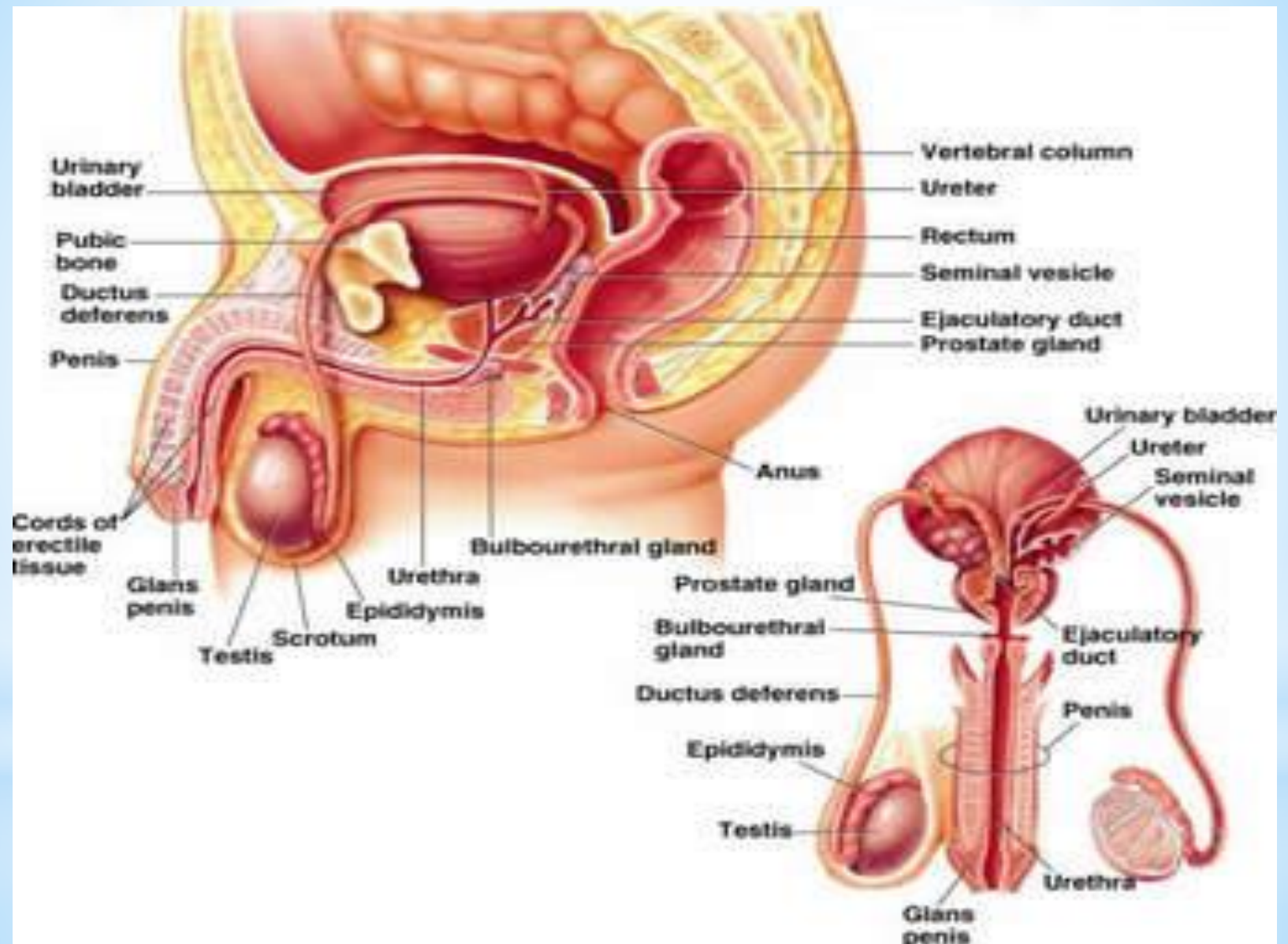# MALE REPRODUCTIVE SYSTEM *

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MALE REPRODUCTIVE SYSTEM

The internal male genitalia consist of the testes with the adjoining epididymis, the vas deferens and the accessory sex glands, namely the seminal vesicles, the prostrate and the bulbourethral glands (the latter sometimes are included in the external genitalia).

Testes

The testes have, like the ovaries, two functions:

1- they *produce the male gametes or spermatozoa,*

2-*they produce male sexual hormone, testosterone*, which stimulates the accessory male sexual organs and causes the development of the masculine extragenital sex characteristics.

