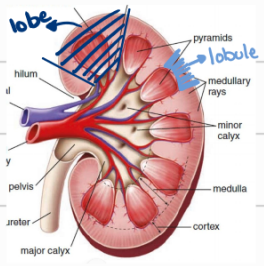
UGS Mid Histo Summary

Lec 1: Urinary System

* includes all material
* what the doctor focused on

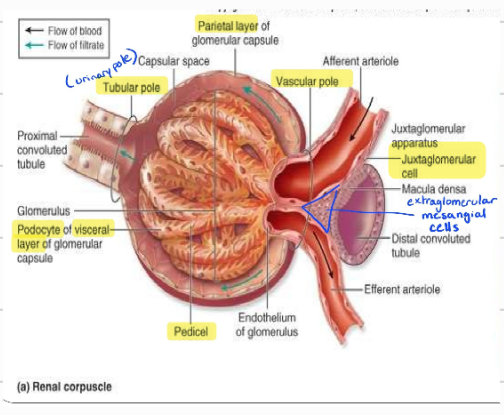
Kidney

* external capsule → sends trabeculae into kidney
* divided into cortex (outer) + medulla (inner)
  - medulla has medullary pyramids
    - → apex: renal papillae → opens into minor calyx ⇒ major calyx ⇒ renal pelvis ⇑ ureter
    - → base: extends into cortex ⇒ medullary rays → contains collecting duct draining a group of nephrons
  - cortex extends between medullary pyramids → renal columns
  - kidney lobe: medullary pyramid + medullary ray + overlaying cortex + renal column
  - kidney lobule: medullary ray + overlaying cortex
    - → basically a collecting duct + its associated nephrons



* functional unit: Uriniferous tubule

- nephron
  - renal corpuscle (in cortex)
    - glomerulus
    - bowman's capsule
  - proximal convoluted tubule (PCT) (in cortex)
  - Loop of Henle
    - thick descending (in cortex (medullary ray))
    - thin descending (in medulla)
    - thin ascending (in medulla)
    - thick ascending (in medulla + part in medullary ray)
  - Distal convoluted tubule (DCT) (in cortex)
- Collecting tubules (in medullary rays)
- Collecting duct (in medullary rays + medulla)



Nephron

* 2 types:

Cortical → Short loop of henle, in superficial cortex

juxtamedullary → long loop of henle, at corticomedullary junction

↑ age → ↓ nephrons

Renal Corpuscle (in cortex)

* Bowman's Capsule ⇒ 2 layers of epithelium + space between:
- outer parietal is simple squamous, inner visceral is modified epithelium ⇒ Podocytes
- Urinary Pole opens into PCT, Vascular Pole has afferent + efferent arterioles

Podocytes: flat cells ⇒ have long primary cytoplasmic processes ⇒ have secondary processes (pedicles) around glomerular basement membrane
→ spaces between pedicles are filtration slits, covered by slit diaphragm
→ slit diaphragm: nephrin (protien), glycoprotiens

*Glomerulus: afferent + efferent arteriole, capillary loops between
- fenestrated endothelium on a thick continuous basement membrane

Mesangial Cells

contractile cells + phagocytosis + support

- intraglomerular ⇒ between capillaries
- extraglomerular ⇒ between afferent + efferent + DCT (at vascular pole)

What are the filtration barrier / blood renal barrier layers?

