

Male reproductive system

Aleš Hampl

Key components & Gross anatomy

Paired gonads = testes

Genital ducts	Intratesticular
	Extratesticular

Intratesticular

- Tubuli recti
- Rete testis
- Ductuli efferentes

Extratesticular

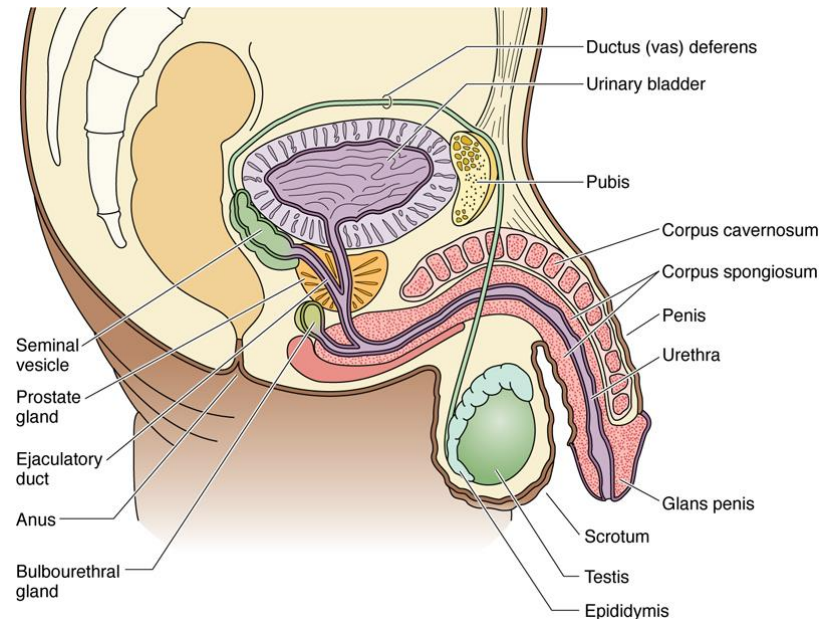
- Epididymis
- Ductus (vas) deferens
- Ejaculatory duct
- Urethra

Associated glands

- Seminal vesicles (paired)
- Prostate
- Bulbourethral glands (paired)

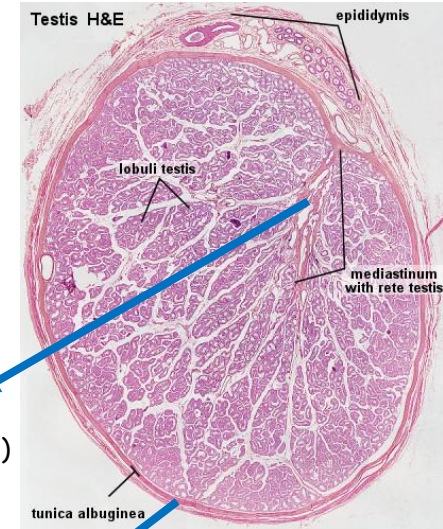
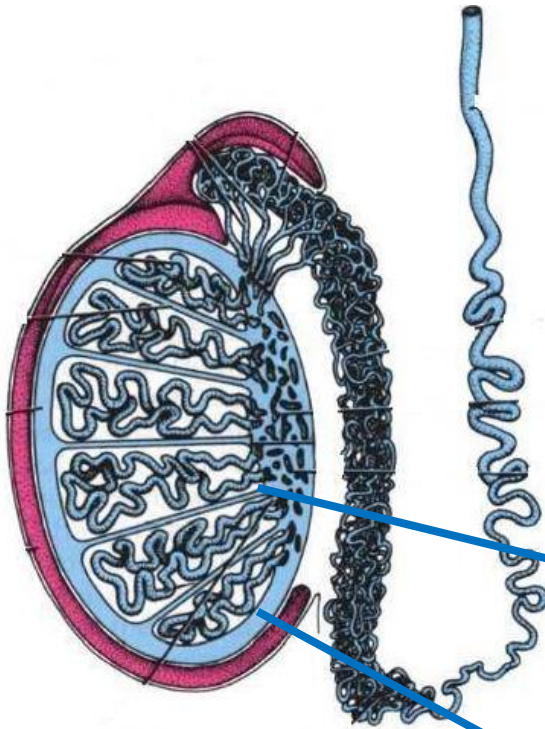
External genital organs

- Scrotum
- Penis



Testis - 1

Length: 4 cm
Width: 2-3 cm
Thickness: 3 cm



Mediastinum + Septa

- divide testis into lobuli (250-300)

Tunica albuginea - capsule

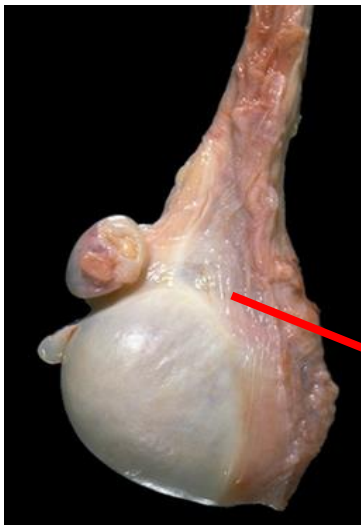
- dense connective collagenous tissue

Tunica vasculosa

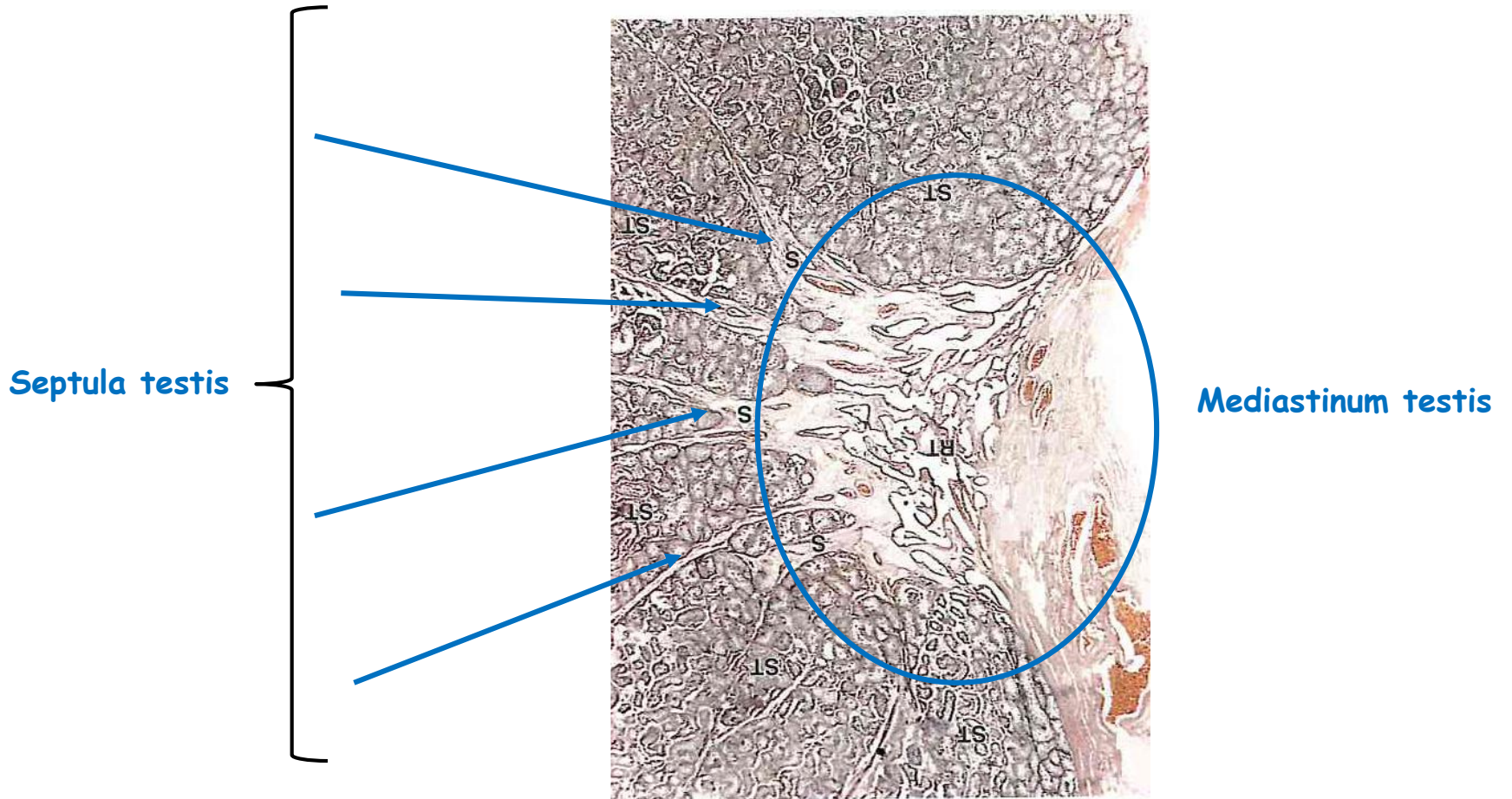
- inside of T. albuginea + adjacent to septa

Tunica vaginalis

- serous, originates from peritoneum



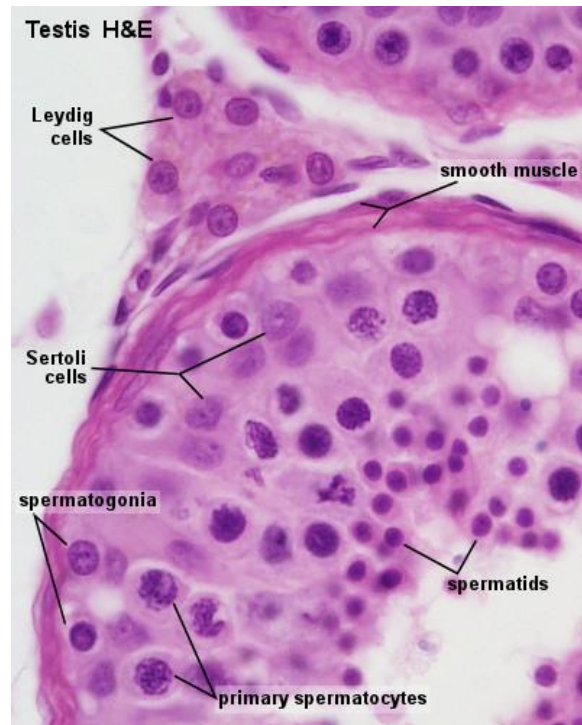
Testis - 2



Testis - 3

Septulum testis

Tunica albuginea



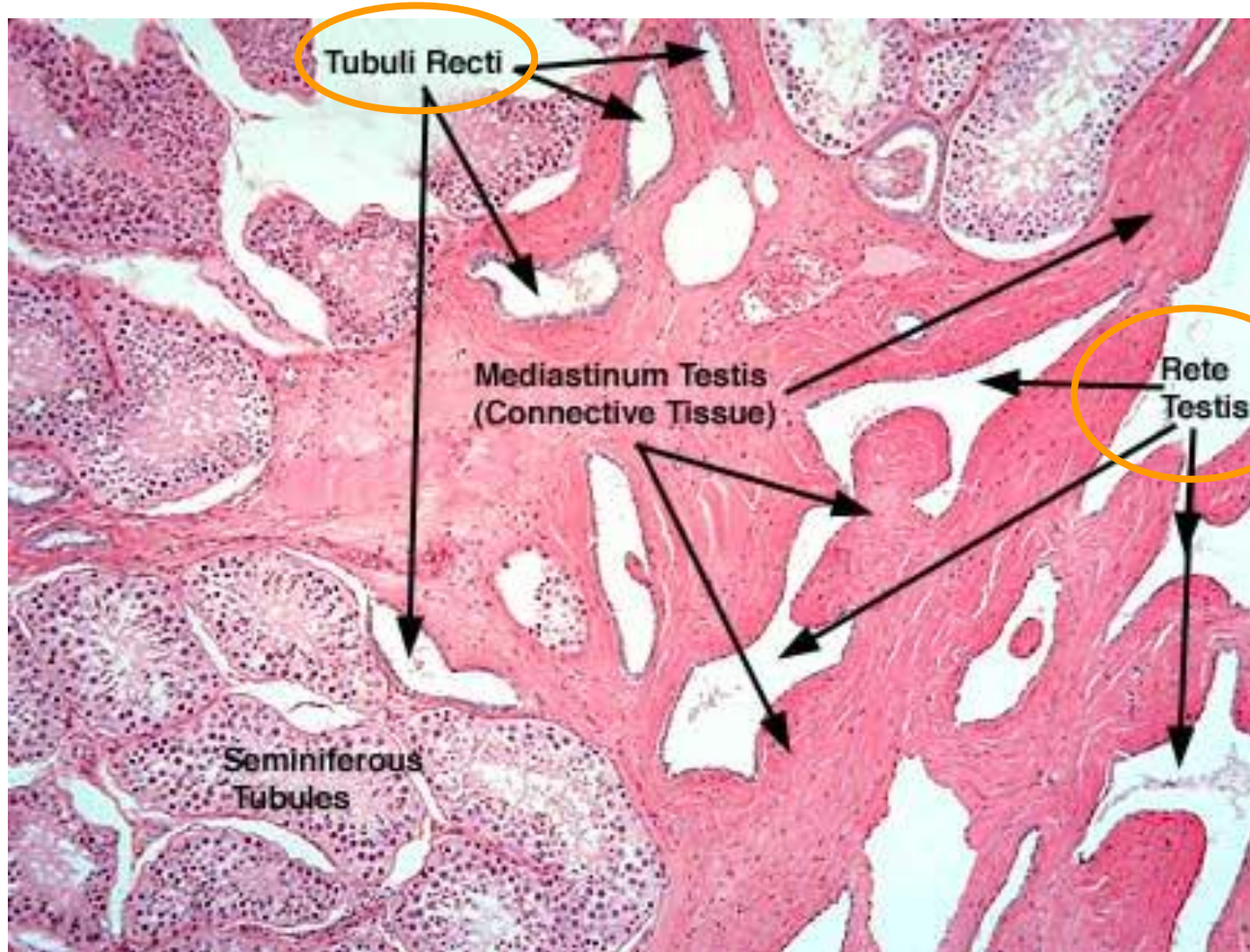
Seminiferous tubules

- 1 to 4 in one lobule
- 1 tubule - 30 to 70 cm in length
- total number about 1000
- total length about 500 m

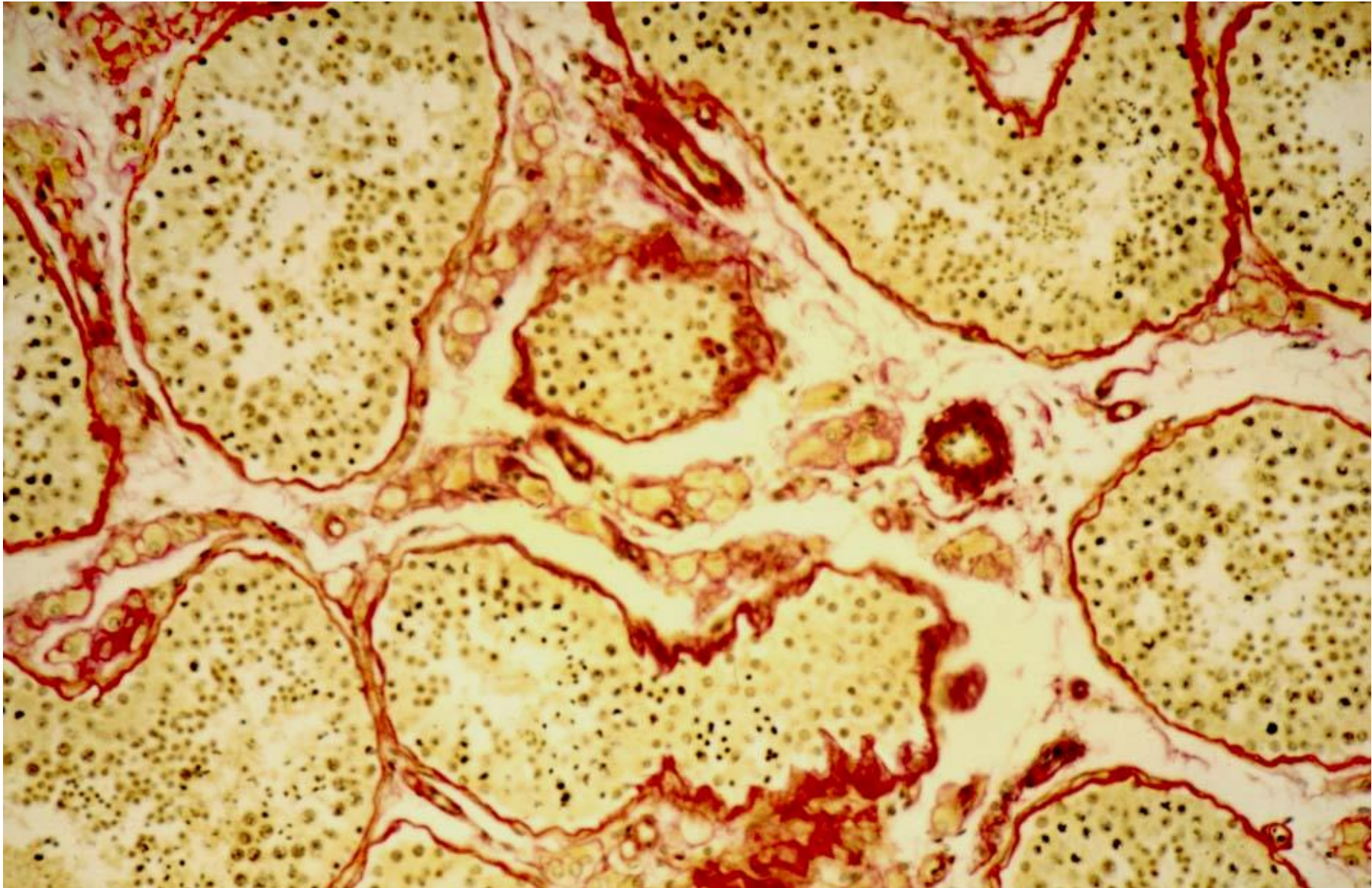
Interstitial tissue

- derived from T. vasculosa
- contains dispersed Leydig cells (brown)

Testis - 4 - continuation of seminiferous tubuli



Testis - 5



Testis - 6 - interstitium - Leydig cells

Interstitium

- loose connective tissue
- fenestrated capillaries + lymphatics + nerves
- mast cells + macrophages + **Leydig cells**