The testis is surrounded by a thick capsule, the *tunica albuginea*, from which a conical mass of connective tissue, the *mediastinum testis*, projects into the testis. The tunica albuginea is covered externally by a serosa.
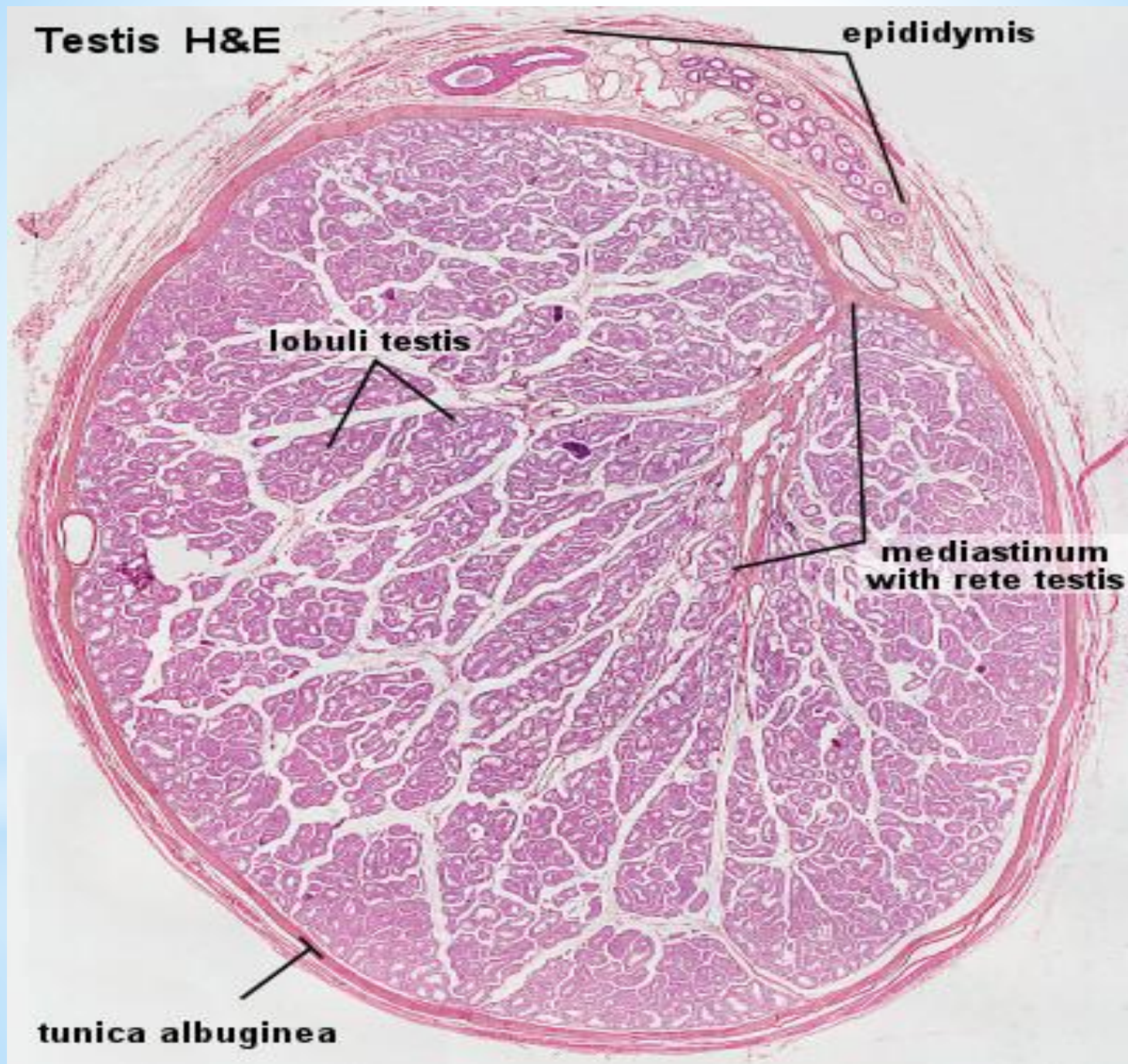
From the mediastinum, delicate fibrous septa radiate towards the tunica albuginea and divide the parenchyma of the testis into about **300 lobuli testis**, which communicate peripherally. Each lobule contains ;
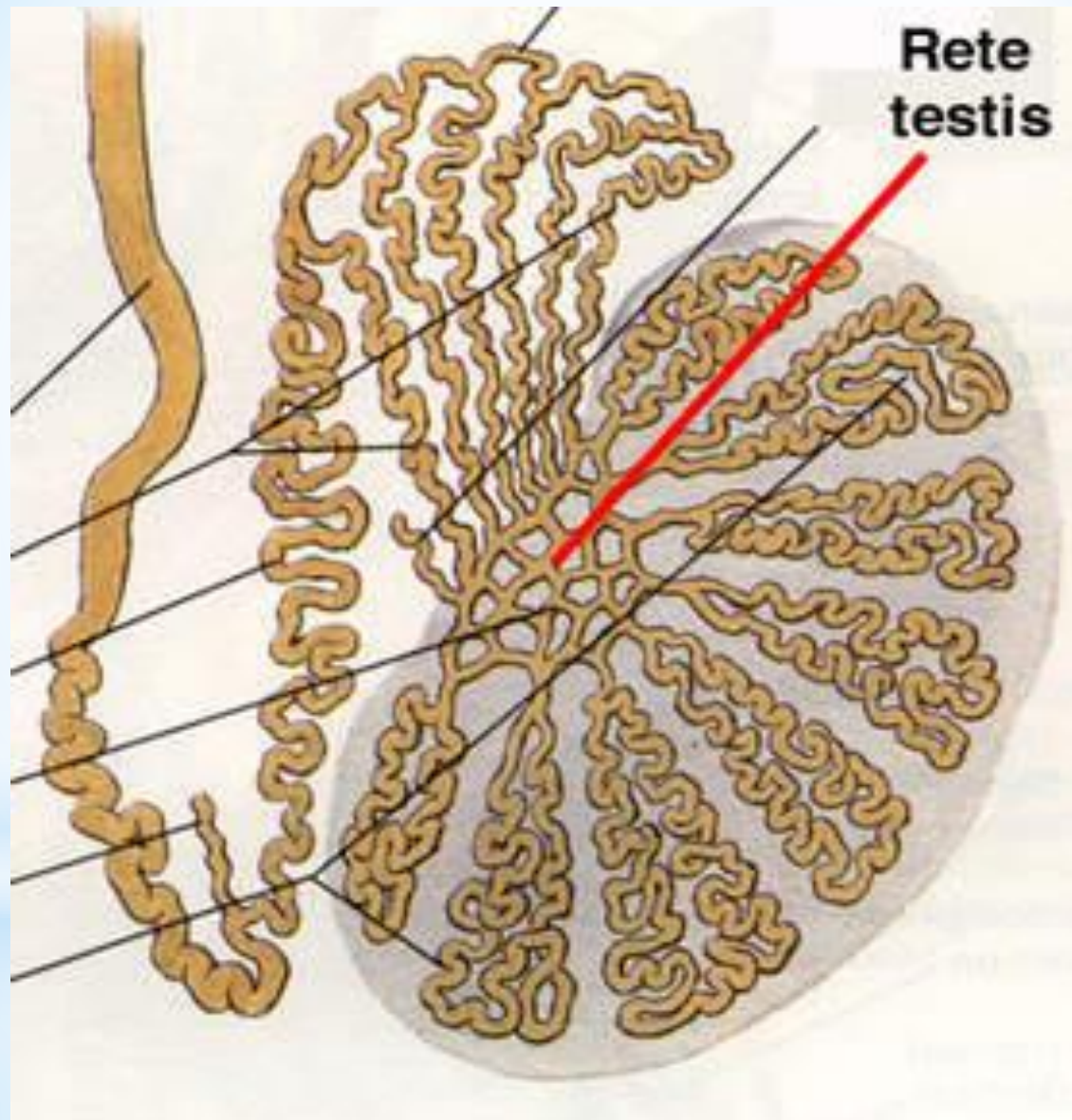*1-4 convoluted seminiferous tubules* (about 150-300 μm in diameter, 30-80 cm long).
Interstitial tissue between the convoluted tubules is continuous with a layer of loose vascular connective tissue, the *tunica vasculosa testis*, which is found beneath the tunica albuginea. Each seminiferous tubule continues near the mediastinum into a straight tubule, a *tubulus rectus*. The straight tubules continue into the **rete testis**, a labyrinthine system of cavities in the mediastinum.
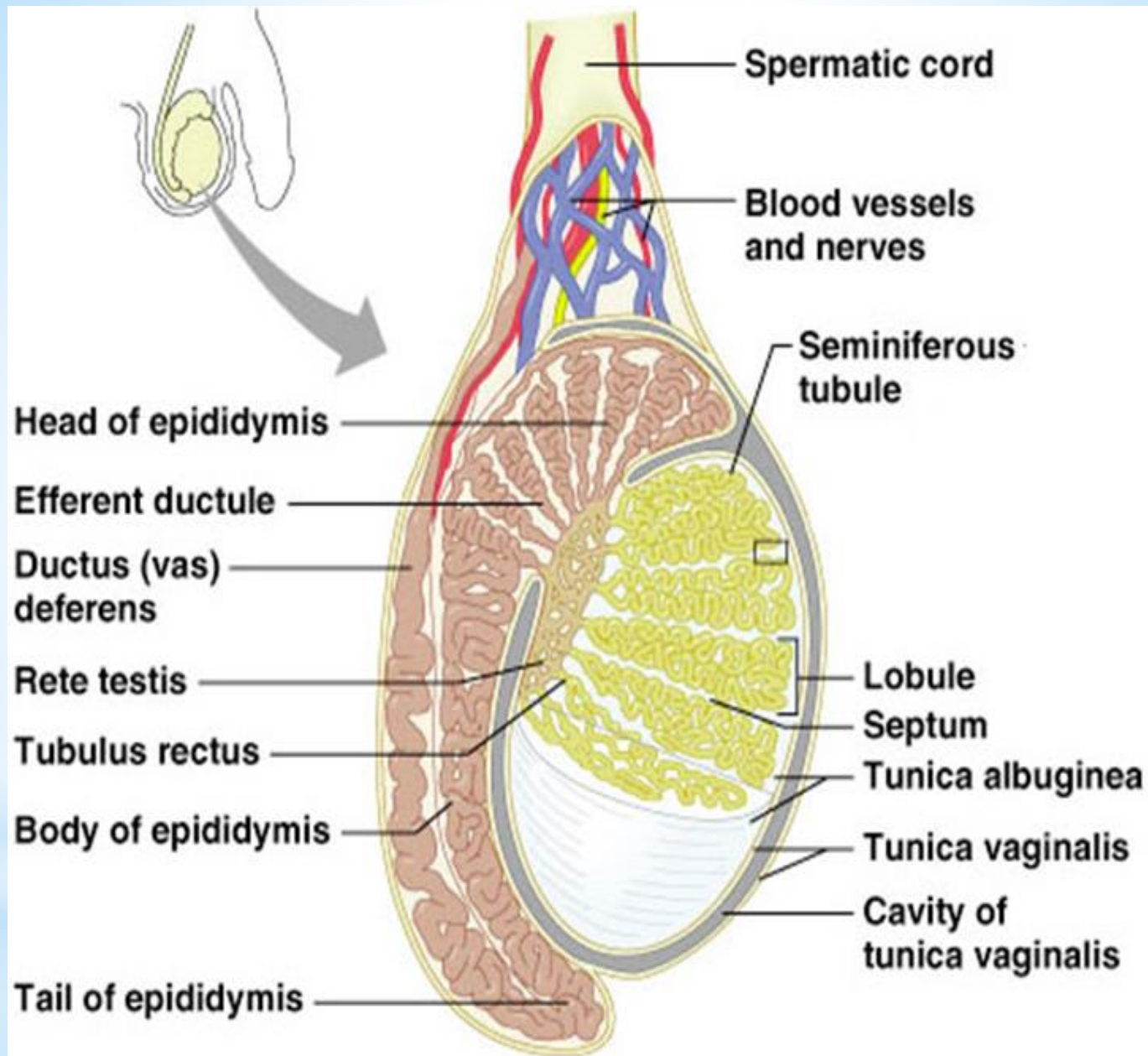
Testis H&E

