Male reproductive system

Aleš Hampl

Key components & Gross anatomy

Paired gonads = testes

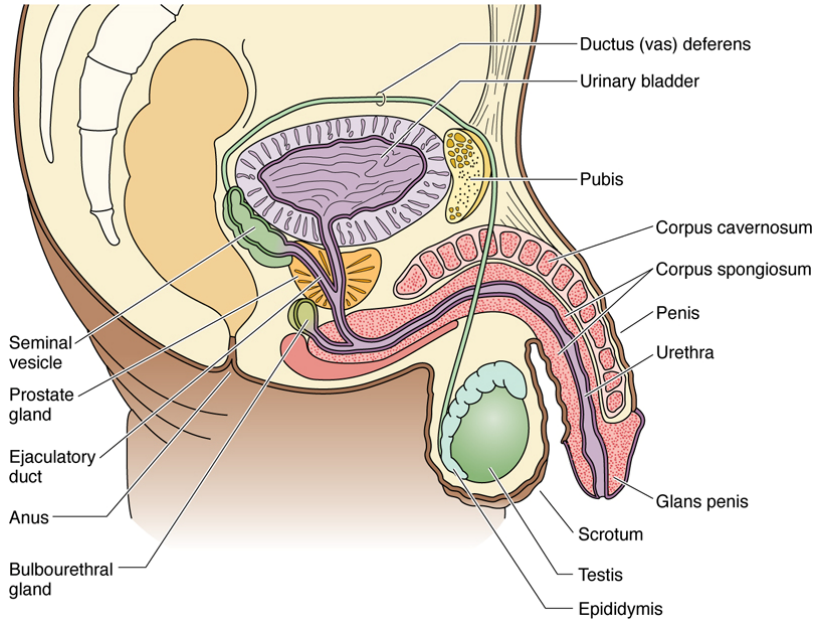
Genital ducts

Intratesticular
- Tubuli recti
- Rete testis
- Ductuli efferentes

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

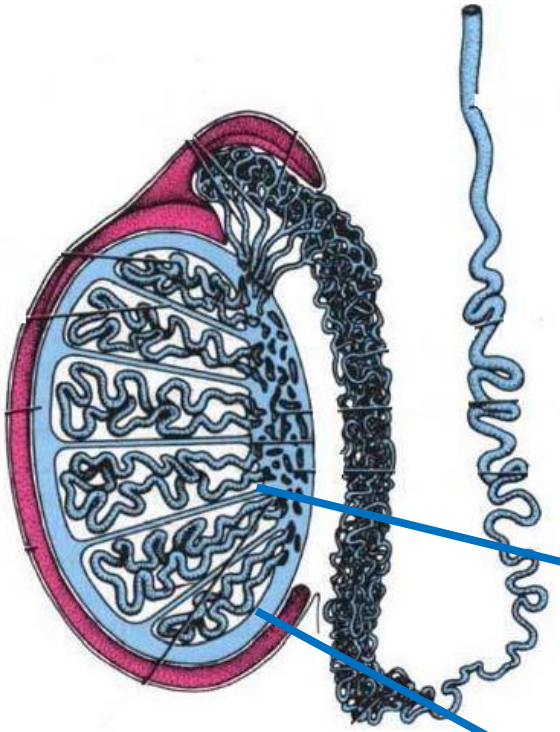
Associated glands
- Seminal vesicles (paired)
- Prostate
- Bulbourethral glands (paired)

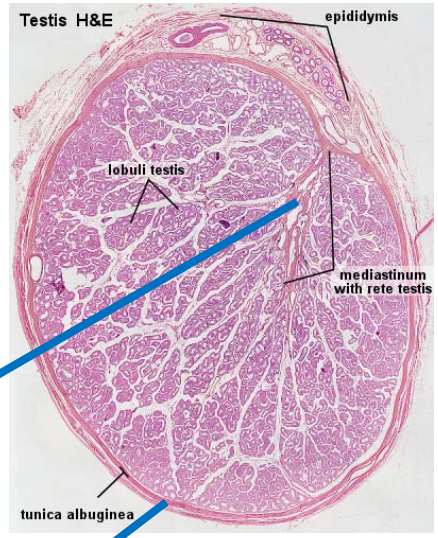
External genital organs
- Scrotum
- Penis



Testis - 1

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



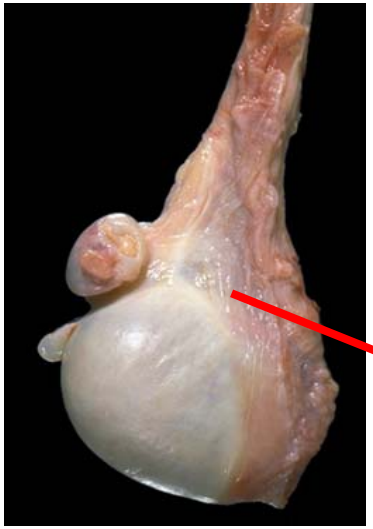


Mediastinum + Septa

- divide testis into **lobuli** (250-300)

Tunica albuginea - capsule

- dense connective collagenous tissue



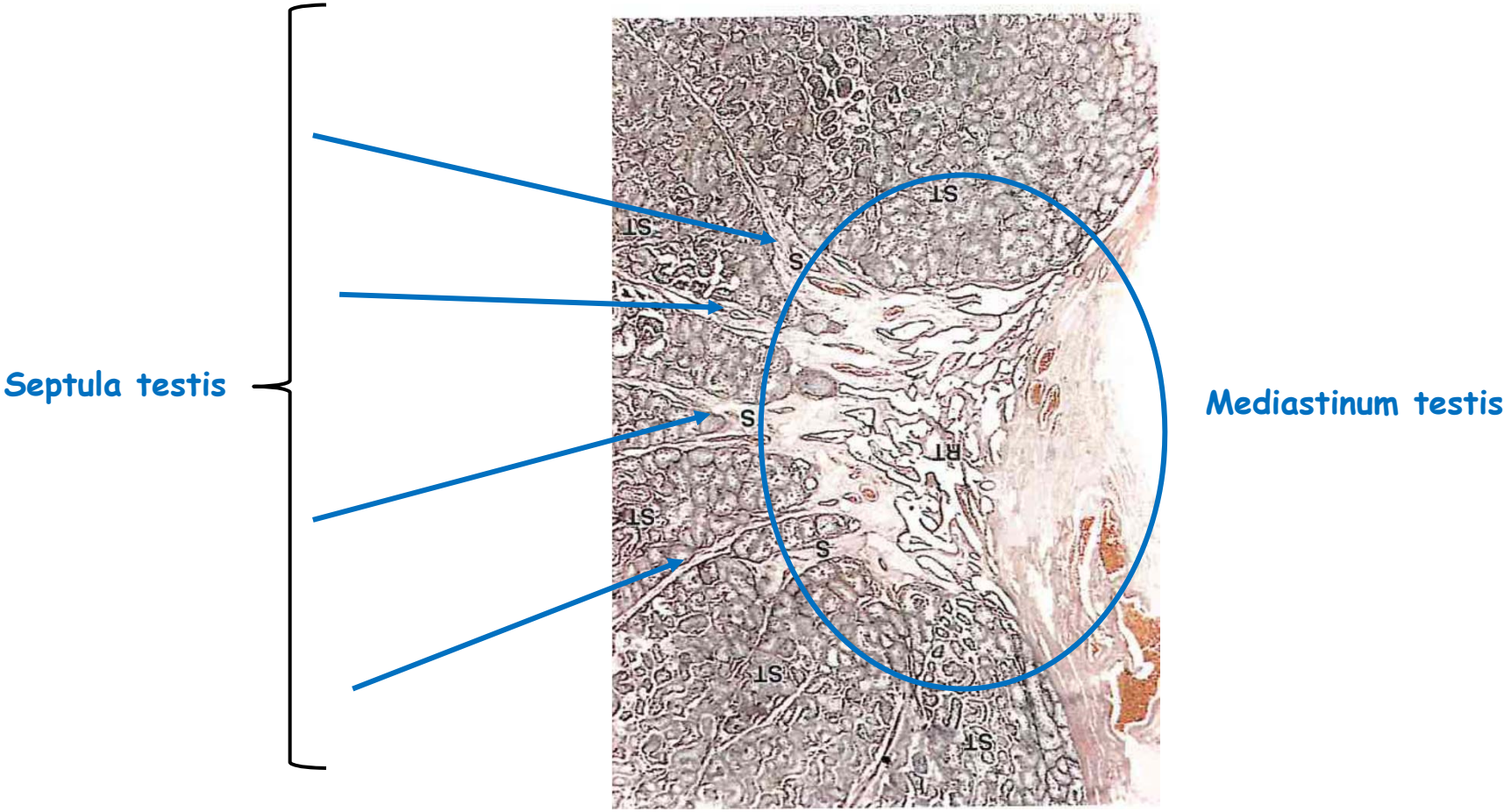
Tunica vasculosa

- inside of T. albuginea + adjacent to septa

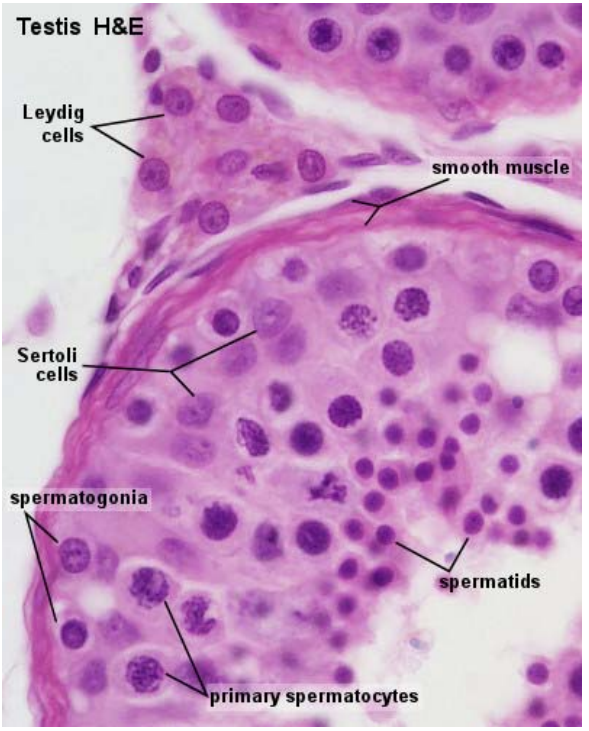
Tunica vaginalis

- serous, originates from peritoneum

Testis - 2



Testis - 3



Septulum testis

Tunica albuginea

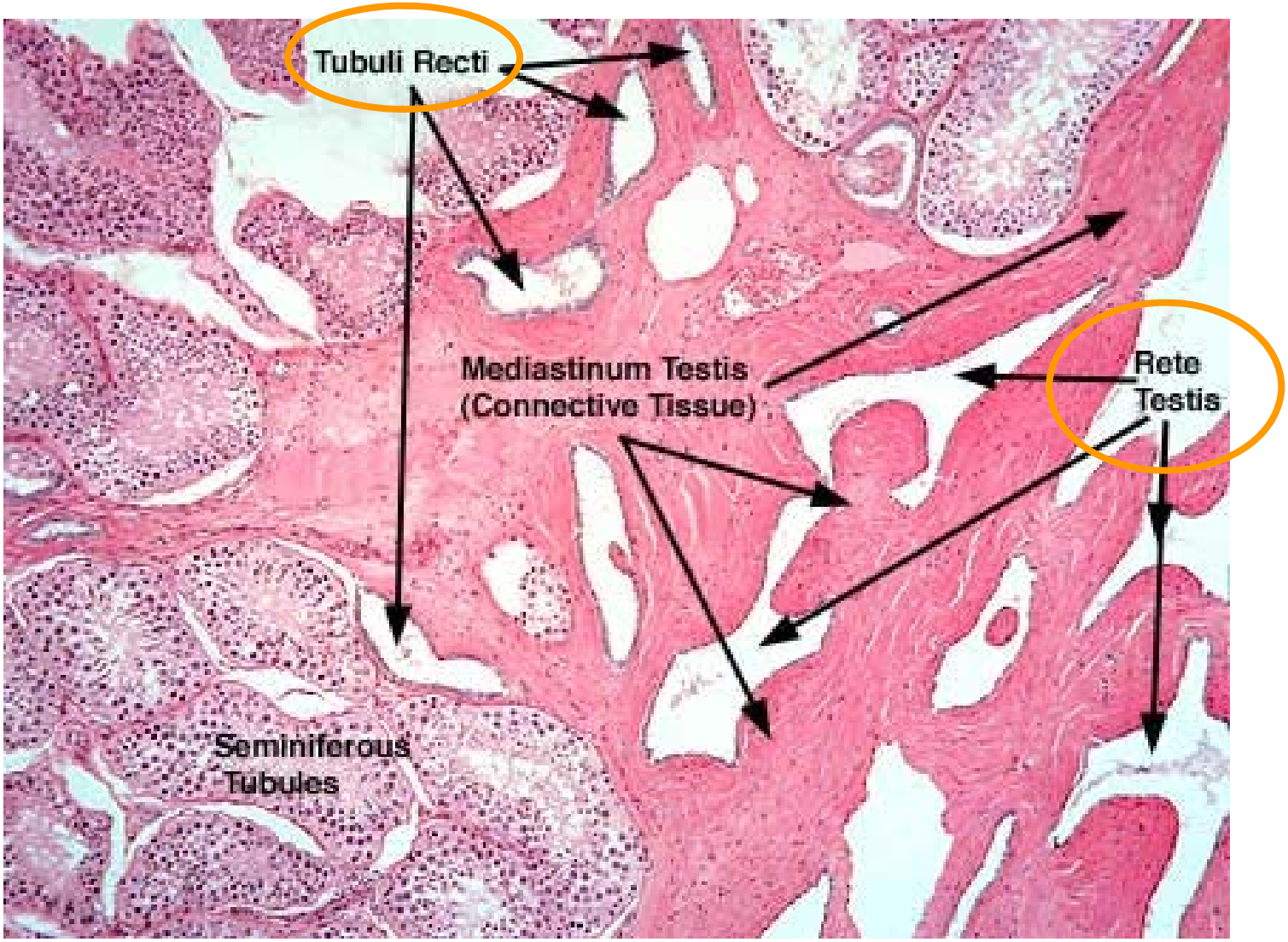
Seminiferous tubules

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

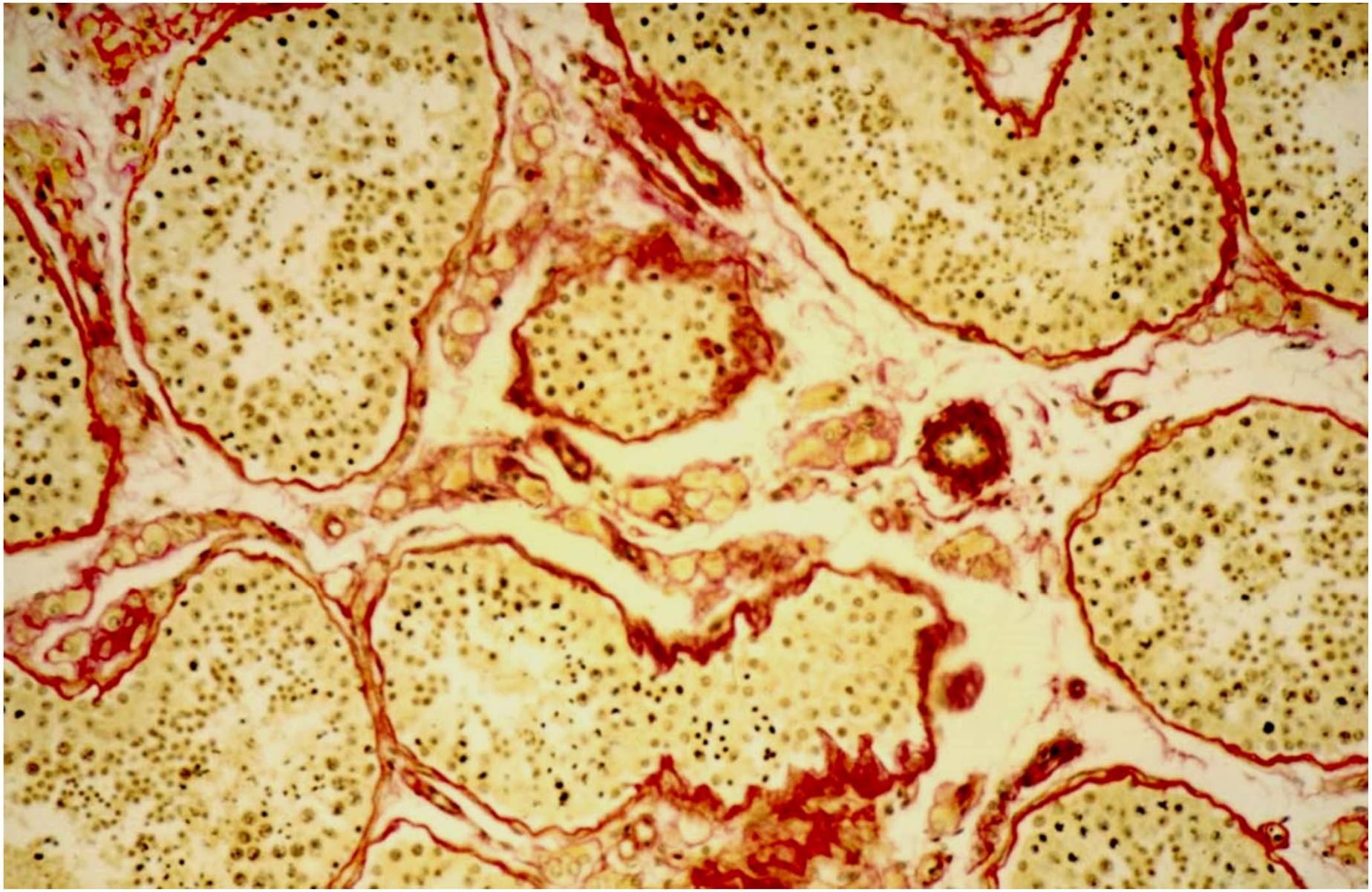
Interstitial tissue

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

Testis – 4 – continuation of seminiferous tubuli



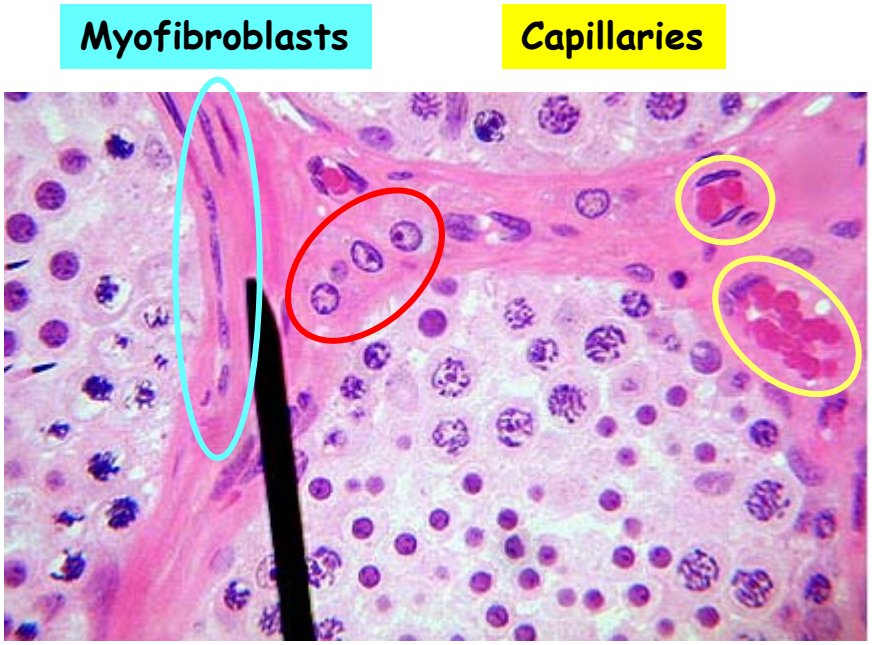
Testis - 5



Testis – 6 – interstitium – Leydig cells

Interstitium

- loose connective tissue
- fenestrated capillaries + lymphatics + nerves
- mast cells + macrphages + Lyedig cells