Myofibroblasts

Capillaries



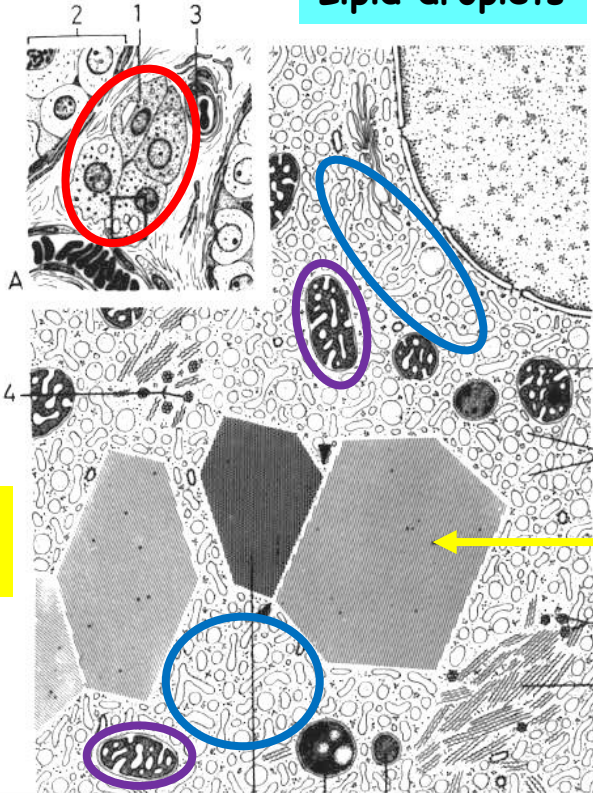
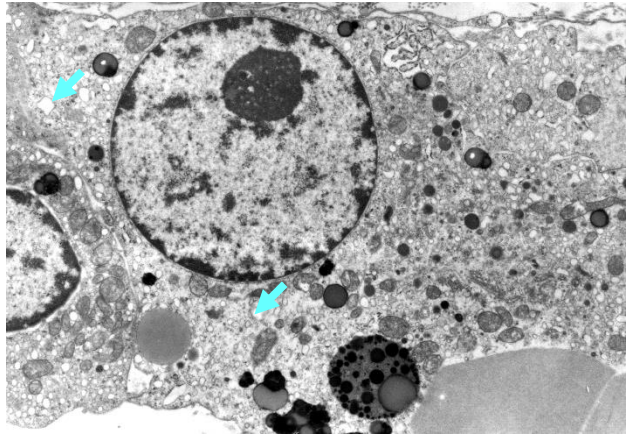
Leydig cells

- round shaped
- large centrally located nuclei
- eosinophilic cytoplasm
- lipid droplets
- **testosterone** synthesis

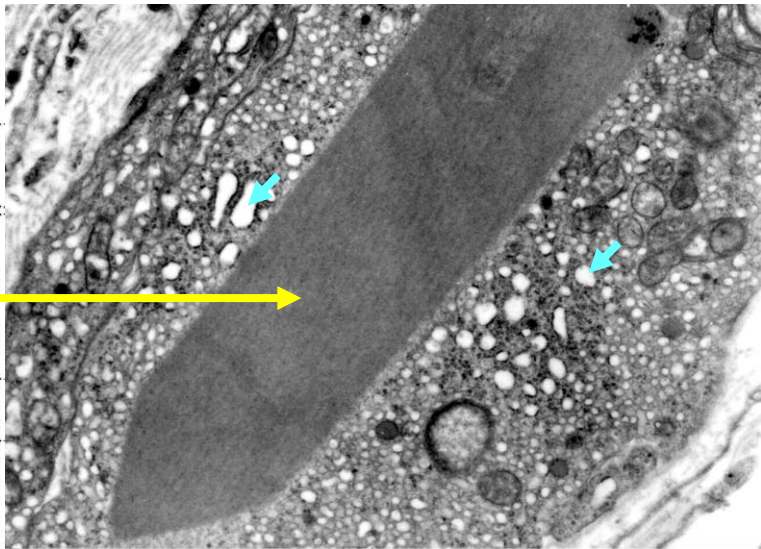
Testis - 7 - interstitium - Leydig cells

Mitochondria
+
Smooth ER
} Testosterone

Lipid droplets



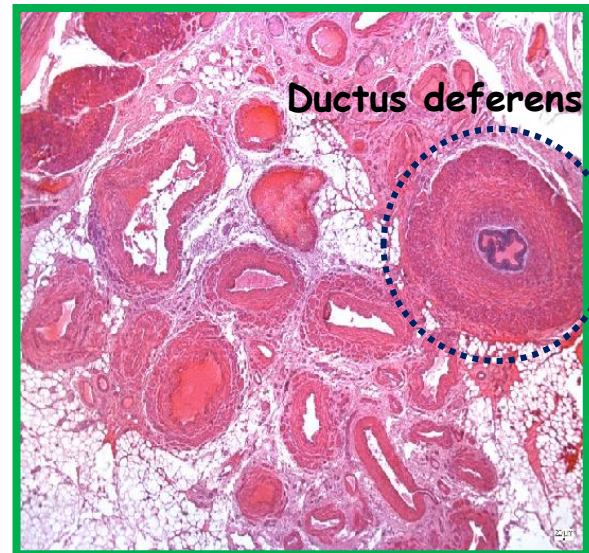
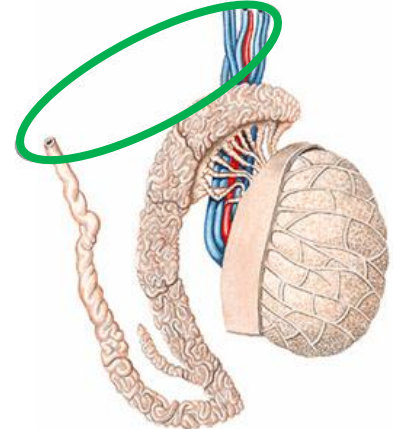
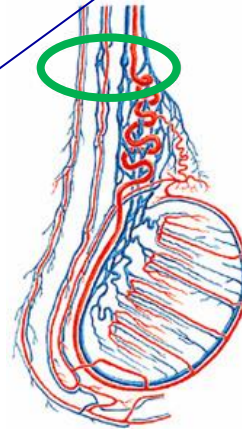
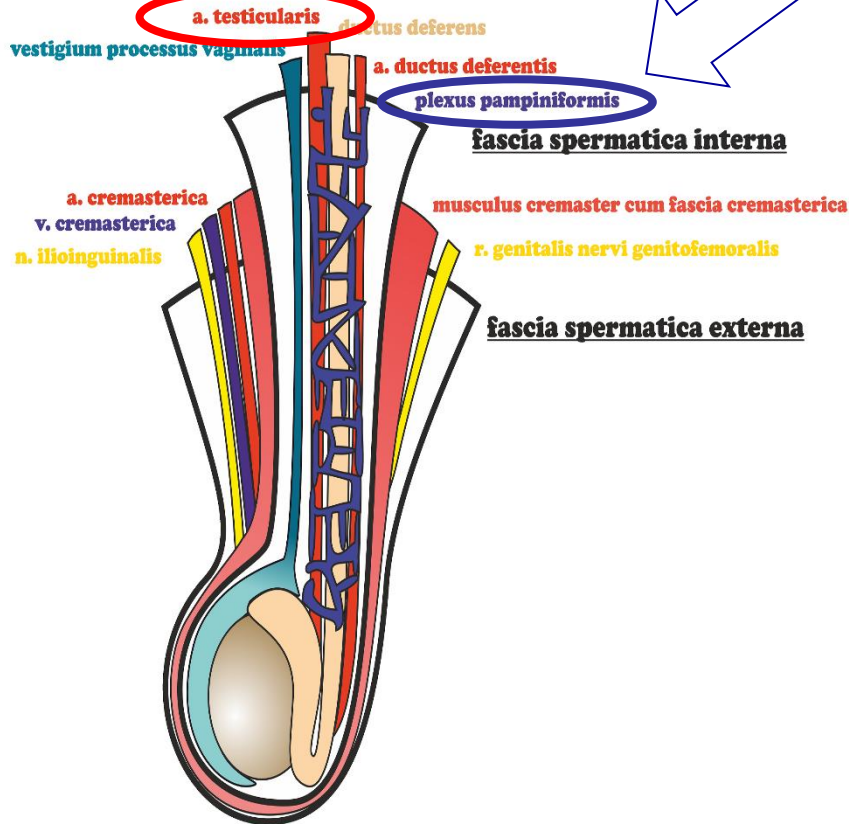
crystals
of Reinke



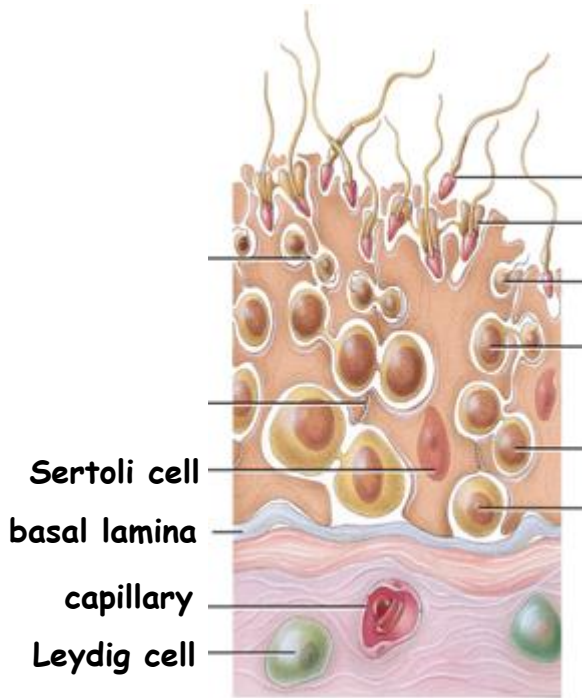
Testis - 8 - Blood supply - Plexus pampiniformis

Spermatic cord

Funiculus spermaticus



Testis - 9 - Seminiferous / Germinal epithelium



Testis - 10 - Sertoli cells

Morphology:

- tall, columnar
- highly folded membranes, undistinguishable boundaries
- hosts 30 to 50 germ cells
- abundant SER, minimal RER
- numerous mitochondria + well developed Golgi
- abundant cytoskeletal elements
- occluding + gap junctions

Function:

- support - physical + nutritional
- blood-testis barrier
- phagocytosis
- secretion of sperm transporting fluid + fructose
- endocrine: **anti-Mullerian hormone** + **inhibin** + **androgen-binding protein**



adluminal
compartment

basal
compartment

Sertoli-to-Sertoli
junctional complexes
=
blood-testis barrier
occluding + gap junctions

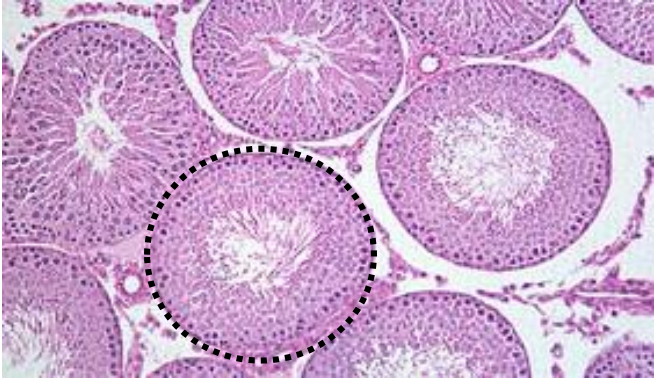
Testis - 11 - Sertoli cells - Junctional complexes



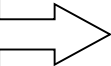
Sertoli-to-Sertoli

Sertoli-to-Spermatid

Spermatogenesis

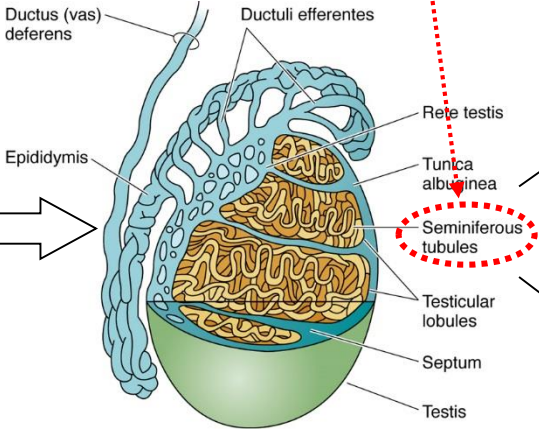
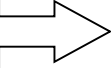


Before puberty

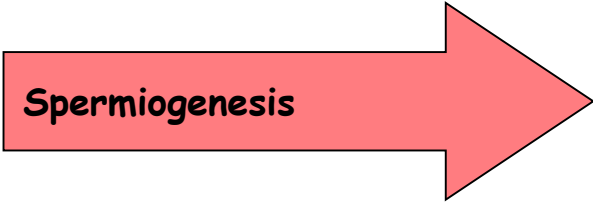
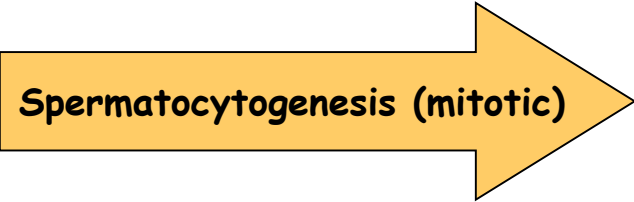
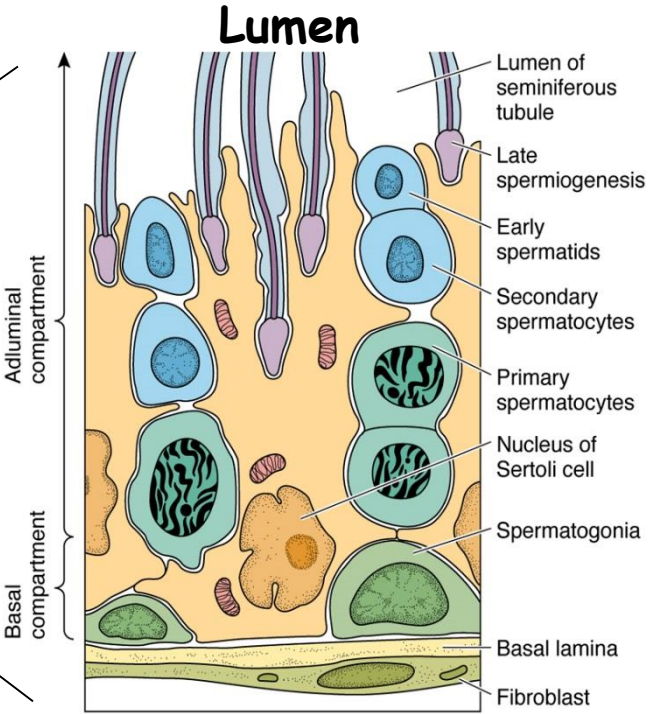


Slowly mitotically dividing spermatogonia in **genital ridges**

After puberty



~0.25 mm
~0.5 km



Spermatogenesis

ADLUMINAL

 A_0 Spermatogonia - **Stem cells**

 A_1 Spermatogonia

 A_2 Spermatogonia

 A_3 Spermatogonia

 B Spermatogonia

- Mitotic divisions
- Connected to basal membrane
- $2N, 4C$

BASAL

 Primary Spermatocytes

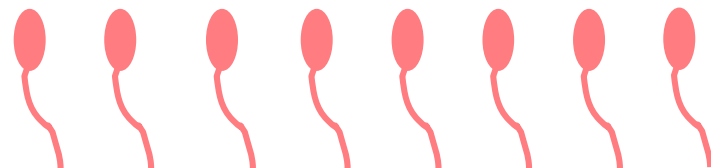
 Secondary Spermatocytes - $1N, 2C$

 Spermatides - $1N, 1C$

1. Meiotic division

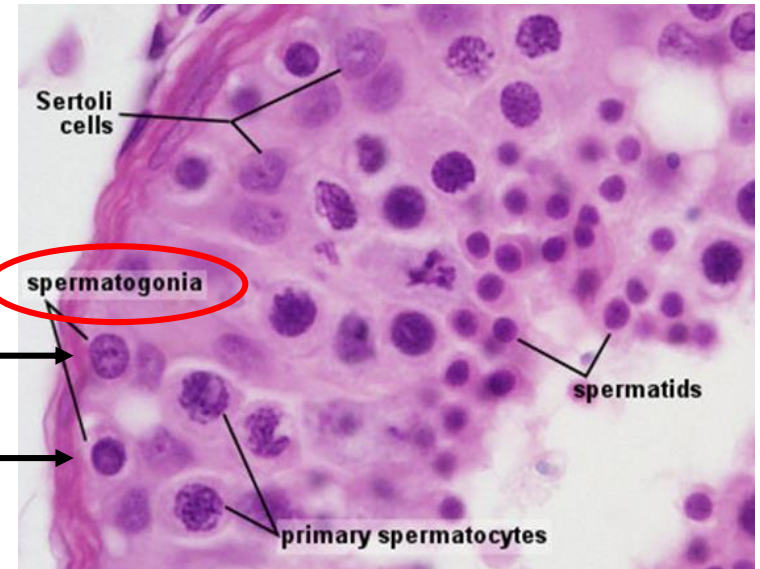
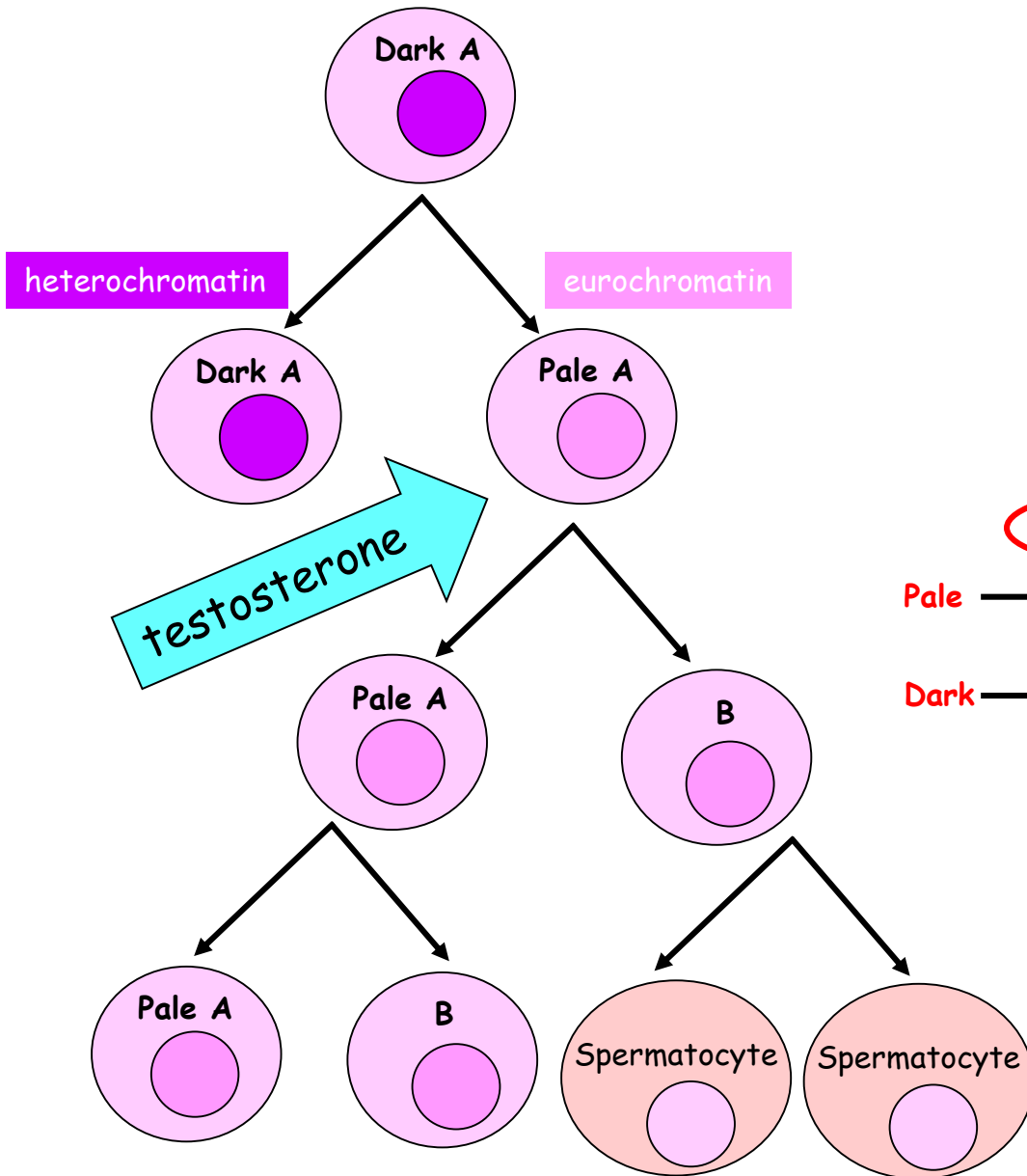
2. Meiotic division