epididymis

lobuli testis

mediastinum with rete testis

tunica albuginea

Rete testis

Spermatic cord

Blood vessels and nerves

Seminiferous tubule

Head of epididymis

Efferent ductule

Ductus (vas) deferens

Rete testis

Tubulus rectus

Body of epididymis

Tail of epididymis

Lobule

Septum

Tunica albuginea

Tunica vaginalis

Cavity of tunica vaginalis

(a)

The Convoluted Seminiferous Tubules

These tubules are enclosed by a thick basal lamina and surrounded by 3-4 layers of smooth muscle cells (or myoid cells). The insides of the tubules are lined with seminiferous epithelium, which consists of two general types of cells: spermatogenic cells and Sertoli cells.

Spermatogenic cells:
Spermatogonia

are the first cells of spermatogenesis. They originate in the 4th week of foetal development in the endodermal walls of the yolk sac and migrate to the primordium of the testis, where they differentiate into spermatogonia. Spermatogonia remain dormant until puberty. They are always in contact with the basal lamina of the tubule.

Two types of spermatogonia can be distinguished in the human seminiferous epithelium:

Type A spermatogonia have a rounded nucleus with very fine chromatin grains and one or two nucleoli. They are stem cells which divide to form new generations of both type A and type B spermatogonia.

Type B spermatogonia have rounded nuclei with chromatin granules of variable size, which often attach to the nuclear membrane, and one nucleolus. Although type B spermatogonia may divide repeatedly, they do not function as stem cells and their final mitosis always results in the formation of primary spermatocytes.

Primary spermatocytes
which lie in the cell layer luminal to the spermatogonia. They appear larger than spermatogonia. They immediately enter the prophase of the first meiotic division, which is extremely prolonged (about 22 days!). A large number of primary spermatocytes is always visible in cross-sections through seminiferous tubules. Cell divisions, from the formation of primary spermatocytes and onwards, to the production of the spermatocytes, are incomplete. The cells remain connected by bridges of cytoplasm. The completion of the first meiotic division results in the formation of secondary spermatocytes

Secondary spermatocytes,
which are smaller than primary spermatocytes. They rapidly enter and complete the second meiotic division and are therefore seldom seen in histological preparations. Their division results in the formation of spermaids.

Spermatids,
which lie in the luminal part of the seminiferous epithelium. They are small (about 10 μm in diameter) with an initially very light (often eccentric) nucleus. The chromatin condenses during the maturation of the spermatids into spermatozoa, and the nucleus becomes smaller and stains darker.
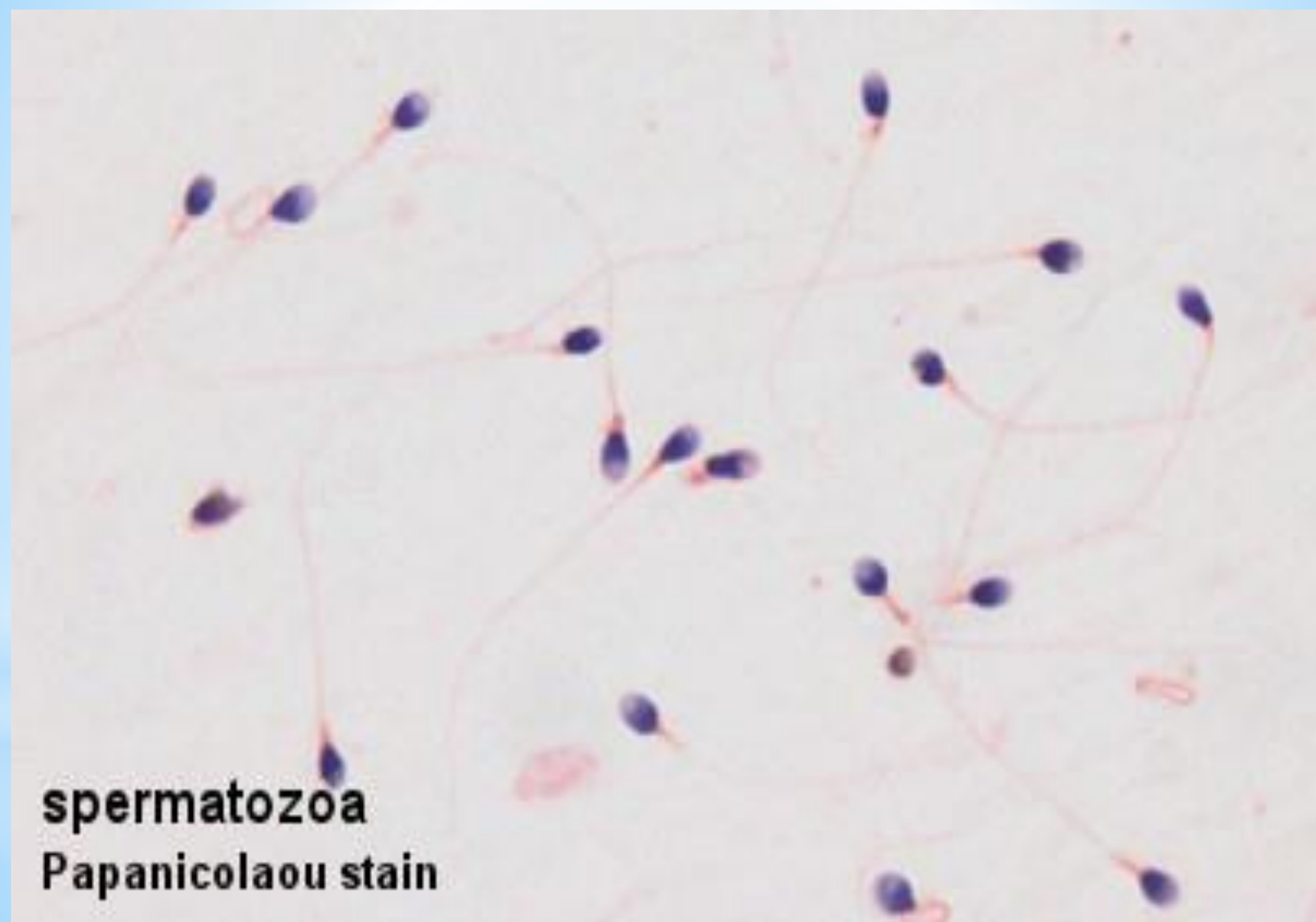
The terminal phase of spermatogenesis is called spermiogenesis and consists of the differentiation of the newly formed spermatids into
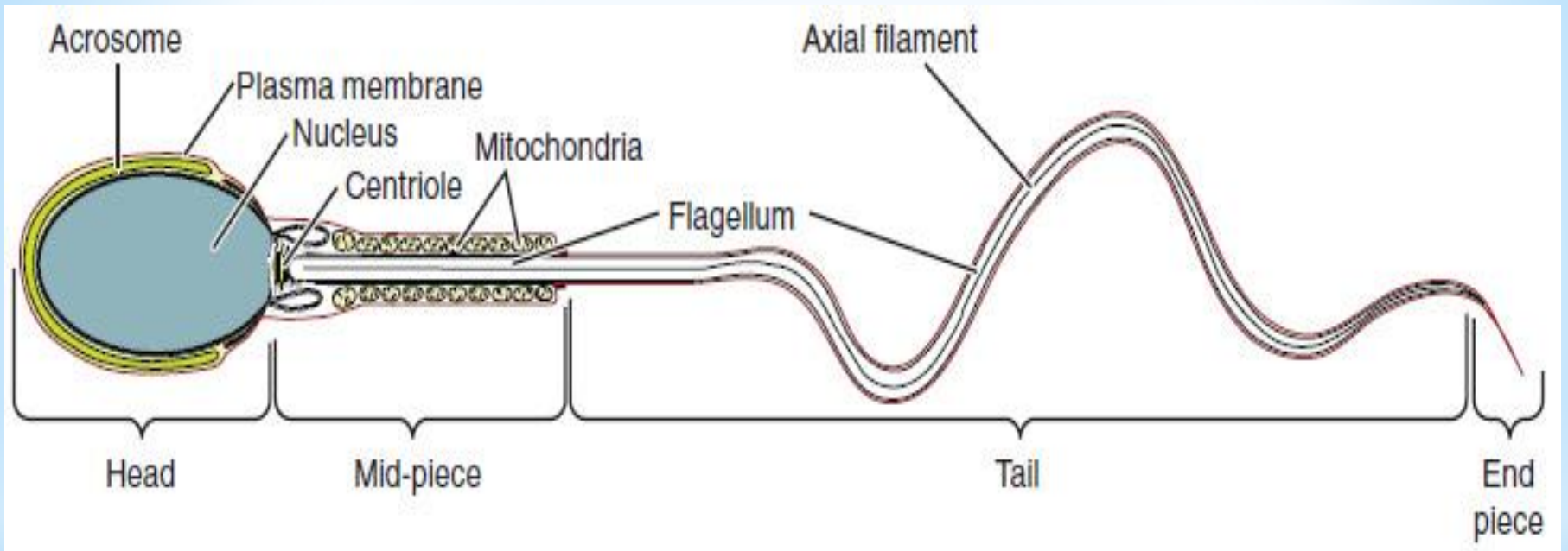
Spermatozoa
The mature human spermatozoon is about 60 μm long and actively motile. It is divided into head, neck and tail.