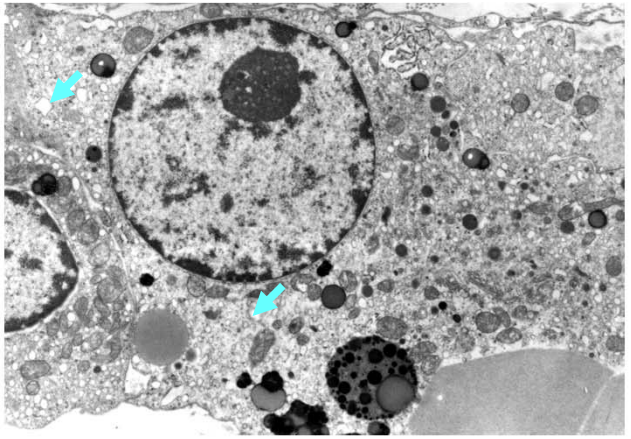
Leydig cells

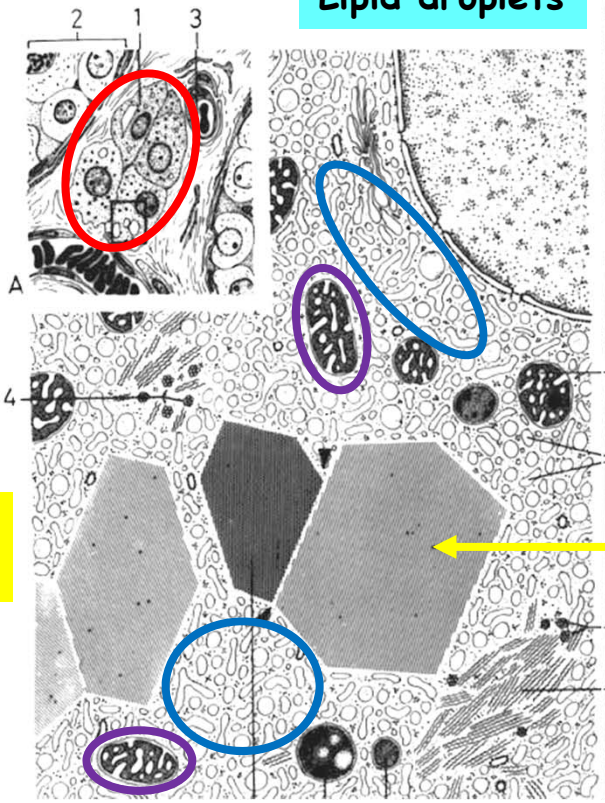
- round shaped
- large centrally located nuclei
- eosinophilic cytoplasm
- lipid droplets
- testosterone synthesis

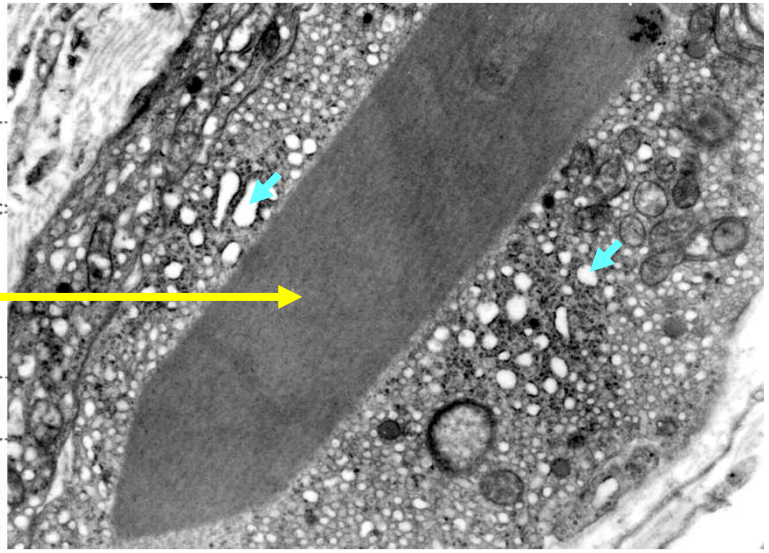
Testis – 7 – interstitium – Leydig cells

Mitochondria
+
Smooth ER
} Testosterone

Lipid droplets



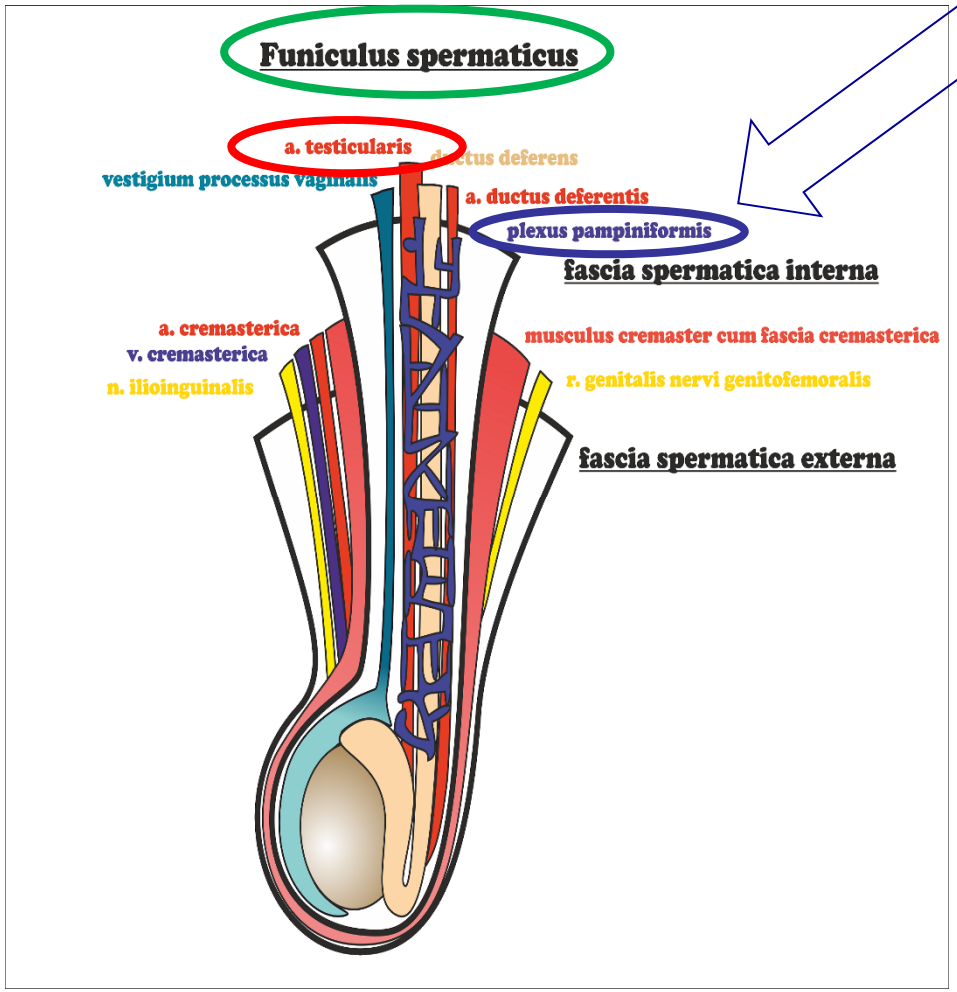


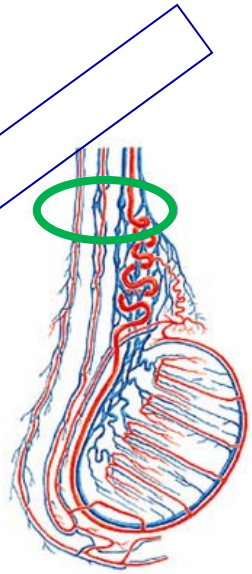


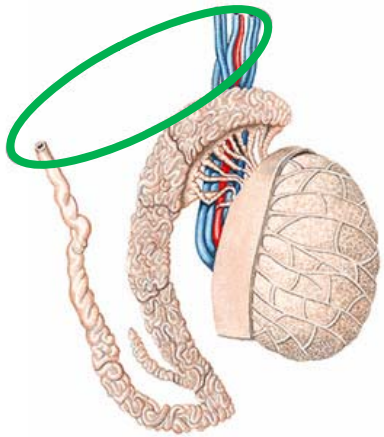
crystals of Reinke

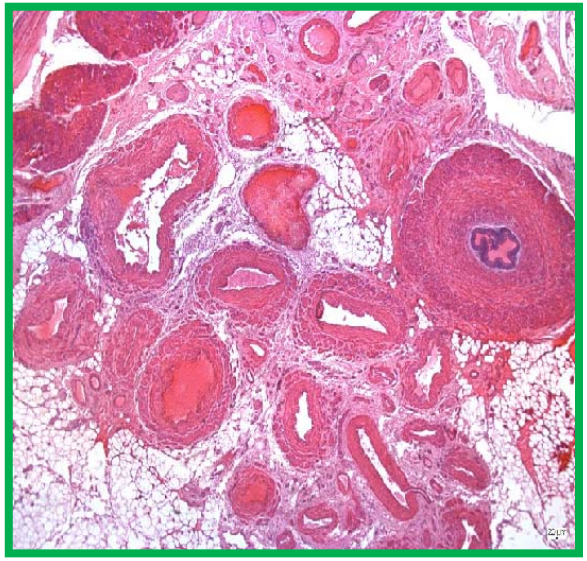
Testis – 8 – Blood supply – Plexus pampiniformis

Spermatic cord

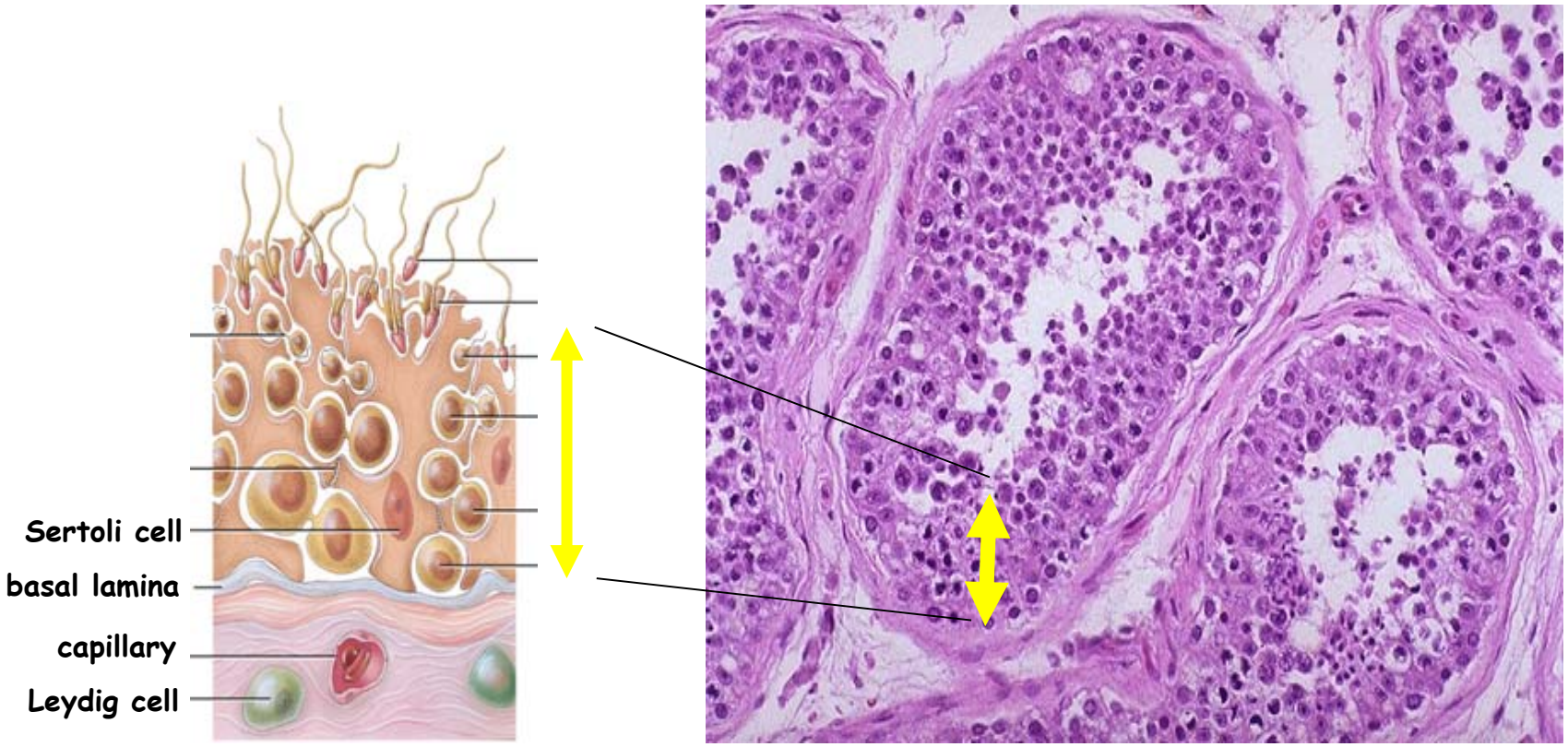








Testis – 9 – Seminiferous / Germinal epithelium



Testis – 10 – Sertoli cells

Morphology:

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

Function:

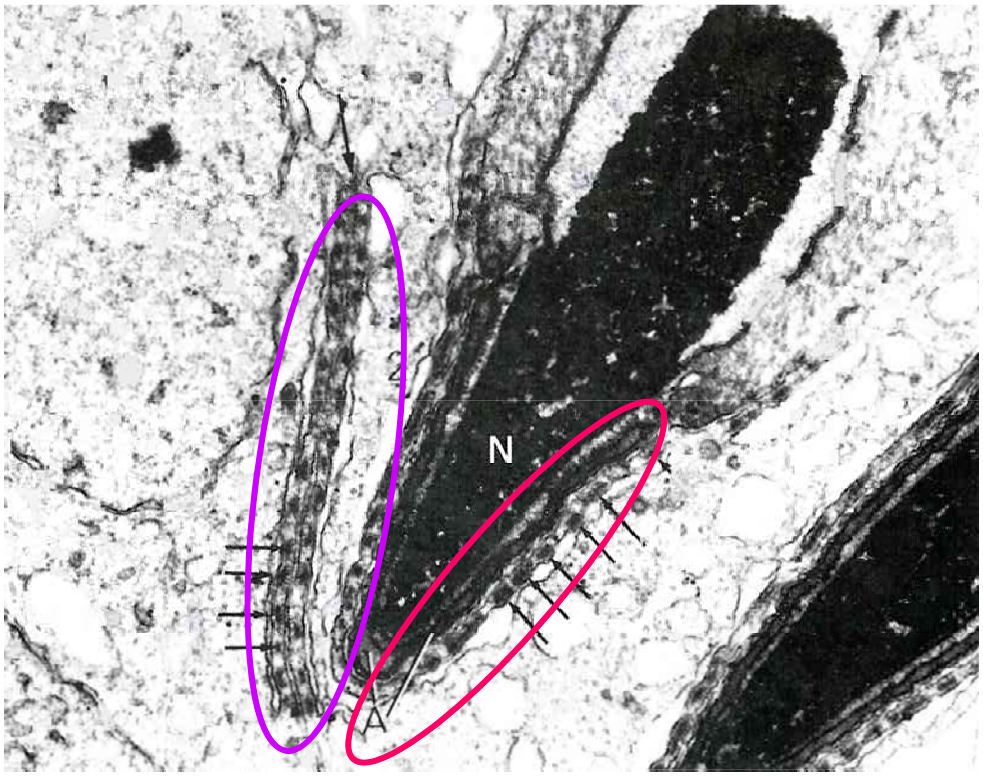
- support – physical + nutritional
- blood-testis barrier
- phagocytosis
- secretion of sperm transporting fluid + fructose
- endocrine: anti-Mullerian hormone + inhibin + androgen-binding protein

adluminal compartment

basal compartment

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

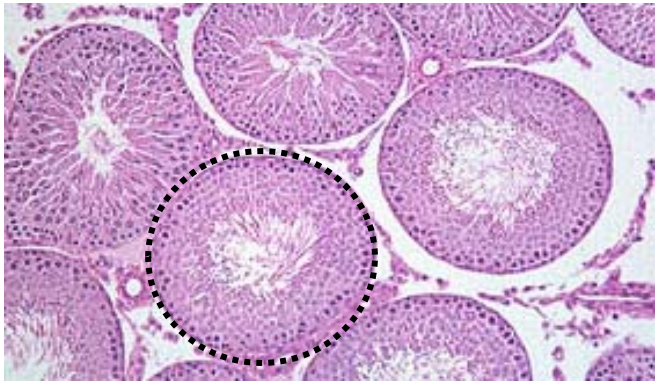
Testis – 11 – Sertoli cells – Junctional complexes