- Spermiogenesis
- No division
 - Differentiation



Spermatogenesis - Spermatogonia

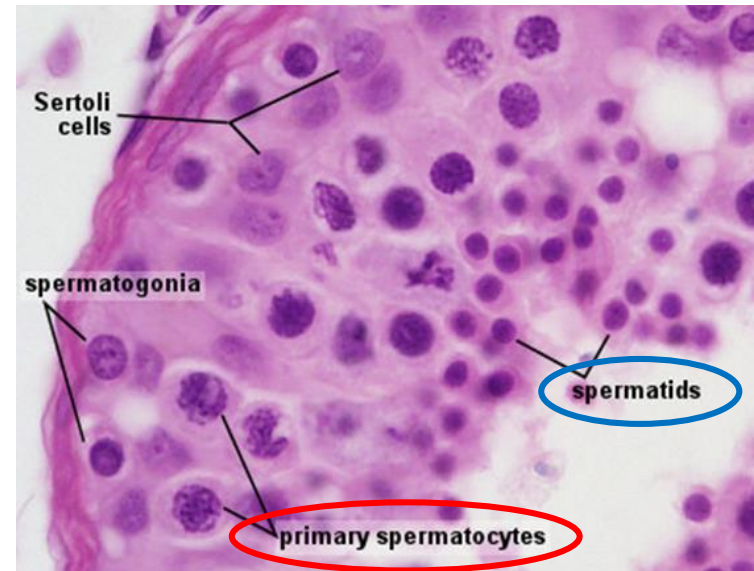
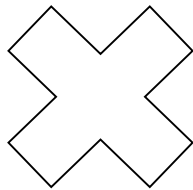
About 12 μm



Spermatogenesis - Spermatocytes

Primary spermatocytes

- largest germ cells (16 μm)
- at various stages of Mei 1 (~24 days)
- from basal to adluminal compartment
- occlusion junctions with Sertoli cells



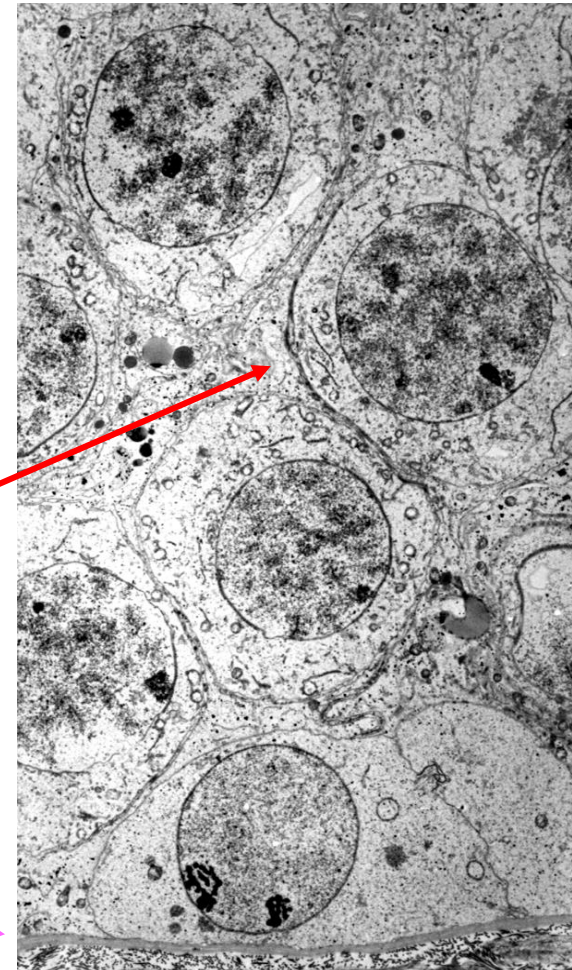
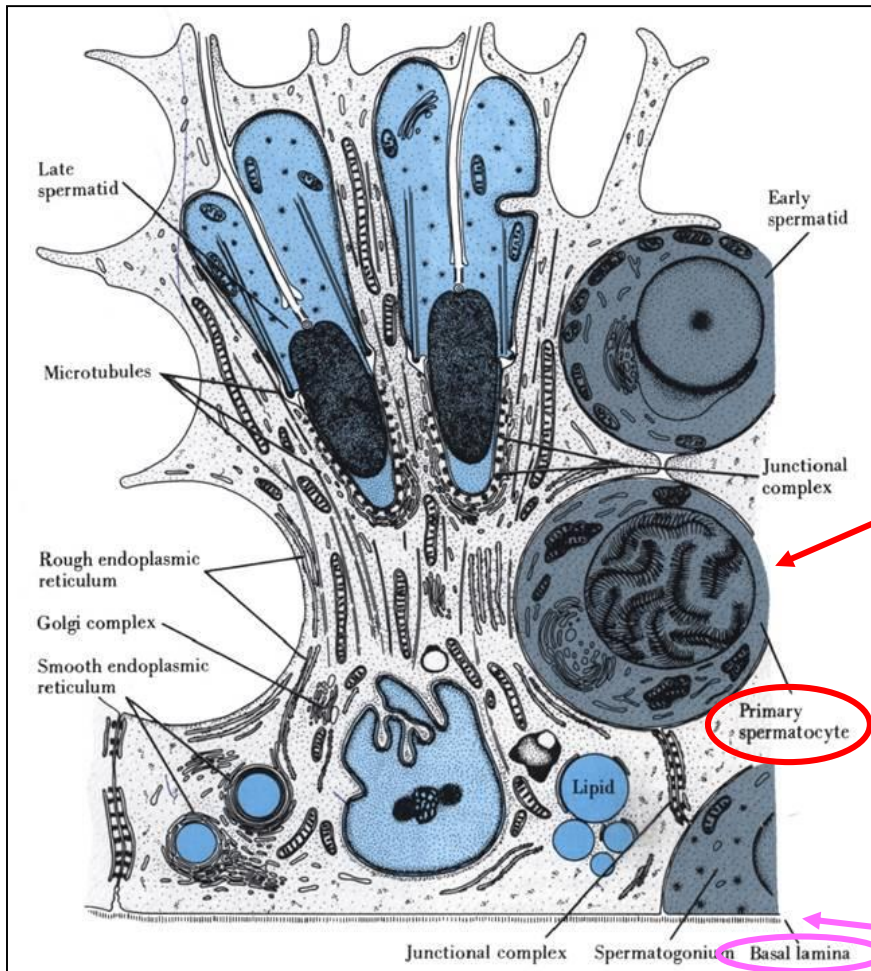
Secondary spermatocytes

- smaller (12 μm)
- short living (~8 hrs)
- infrequently seen

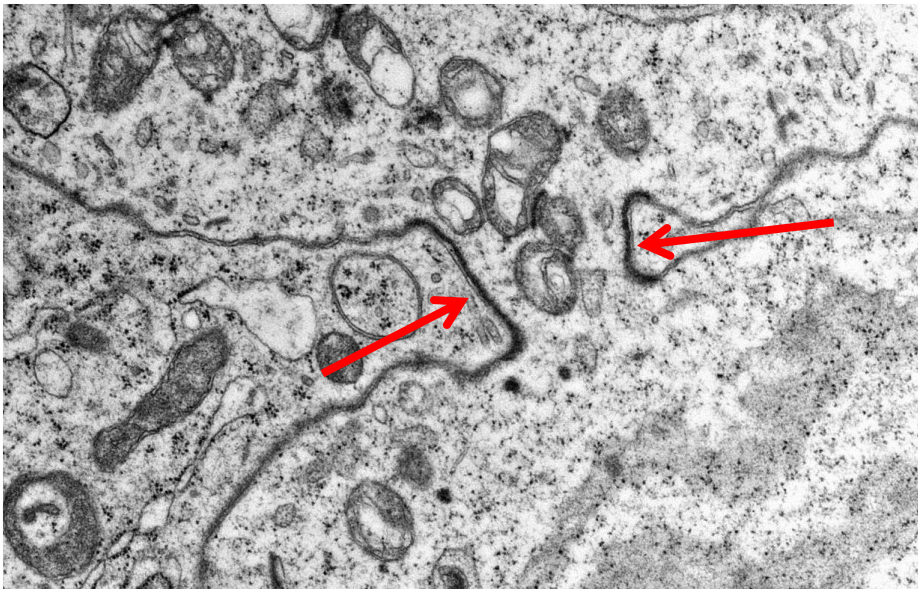
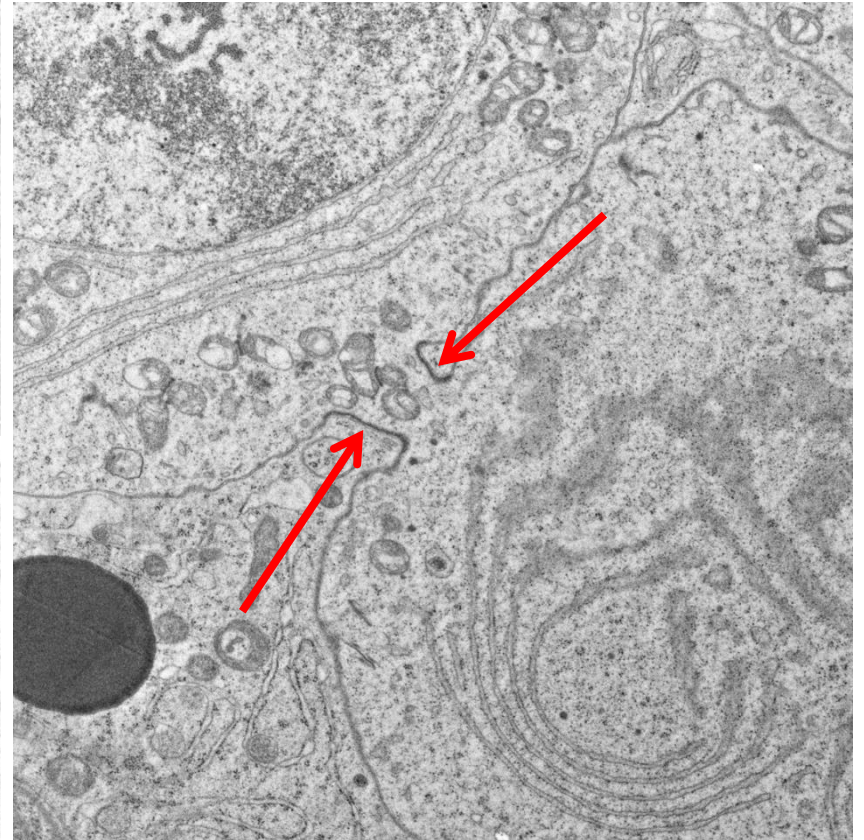
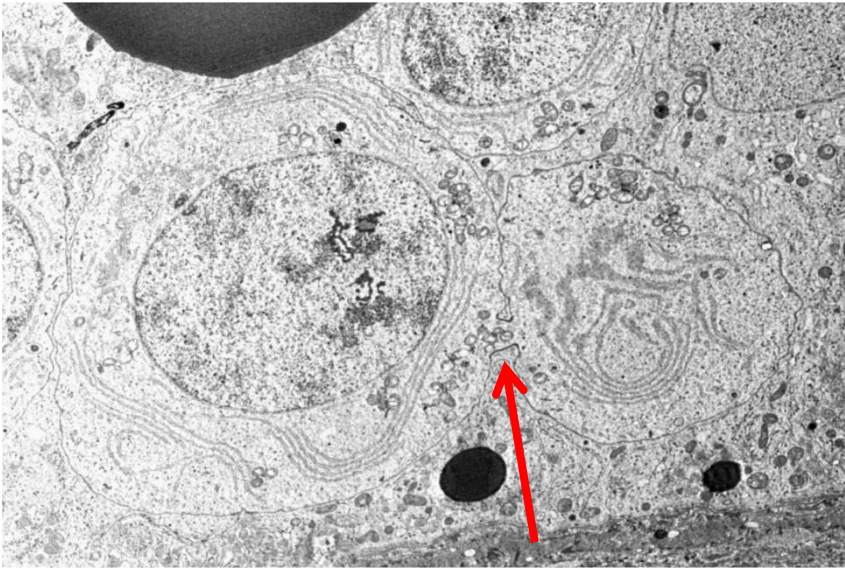
equatorial division - Mei 2

Spermatids

Spermatogenesis - Spermatocytes



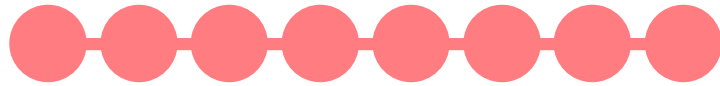
Spermatogenesis - Cytoplasmic bridges



Spermatogenesis - Spermiogenesis

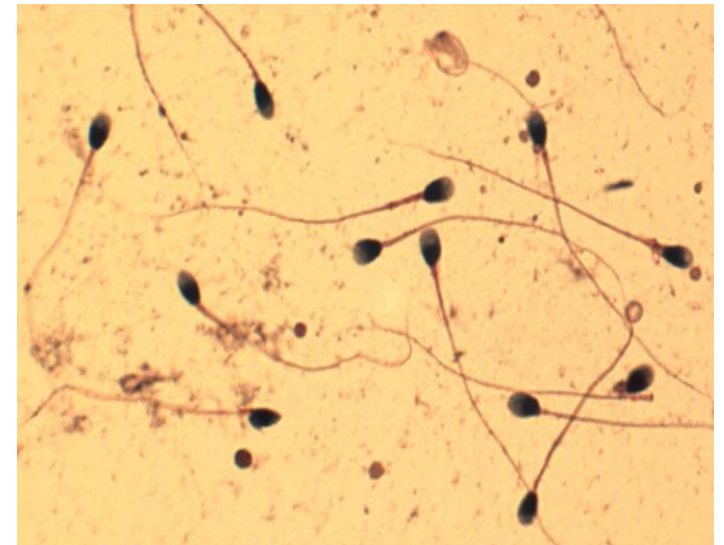
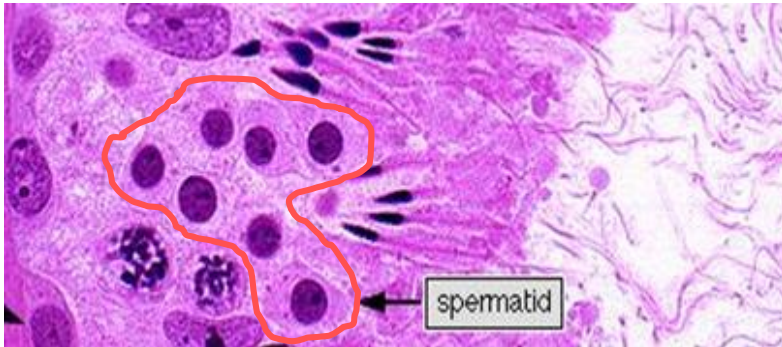
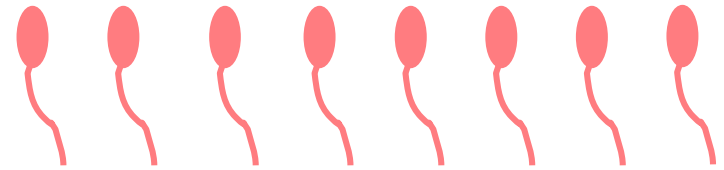
Spermatides