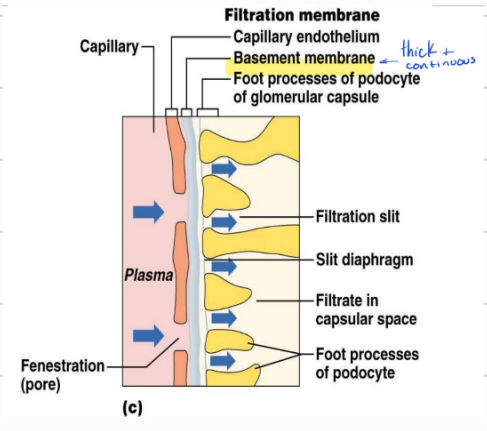
↑permeability ⇒ protienuria (bad)

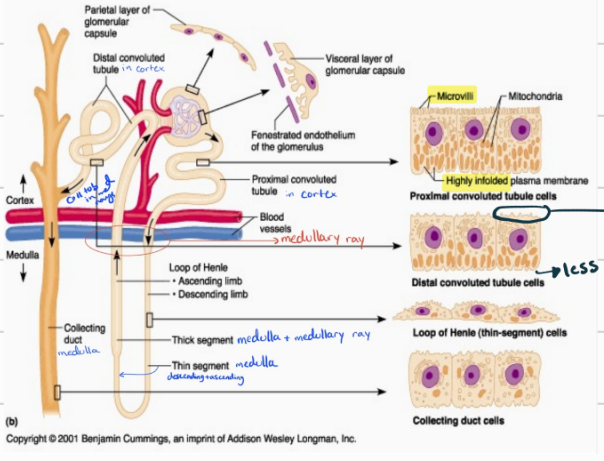
① fenestrated endothelium (X RBCs passage)

② thick continuous basement membrane (X protiens > 70 kDa)

- lamina rara externa
  - next to podocytes
  - light appearance (EM)
- intermediate
  - dark (EM)
- lamina rara interna
  - next to glomerulus endothelium
  - light

③ podocyte pedicles + filtration slits + covering slit diaphragm





PCT (in cortex)

→ Simple cuboidal epithelium
→ a lot of basal infolding
→ long microvilli (apical)
↳ visible brush border
→ abundant mitochondria (dark staining)
→ Narrow lumen
→ unclear borders between cells

DCT (smaller) (in cortex)

→ Simple cuboidal epithelium
→ very little basal infolding
→ Short microvilli
↳ brush border not visible
→ fewer mitochondria
→ Wide lumen
→ unclear borders between cells

Loop of Henle

Thick descending + thick ascending

→ Simple cuboidal (in medullary rays + medulla)
→ very short microvilli
→ ↑↑ mitochondria

Thin descending + Thin ascending (in medulla)

→ Simple squamous epithelium
→ ↓mitochondria
→ nuclei bulge into lumen

* looks like capillary endothelium, to differentiate from capillary: loop has empty lumen, capillary doesn't

Collecting Ducts

Collecting tubule (in medullary rays) + cortical collecting duct
→ simple cuboidal (like DCT)

medullary collecting duct (in medulla) → opens into papillary duct at renal papillae (duct of Bellini)
→ Simple columnar

* Collecting duct cells

- principal
  - cuboidal initially near DCT, columnar distally
  - short microvilli, not visible
  - pale
- intercalated (A + B)
  - cuboidal
  - ↑↑ microvilli, ↑↑ organelles
  - dark

Juxtaglomerular Apparatus

① Macula Densa
- packed columnar cells
- in DCT near vascular pole of B.C.
- dark nuclei
- sense Na^+ concentration

② Juxtaglomerular Cells
- in afferent arteriole mainly
- contractile (modified smooth muscle)
- secrete renin

③ extraglomerular mesangial cells
- a.k.a. Lacis cells

Urothelium / Transitional Epithelium

protects against hypertonic urine + prevents dilution

Layers

1. Thin basement membrane + small basal cells on it
2. Intermediate region: 1+ layers of cuboidal or columnar cells
3. Elliptical / Umbrella cells
   - tight junctions between them
   - covered by thick membrane of uroplakin (protien) ⇒ forms plaques

Ureter

muscular tube, 3 layers:

mucosa	muscularis	Adventitia
Urothelium lamina propria → loose connective tissue	• inner longitudinal + outer circular smooth muscle (2 layers) • near bladder ⇒ 3 layers	connective tissue nerves blood vessels