Sertoli-to-Sertoli

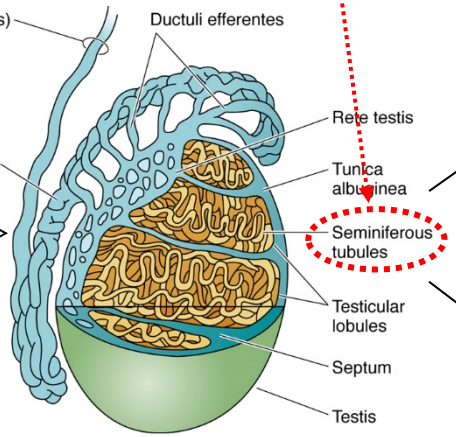
Sertoli-to-Spermatid

Spermatogenesis

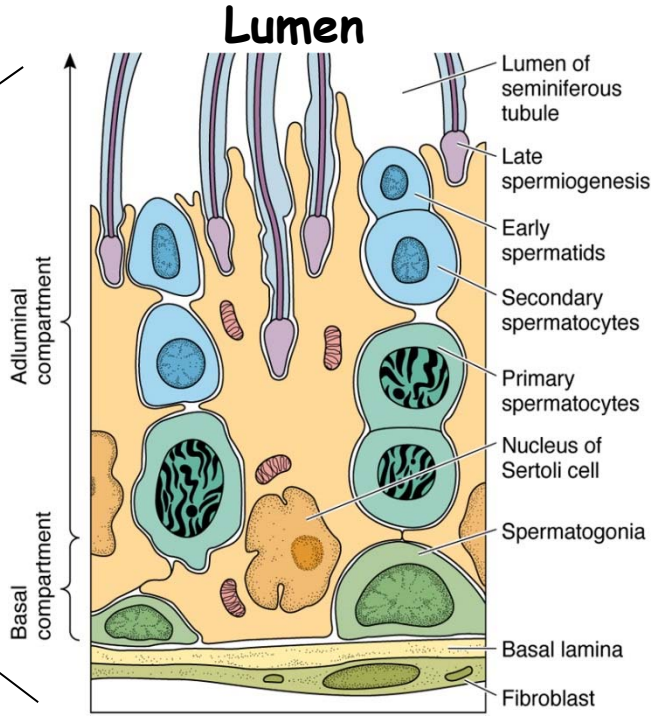


Before puberty → Slowly mitotically dividing spermatogonia in **genital ridges**

After puberty

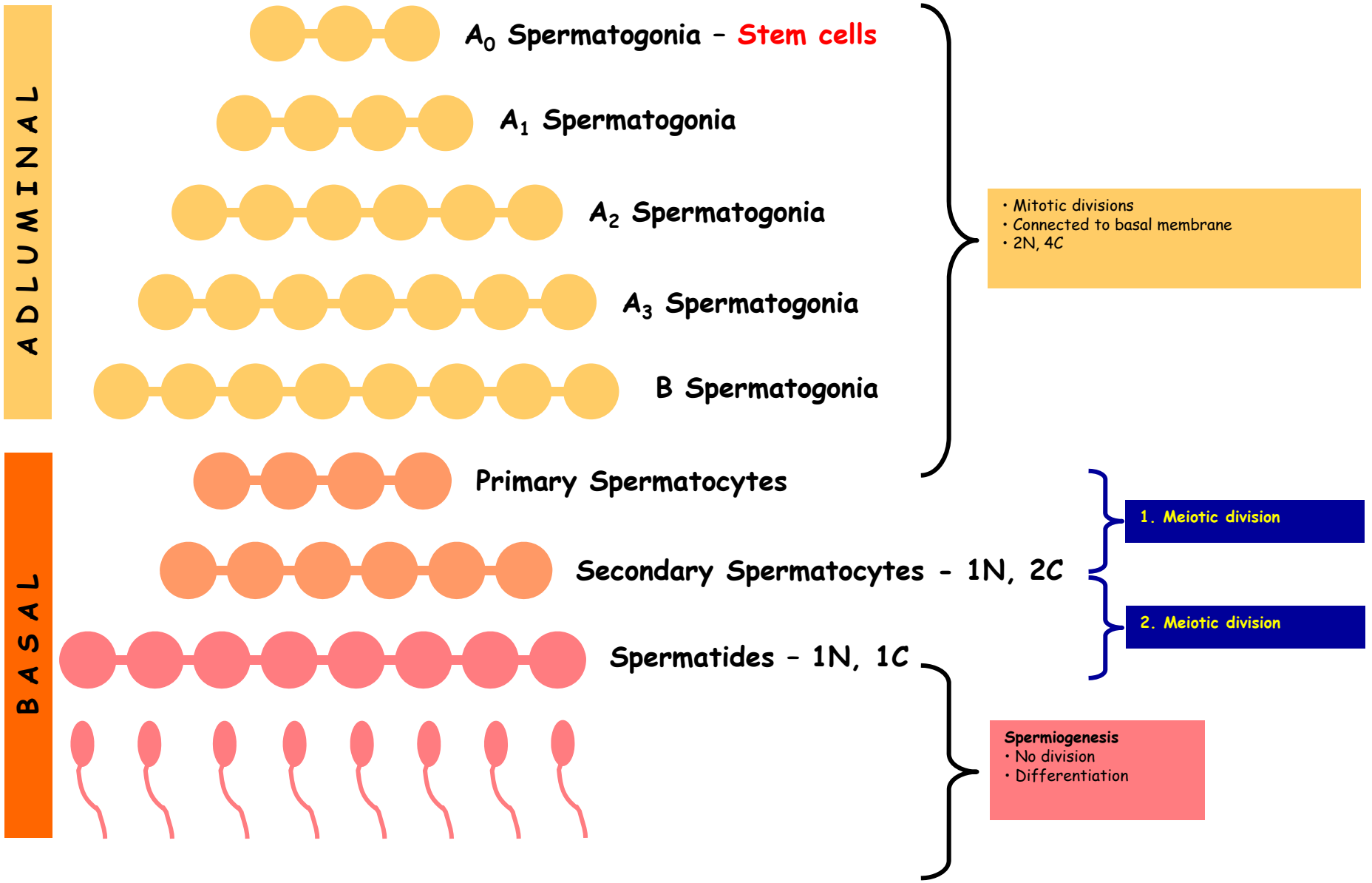


~0.25 mm
~0.5 km



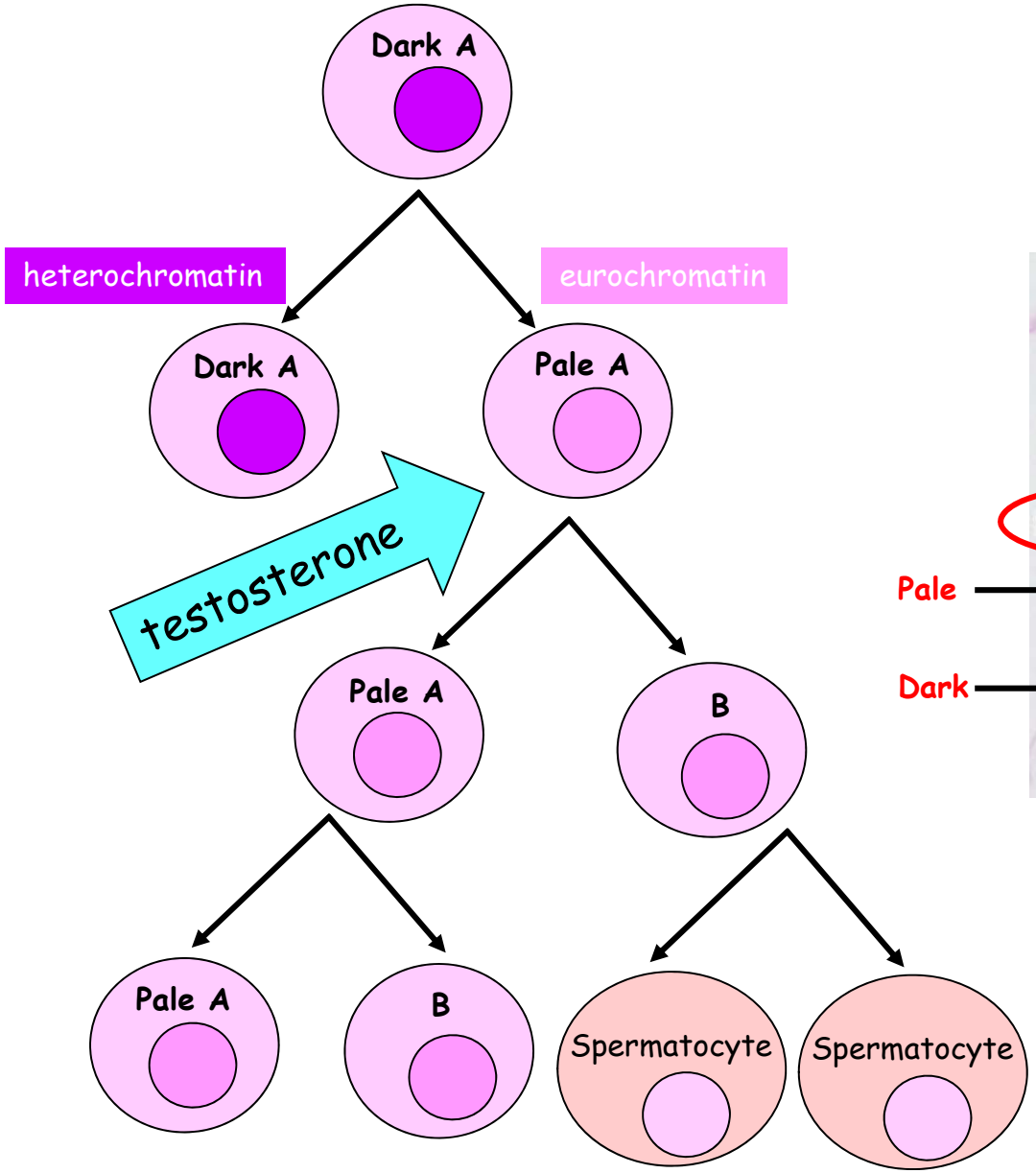
Spermatocytogenesis (mitotic) → **Meiotic phase** → **Spermiogenesis**

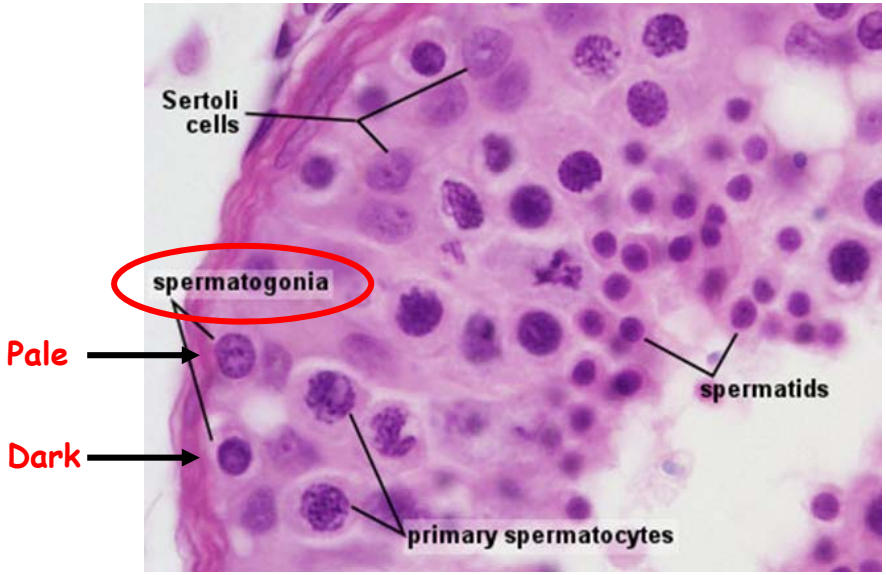
Spermatogenesis



Spermatogenesis - Spermatogonia

About 12 μm

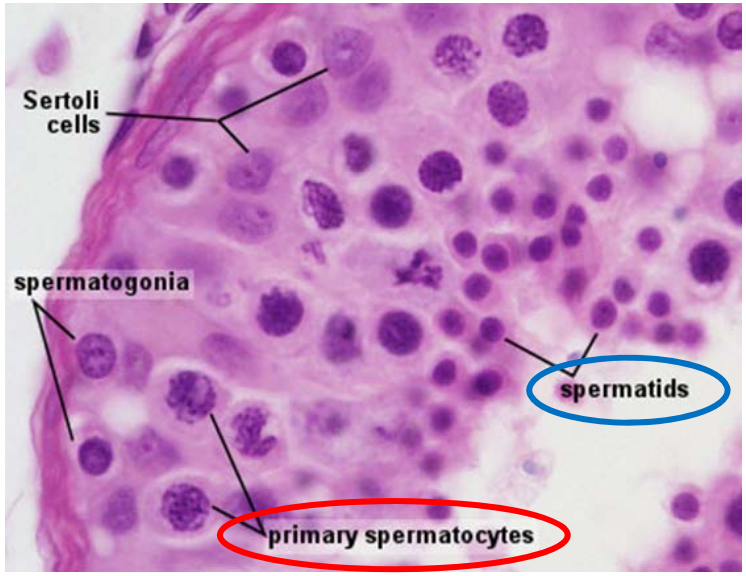




Spermatogenesis - Spermatocytes

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



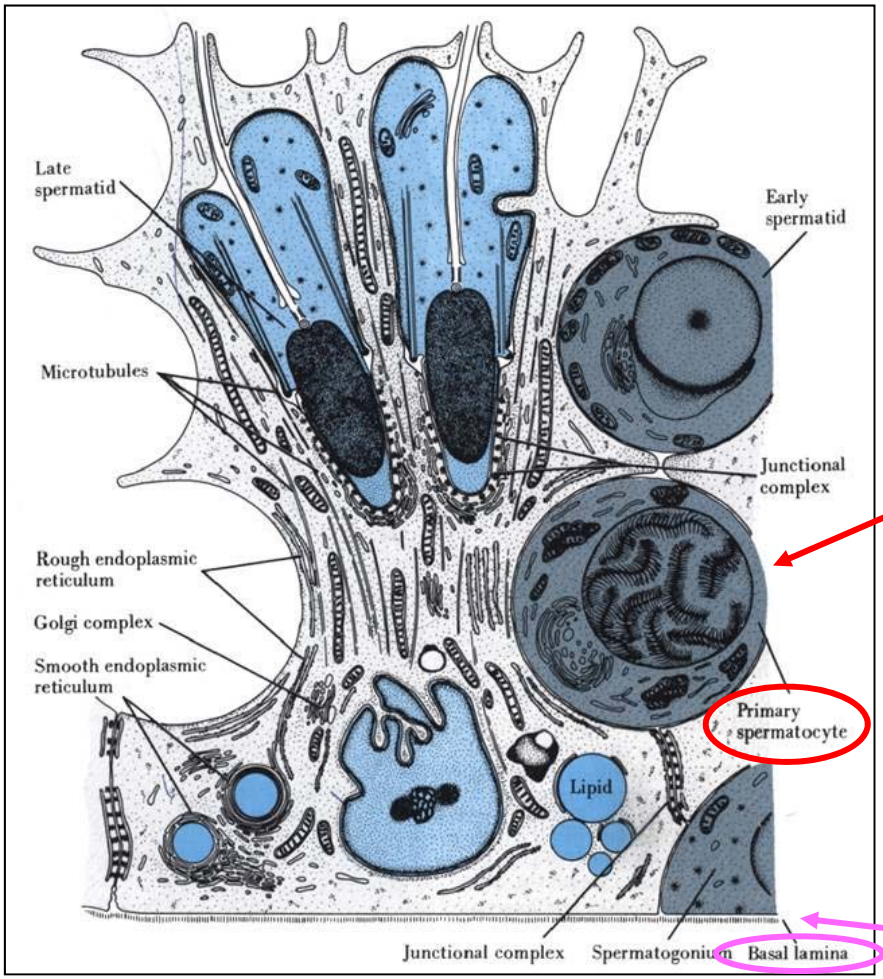
Secondary spermatocytes

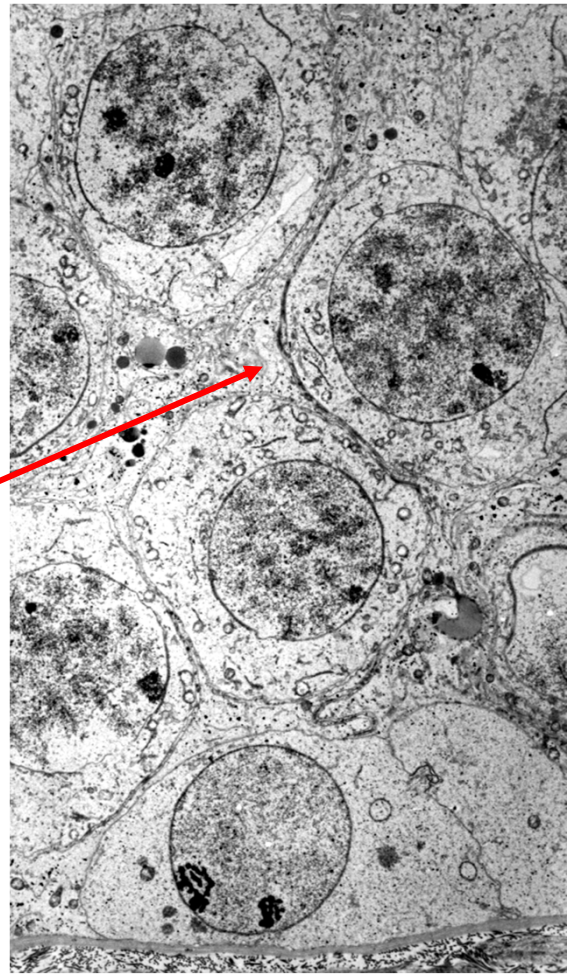
- smaller (12 μm)
- short living (~8 hrs)
- infrequently seen

