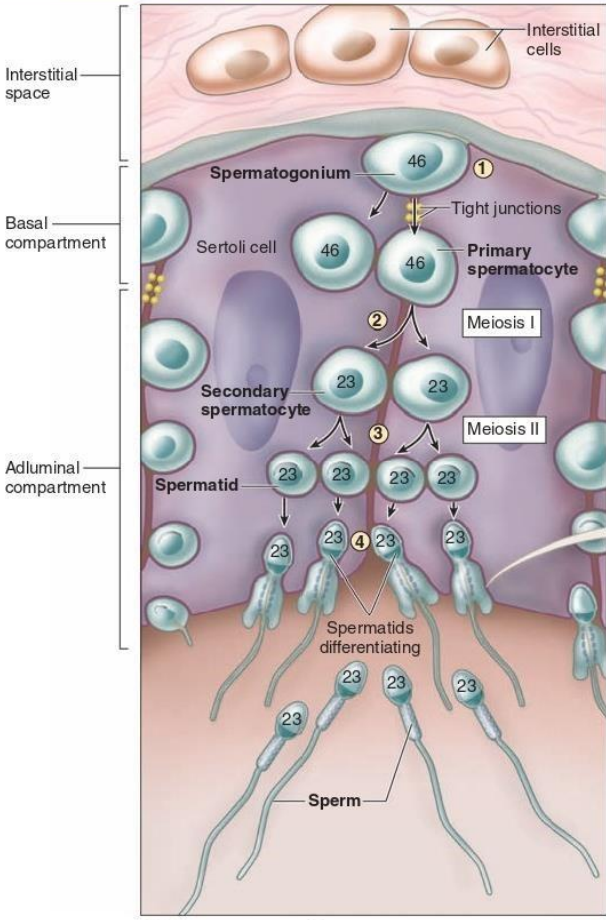

**(a) Spermatogenesis**

1. The spermatogenic progenitor cells, called spermatogonia, are diploid cells containing 46 chromosomes (23 pairs). Mitotic divisions of these cells each produce a new spermatogonium and a cell called a primary spermatocyte committed to meiosis.
2. Each new primary spermatocyte transiently disassembles the tight junctions of the blood-testis barrier and moves from the tubule's basal compartment to the adluminal compartment. At the same time these cells replicate their DNA, enter meiosis I, and undergo synapsis. The first meiotic division produces two haploid secondary spermatocytes each with 23 chromosomes.
3. Meiosis II is rapid as chromatids in the secondary spermatocyte chromosomes separate into two smaller haploid cells, the spermatids.
4. Near the lumen but still embedded in Sertoli cells, the spermatids differentiate and undergo the morphological changes required to become motile and capable of fertilization.

**(a)** The diagram shows two large, columnar Sertoli cells with their surfaces binding many germ cells in various stages of spermatogenesis. Near the basement membrane are **spermatogonia,** which divide by mitosis to produce both more spermatogonia and also **primary spermatocytes** that undergo meiosis to produce haploid spermatids that differentiate as sperm. Newly formed spermatocytes temporarily disassemble the tight junctions between Sertoli cells that act as the "blood-testis barrier" in order to move from the **basal compartment** to the **adluminal compartment** of the tubule.

The cells of the spermatogenic lineage comprise four to eight concentric cell layers and produce the cells that become sperm. As shown in Figure 21–5, spermatogenesis is the first part of sperm production, including stem cell mitosis and meiosis, and spermiogenesis is the final differentiation process occurring in the haploid male germ cells.

FIGURE **21–5** **Spermatogenesis and spermiogenesis.**

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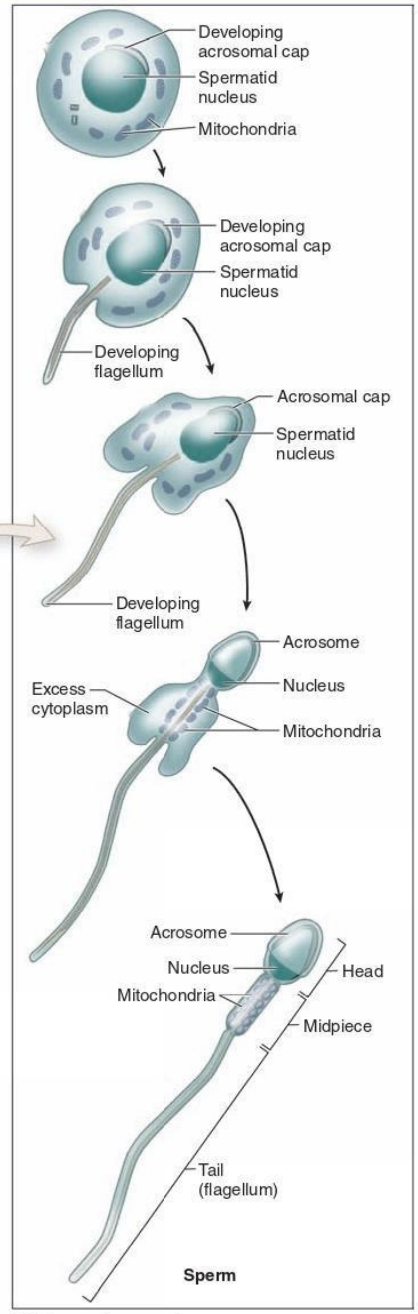


**(b) Spermiogenesis**

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**(b)** Spermiogenesis is the process of cell differentiation by which spermatids become sperm. The major changes that occur during spermiogenesis are shown here. These involve flattening of the nucleus, formation of an **acrosome** that resembles a large lysosome, growth of a **flagellum** (tail) from the basal body, reorganization of the mitochondria in the **midpiece** region, and shedding of unneeded cytoplasm.