The head (flattened, about 5 μm long and 3 μm wide) chiefly consists of the nucleus (greatly condensed chromatin!). The anterior 2/3 of the nucleus is covered by the acrosome, which contains enzymes important in the process of fertilisation. The posterior parts of the nuclear membrane forms the so-called basal plate.

The neck is short (about 1 μm) and attached to the basal plate. A transversely oriented centriole is located immediately behind the basal plate. The neck also contains nine segmented columns of fibrous material, which continue as the outer dense fibres into the tail.
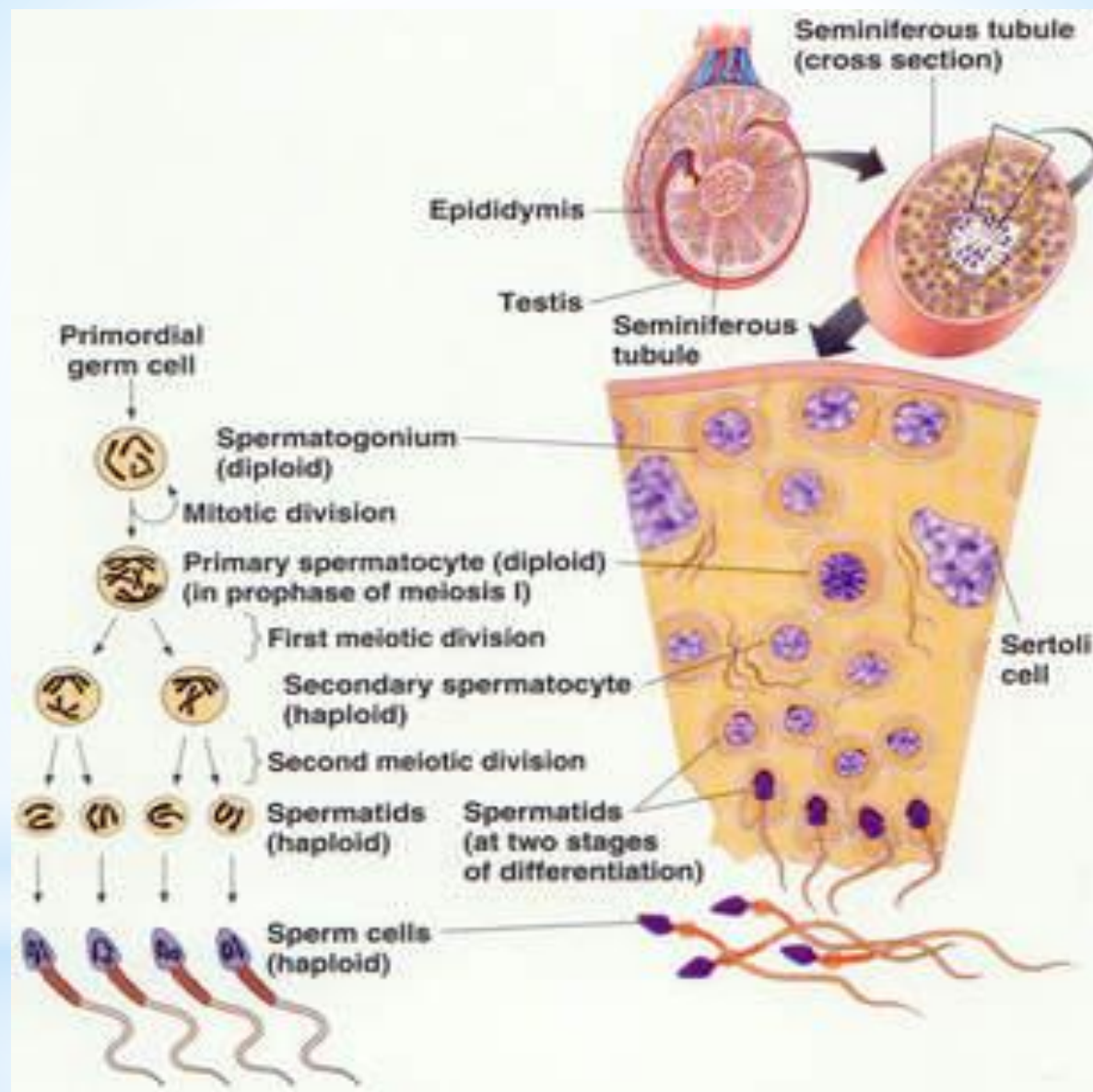
spermatozoa
Papanicolaou stain

The tail is further divided into a middle piece, a principal piece and an end piece. The axonema (the generic name for the arrangement of microtubules in all cilia) begins in the middle piece. It is surrounded by nine outer dense fibres, which are not found in other cilia. In the middle piece (about 5 μm long), the axonema and dense fibres are surrounded by a sheath of mitochondria. The middle piece is terminated by a dense ring, the annulus. The principal piece is about 45 μm long. It contains a fibrous sheath, which consists of dorsal and ventral longitudinal columns interconnected by regularly spaced circumferential hoops. The fibrous sheath and the dense fibres do not extend to the tip of the tail. Along the last part (5 μm) of the tail, called the end piece, the axonema is only surrounded by a small amount of cytoplasm and the plasma membrane.