equatorial division - Mei 2

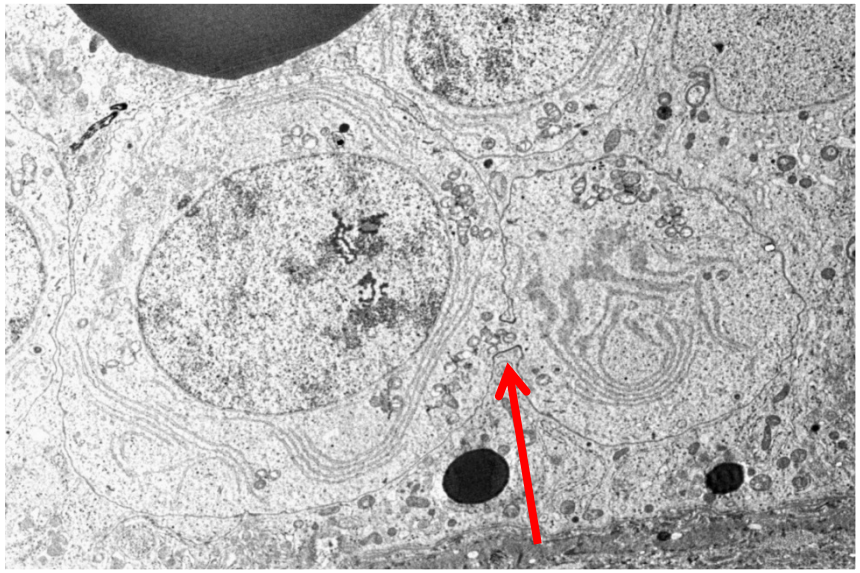
Spermatids

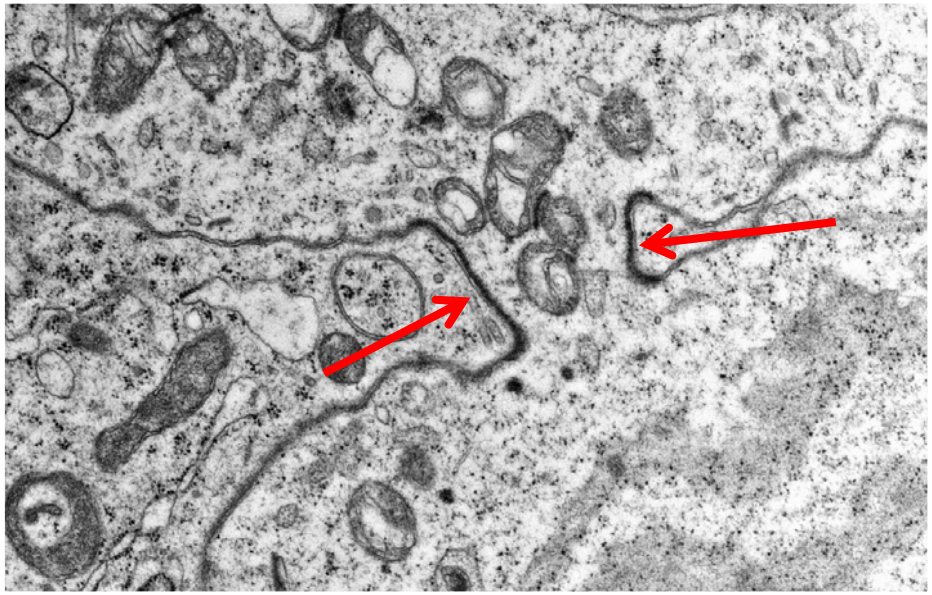
Spermatogenesis - Spermatocytes

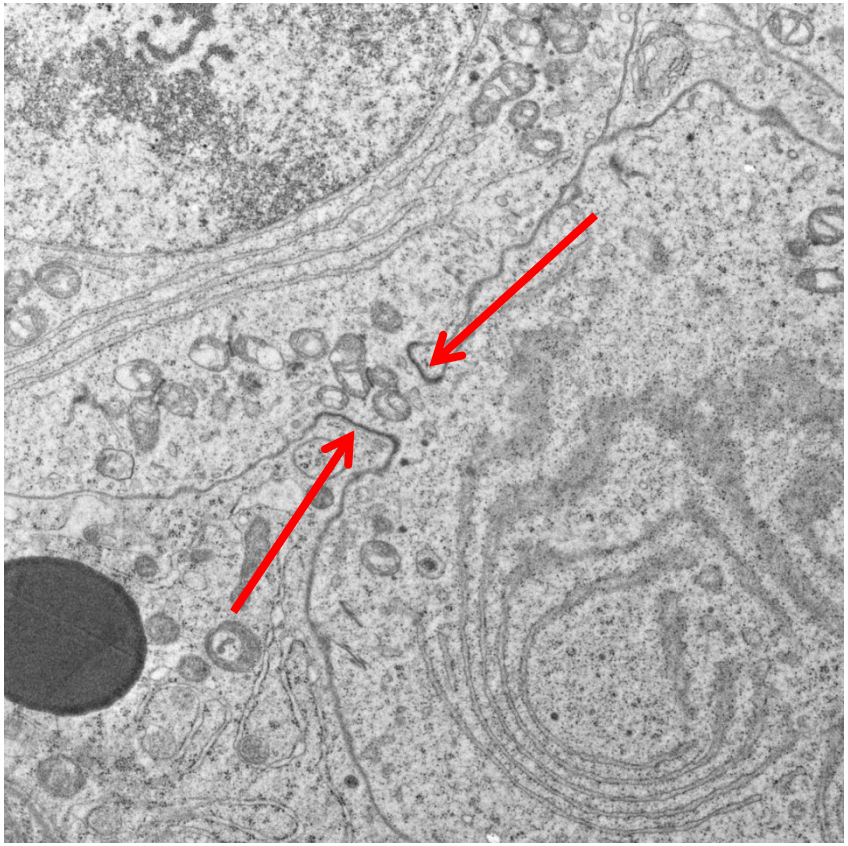




Spermatogenesis – Cytoplasmic bridges



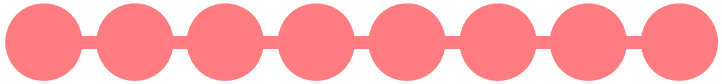




Spermatogenesis – Spermiogenesis

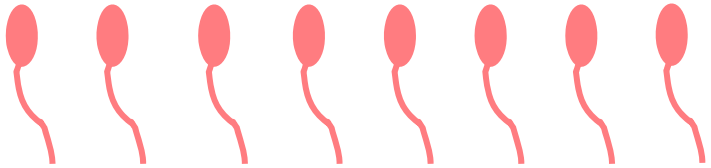
Spermatides

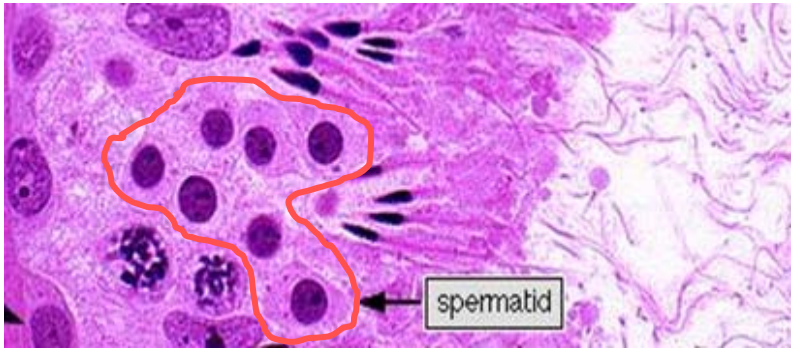
- small germ cells (6-8 μm)
- cytoplasmic bridges

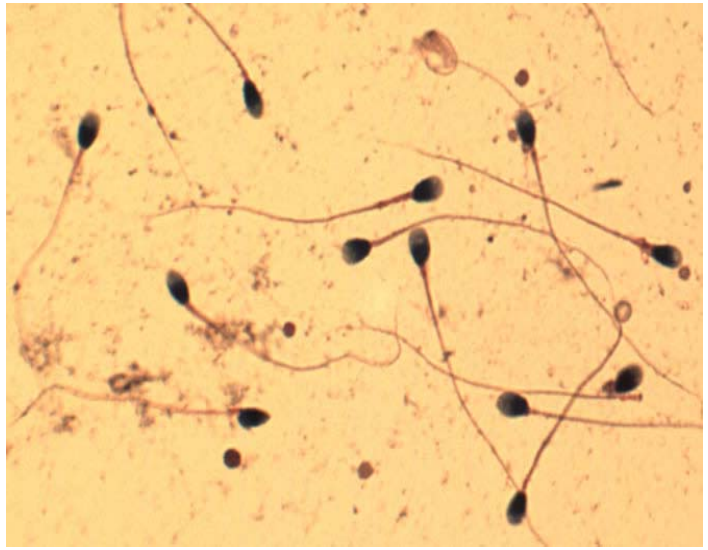


morphogenesis

Spermatozoa







Key elements

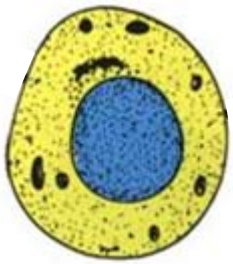
1. Formation of acrosome
2. Development of flagellum
3. Chromatin condensation + shaping the nucleus
4. Reduction of cytoplasm

Spermatogenesis – Spermiogenesis

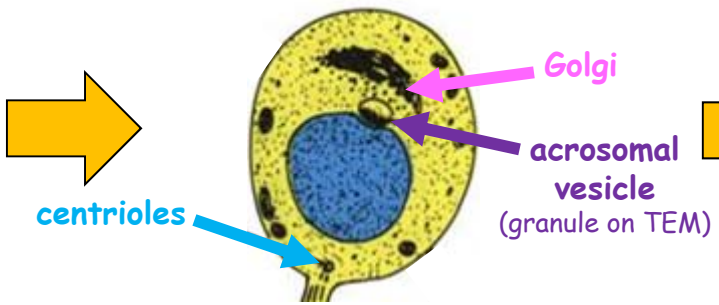
- Prominent Golgi complex
- Numerous mitochondria
- Pair of centrioles

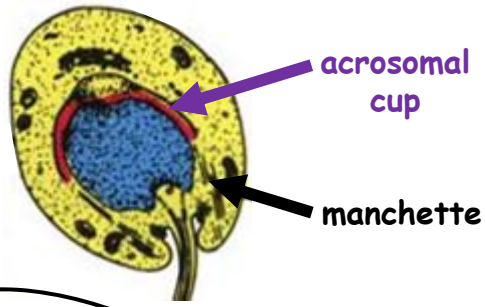
- Transgolgi pathway produces granules
- Granules form **acrosomal vesicle**

- Acrosomal vesicle flatten - **cup**
- Microtubules arrange into **manchette**
- Chromosemes begin to condensate

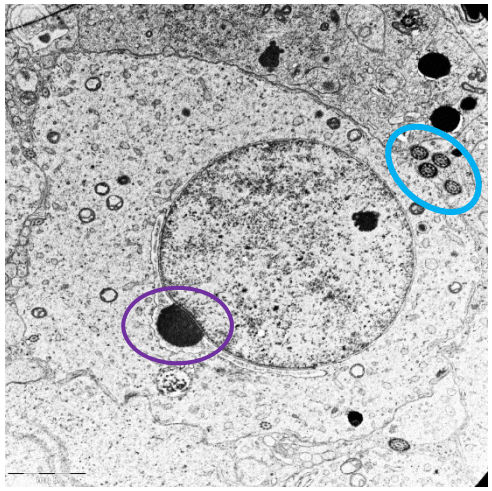


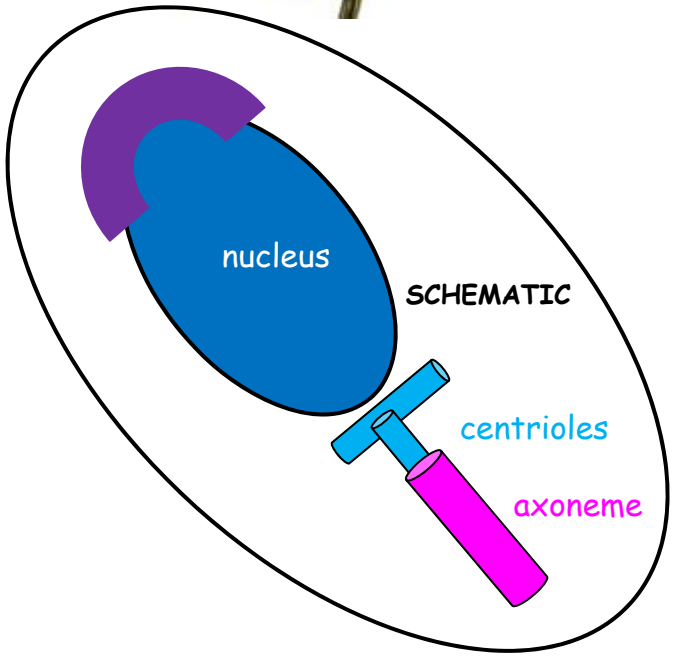
Spermatid



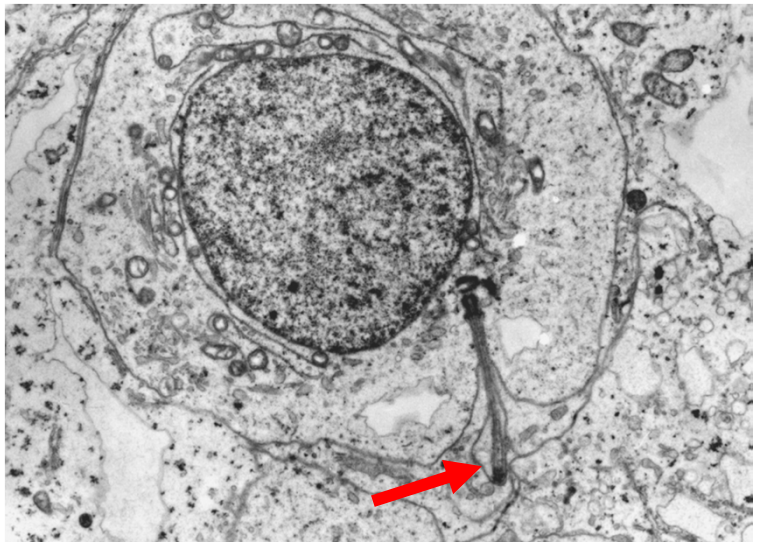


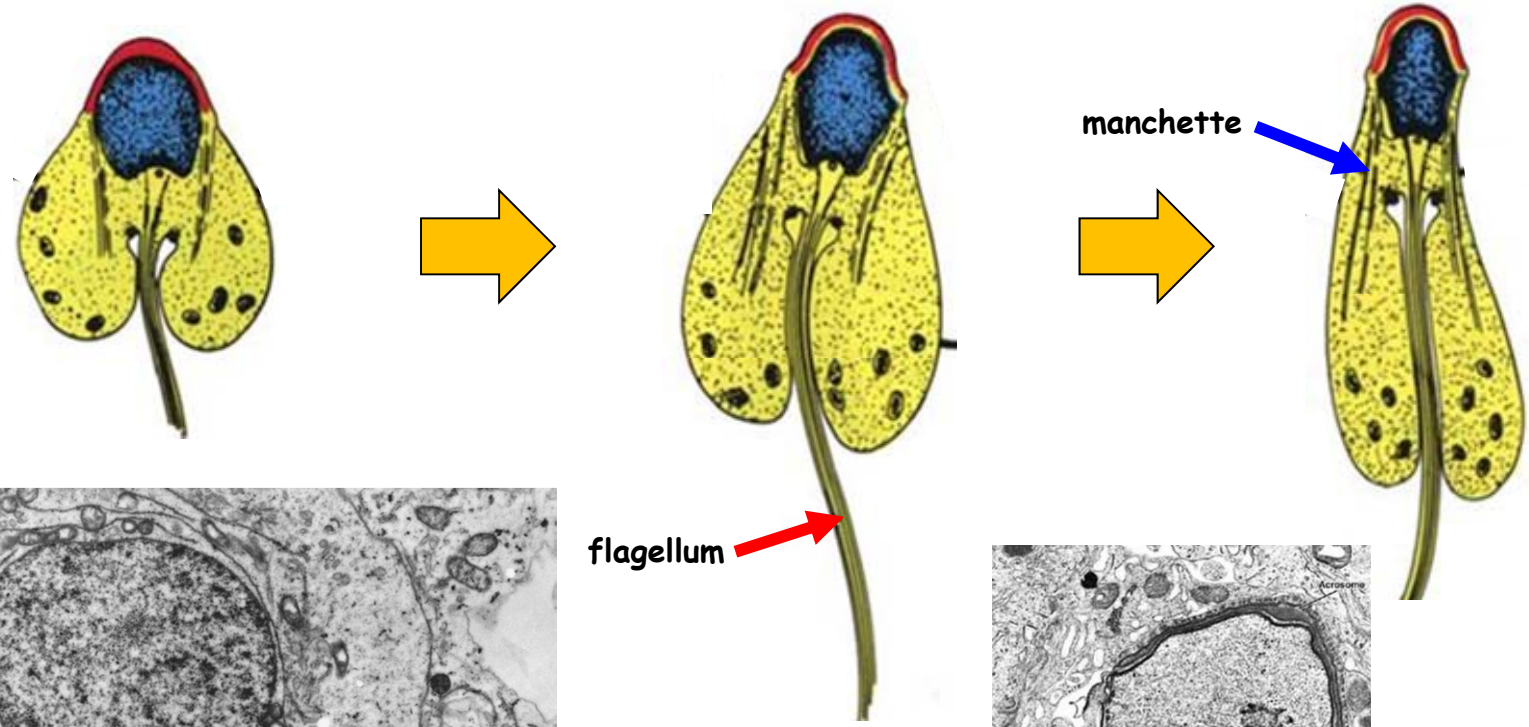
Acrosomal enzymes
- hyaluronidase
- acrosin
- acid phosphatase
- neuraminidase