- small germ cells (6-8 μm)
- cytoplasmic bridges



morphogenesis

Spermatozoa



Key elements

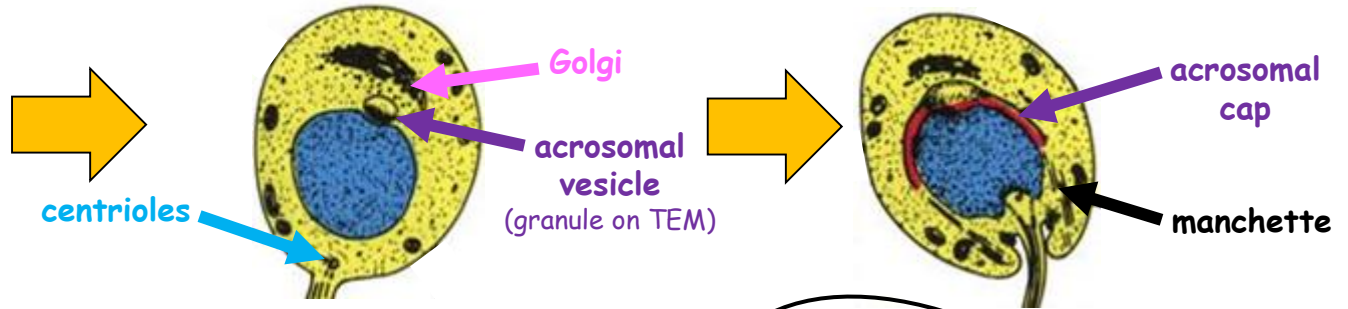
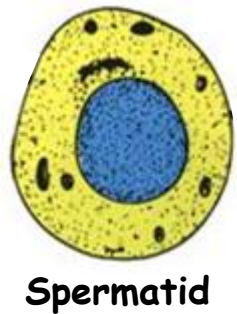
1. Formation of acrosome
2. Development of flagellum
3. Chromatin condensation + shaping the nucleus
4. Reduction of cytoplasm

Spermatogenesis - Spermiogenesis

- Prominent Golgi complex
- Numerous mitochondria
- Pair of centrioles

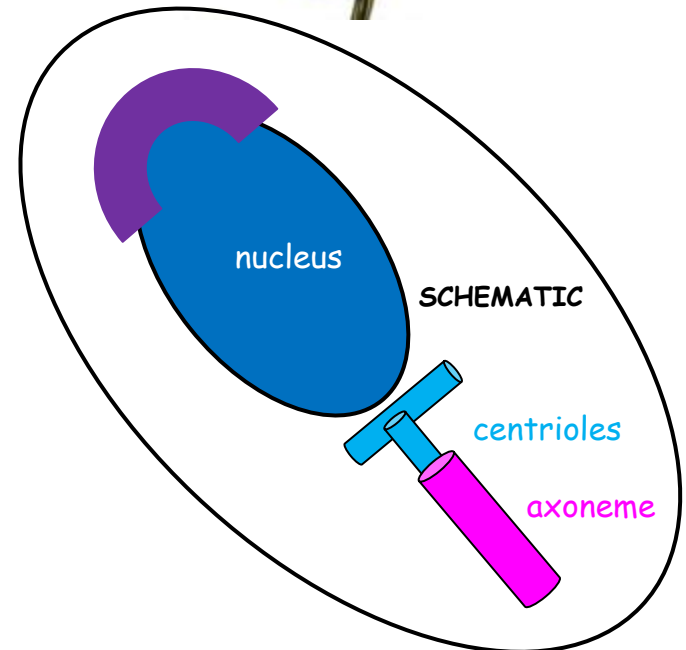
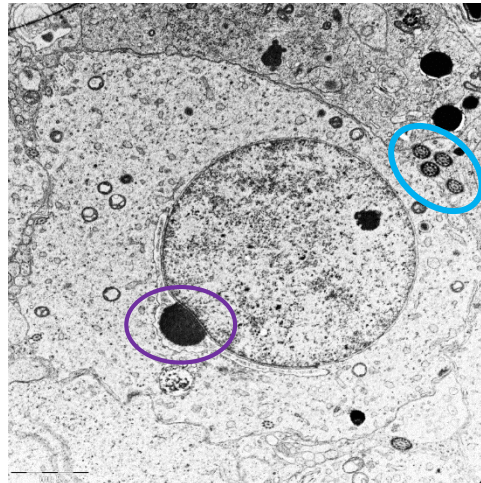
- Transgolgi pathway produces granules
- Granules form **acrosomal vesicle**

- Acrosomal vesicle flatten - **cap**
- Microtubules arrange into **manchette**
- Chromosomes begin to condense

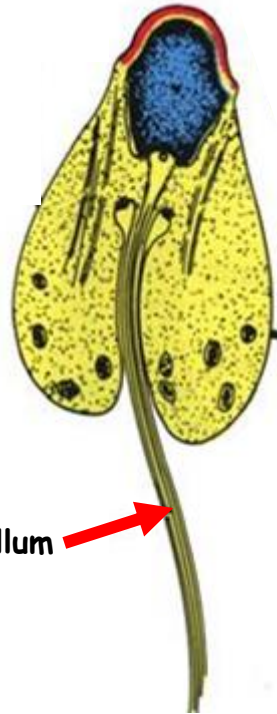
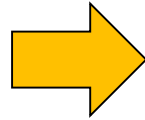
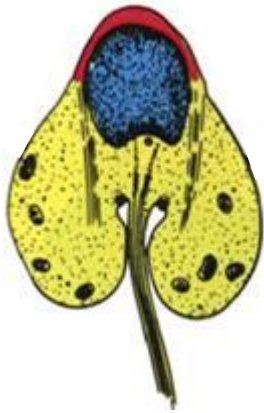


Acrosomal enzymes

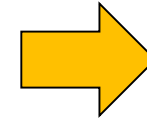
- hyaluronidase
- acrosin
- acid phosphatase
- neuraminidase



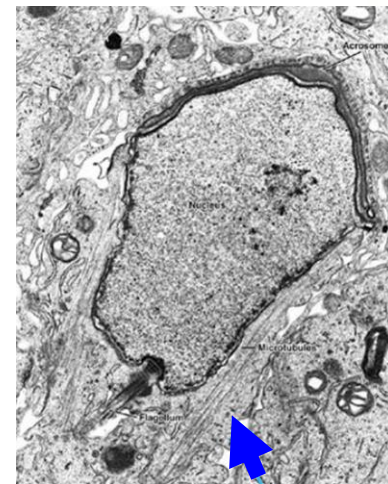
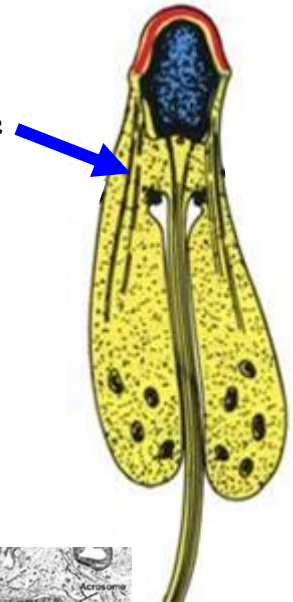
Spermatogenesis - Spermio genesis



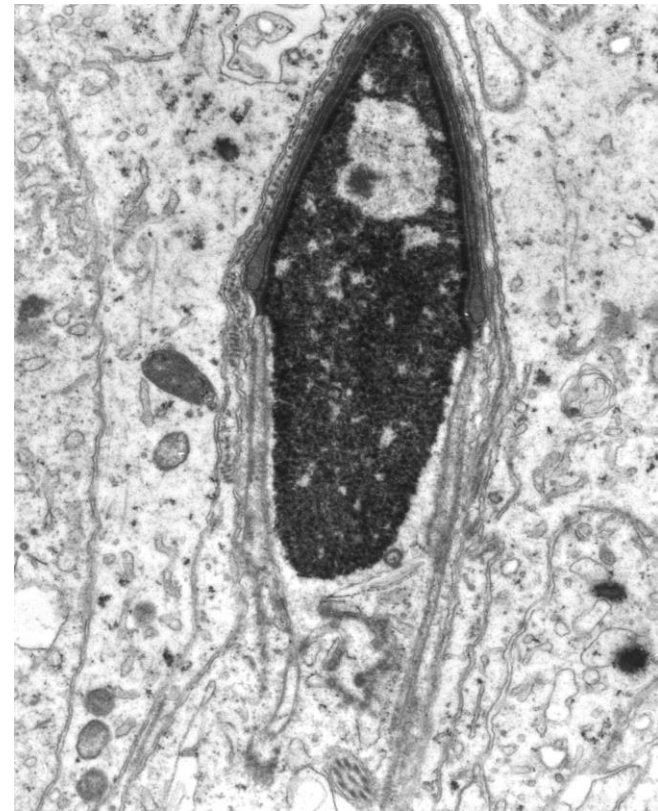
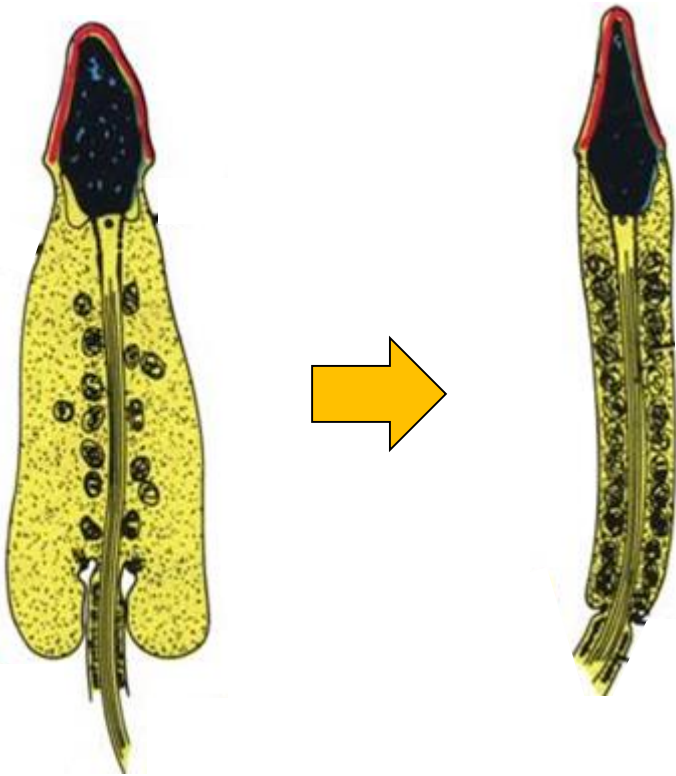
flagellum



manchette

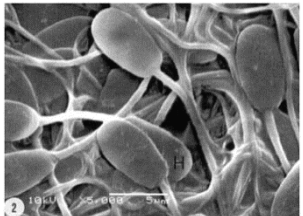
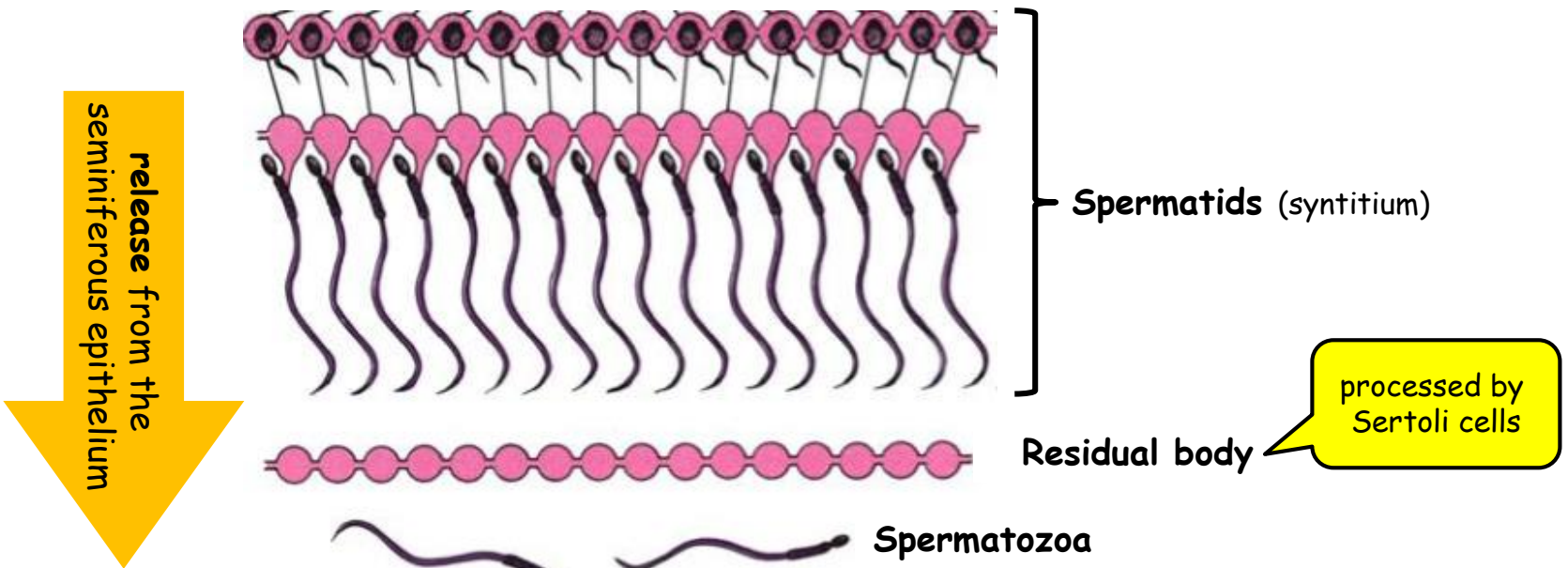


Spermatogenesis - Spermogenesis



Spermatogenesis - Spermiation

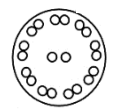
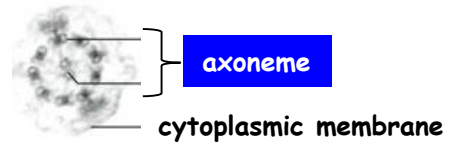
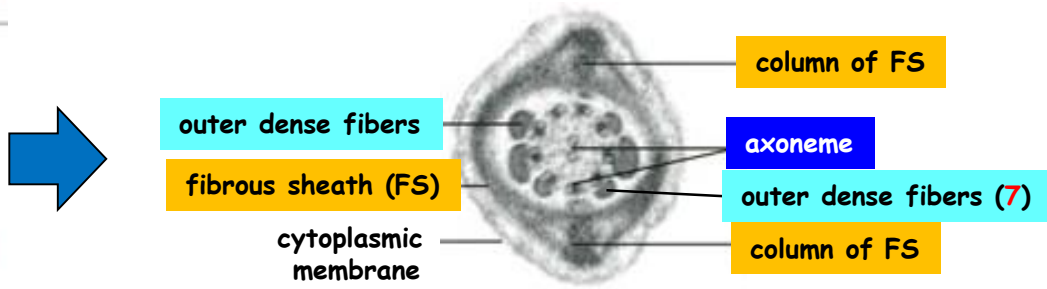
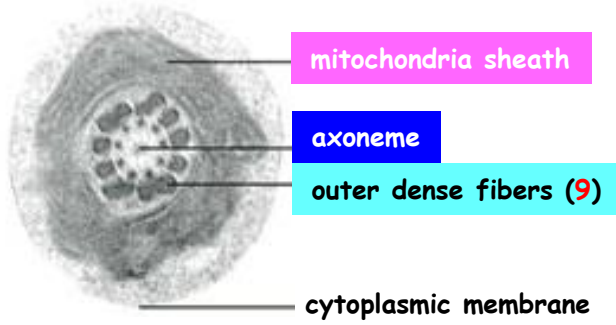
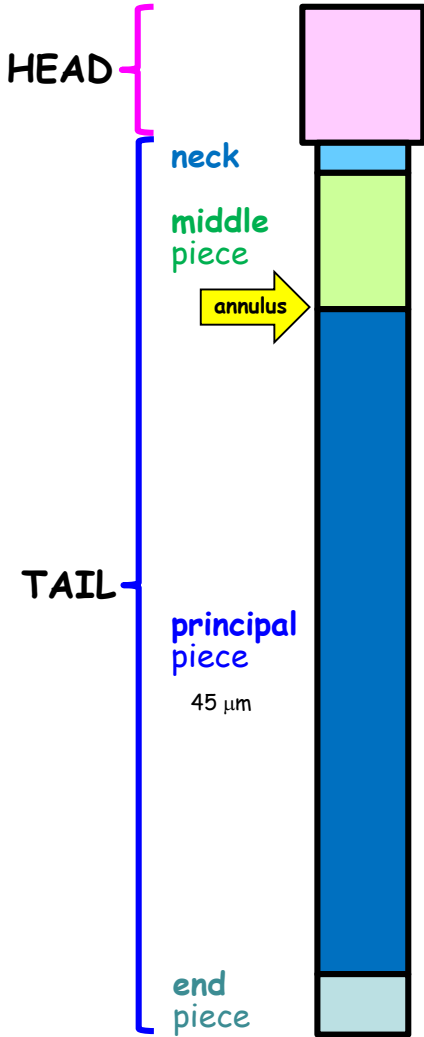
= final stage of spermiogenesis