Spermatogenesis.

takes about 48 days from the time cells enter meiosis until morphologically mature spermatozoa are formed. Depending on the length of reproduction of spermatogonia (which is not precisely determined) it takes approximately 64 days to complete spermatogenesis.

Spermatogenesis is regulated by follicle stimulating hormone (FSH), which in males stimulates the spermatogenic epithelium, and luteinizing-hormone (LH), which in males stimulates testosterone production by Leydig cells in the interstitia

Sertoli cells

are far less numerous than the spermatogenic cells and are evenly distributed between them. Their shape is highly irregular - columnar is the best approximation. Sertoli cells extend from the basement membrane to the luminal surface of the seminiferous epithelium. Processes of the Sertoli cells extend in between the spermatogenic cells (cell limits are therefore not clearly visible in the LM). The nucleus of Sertoli cells is ovoid or angular, large and lightly stained and often contains a large nucleolus. The long axis of the nucleus is oriented perpendicular to wall of the tubule. A fold in the nuclear membrane is characteristic for Sertoli cells but not always visible in the LM (well ... actually ... it's not that difficult to find, but not that easy either ....).

Lateral processes of Sertoli cells are interconnected by tight junctions. Sertoli cells provide mechanical and nutritive support for the spermatogenic cells. Sertoli cells also secrete two hormones - **inhibin and activin** - which provide positive and negative feedback on FSH secretion from the pituitary.

Interstitial tissue

Leydig cells (15-20 µm), located in the interstitial tissue between the convoluted seminiferous tubules, constitute the endocrine component of the testis. They synthesize and secrete testosterone. Leydig cells occur in clusters , which are variable in size and richly supplied by capillaries. The cytoplasm is strongly acidophilic and finely granular. The nucleus is large, round and often located eccentric in the cell.
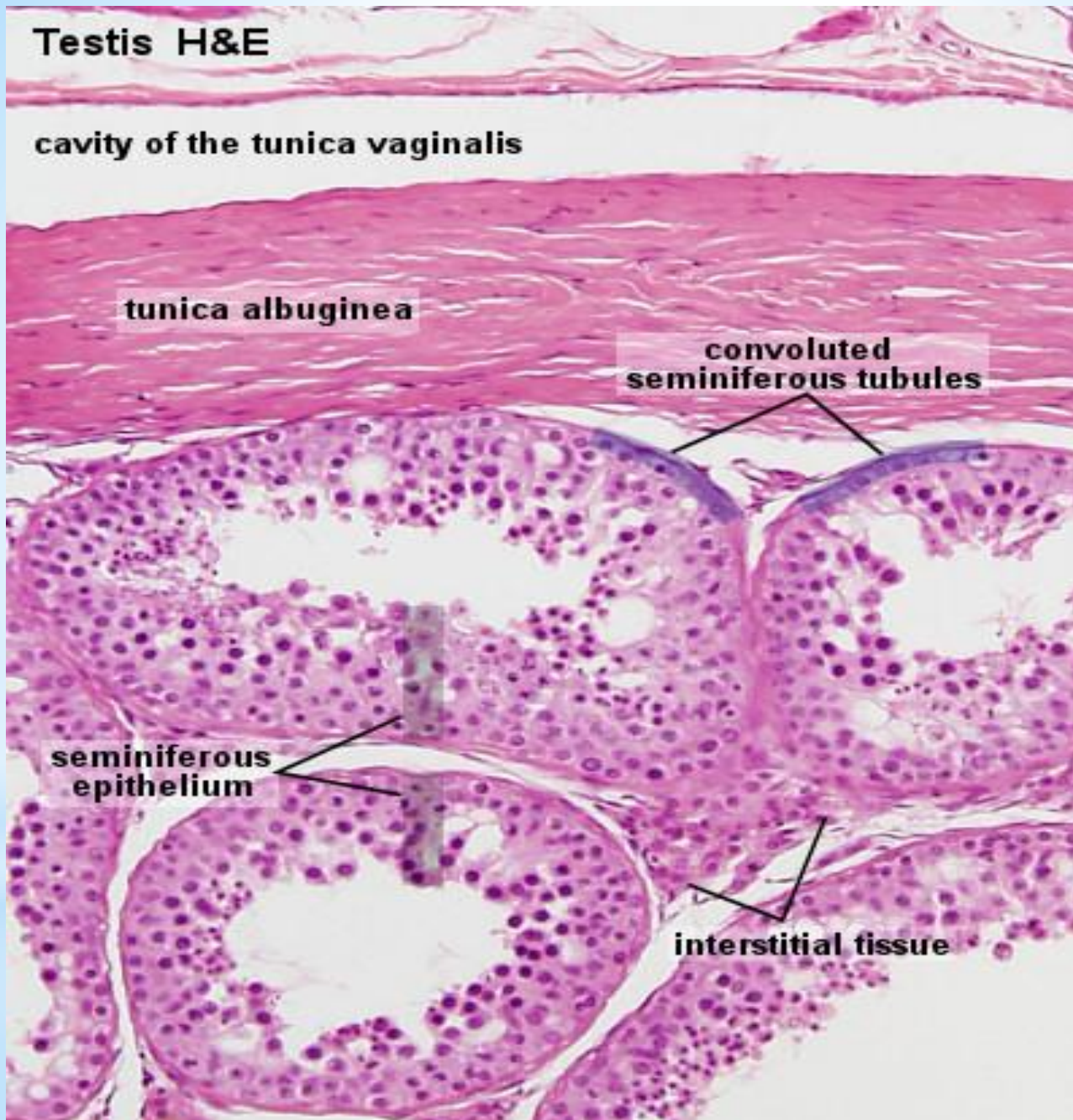
Testis H&E