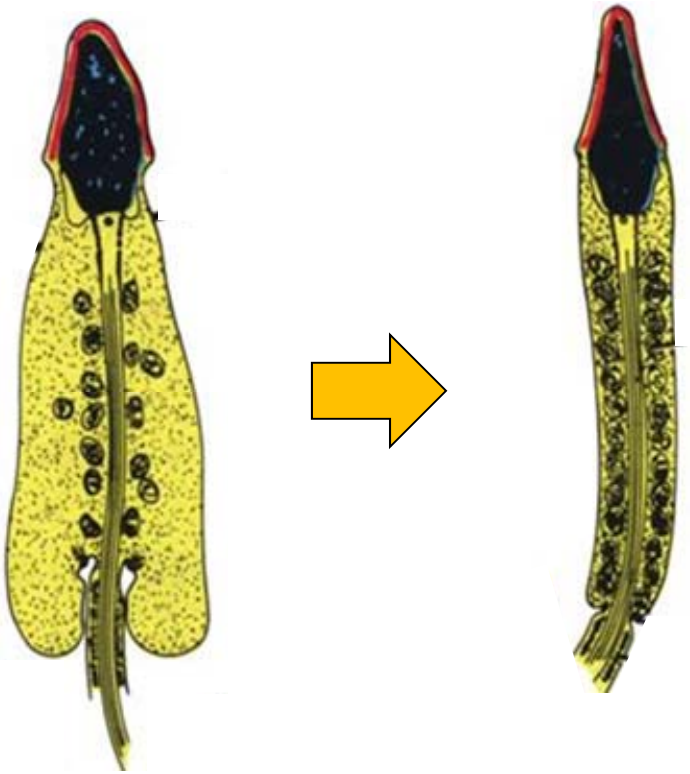


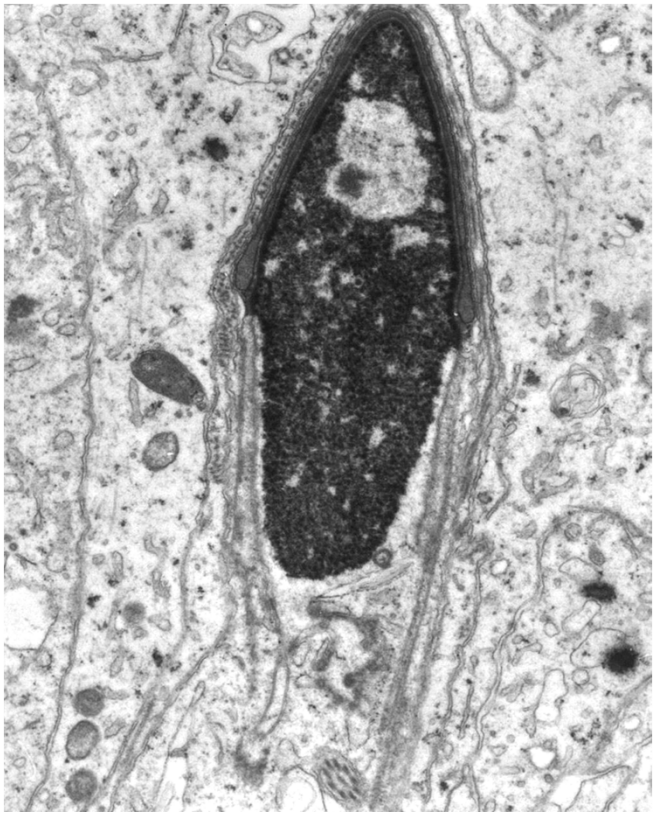
Spermatogenesis – Spermiogenesis





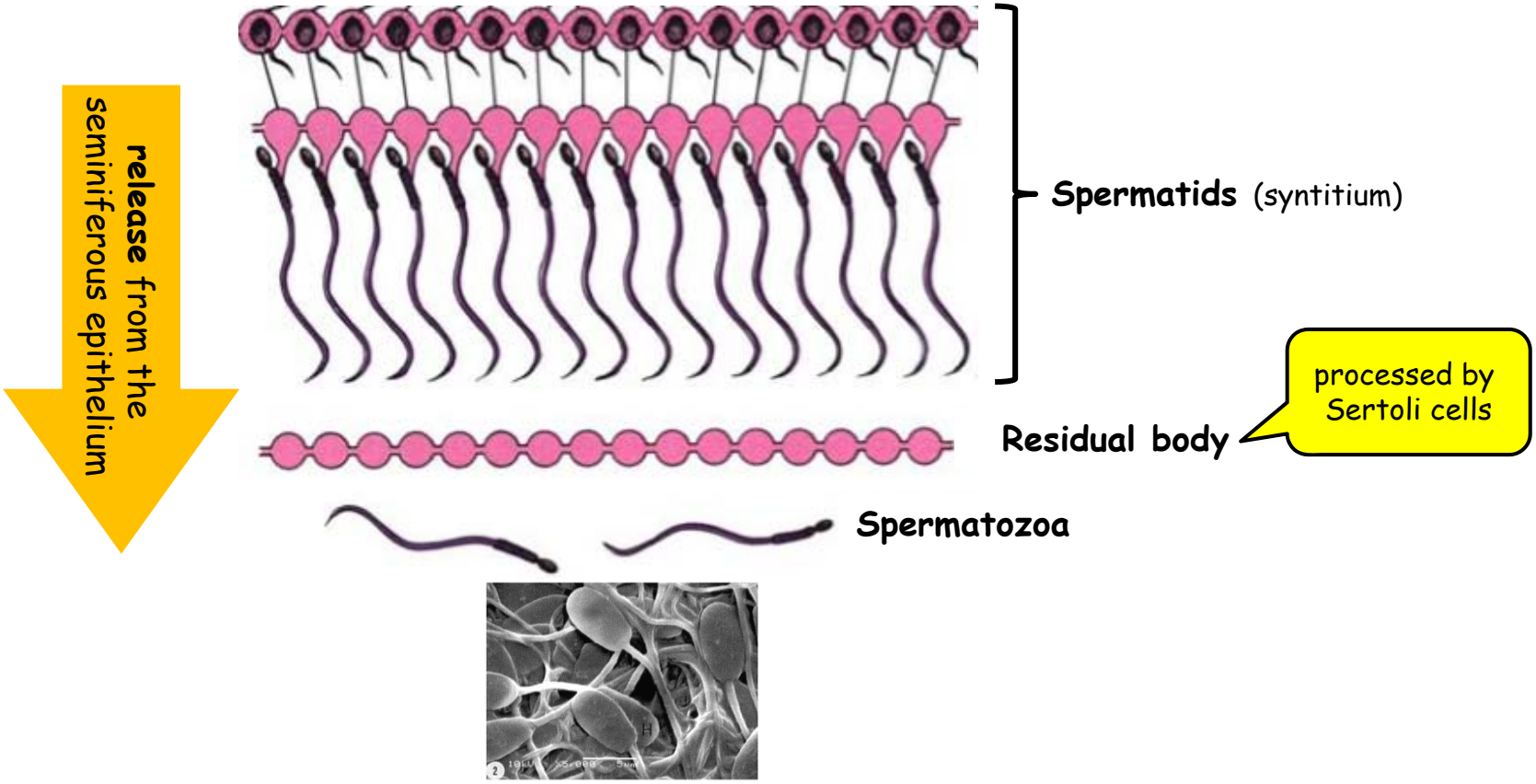
Spermatogenesis – Spermiogenesis





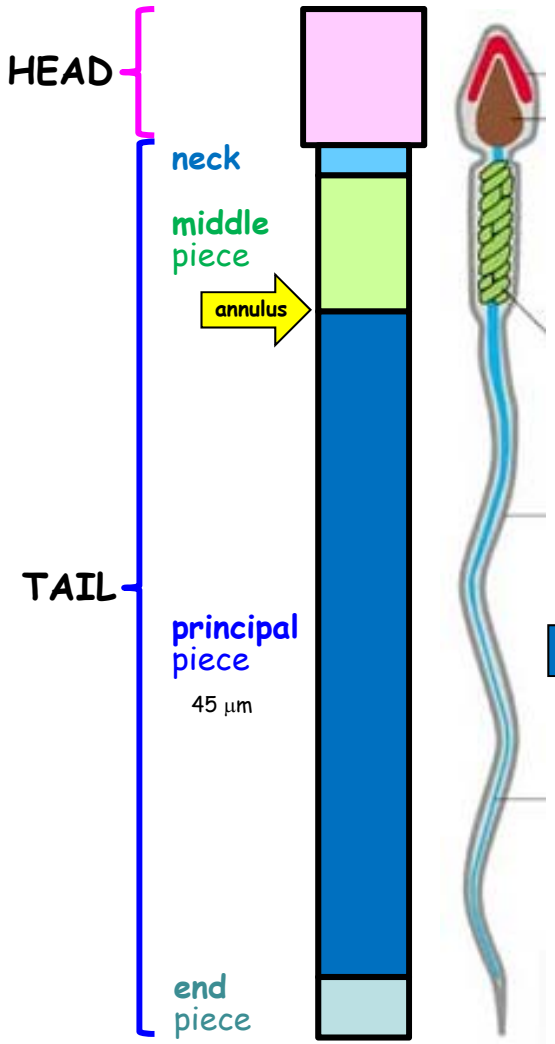
Spermatogenesis – Spermiation

= final stage of spermiogenesis

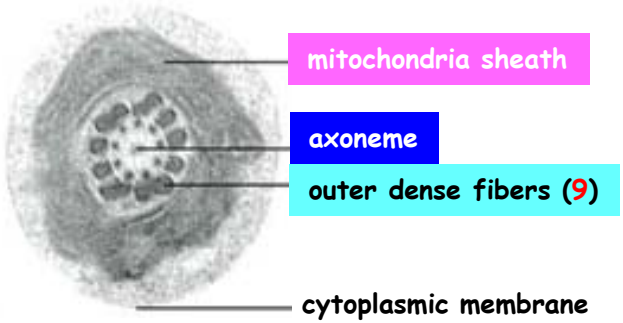


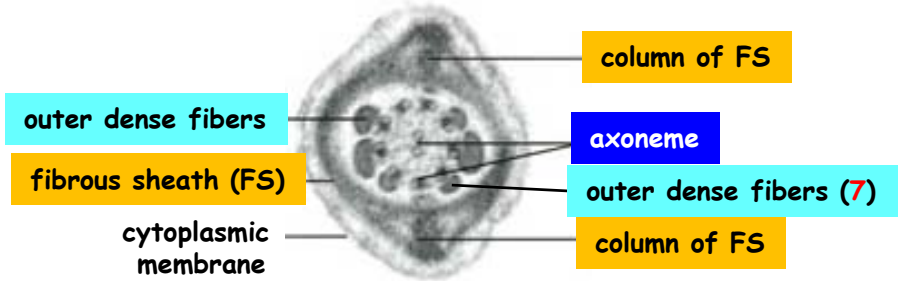
Spermatozoon

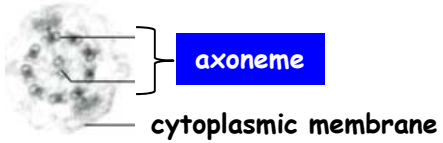
Total length = 65 μm

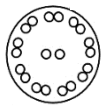


at „annulus"

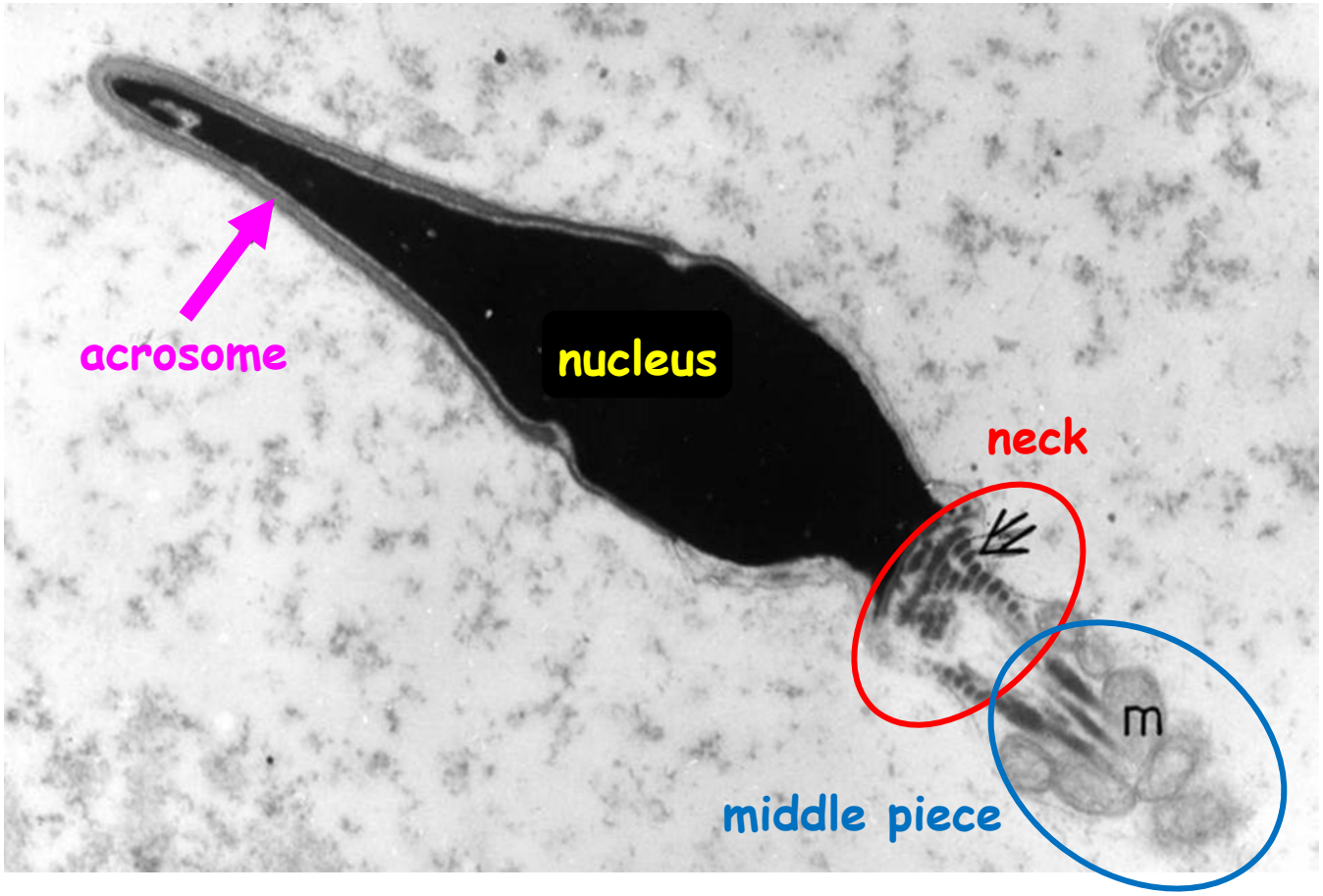






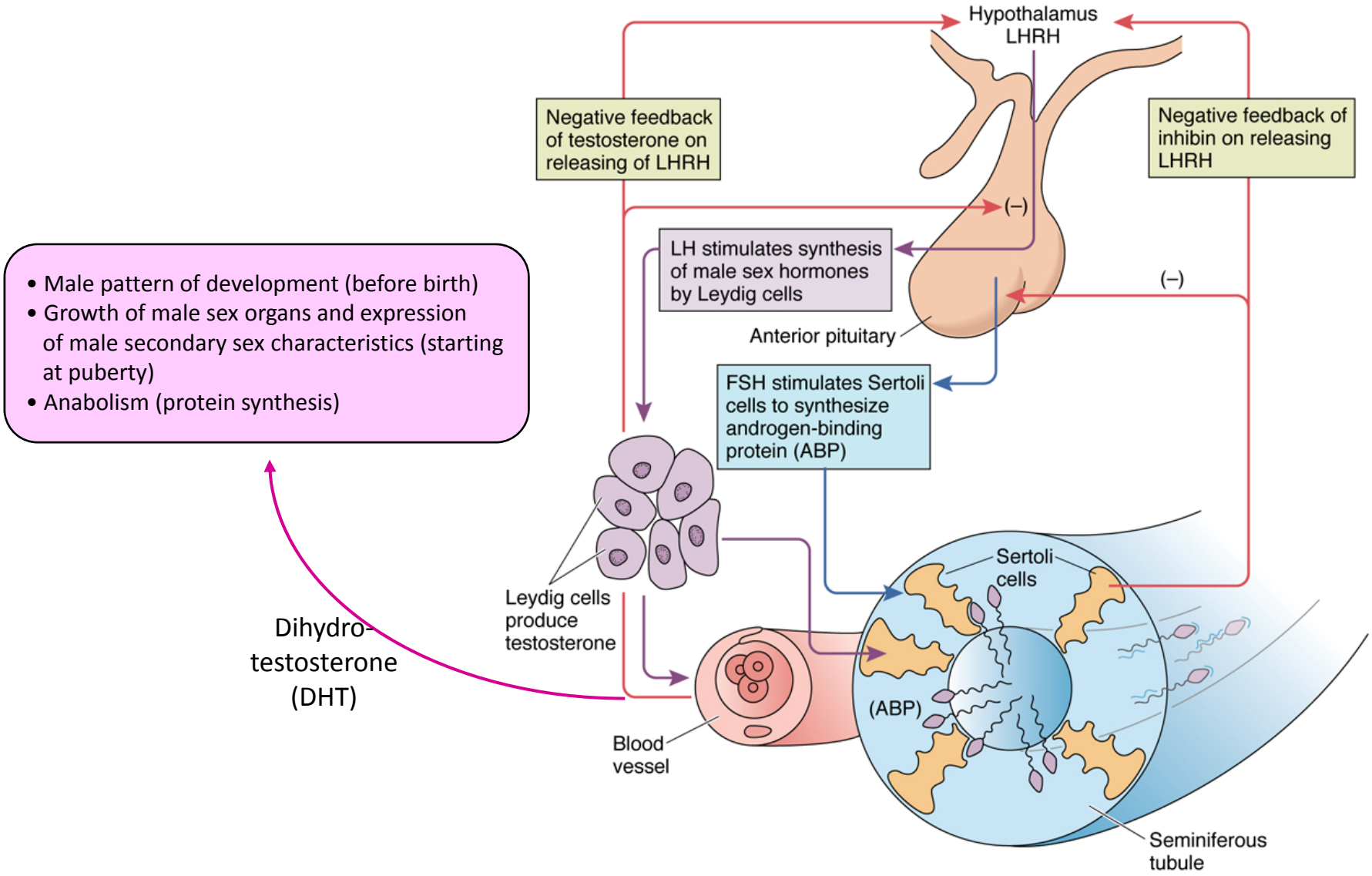


Spermatozoon



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 epidydimis
- 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 concrements

Seminal plasma:

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

Spermatozoa + Ejaculate

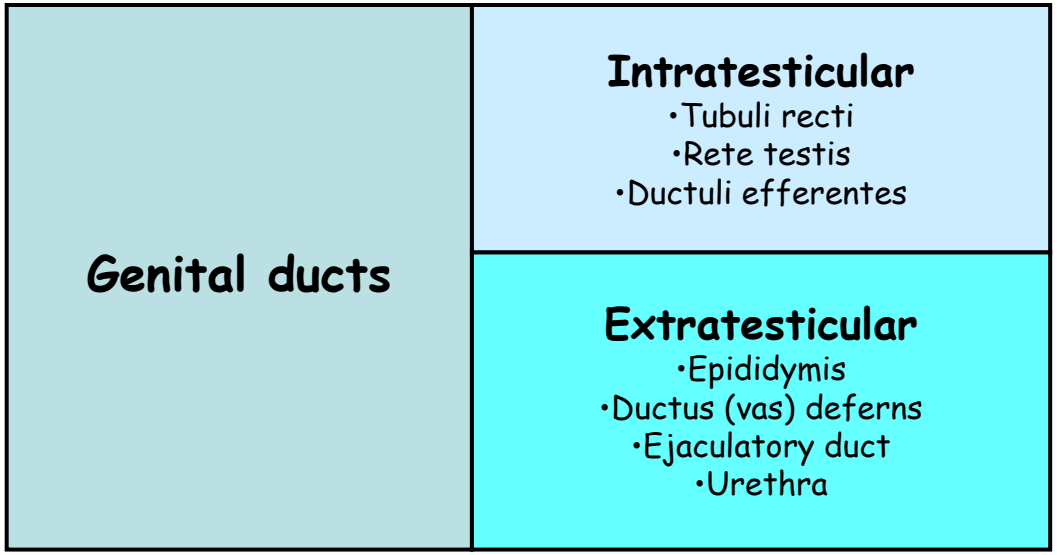
Normozoospermia – WHO standard

- **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 %

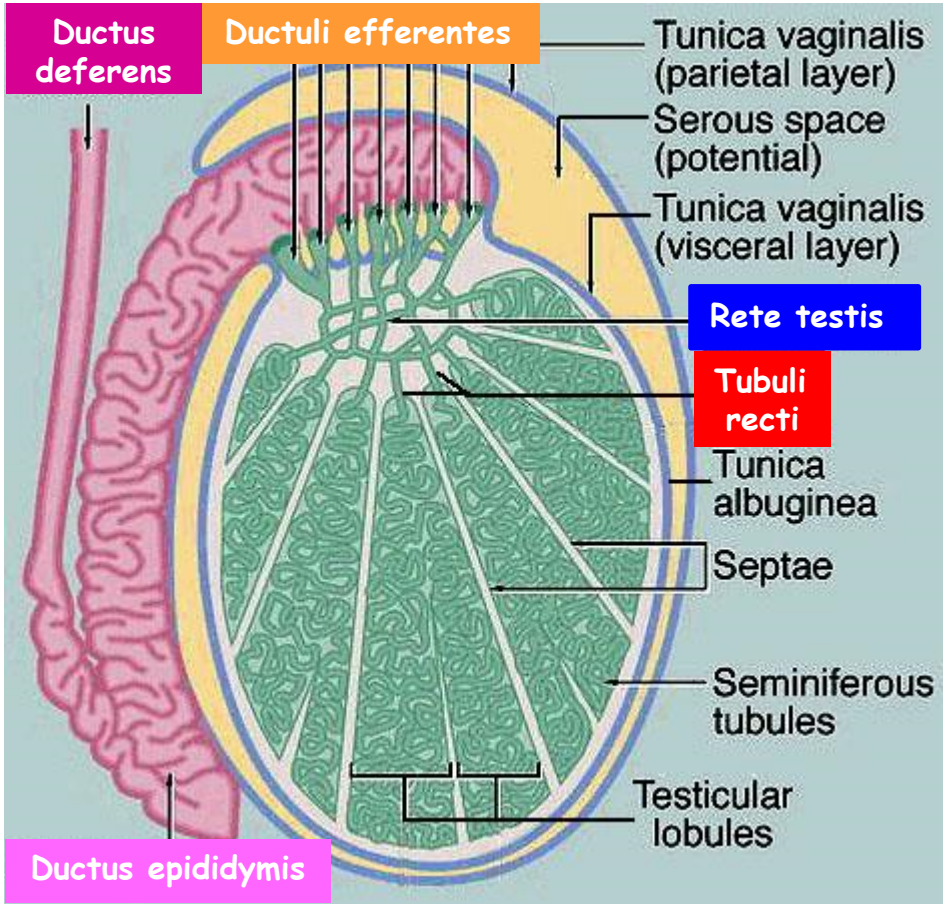
Abnormal spermiogram - Nomeclature

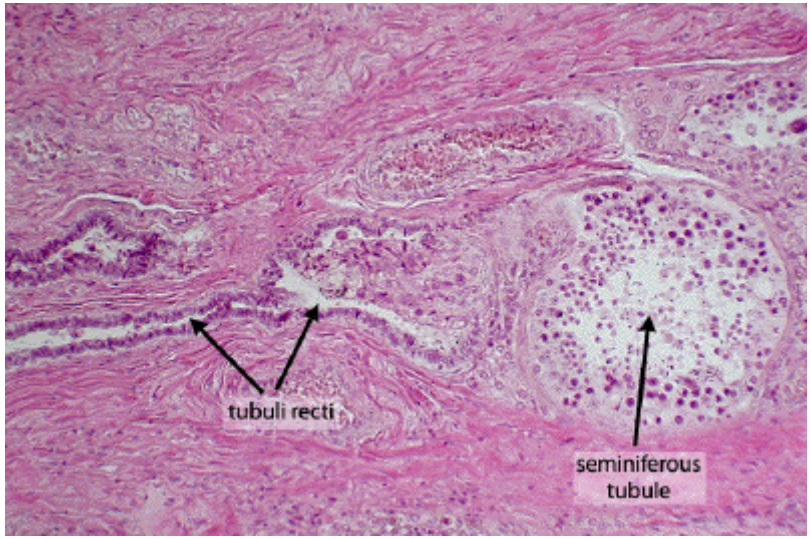
- **Asthenozoospermia**: reduced sperm motility
- **Oligozoospermia**: reduced sperm concentration in ejaculate
- **Teratozoospermia**: large numbers of morphologically abnormal sperm
- **Oligoastenoteratospermia**: combined abnormality in numbers, motility, and morphology of sperm
- **Azoospermia**: complete absence of sperm in ejaculate
- **Necrozoospermia**: high percentage of dead sperm (norm = minimum 58%)
- **Pyospermia**: unusually high numbers of leucocytes in ejaculate (norm = max. 1 million)