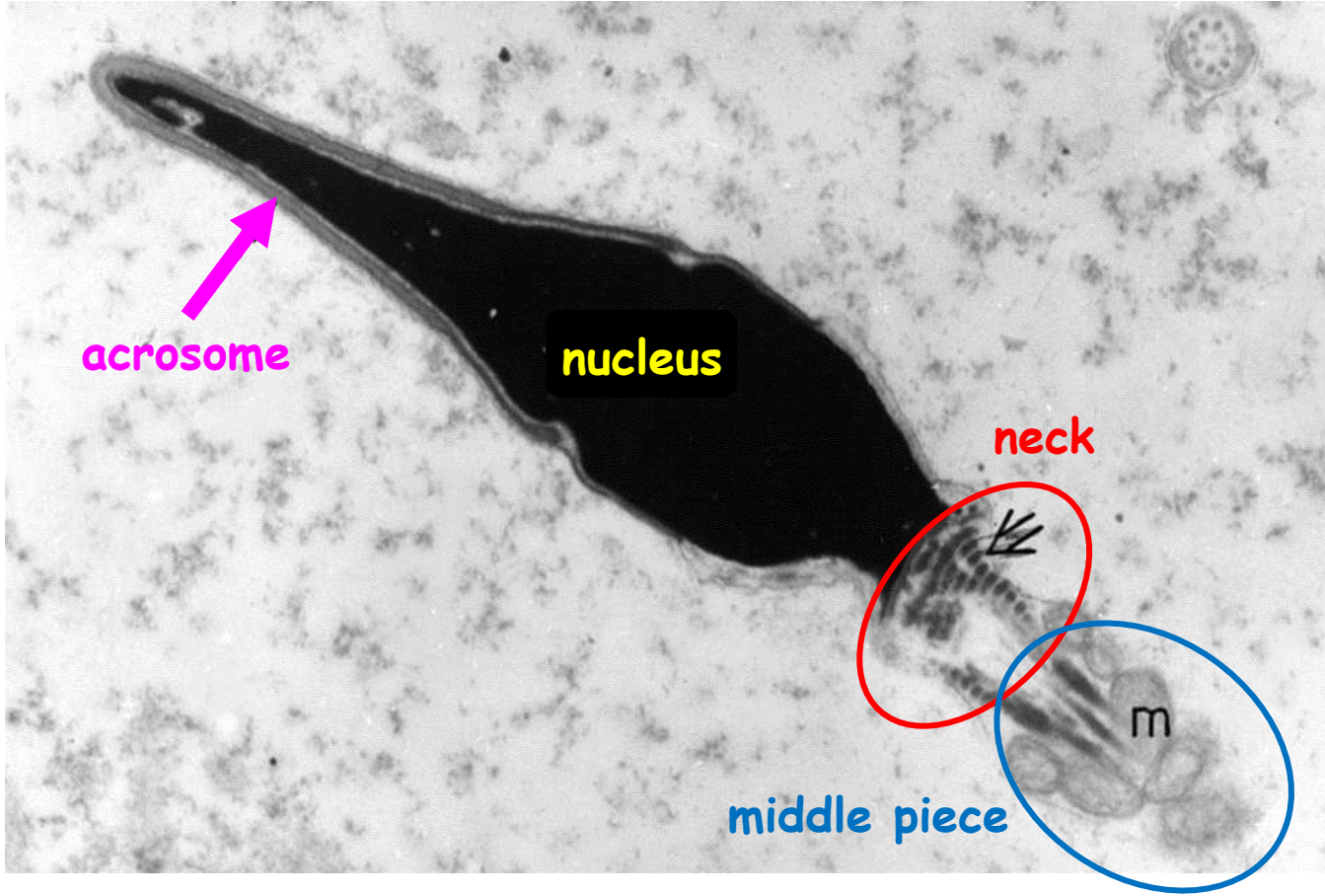
Spermatozoon



Total length = 65 μm

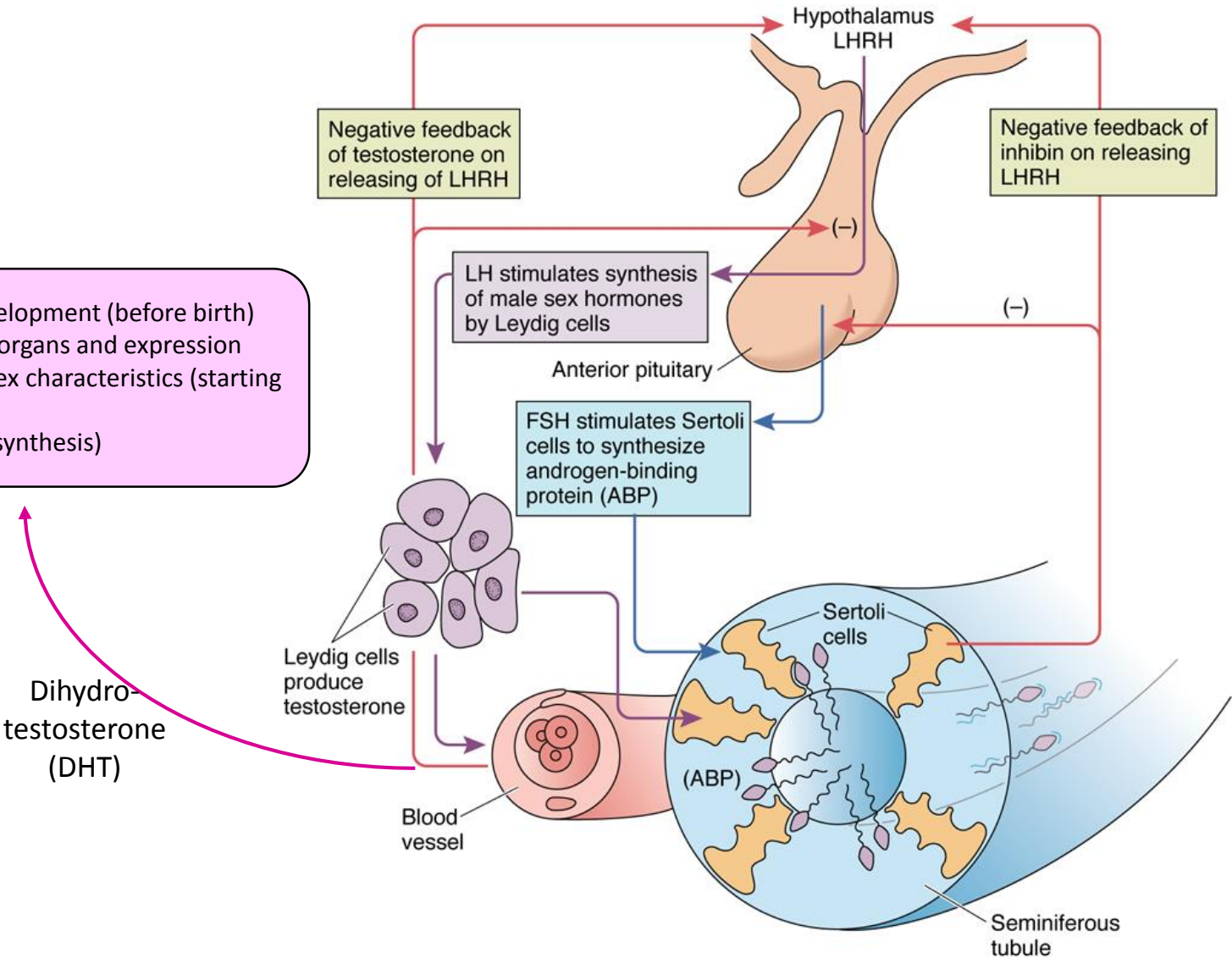


Spermatozoon



Spermatogenesis - Hormonal regulation

- Male pattern of development (before birth)
- Growth of male sex organs and expression of male secondary sex characteristics (starting at puberty)
- Anabolism (protein synthesis)



Spermatozoa + Ejaculate

Properties of spermatozoa

- life-span: 2 to 3 dys in female reproductive tract
several weeks in epididymis
- fertilising ability: up to 2 days
- velocity: 3-5 mm/min.
- 2 types of spermatozoa: with X or Y chromosome

Composition of ejaculate

Corpuscular:

- spermatozoa (40-100 mil./1ml)
- desquamated epithelia
- residual bodies
- prostatic concretions

Seminal plasma:

- secretions of seminal vesicles, prostate, bulbourethral, and Littre's glands
- testicular fluid
- secretions of epithelia of excretory ducts

Spermatozoa + Ejaculate

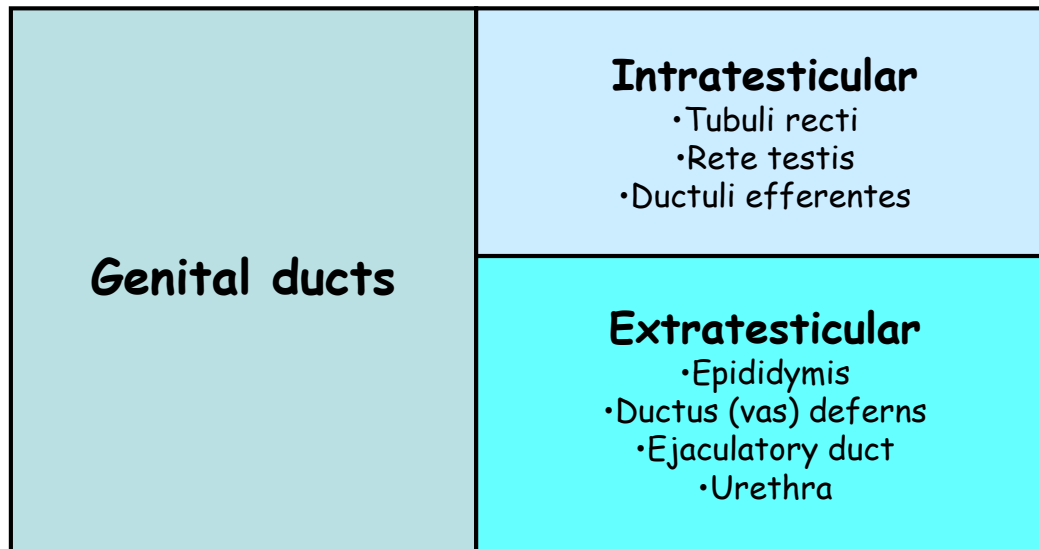
Normozoospermia - WHO standard

- **volume** of ejaculate: 2,0 ml and more
- **pH** of ejaculate: 7,2-7,8
- **sperm concentration**: minimally 20 mil. spermatozoa/1ml, total at least 40 mil./ejaculate
- **movability**: min. 50 % movable with 25 % quickly and progressively moving
- **morphology**: min. 30 % normal spermatozoa
- **vital spermatozoa**: minimally 50 %

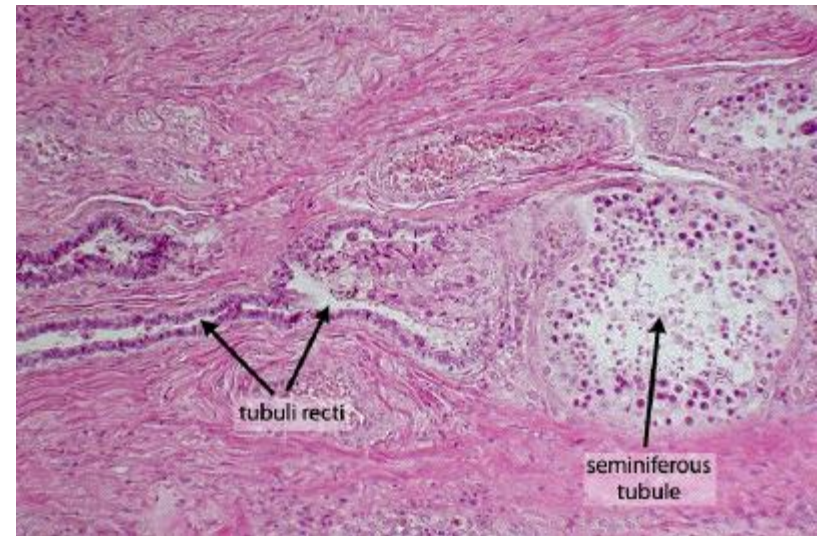
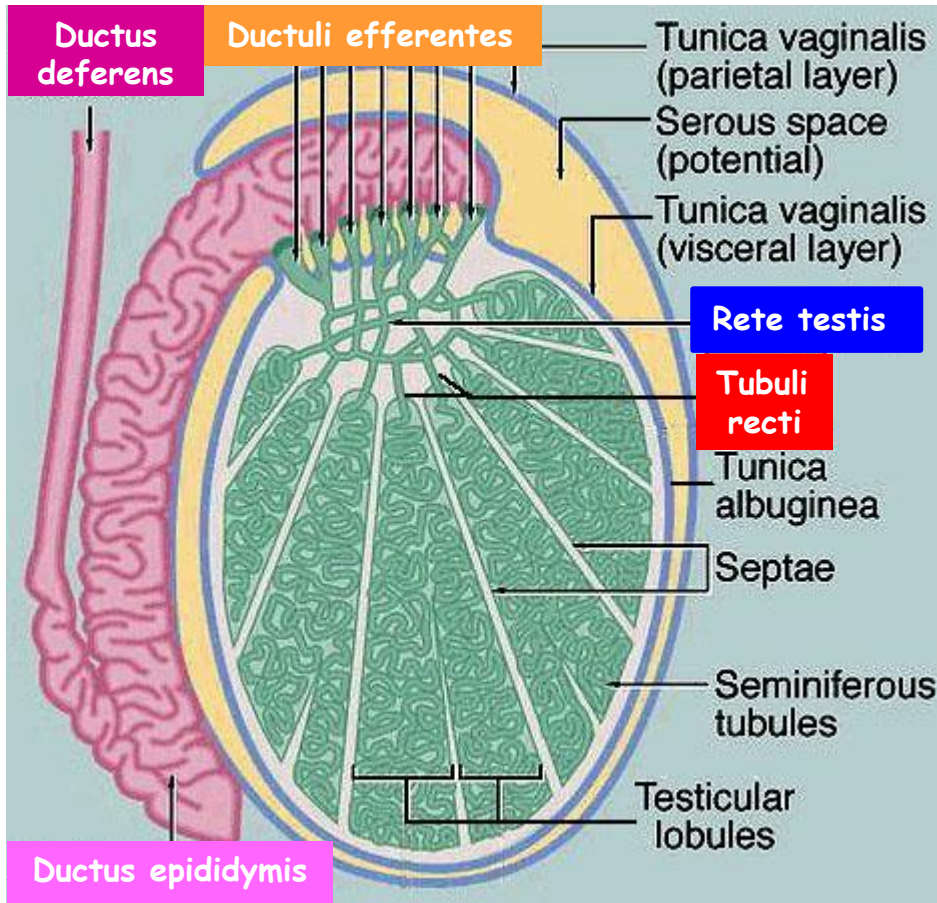
Abnormal spermiogram - Nomenclature

- **Asthenozoospermia**: reduced sperm motility
- **Oligozoospermia**: reduced sperm concentration in ejaculate
- **Teratozoospermia**: large numbers of morphologically abnormal sperm
- **Oligoastenoteratospermia**: combined abnormality in numbers, motility, and morphology of sperm
- **Azoospermia**: complete absence of sperm in ejaculate
- **Necrozoospermia**: high percentage of dead sperm (norm = minimum 50%)
- **Pyospermia**: unusually high numbers of leukocytes in ejaculate (norm = max. 1 million)

Male efferent passages = Genital ducts

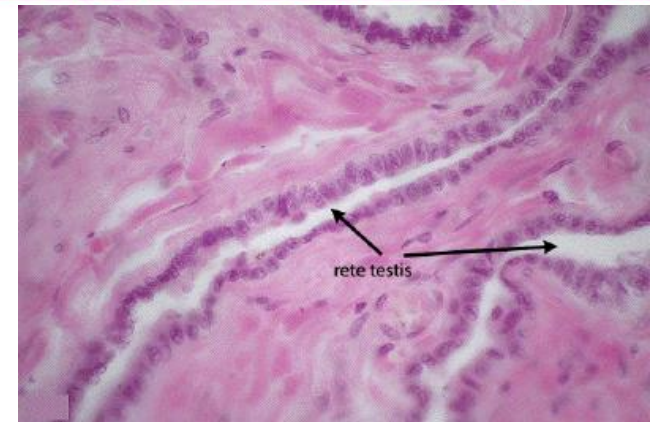
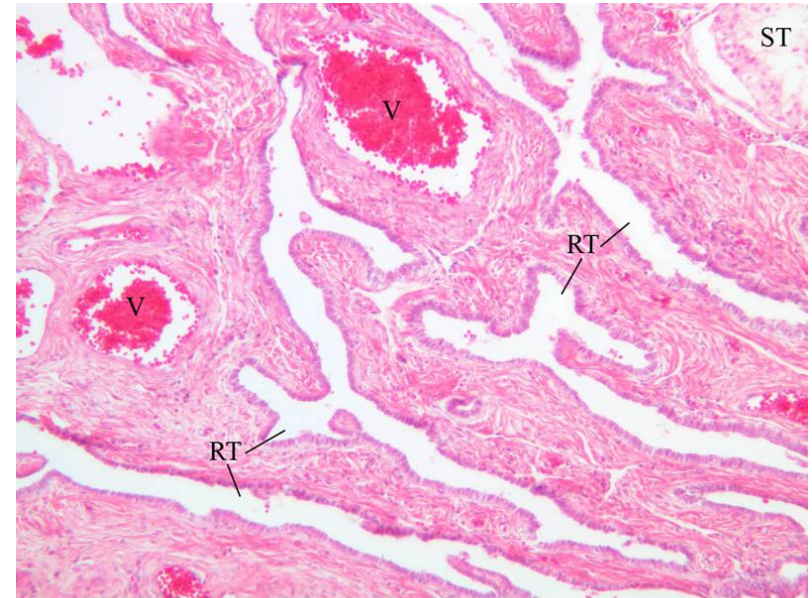
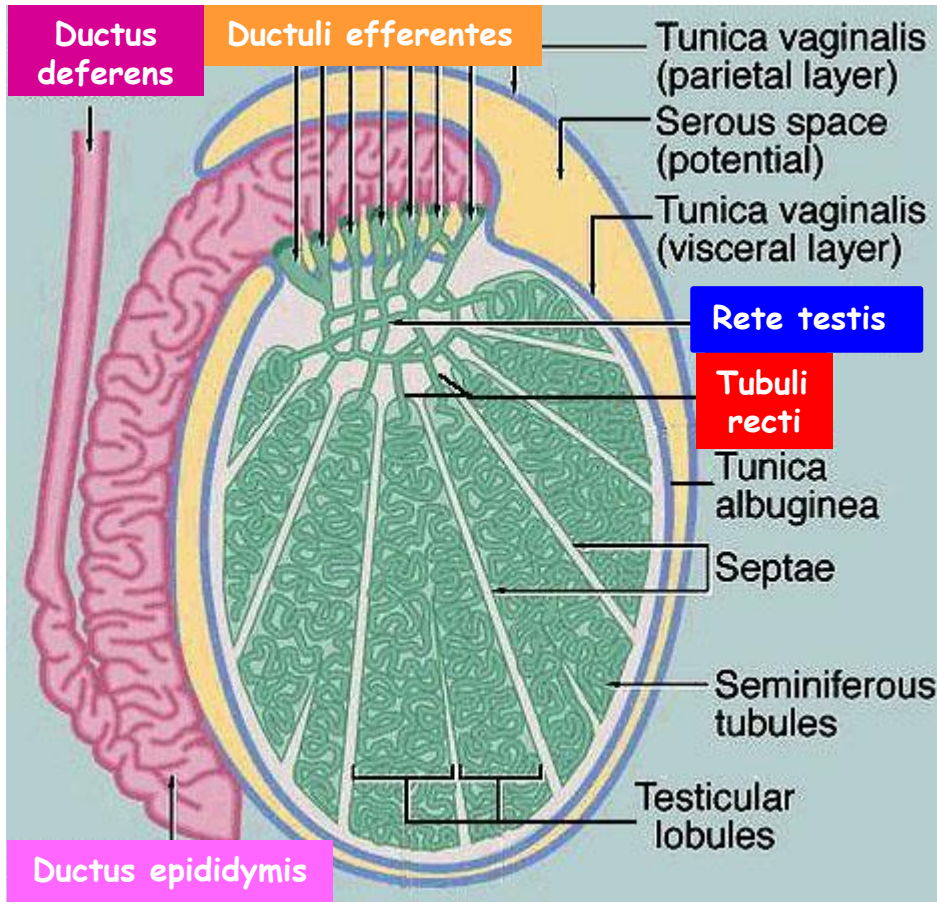