cavity of the tunica vaginalis
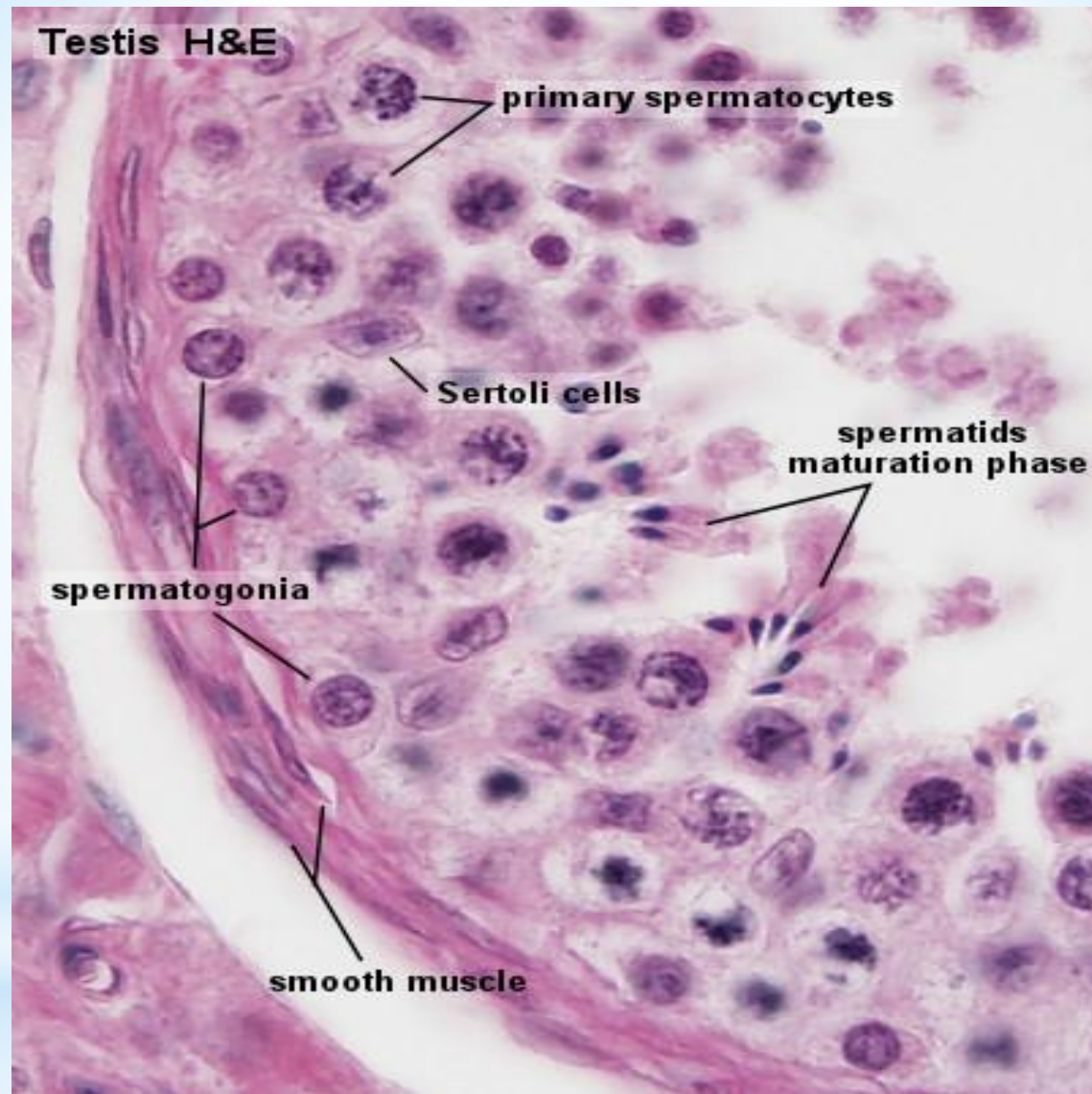
tunica albuginea

convoluted
seminiferous tubules

seminiferous
epithelium

interstitial tissue

Testis H&E

Leydig cells

smooth muscle

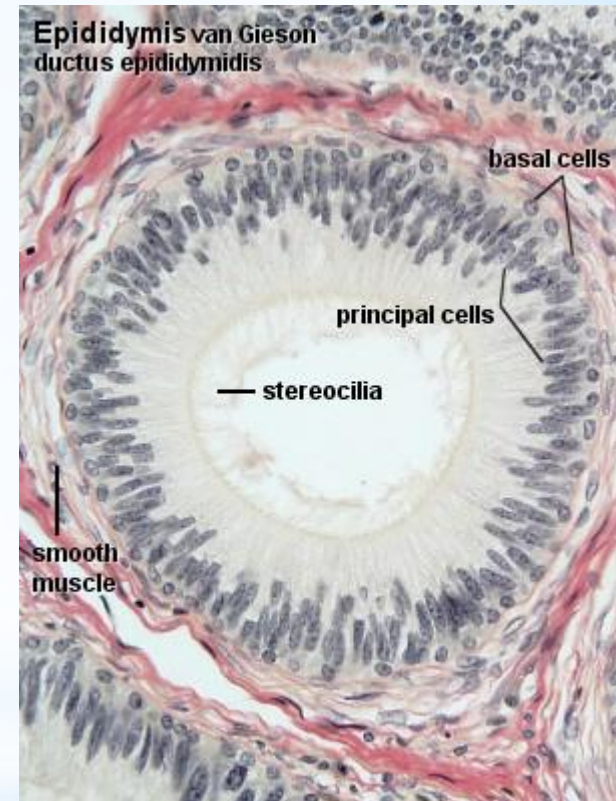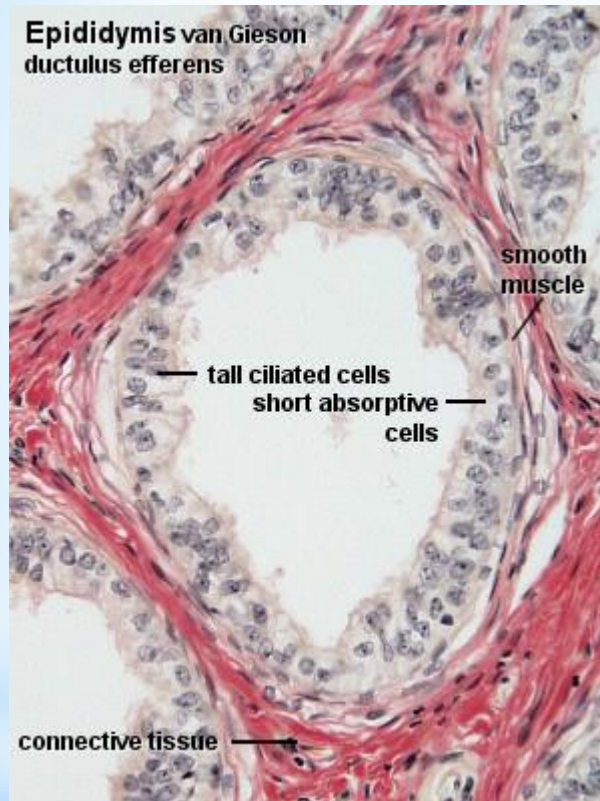Sertoli cells

spermatogonia

spermatids

primary spermatocytes

Ducts of the Testis

Spermatozoa pass via the tubuli recti (low columnar epithelium) and the rete testis (flattened or cuboidal epithelium) into numerous ductuli efferentes, which are lined by a columnar epithelium, which consists of both absorptive and ciliated cells. The height of the two cells types which form the epithelium of the ductuli efferentes is variable which gives the lumen a characteristic wavy outline.

The **ductuli efferentes** leave the testis and open into a common duct, the **ductus epididymidis** (about 6 m long!). It is lined by a very tall pseudostratified columnar epithelium. Most cells of the epithelium, also called principal cells, have long stereocilia. Stereocilia are non-motile structures, which in the EM resemble large microvilli. Towards the basal lamina we see a number of small nuclei, which belong to the basal cells of the ductus epididymidis. These cells regenerate the epithelium.