Male efferent passages = Genital ducts



Intartatesticular genital ducts – Tubuli recti

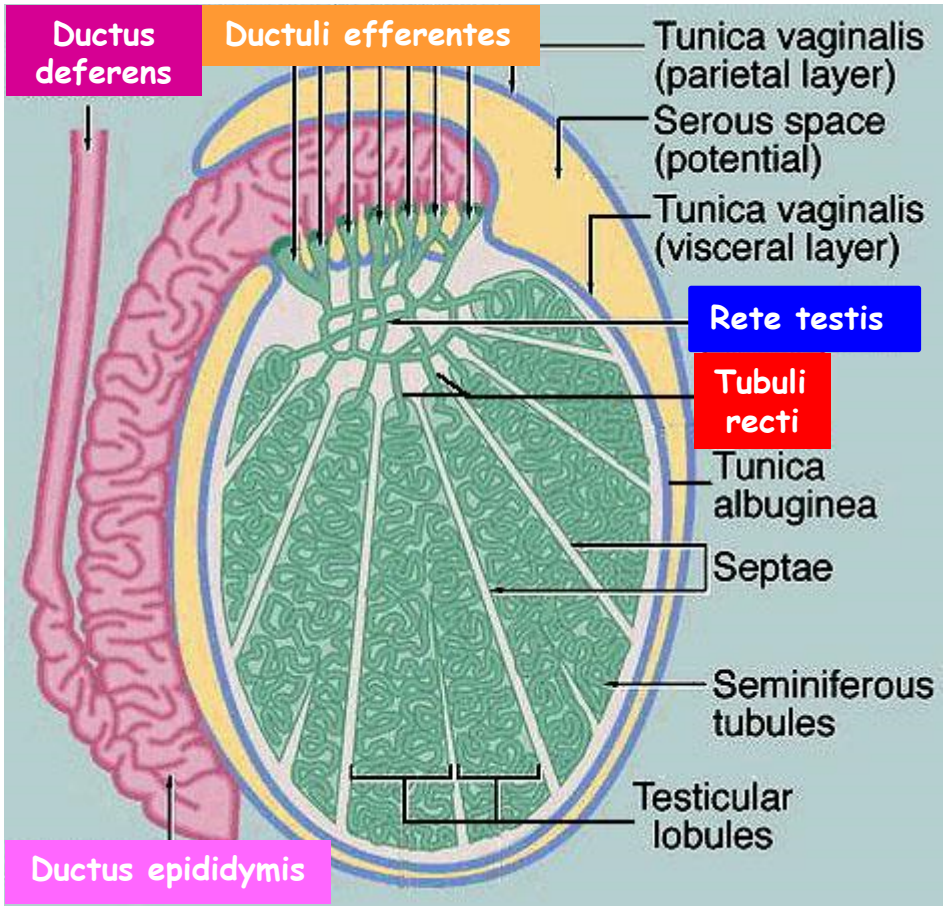


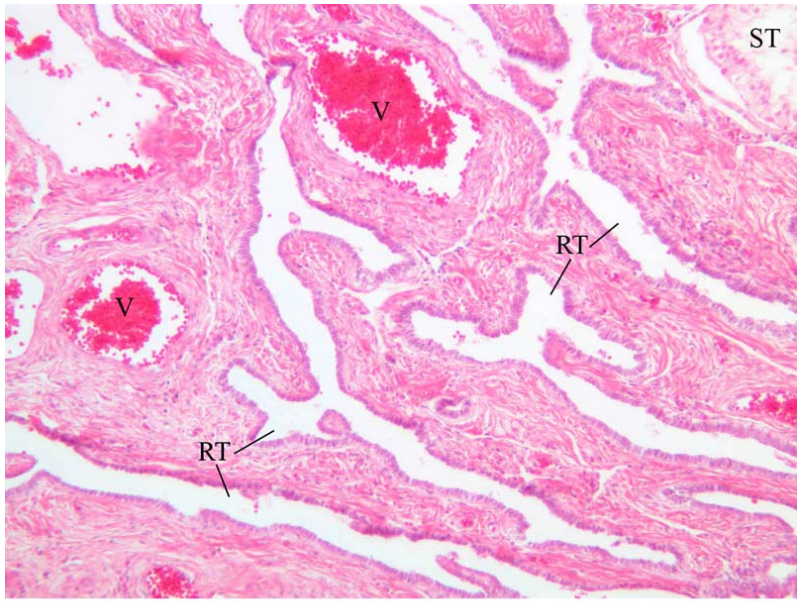


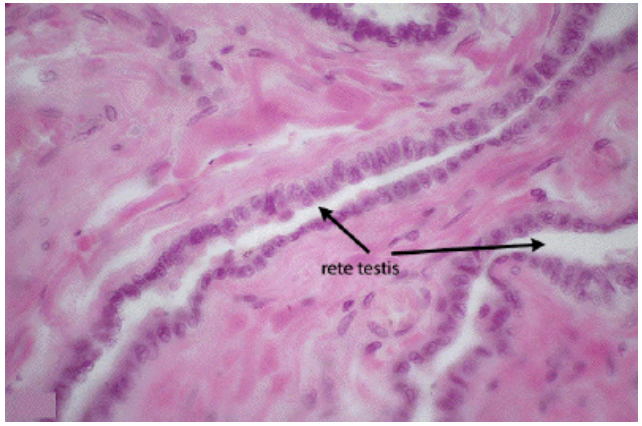
- short – about 1 mm
- in septula
- proximal part: Sertoli cells
- distal part: simple cuboidal epithelium

(with microvili + cilium)

Intartatesticular genital ducts – Rete testis

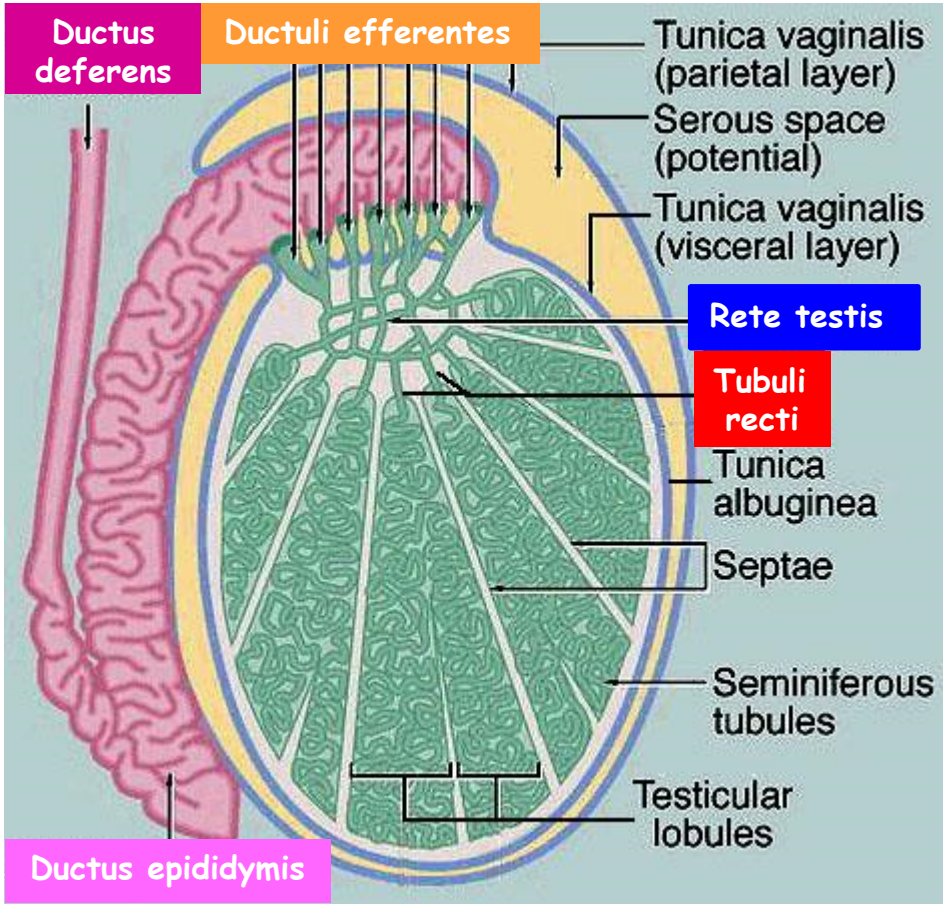


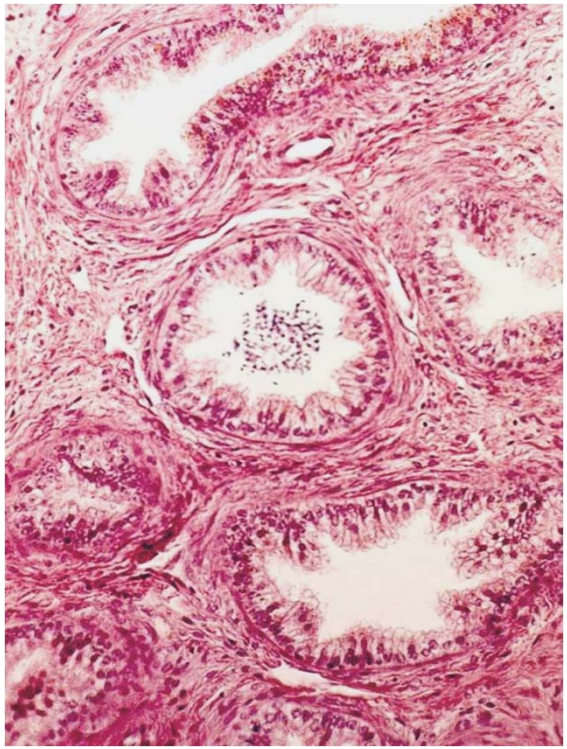




- labyrinth – interconnected channels
- in mediastinum
- simple cuboidal epithelium (as in Tubuli recti)
  (with microvili + cilium)

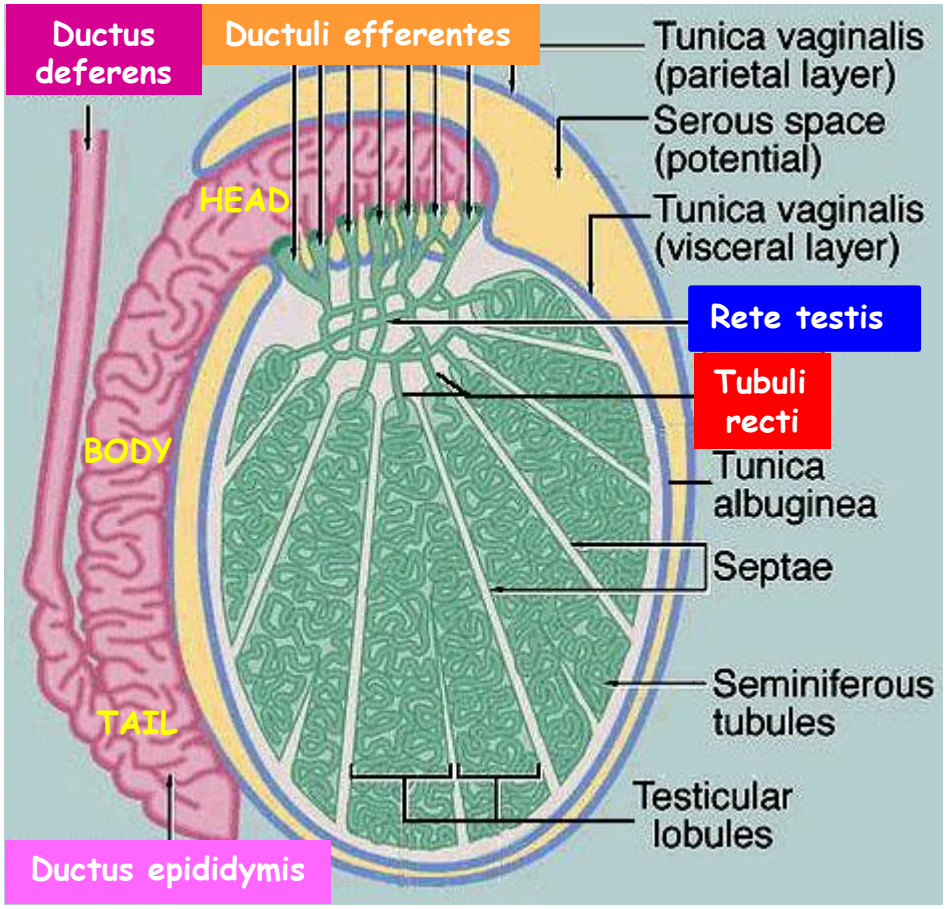
Intartatesticular genital ducts – Ductuli efferentes





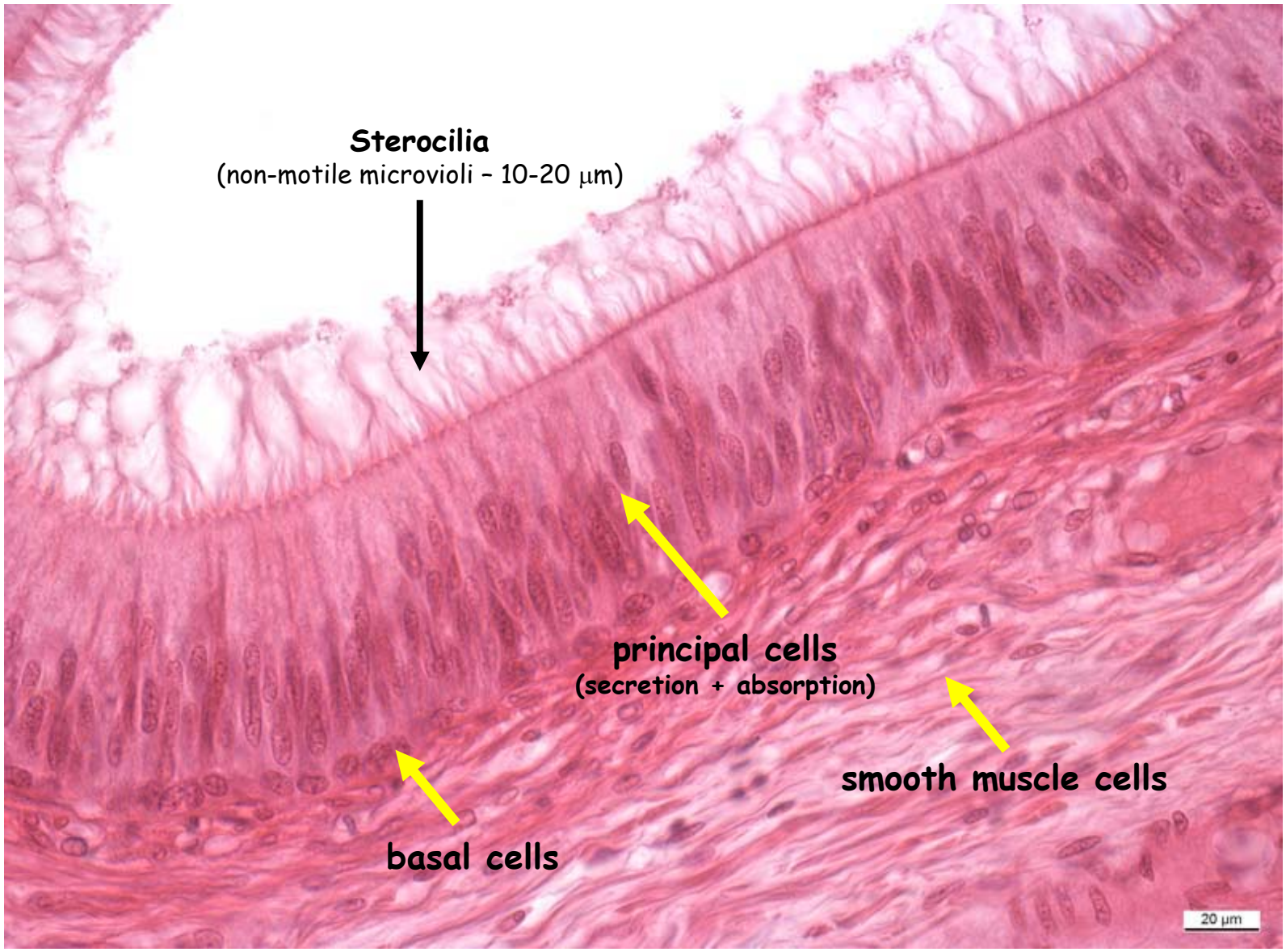
- 10 to 20
- penetrate tunica albuginea
- cuboidal + collumnar cells (patches)
- non-ciliated + ciliated – sperm passage
- microvili + lysosomes – absoption of luminal fluid
- smooth muscle cells – passage of sperm

Extratesticular genital ducts – Ductus epididymis 1

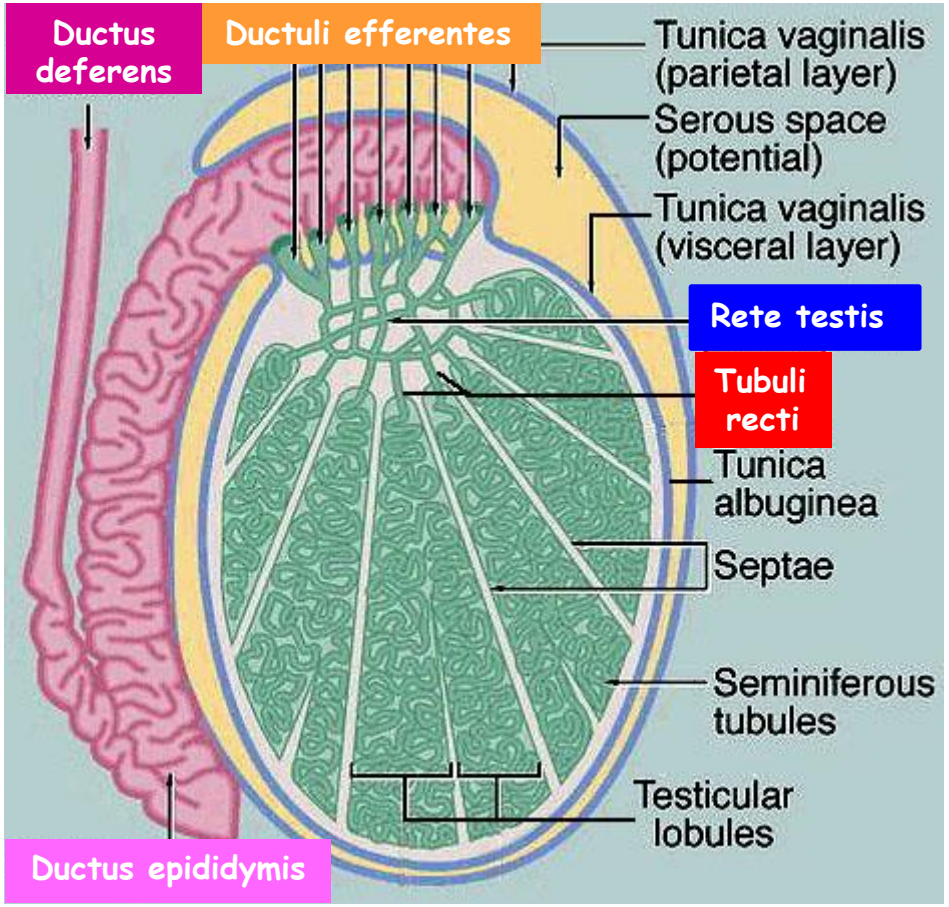


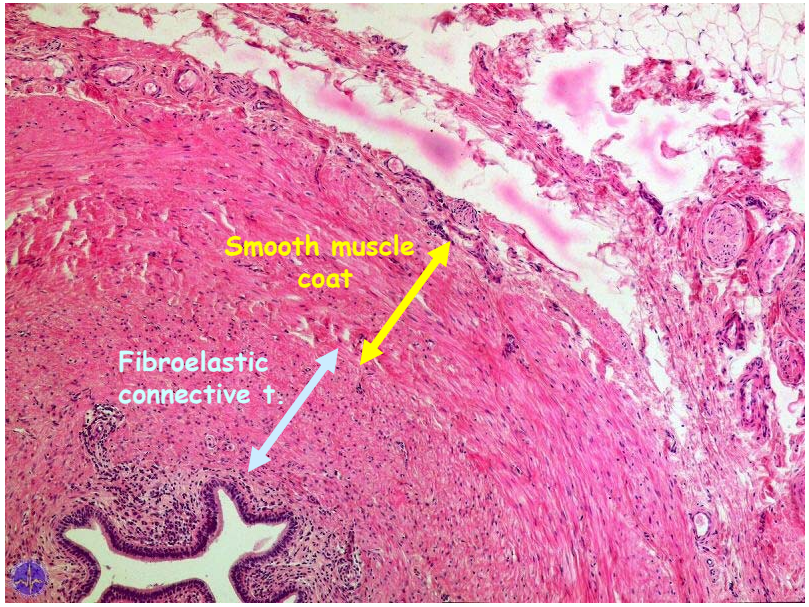
- about 5 meters long
- highly convoluted (head + body)
- tail (cauda) straight – sperm storage + maturation (under hormonal influence)
- collumnar pseudostratified lining: basal cells (polyhedral) + principal cells (collumnar)
- principal cells with stereocilia
- surrounded by circular smooth muscle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