Intartatesticular genital ducts - **Tubuli recti**



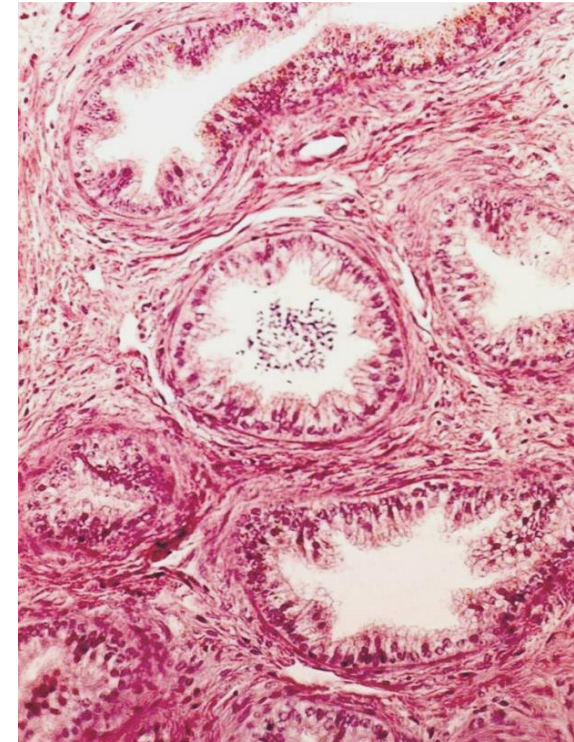
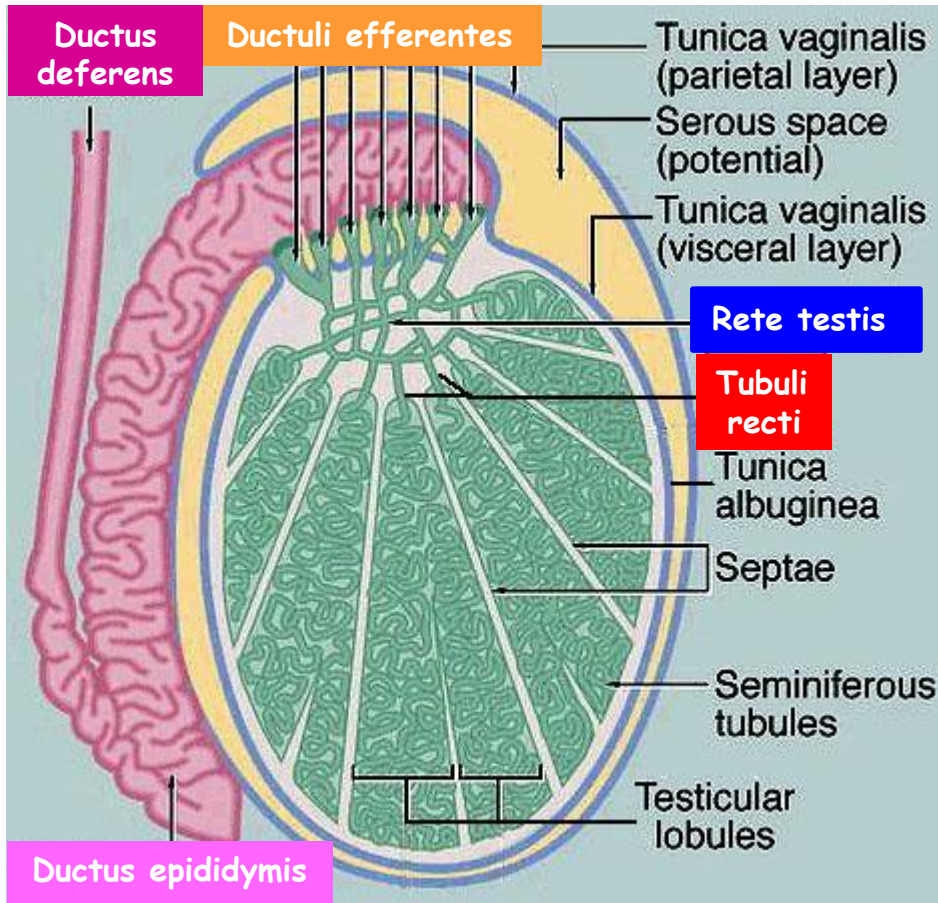
- short - about 1 mm
- in septula
- proximal part: Sertoli cells
- distal part: simple cuboidal epithelium

Intartatesticular genital ducts - Rete testis



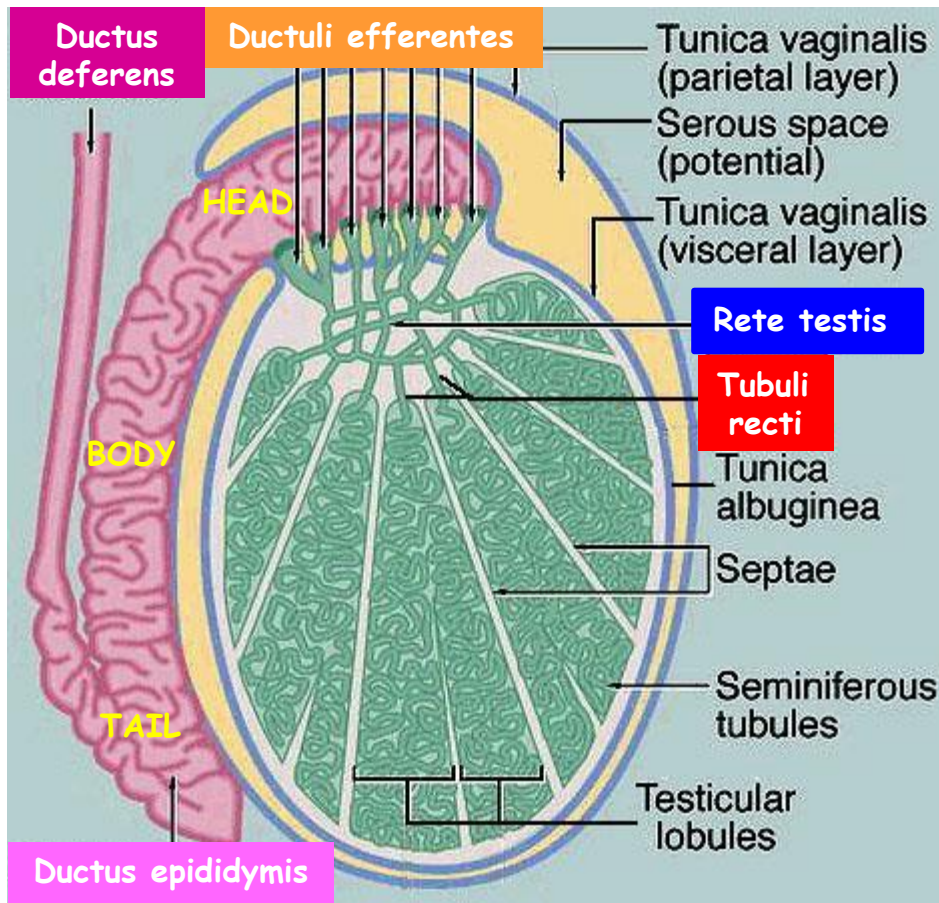
- labyrinth - interconnected channels
- in mediastinum
- simple cuboidal epithelium (as in Tubuli recti)
(with microvili + cilium)
- circular smooth muscle cells

Intartatesticular genital ducts - **Ductuli efferentes**



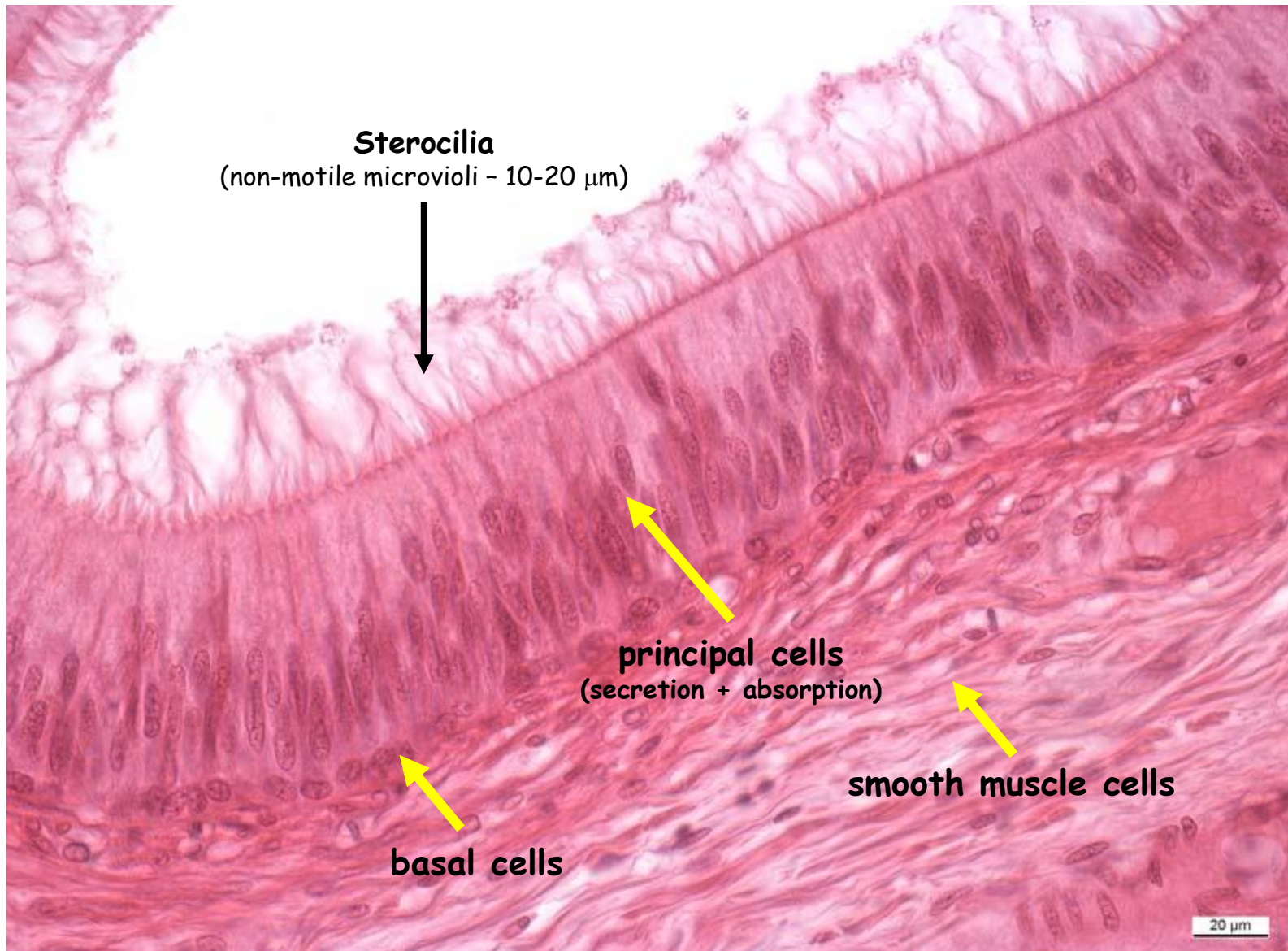
- 10 to 20
- penetrate tunica albuginea
- cuboidal + columnar cells (patches)
- **non-ciliated + ciliated** - sperm passage
- microvili + lysosomes - absorption of luminal fluid
- **smooth muscle cells** - passage of sperm

Extratesticular genital ducts - Ductus epididymis 1

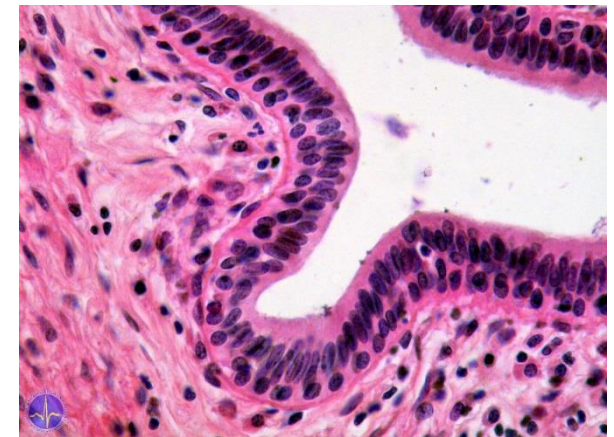
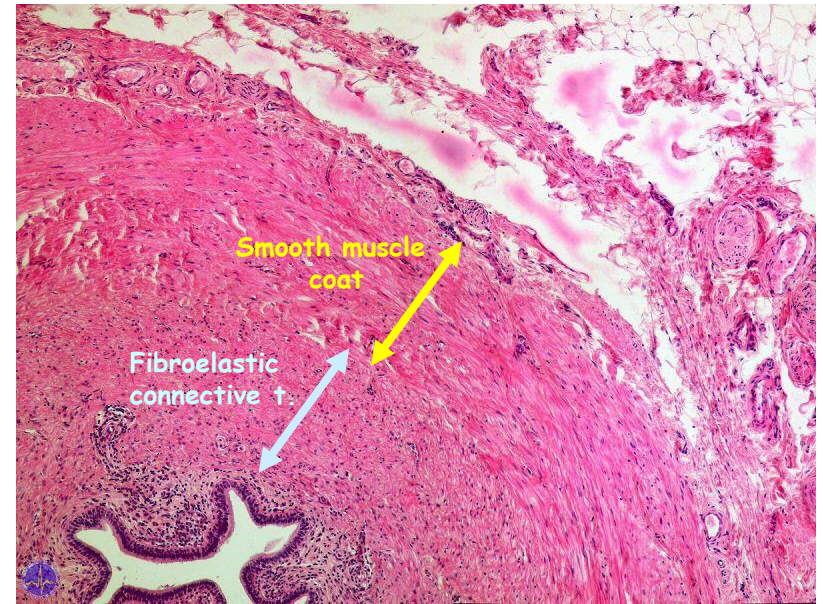
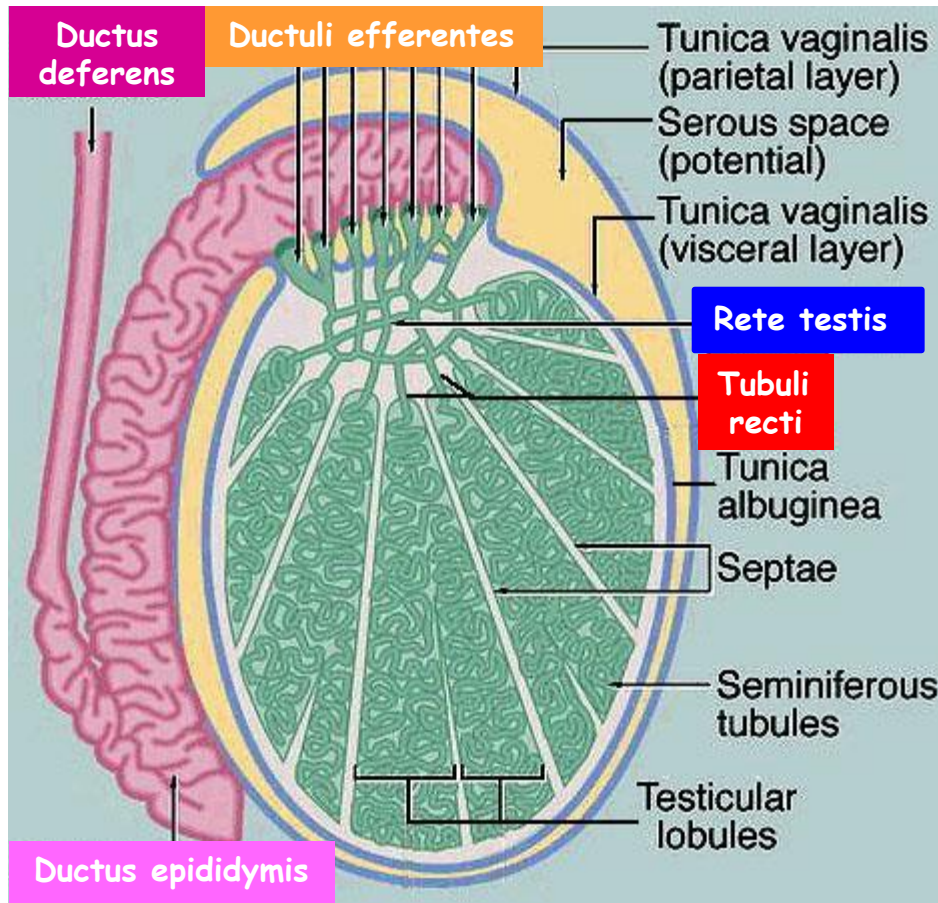


- about 5 meters long
- highly convoluted (head + body)
- tail (cauda) straight - sperm storage + maturation (under hormonal influence)
- columnar pseudostratified lining: **basal cells** (polyhedral) + **principal cells** (columnar)
- principal cells with **stereocilia**
- surrounded by circular **smooth muscle** layer (peristaltic motion)