Bladder

mucosa	muscularis	adventitia / serosa
• urothelium • lamina propria empty bladder: folded mucosa + enlarged umbrella cells full bladder: smooth mucosa + shrunken / flat umbrella cells	• inner longitudinal middle circular outer longitudinal ⇒ detrusor muscle (3 layers)	adventitia / connective tissue except superior surface: peritoneum ⇒ serosa (mesothelium)

Male Urethra

lining

prostatic	membranous	spongy
urothelium	Stratified + pseudostratified columnar	Stratified + pseudostratified columnar distally: Stratified squamous

Female Urethra

mainly urothelium, at termination ⇒ Stratified squamous

Lec 2: Male Reproductive System

Testis

* primary sex organ
* coverings (out to in)

① Tunica vaginalis: anterolateral, visceral + parietal layers

② Tunica albuginea: dense connective tissue, thickens at posterosuperior aspect ⇒ forms mediastinum → sends septa in ⇒ lobules

③ Tunica vasculosa

- Parenchyma
  * each lobule 1-4 seminiferous tubules
  * layers:
  - Basement membrane, has myoid cells (smooth muscle) + capillaries outside
  - Stratified epithelium of multiple types (seminiferous epithelium)

lining epithelium of seminiferous tubules

Spermatogenic cells (endodermal)

migrate from basement to lumen

Spermatogonia (germ cells) ← nearest to basement/basal lamina

- type A_d
  - dark
  - form reserve of spermatogonia
  - diploid
- type A_p pale, diploid
  - type B larger
    - FSH ⊕ → mitosis
    - Primary Spermatocyte largest, 46 chromosomes
      - meiosis 1 → Secondary Spermatocyte small, short lived, rarely seen
        - meiosis 2 → 23 chromosomes
          - 2 spermatids small + round, small nuclei
            - differentiation → 23 chromosomes
              - mature spermatozoa

(mesodermal) Sertoli cells

- between spermatogenic cells
- tall columnar
- unclear borders
- FSH receptors
- hemidesmosomes with basement
- desmosomes with spermatogenic cells
- gap + tight junctions w/ other sertolis

↓

Blood-Testis Barrier

- Spermatozoa — mature → in seminiferous lumen

layers in each part

head
- ovoid nucleus
- acrosome cap
  outside → ovum penetration

neck
- 2 centrioles
- connecting piece

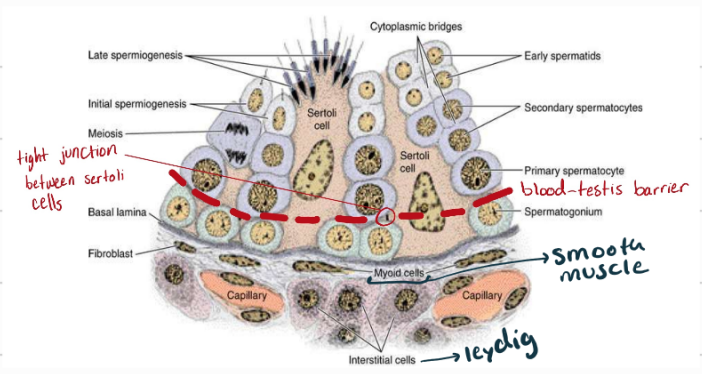
middle piece
- plasma membrane
- mitochondrial sheath
- fibrous sheath
- axoneme (2 central microtubules, 9 pairs around them)

tail

principal piece
- plasma membrane
- fibrous sheath (ends here)
- axoneme

shortest 2 end piece
- plasma membrane
- axoneme

- Sertoli Cells
  - * ↑↑ before puberty, ↓ after
  - * support germ cells
  - * phagocytic
  - * Blood-testis barrier
  - *secrete testicular fluid, androgen-binding protien, inhibin, anti-mullerian hormone
  - * nutrition