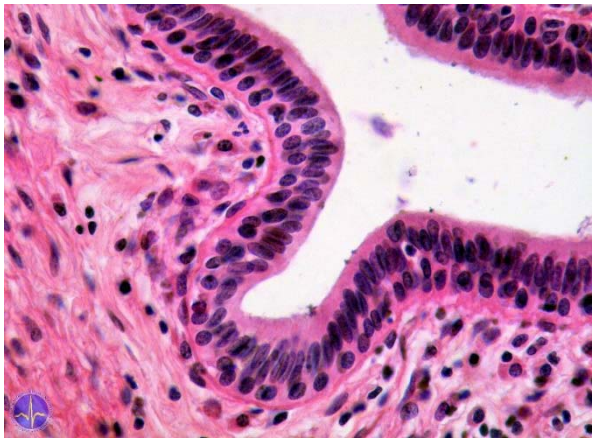
Extratesticular genital ducts – Ductus epididymis 2



Extratesticular genital ducts – Ductus deferens 1

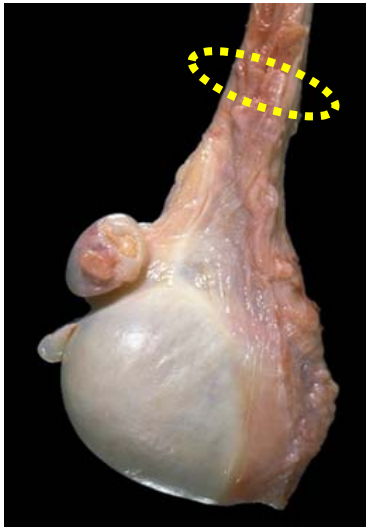




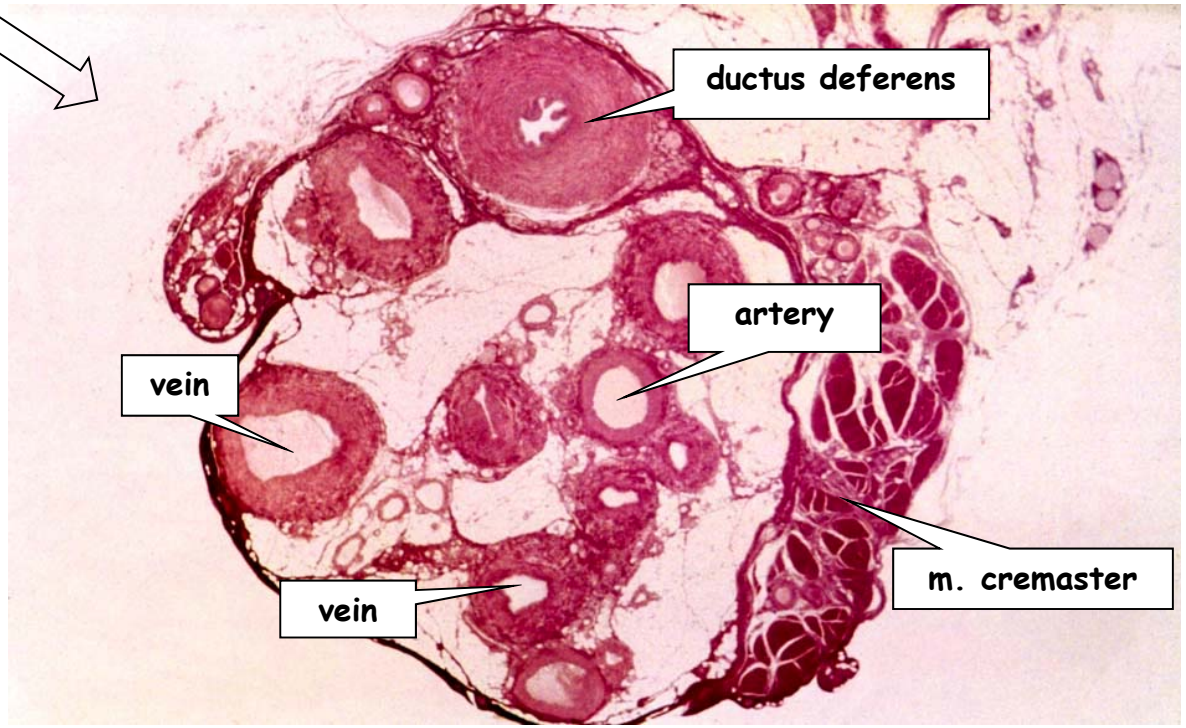


- thick walled + folded lumen
- epithelia similar to D. epididimis – collumnar pseudostratified (basal cells + principal cells)
- surrounded by three layers of smooth muscle layer (circ+long+long)
- sympathetic inervation – initiate ejaculation

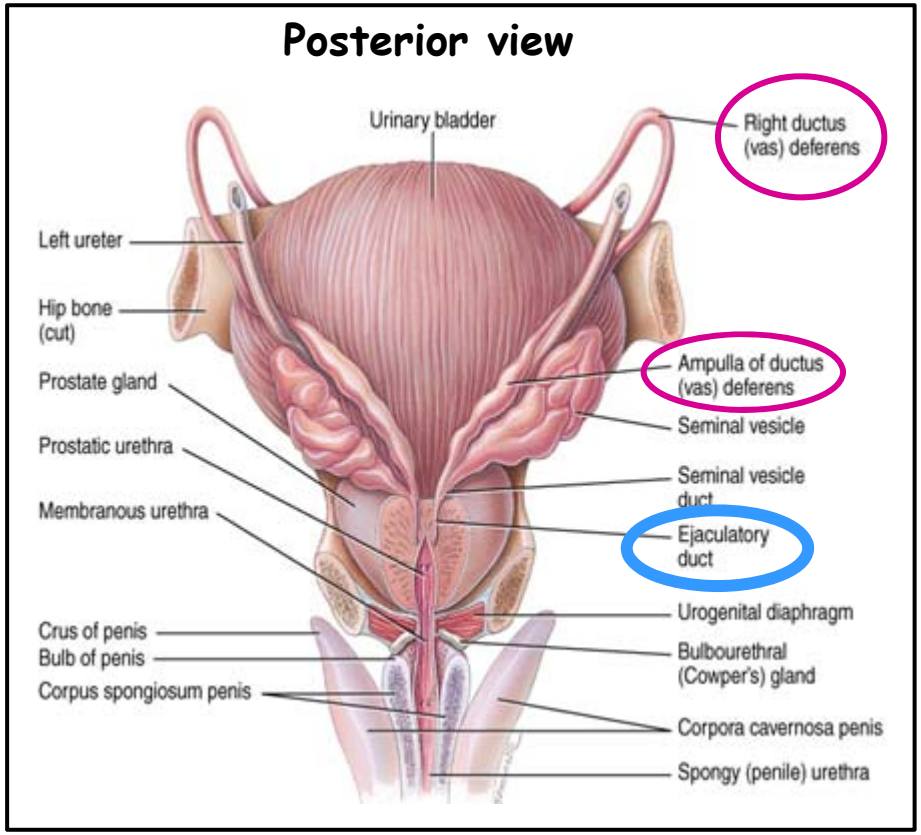
Extratesticular genital ducts – Ductus deferens 2

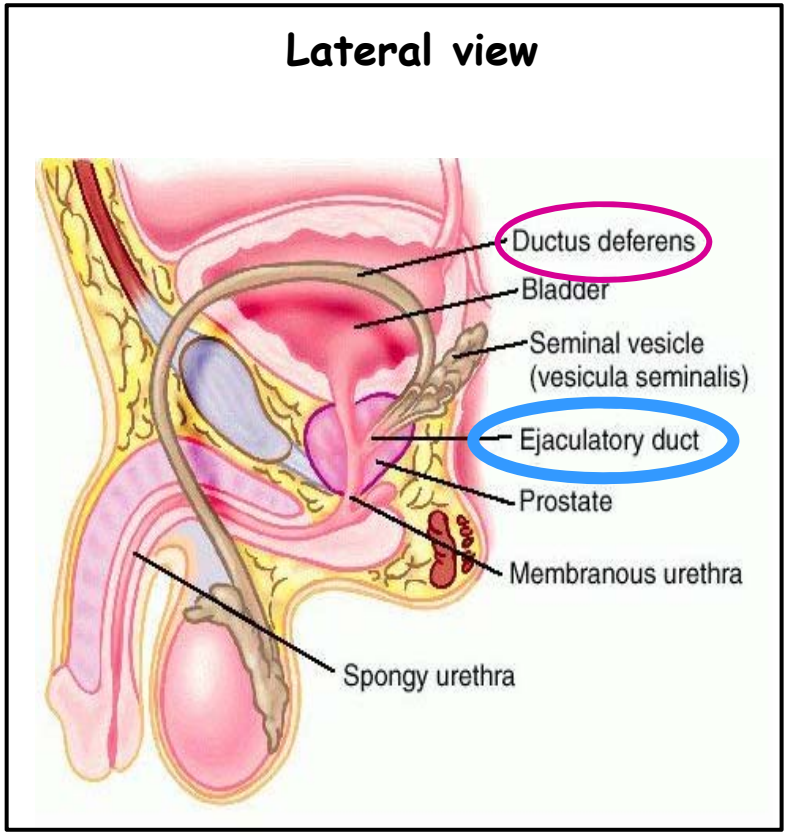


Funiculus spermaticus



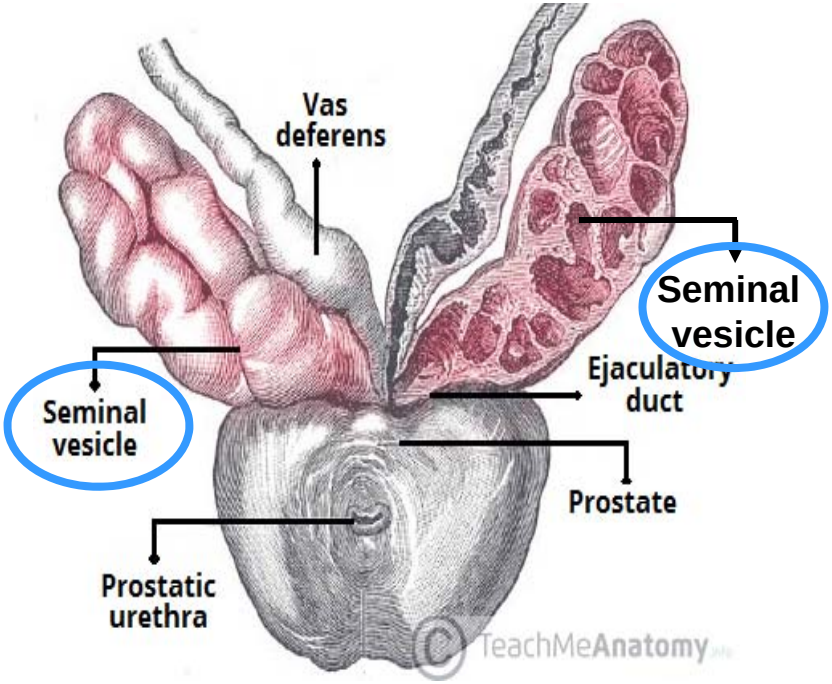
Extratesticular genital ducts – Ejaculatory duct

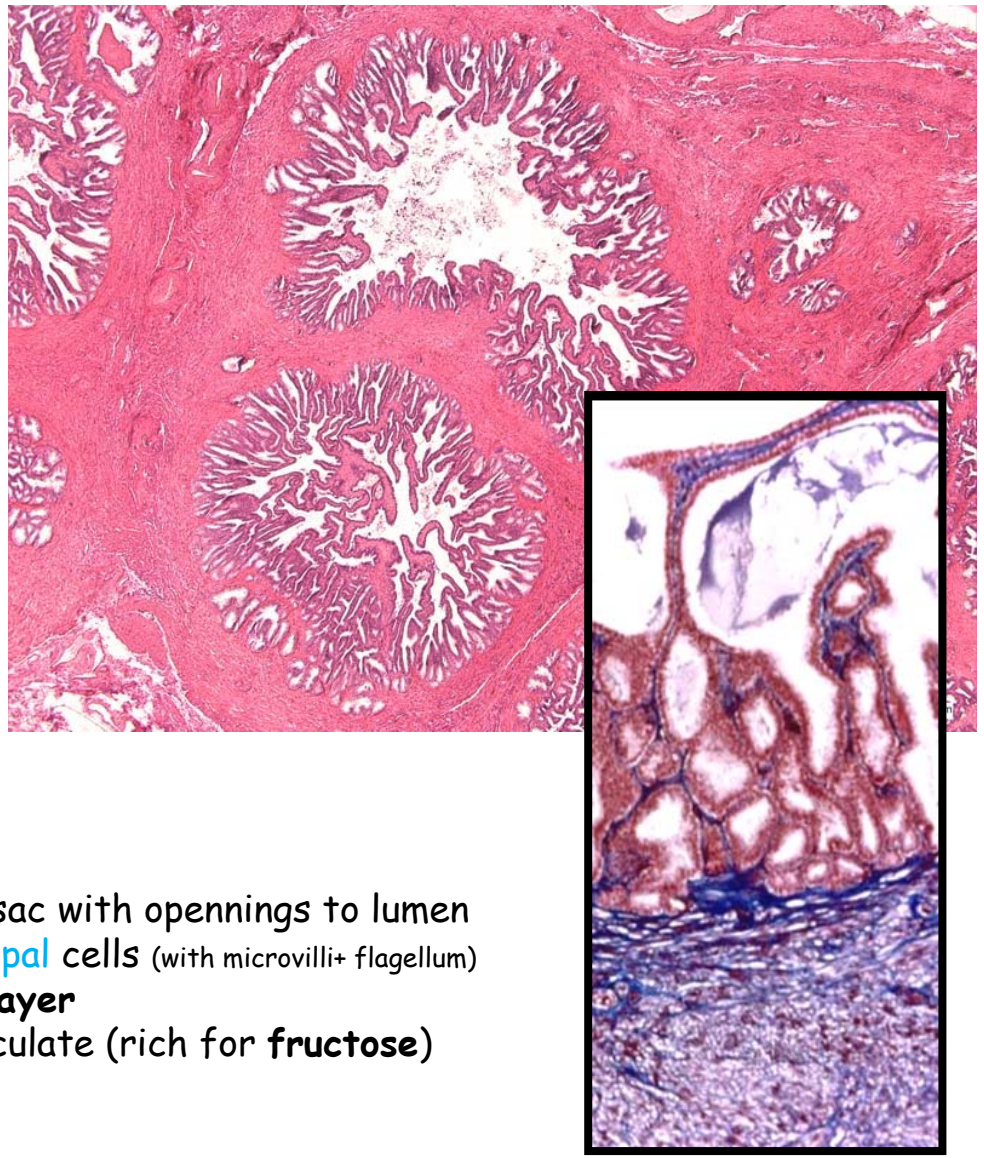




- short + straight
- portion after entry of seminal vesicle duct
- surrounded by prostate
- enters urethra at the **colliculus seminalis** (verumontanum)
- lined with **simple collumnar epithelium**
- **NO smooth muscle laeyer**

Accessory genital glands – Seminal vesicles





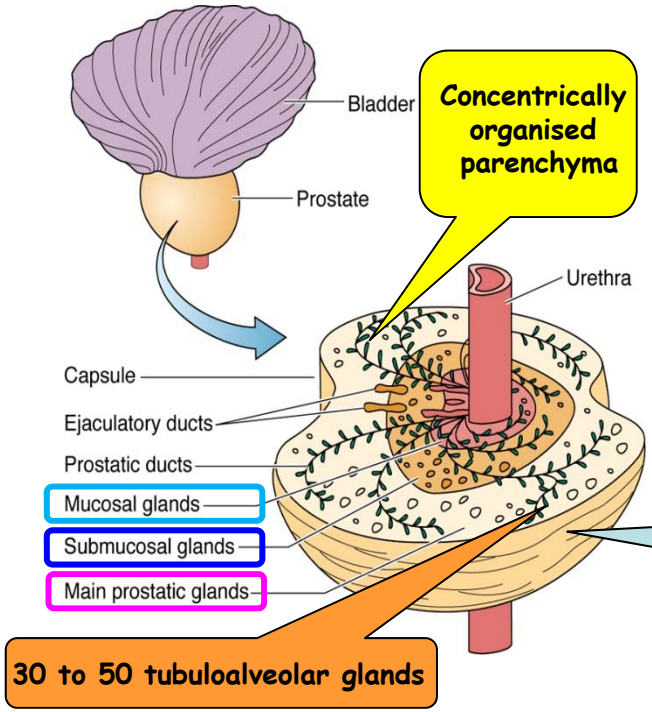
- develops from ductus deferens
- about 15 cm long snaking tube
- highly folded mucosa – labyrinthous cul-de-sac with openings to lumen
- **pseudostratified epithelium** - basal + principal cells (with microvilli+ flagellum)
- **fibroelastic submucosa + smooth muscle layer**
- **seminal fluid** – constitutes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