Extratesticular genital ducts - Ductus epididymis 2

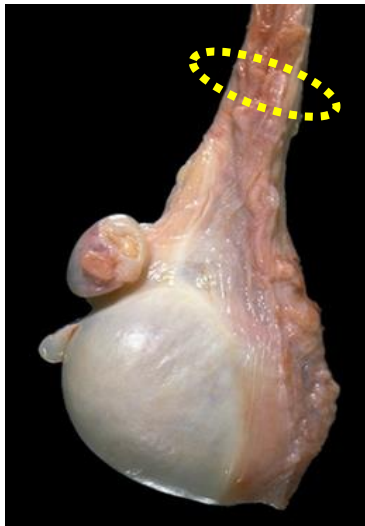


Extratesticular genital ducts - Ductus deferens 1

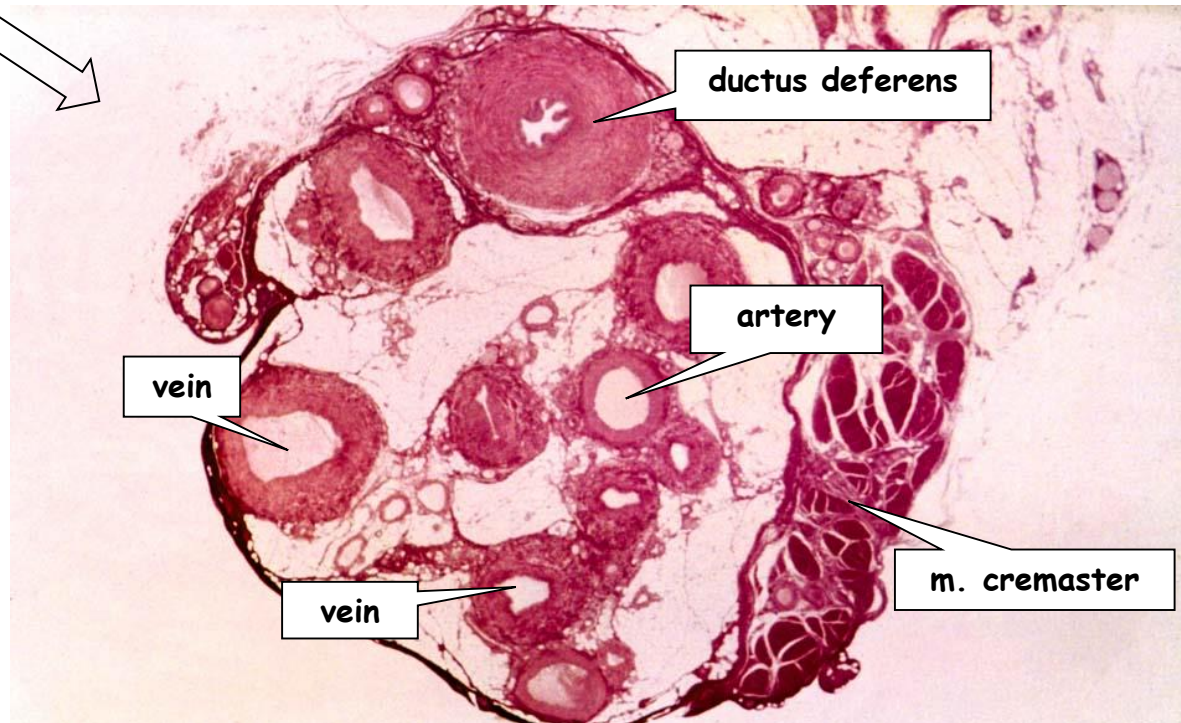


- thick walled + folded lumen
- epithelia similar to D. epididymis - columnar pseudostratified (basal cells + principal cells)
- surrounded by three layers of smooth muscle layer (circ+long+long)
- sympathetic innervation - initiate ejaculation

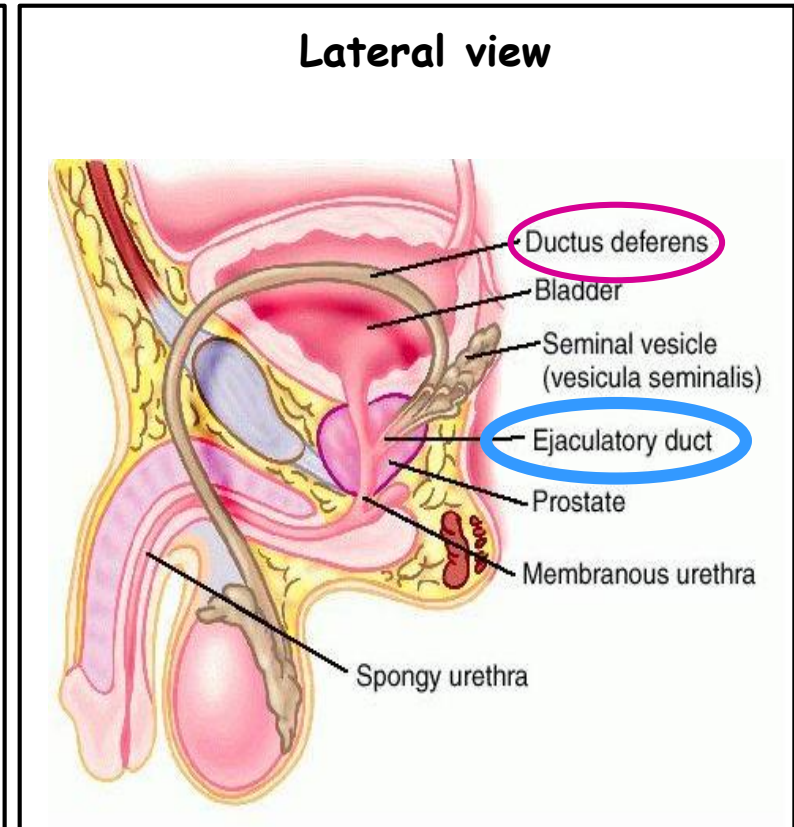
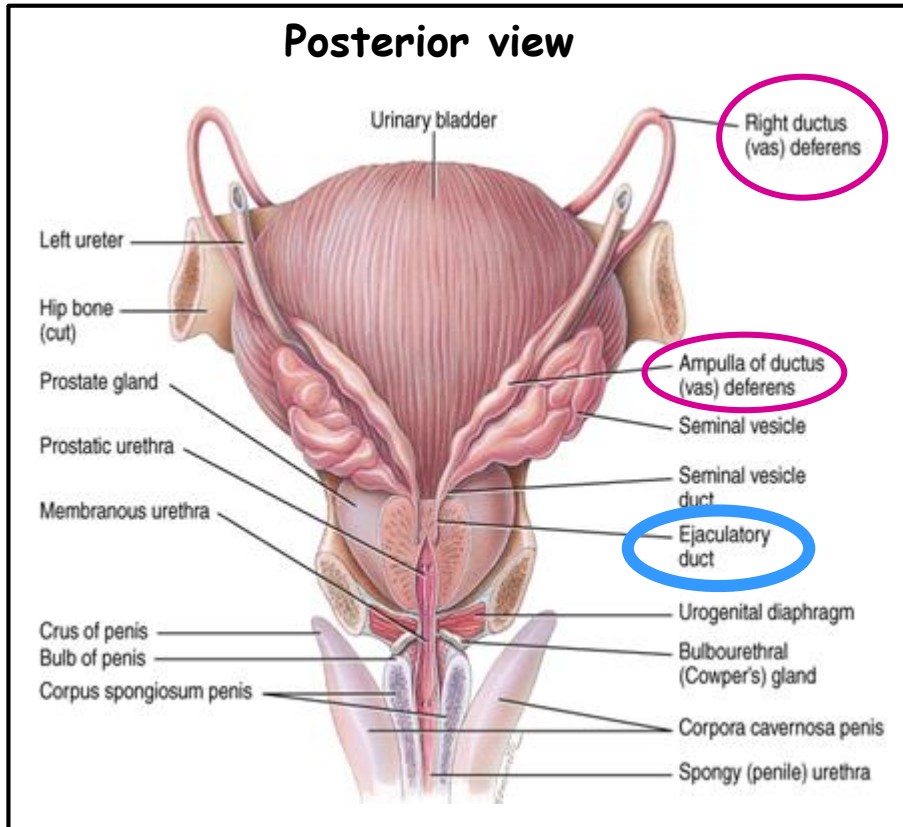
Extratesticular genital ducts - Ductus deferens 2



Funiculus spermaticus

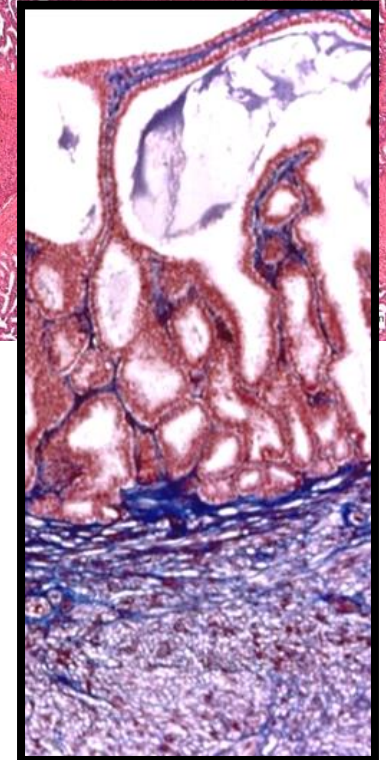
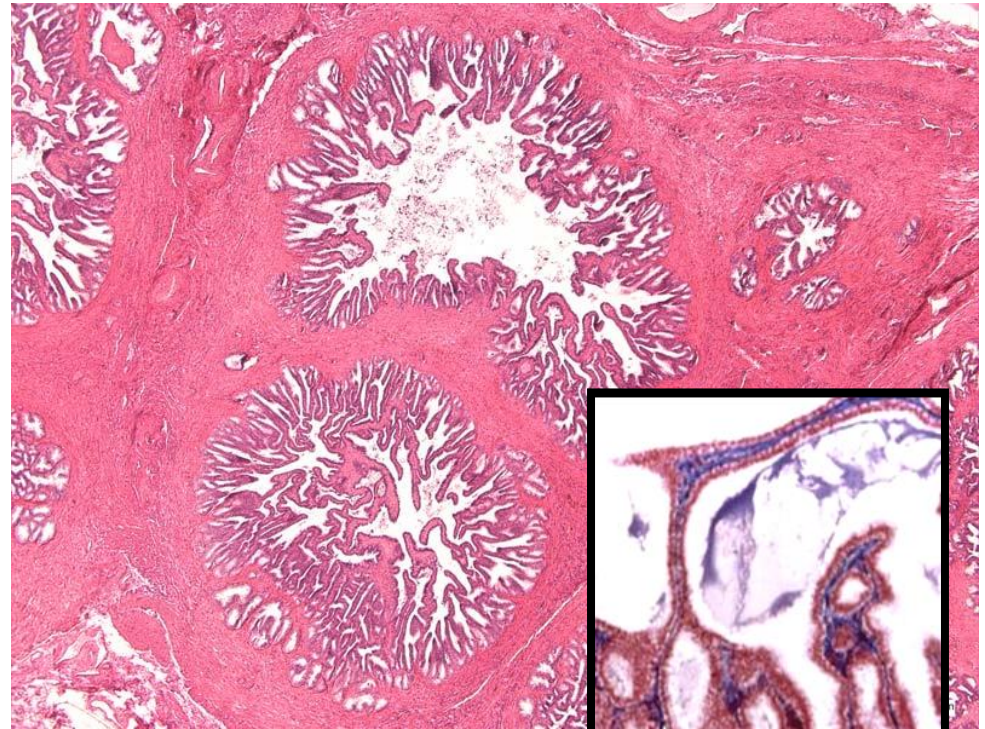
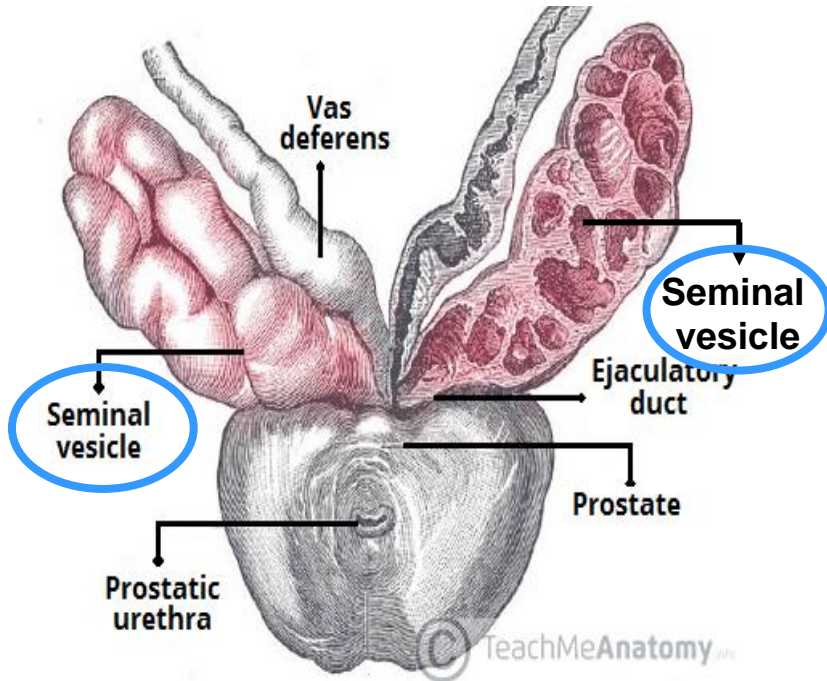


Extratesticular genital ducts - Ejaculatory duct



- short + straight
- portion after entry of seminal vesicle duct
- surrounded by prostate
- enters urethra at the **colliculus seminalis** (verumontanum)
- lined with **simple columnar epithelium**
- **NO smooth muscle laeyer**

Accessory genital glands - Seminal vesicles



- develops from ductus deferens
- about 15 cm long snaking tube - **tubular gland**
- highly folded mucosa - labyrinthous cul-de-sac with openings to lumen
- **pseudostratified epithelium** - **basal** + **principal** cells (with microvilli+ flagellum)
- **fibroelastic submucosa** + **smooth muscle layer**
- **seminal fluid** - constitutes about 70 of ejaculate (rich for **fructose**)

Accessory genital glands - Prostate gland 1

Mucosal

- closest to the urethra = shortest

Submucosal

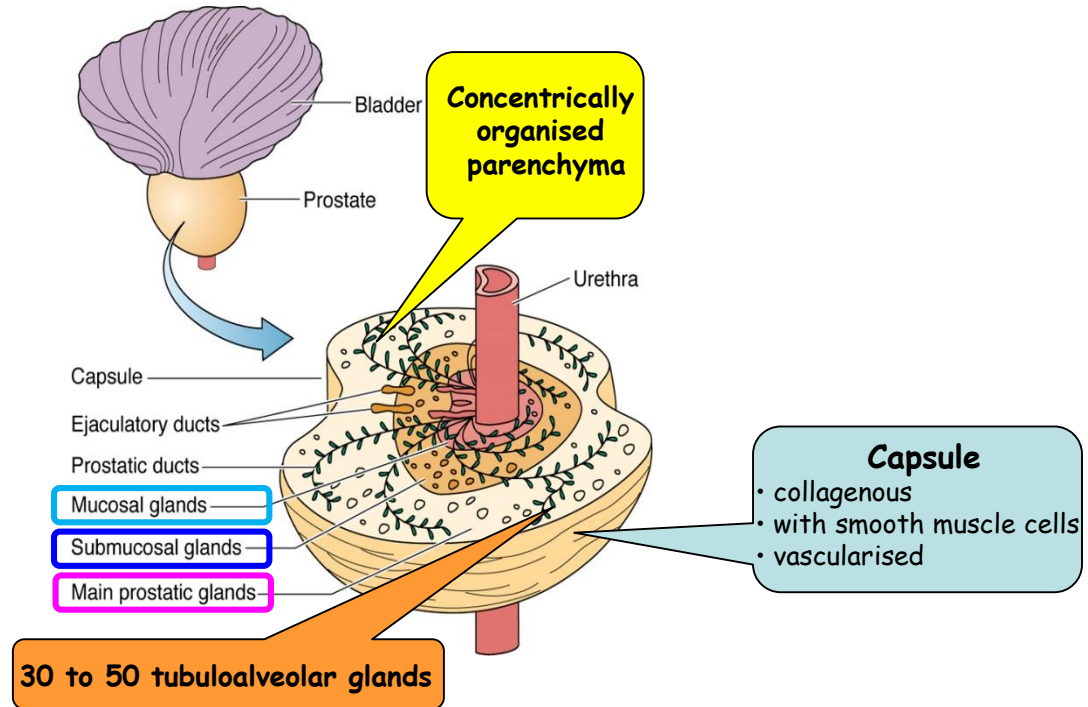
- larger than mucosal

Main

- largest
- most abundant

GLANDS

- simple pseudostratified columnar epithelium
- abundant RER + Golgi + secretory granules



Concentrically organised parenchyma

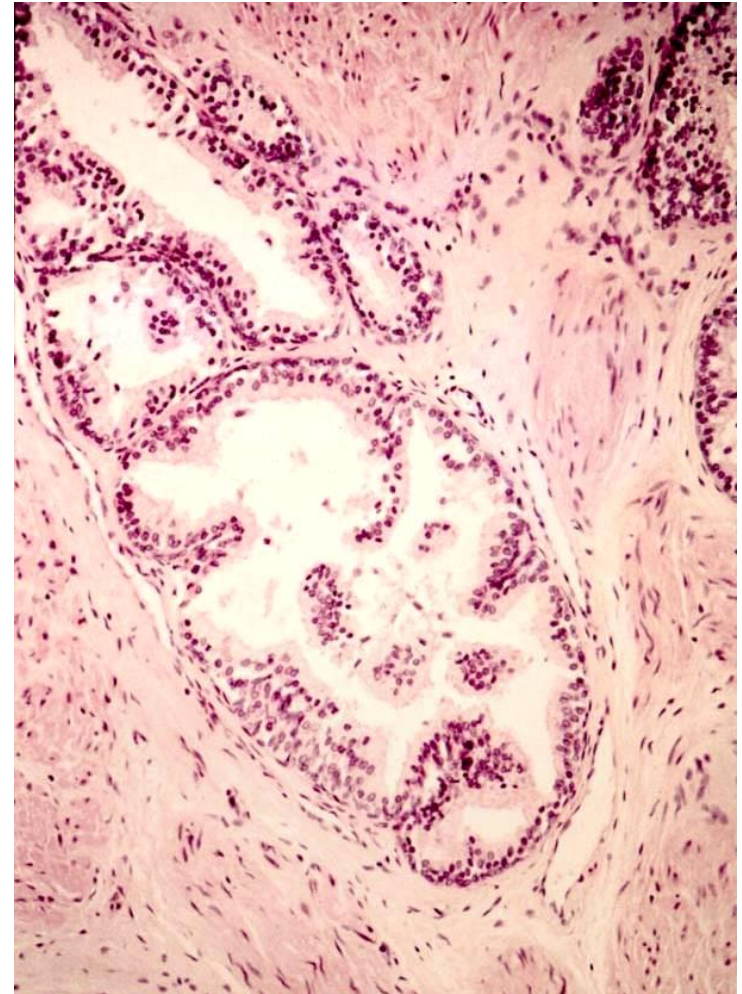
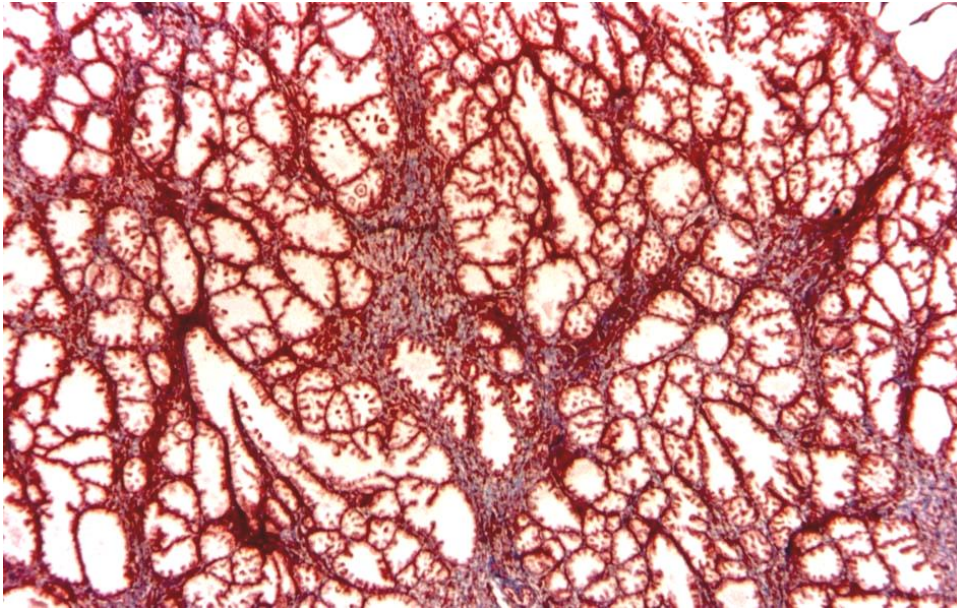
Capsule