FSH (×) → androgen-binding protien → ↑testosterone → ↑spermatogenisis

inhibin → (−) FSH → (−) spermatogenisis

anti-mullerian hormone → ✗ female genital system formation in embryo

- Blood Testis Barrier
  - * formed by the tight junctions between sertoli cells
  - * divides seminiferous tubule into basal + adluminal parts
    - * Basal: basement membrane to tight junction, has spermatogonia
    - * Adluminal: tight junction to lumen, has rest of spermatogenic cells
  - * allows nutrients + hormones (e.g. testosterone) in, blocks toxin + antibody entry, blocks sperm entry into blood (⇒ autoimmune reaction, antibodies against sperm form)

- Interstitial cells of Leydig ⇒ Produce testosterone
  - * between seminiferous tubules in connective tissue
  - * ↓ with age → ↓ testosterone
  - * large + rich in fat droplets + SER + Golgi + mitochondria
  - * mesodermal

L.H. from pituitary (+) → Leydig cells

GnRH from hypothalamus (+) → L.H.

_*very active in 3rd + 4th month of pregnancy, then inactive till puberty

Intratesticular Ducts

seminiferous tubules ⇒ Straight tubules ⇒ rete testis (at mediastinum) ⇒ efferent ductules

Genital Ducts

(secondary sex organs)

Epididymus ⇒ vas deferens ⇒ ejaculatory duct ⇒ urethra

Dr. Ahmed really focused on the differences in epithelium + musculosa

Epididymis

* ↑↑ coiled, head + body + tail
* storage + maturation

mucosa	musculosa	adventitia
• pseudostratified ciliated columnar + small basal cells • long stereocilia (microvilli)	• 1 layer • circular smooth muscle	

Vas Deferens

mucosa	musculosa	adventitia
• pseudostratified columnar • short stereocilia (less than epididymis)	• 3 layers • thin inner longitudinal thick middle circular outer longitudinal • sympathetic innervation ⇒ ejaculation	

Ejaculatory Ducts

* ampulla of vas + seminal vesicle open into it ⇒ opens into prostatic urethra

mucosa	musculosa	adventitia
• pseudostratified columnar (secretory) • NO stereocilia	NONE	

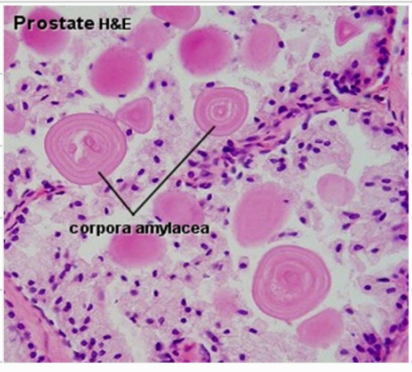
Accessory Glands (secondary sex organs) (+ 2 bulbourethral glands)

· Seminal vesicles (2)

* each is a coiling tube
* produce secretions ⟹ nutrition + energy production in sperm

- mucosa
  - columnar or pseudostratified secretory (glands)
  - NO cilia
- musculosa
  - 2 layers
  - inner circular + outer longitudinal
- adventitia

· Prostate (1)



* tubuloalveolar glands around prostatic urethra
* stroma: capsule ⟹ trabeculae ⟹ lobules
* Parenchyma: glands + ducts, 3 layers (in to out)

① periurethral / mucosal ② submucosal ③ main prostatic ↳ enlarges in cancer prostate

enlarge with old age ⟹ senile prostate

- Glandular epithelium
  - variable
  - squamous, simple or pseudostratified columnar, cuboidal
- acini + ducts
  - simple columnar

corpora amylacea
onion like condensation of secretions, ↑ with age

Penis

* dense fibroelastic tunica albuginea bundling 3 erectile tissues together + forms septa between them

- corpora cavernosa
  - * 2, dorsal
  - * have cavernous blood spaces lined by endothelium
  - * supplied by helicine arteries
- corpora spongiosum
  - * 1, ventral
  - * thinner + more elastic tunica albuginea
  - * contains urethra

good luck!