Concentrically organised parenchyma

Capsule
• collagenous
• with smooth muscle cells
• vascularised

30 to 50 tubuloalveolar glands

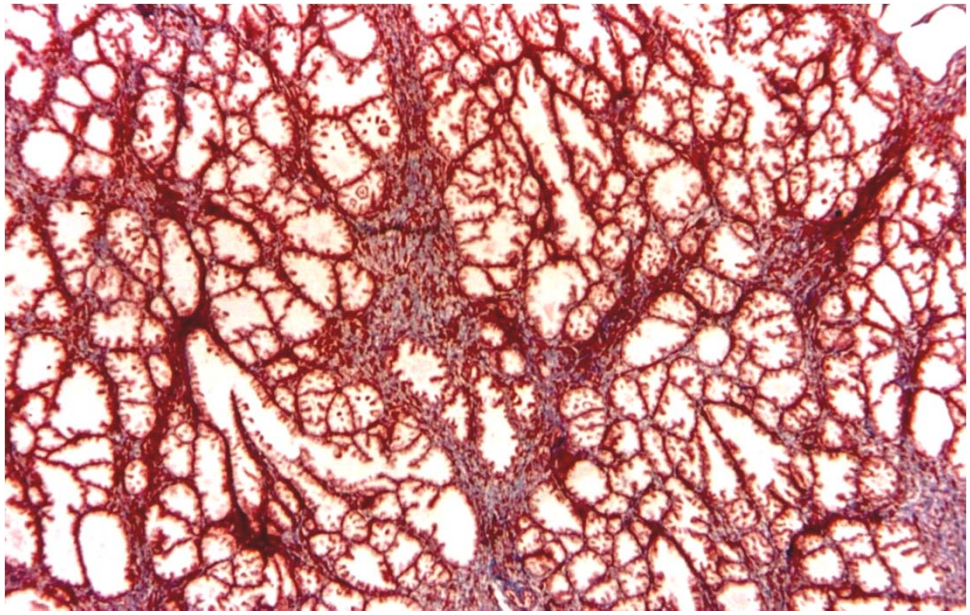
GLANDS

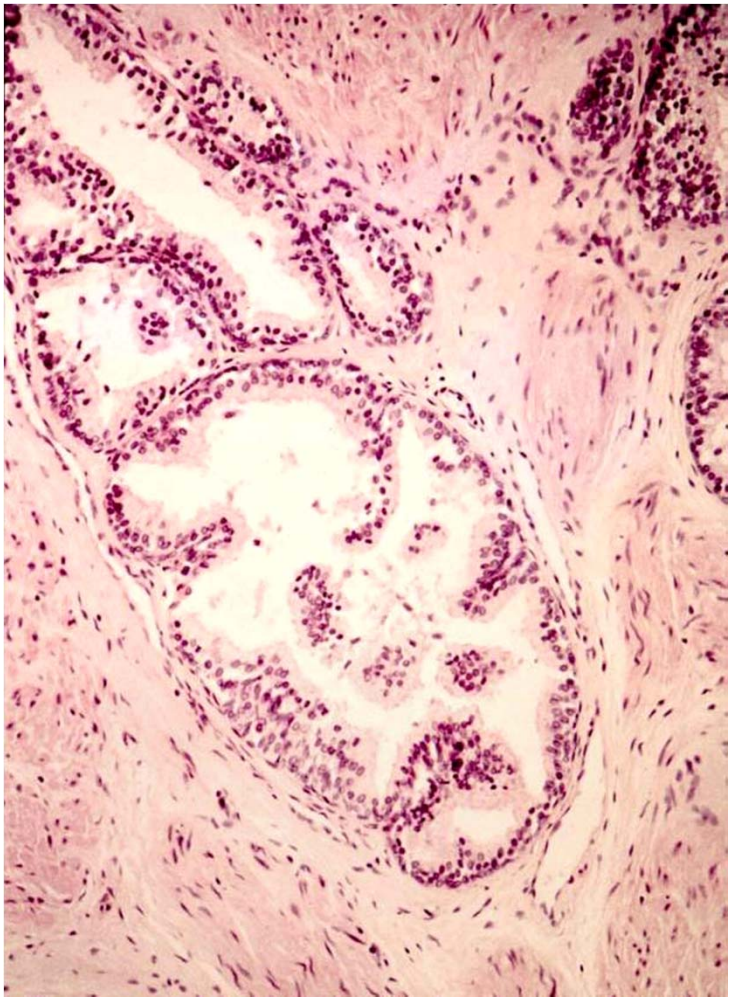
• simple pseudostratified collumnar epithelium

• abundant RER + Golgi + secretory granules

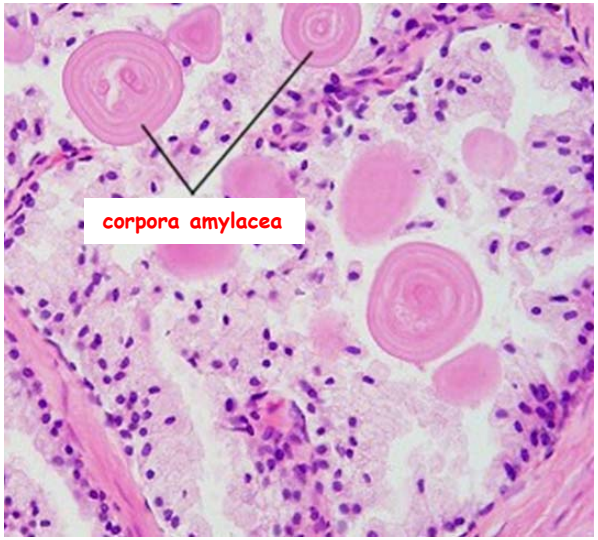
• size and shape of **chesnut** (the largest accesory gland)
• stroma (derives from the capsule): fibroelastic elements, many **smooth muscle cells**
• **prostatic secretion**: lipids, acid phosphatase, proteolytic enzymes, citric acid, fibrinolysin (liquifies semen)

Accessory genital glands – Prostate gland 2

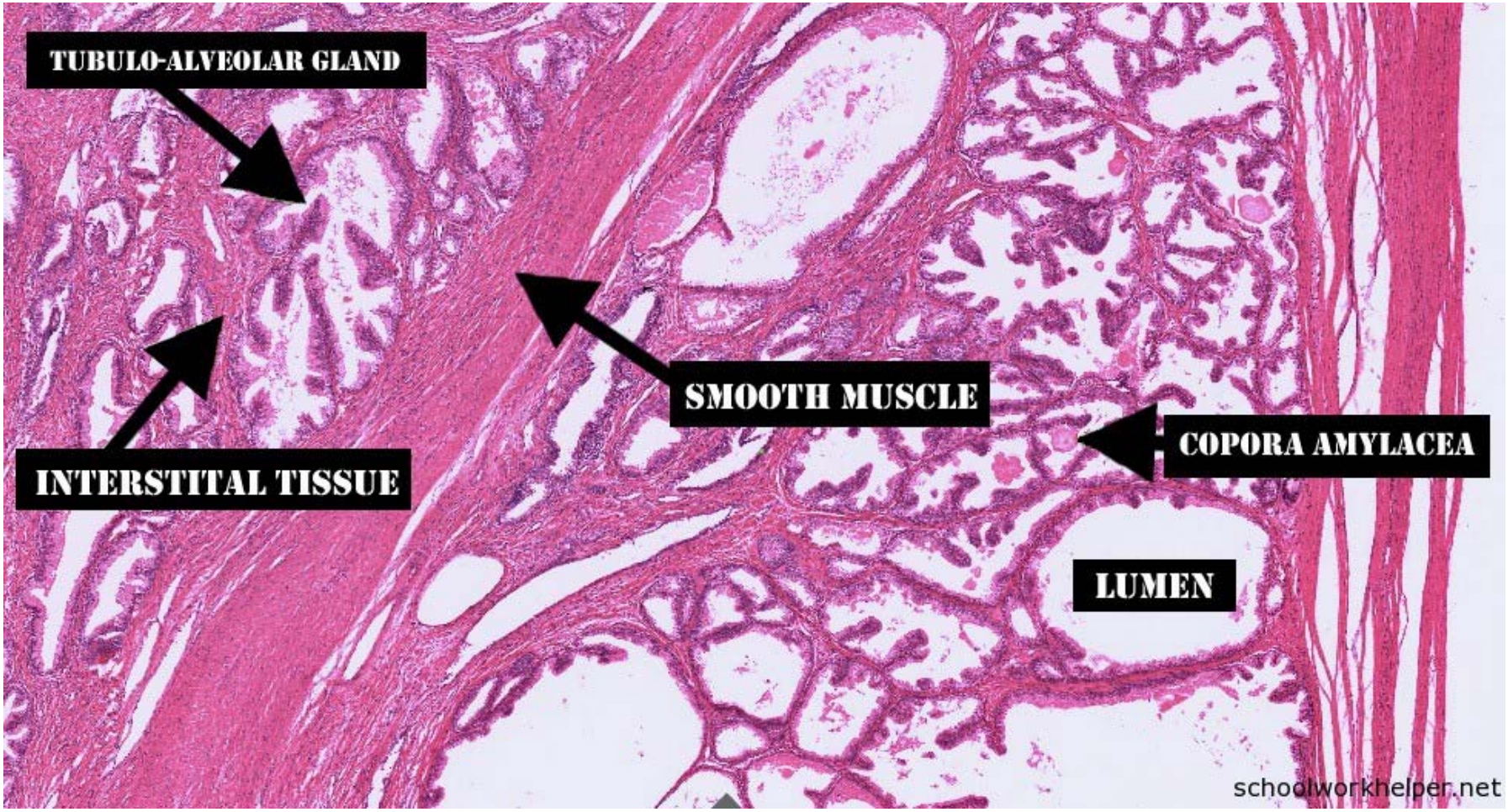




Corpora amylacea
= prostate concretions
- increase with age
- may calcify
- size even 1 mm

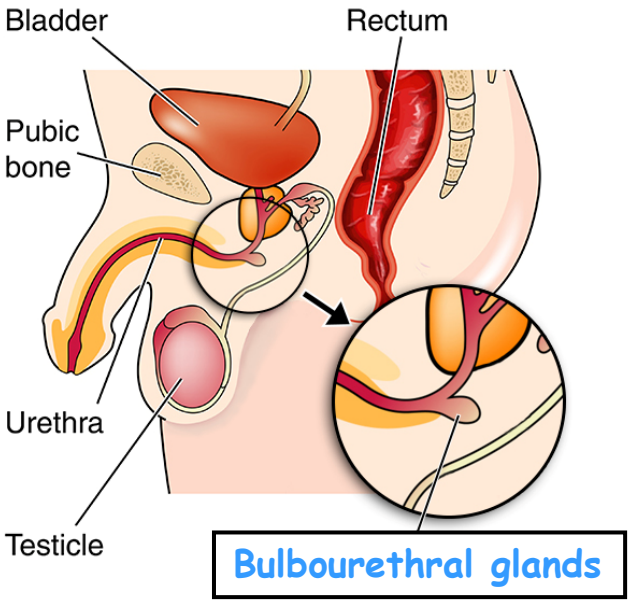


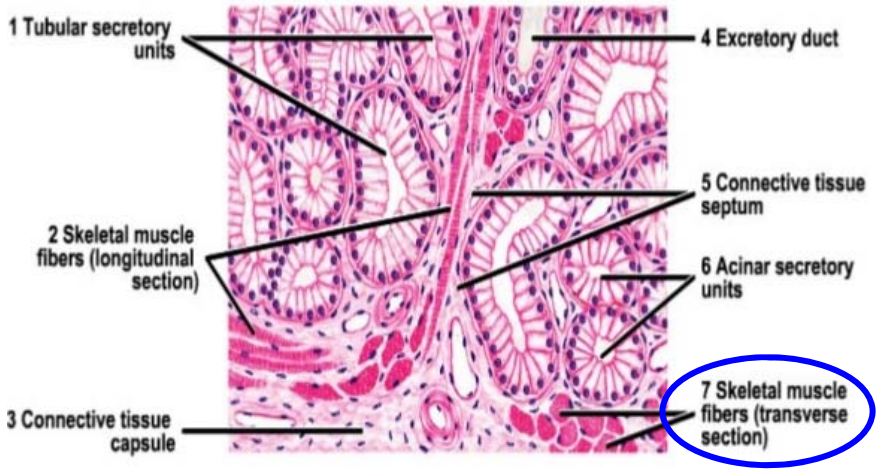
Accessory genital glands – Prostate gland 3

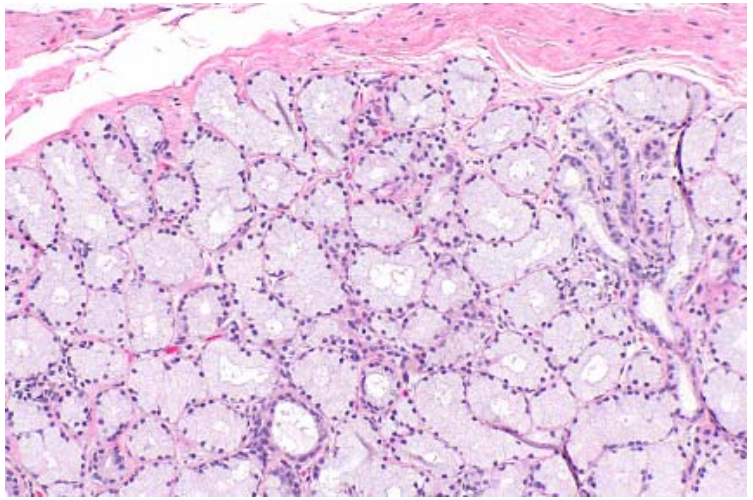


Accessory genital glands – Bulbourethral glands

Lateral view

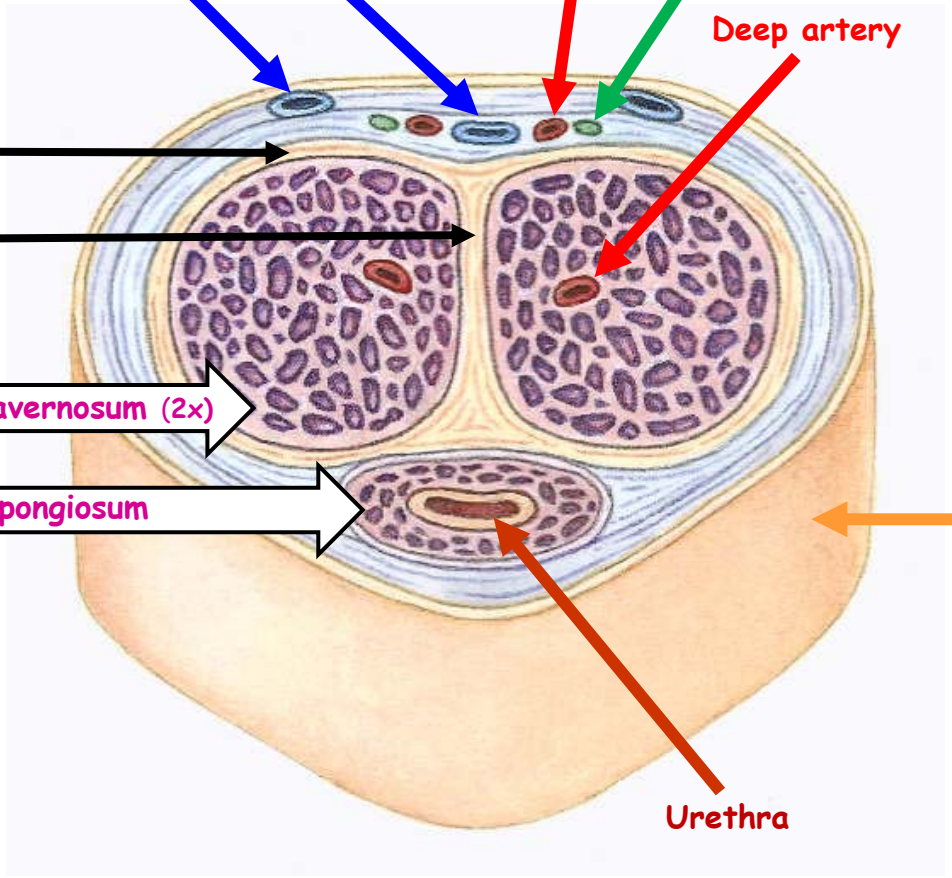




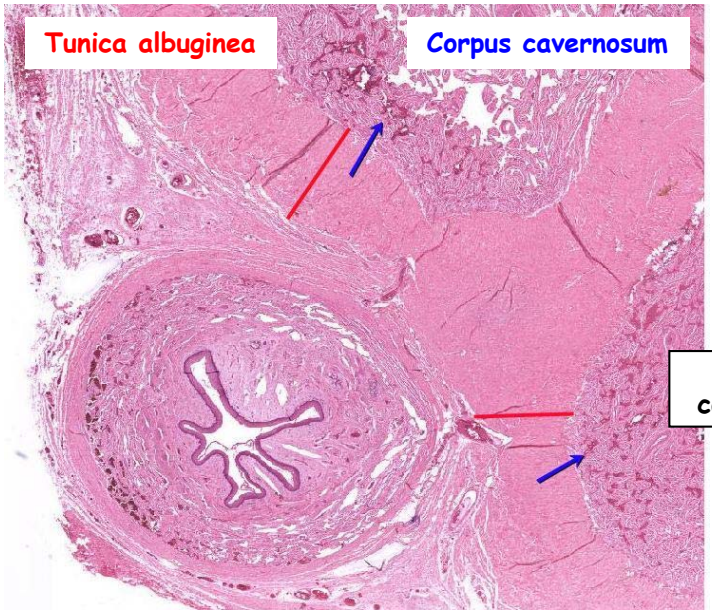


- small – 3 to 5 mm
- at the root of the penis
- lobular structure (septa)
- **skeletal muscle fibers** (derived from urogenital diaphragm)
- simple cuboidal epithelium
- lubricating fluid (sialic acid + galactose)

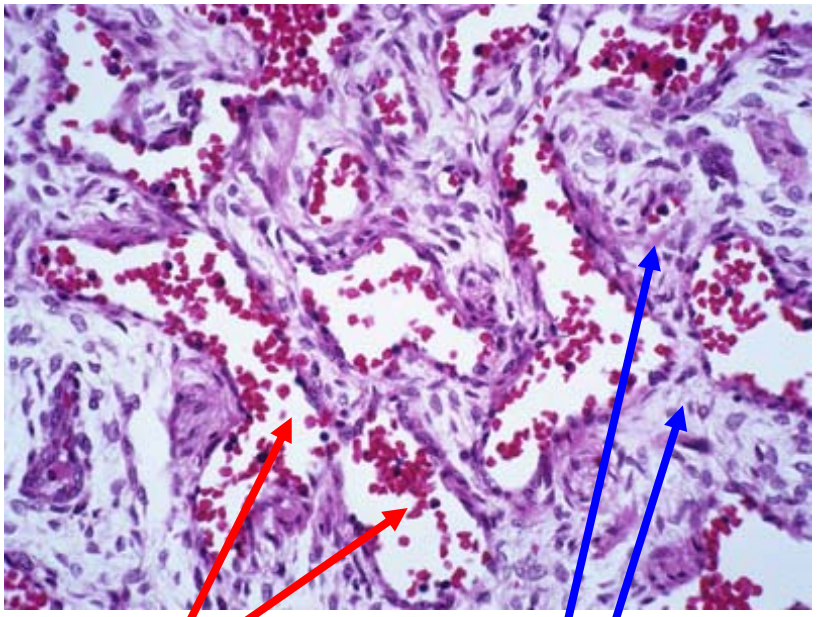
Penis - 1


Superficial dorsal vein
Deep dorsal vein
Dorsal artery
Dorsal nerve
Deep artery
Tunica albuginea
Septum
(discontinuos)
Erectile tissue
Corpus cavernosum (2x)
Corpus spongiosum
Skin
Urethra

Penis - 2



Corpus cavernosum

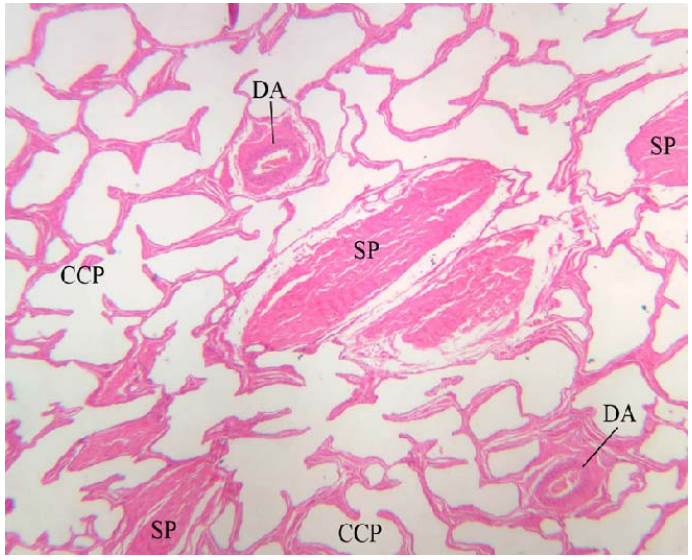


Vascular spaces

- lined by endothelia

Trabeculae

- elastic fibers
- smooth muscle cells



Capillary plexuses
+
Helical arteries

Deep arteries
+
Dorsal arteries

Thank you for your attention !

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