- collagenous
- with smooth muscle cells
- vascularised

30 to 50 tubuloalveolar glands

- size and shape of **chestnut** (the largest accessory gland)
- **stroma** (derives from the capsule): fibroelastic elements, many **smooth muscle cells**
- **prostatic secretion**: lipids, acid phosphatase, proteolytic enzymes, citric acid, fibrinolysin (liquifies semen)

Accessory genital glands - Prostate gland 2

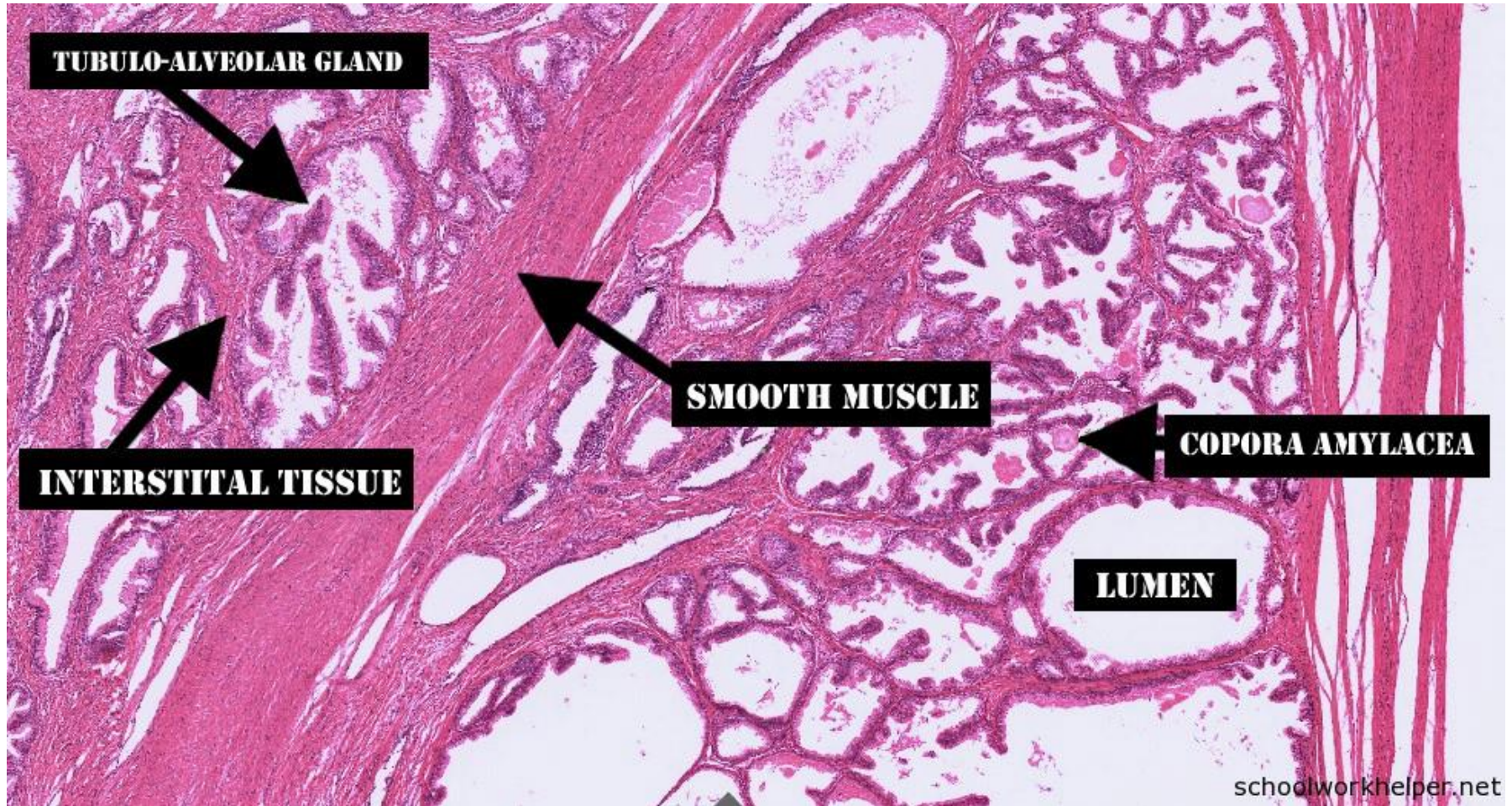


Corpora amylacea
= prostate concretions

- increase with age
- may calcify
- size even 1 mm

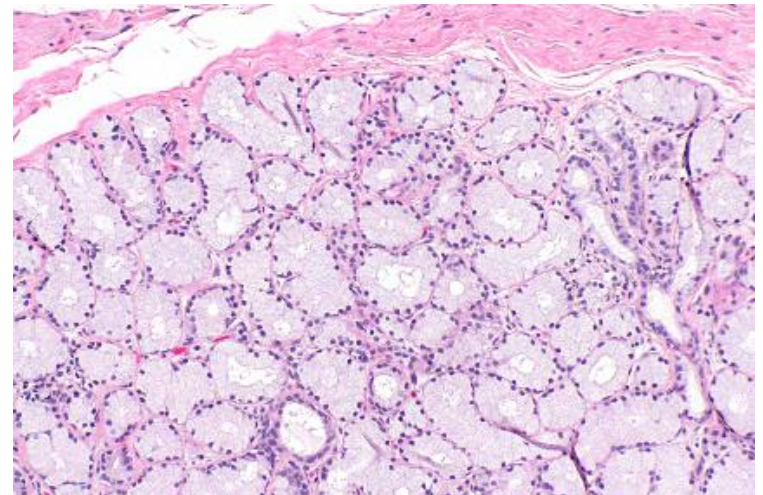
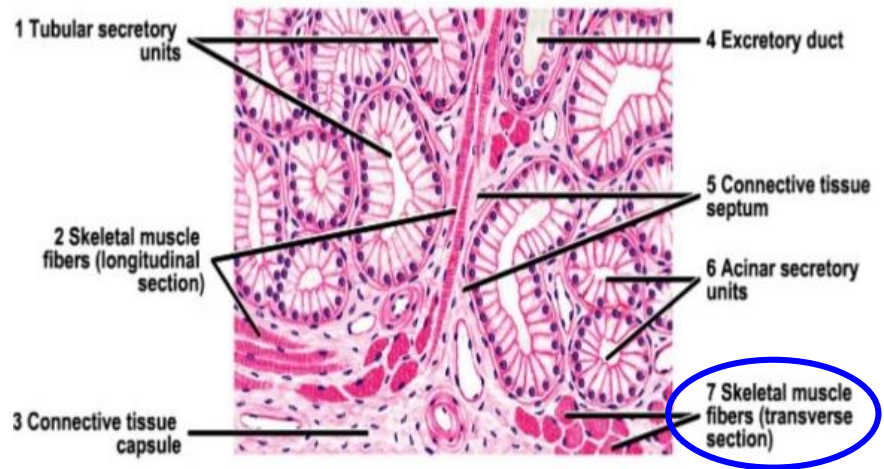
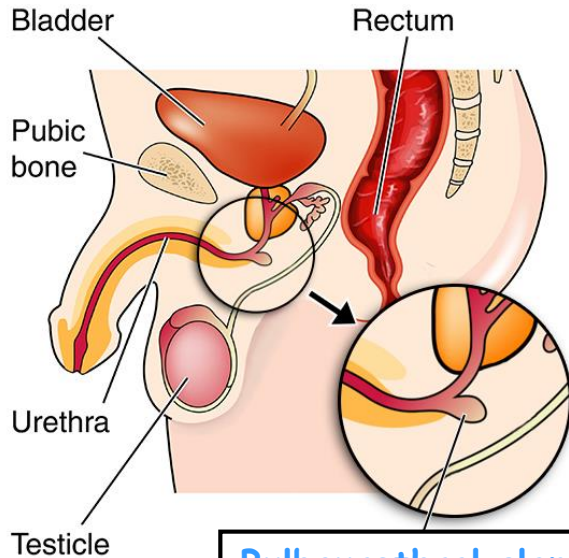


Accessory genital glands - Prostate gland 3



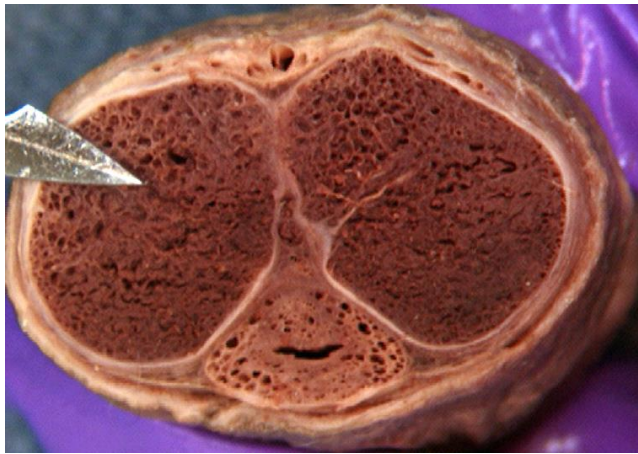
Accessory genital glands - **Bulbourethral glands**

Lateral view



- small - 3 to 5 mm
- at the root of the penis
- lobular structure (septa)
- **skeletal muscle fibers** (derived from urogenital diaphragm)
- simple cuboidal epithelium
- lubricating fluid (sialic acid + galactose)

Penis - 1



Superficial dorsal vein

Deep dorsal vein

Dorsal artery

Dorsal nerve

Deep artery

Tunica albuginea

Septum
(discontinuus)

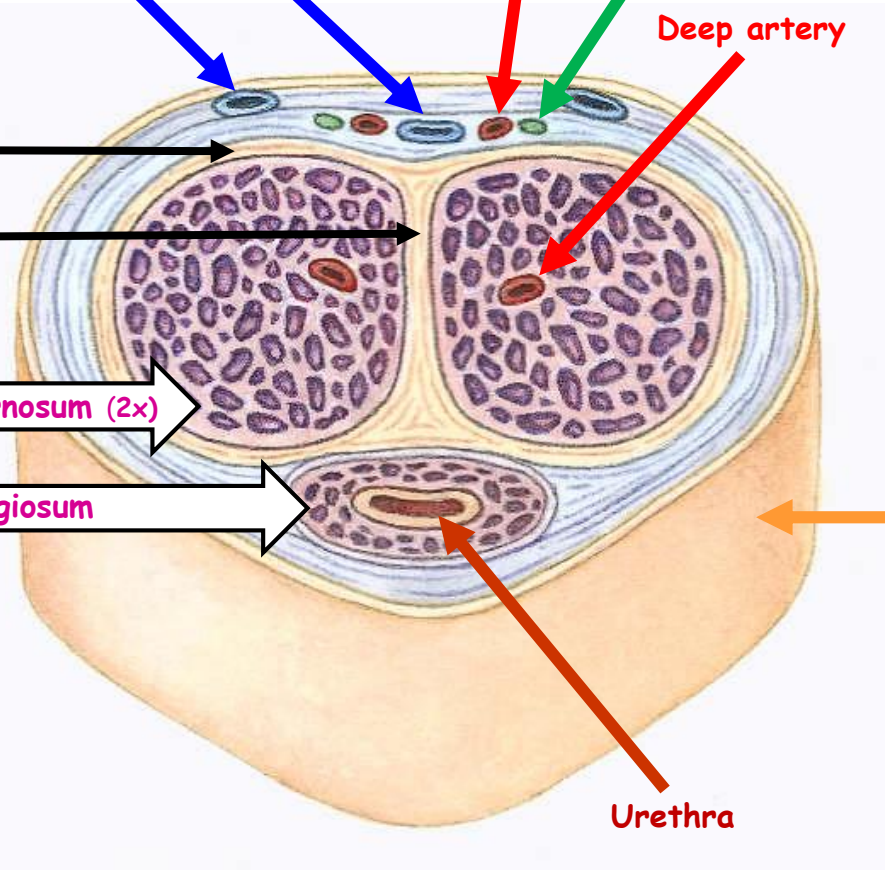
Erectile tissue

Corpus cavernosum (2x)

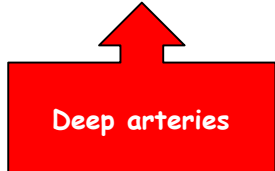
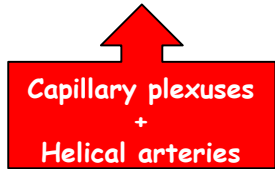
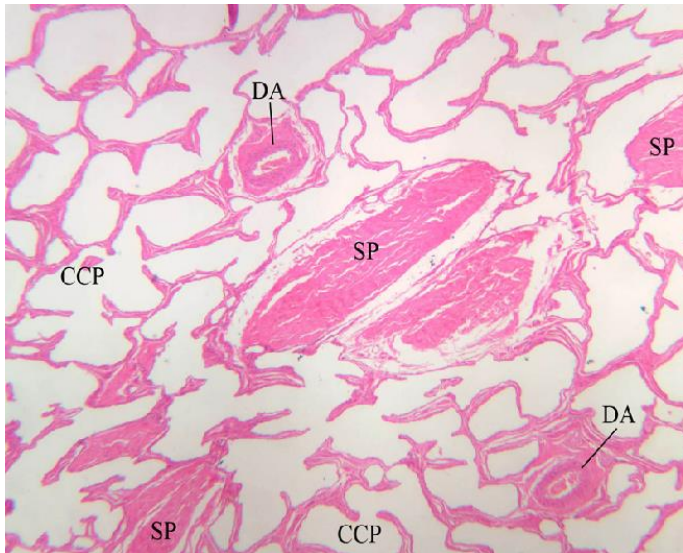
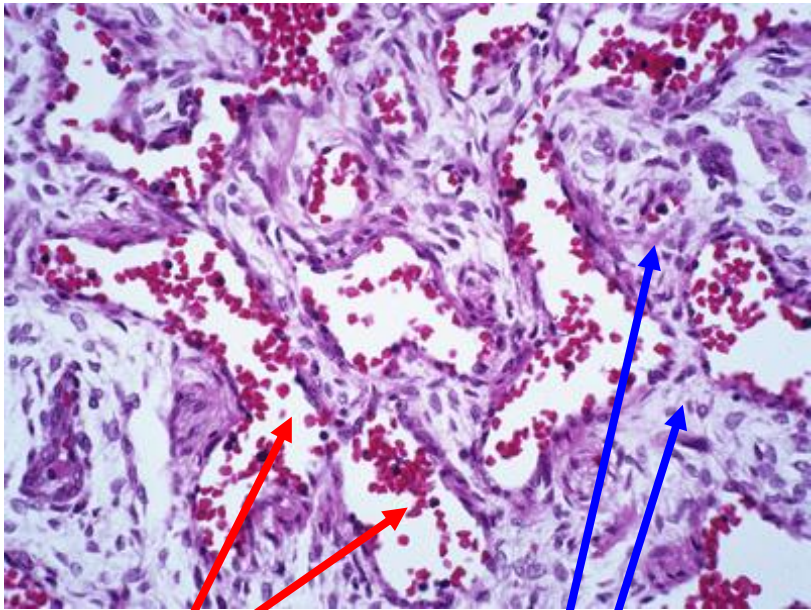
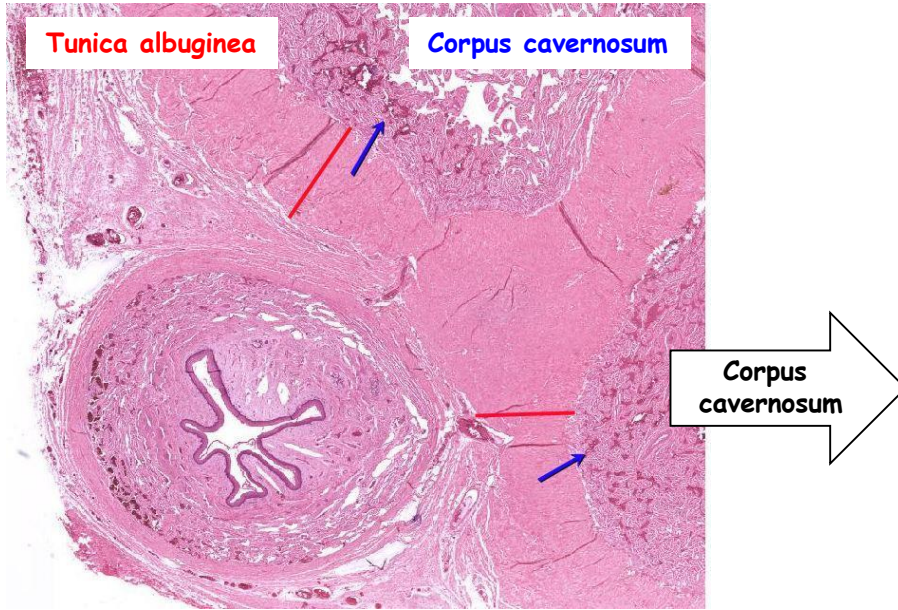
Corpus spongiosum

Skin

Urethra



Penis - 2



Thank you for your attention !

Questions and comments at:
ahampl@med.muni.cz