Peristaltic contractions of smooth muscle cells surrounding the ductus epididymidis move the spermatozoa towards the middle segment of the duct, which is the site of final functional maturation of the spermatozoa - now they are motile. The terminal segment of the ductus epididymidis is the site of storage of the mature spermatozoa. Smooth muscle fibres of the terminal part of the ductus epididymidis do not contract spontaneously. They contract during sexual stimulation concurrently with the contraction of the musculature of the duct into which it opens, the vas deferens.
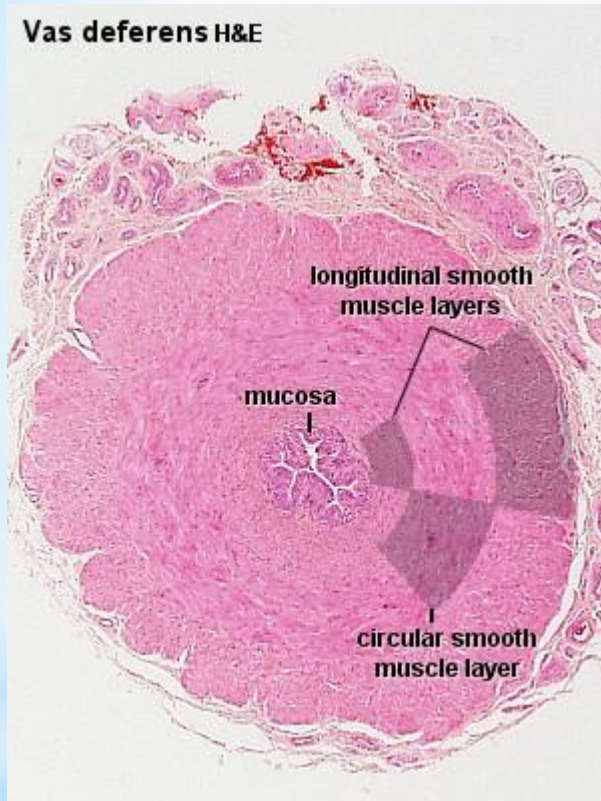
Epididymis van Gieson
ductulus efferens

smooth
muscle

tall ciliated cells
short absorptive
cells

connective tissue

Epididymis van Gieson
ductus epididymidis

basal cells

principal cells

stereocilia

smooth
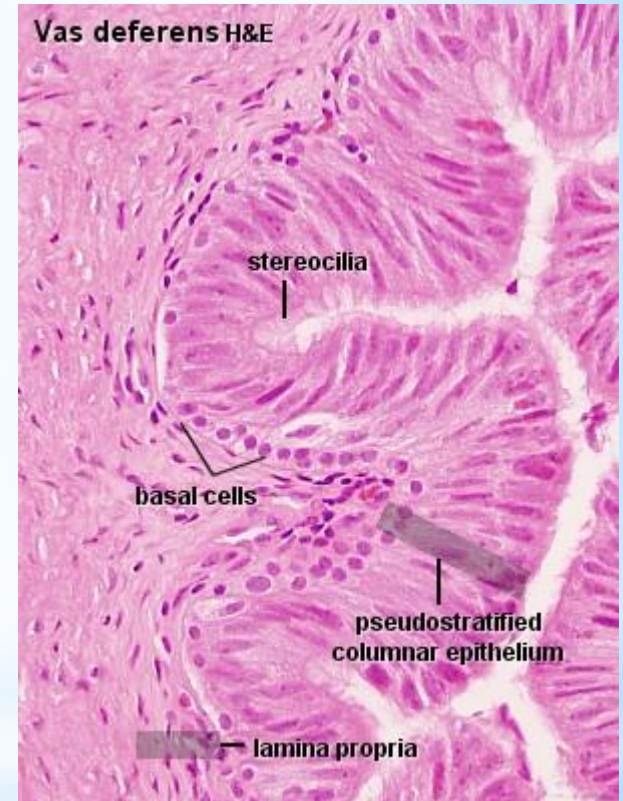muscle

The Vas deferens (or ductus deferens)

The mucosa of the vas deferens forms low longitudinal folds. It is lined by a pseudostratified columnar epithelium. Similar to the epididymis, cells have long stereocilia. The lamina propria is unusually rich in elastic fibres. The muscularis is well developed (up to 1.5 mm thick) and consists of a thick circular layer of smooth muscle between thinner inner and outer longitudinal layers. The muscularis is the structure which makes the vas deferens palpable in the spermatic cord. The vas deferens is surrounded by an adventitia, which is slightly denser than usual.

Vas deferens H&E

longitudinal smooth muscle layers

mucosa

circular smooth muscle layer

Vas deferens H&E

stereocilia

basal cells

pseudostratified columnar epithelium

lamina propria

Male Accessory Reproductive Glands

The accessory (or secondary) male sex glands consist of the seminal vesicles, the prostrate and the bulbourethral glands.

Prostate

The prostate is the largest accessory sex gland in men (about 2 × 3 × 4 cm). It contains 30 - 50 tubuloalveolar glands, which empty into 15 - 25 independent excretory ducts. These ducts open into the urethra. The glands are embedded into a fibromuscular stroma, which mainly consists of smooth muscle separated by strands of connective tissue rich in collagenous and elastic fibres. The muscle forms a dense mass around the urethra and beneath the fairly thin capsule of the prostrate.

The secretory alveoli of the prostate are very irregularly shaped because of papillary projections of the mucosa into the lumen of the gland. The epithelium is cuboidal or columnar. Basal cells are again present, and the epithelium may look pseudostratified where they are found. The secretory cells are slightly acidophilic and secretory granules may be visible in the cytoplasm. Small extensions of the apical cytoplasm into the lumen of the alveoli may represent cells which release their secretory products (secretion is apocrine/merocine). The secretion of the prostate contains citric acid, the enzyme fibrinolysin (liquefies the semen), acid phosphatase, a number of other enzymes and lipids. The secretion of the prostate is the first fraction of the ejaculate.

the secretory ducts of the prostate are lined by a simple columnar epithelium, which changes to a transitional epithelium near the openings of the ducts into the urethra.

A characteristic feature of the prostate is the appearance of corpora amylacea in the secretory alveoli. They are rounded eosinophilic bodies. Their average diameter is about 0.25 mm (up to 2 mm).. They may undergo calcification. Corpora amylacea may appear in semen.

Macroscopically
the prostrate can be divided into lobes, but they are inconspicuous in histological sections. In good histological sections it is possible to distinguish three concentric zones, which surround the prostatic part of the urethra.
1-The peripheral zone contains large, so-called *main glands*, whose ducts run posteriorly to open into the urethra.
2-The internal zone consists of the so-called *submucosal glands*, whereas
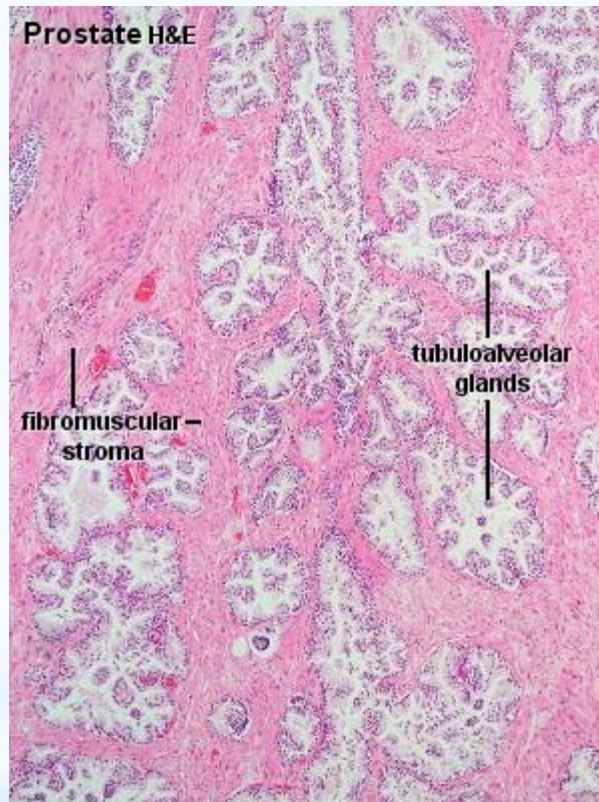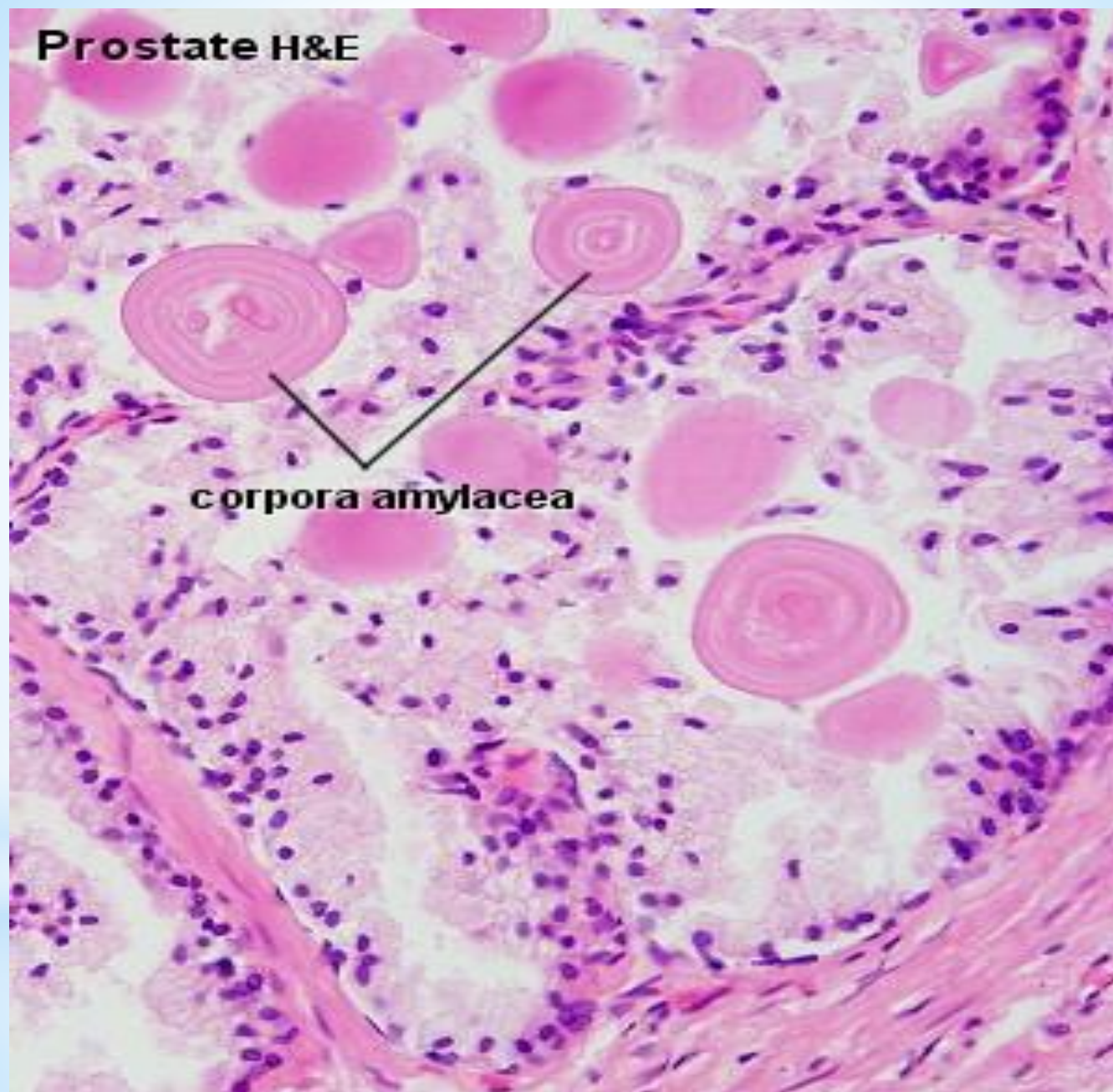3-the innermost zone contains *mucosal glands*.

This subdivision of the prostate is of clinical importance. With age the prostate becomes enlarged due to benign nodular hyperplasia. The onset age of these hyperplastic changes is 45. About 3/4 of the males above 60 are affected of which half will be symptomatic. This condition affects the mucosal glands.

Cancer of the prostate, which is the second most common malignant tumor in western males, involves the peripheral zone.
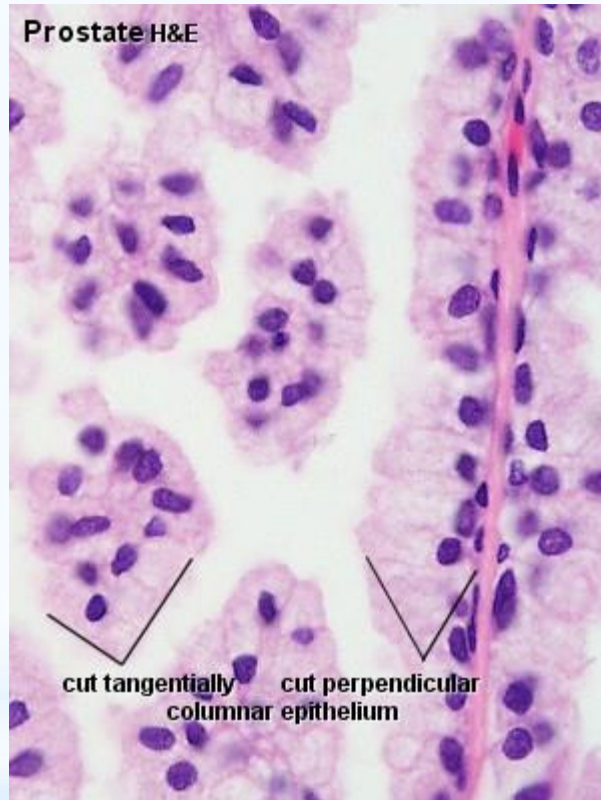
Prostate H&E

corpora amylacea

Prostate H&E

cut tangentially   cut perpendicular
columnar epithelium

Seminal Vesicles

The seminal vesicles develop from the vas deferens. Their histological organisation resembles to some extent that of the vas deferens. They are elongated sacs (about 4 cm long and 2 cm wide), which taper where they unite with the vas deferens. Each seminal vesicle consists of one coiling tube (about 15cm long). All the lumina visible in sections of the seminal vesicle are in continuity in the intact organ.

The mucosa shows thin, branched, anastomosing folds. The structure of the epithelium is variable appearing columnar or pseudostratified columnar (columnar cells and basal cells). The lamina propria of the mucosa is fairly thin and loose. The muscularis consists of inner circular and outer longitudinal layers of smooth muscle.

Seminal vesicles were thought to store semen - hence there name. This turned out to be wrong. They are glands, whose secretion constitutes 60-70 % of the ejaculate. The secretory product of the columnar cell, which may be seen in the lumen of the seminal vesicles, is strongly acidophilic. It contains large amounts of *fructose* which the spermatozoa utilise as a source of energy. Furthermore, the secretion contains prostaglandins, flavins (yellow fluorescing pigment - of use in forensic medicine to detect semen stains) and several other proteins and enzymes.

The cocktail of compounds which is released by the seminal vesicles in addition to fructose has three main functions:

1-the formation of the sperm coagulum,
2-the regulation of sperm motility and
3-the suppression of immune function in the female genital tract.

The secretion of the seminal vesicles is the third fraction of the ejaculate (the spermatozoa are released with the second fraction - the contents of the vas deferens).

Seminal Vesicle H&E

lumen

epithelium

muscularis

Seminal Vesicle H&E

basal cells

pseudostratified columnar epithelium

lumen

lumen