

overview

- two kidneys, two ureters, one urinary bladder & one urethra
- urine excreted from each kidney through its ureter & is stored in bladder until expulsion from body through urethra
- **nephrology** = specialised branch of medicine dealing with structure, function & diseases of the male & female urinary systems & the male reproductive system
- **urology** = branch of surgery related to male & female urinary systems & the male reproductive system

internal anatomy of kidney

- | | |
|------------|---|
| parenchyma | renal cortex = superficial layer |
| | renal medulla = inner portion consisting of 8-18 cone-shaped renal pyramids separated by renal columns, renal papilla point toward centre of kidney |

- | | |
|--|---|
| drainage system fills renal sinus cavity | cuplike structure (minor calyces) collect urine from papillary ducts of papilla |
|--|---|

internal anatomy of kidney (cont)

- minor & major calyces empty into renal pelvis which empties into ureter

if asked the difference between hilus & sinus - outline a major calyx & the border between cortex & medulla.

cortical nephron

- 80-85% nephrons
- renal corpuscles are in outer cortex & loops of Henle lie main in cortex

- blood flow:
- Bowman's capsule - PCT - descending limb
 - thin ascending limb - thick ascending limb
 - DCT

juxtamedullary nephron

- 15 -20% of nephrons are juxtamedullary nephrons
- renal corpuscles close to medulla & long loops of Henle extend into deepest medulla enabling excretion of dilute/concentrated urine.

- blood flow:
- Bowman's capsule - PCT - descending limb
 - thin ascending limb - thick ascending limb
 - DCT

renal corpuscle structure

Bowman's capsule surrounds capsular space

podocytes cover capillaries to form visceral layer

simple squamous cells form parietal layer of capsule

glomerular capillaries arise from afferent arteriole & form a ball before emptying into efferent arteriole

renal physiology

nephrons & CDs perform:

- glomerular filtration: a portion of the blood plasma is filtered into kidney

- tubular reabsorption: water & useful substances are reabsorbed into the blood

- tubular secretion: wastes are removed from the blood & secreted into urine

rate of excretion of any substance is its rate of filtration + rate of secretion - rate of reabsorption.

kidney functions

regulation of blood ionic composition - Na⁺, K⁺, Ca²⁺, Cl⁻ & phosphate ions

regulation of blood pH, osmolarity & glucose

regulation of blood volume - conserving or eliminating water

regulation of BP - secreting renin enzyme, adjusting renal resistance

release of erythropoietin & calcitriol



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kidney functions (cont)

excretion of wastes & foreign substances

blood & nerve supply of kidney

abundantly supplies with blood vessels - receive approx 20% of resting cardiac output via renal arteries

functions of different capillary beds:

- glomerular capillaries where filtration of blood occurs: vasoconstriction & vasodilation of afferent & efferent arterioles produce large changes in renal filtration
- peritubular capillaries carry away reabsorbed substances from filtrate
- vasa recta supplies nutrients to medulla without disrupting its osmolarity form
- the nerve supply to the kidney is derived from renal plexus (sympathetic division of ANS), sympathetic vasomotor nerves regulate blood flow & renal resistance by altering arterioles.

renal artery - segmental arteries - interlobar arteries - arcuate arteries - interlobular arteries - afferent arterioles - glomerular capillaries - efferent arterioles - peritubular capillaries &/or vasa recta - interlobular veins - arcuate veins - interlobar veins - segmental veins - renal vein

nephron/collecting duct histology

glomerular capsule consists of visceral & parietal layers, visceral layer has modified simple squamous epithelial cells (podocytes), parietal layer has simple squamous epithelium & forms outer wall of capsule

fluid filtered from glomerular capillaries enters capsular space

single layer of epithelial cells forms walls of entire tube

- microvilli, cuboidal vs simple epithelium, hormone receptors are distinctive features due to function of each region

CD & Renal tubule histology

PCT - simple cuboidal with brush border of microvilli to increase SA

descending limb - simple squamous

ascending limb - simple cuboidal to low columnar, forms juxtaglomerular apparatus where makes contact with afferent arteriole, macula densa is a special part of ascending limb

DCT & CDs - simple cuboidal composed of principal & intercalated cells which have microvilli

the **juxtaglomerular apparatus** is a structure where afferent arteriole makes contact with ascending limb of loop of Henle - macula densa is thickened part of ascending limb, juxtaglomerular cells are modified muscle cells in arteriole

external anatomy of kidney

- near centre of concave medial border is a vertical fissure called the **hilus** through which the ureter leaves & blood vessels, lymphatic vessels, & nerves enter & exit

- three layers of tissue surround each kidney; renal capsule, adipose capsule & renal fascia

- **nephroptosis** is an inferior displacement of the kidneys, most often occurs in thin people - ureters may kink & block urine flow

- paired kidney-bean shaped organ

- 4-5 in long, 2-3 in wide, 1 in thick

- found just above waist between peritoneum & posterior wall of abdomen

- retroperitoneal (along with adrenal glands & ureters)

- protected by 11th & 12th ribs, with right kidney lower

nephron

consists of a renal corpuscle where fluid is filtered & a renal tubule into which the filtered fluid passes

three basic functions - glomerular filtration, tubular reabsorption & tubular secretion

renal tubule consists of PCT, loop of Henle, DCT

DCTs of several nephrons drain into a single collecting duct & many collecting ducts drain into a small number of papillary ducts



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nephron (cont)

glomerular capillaries are formed between afferent & efferent arterioles

efferent arterioles give rise to the peritubular capillaries & vasa recta

loop of Henle has a descending limb, thin ascending limb & thick ascending limb

cortical nephron has glomerulus in outer portion of cortex & short loop of Henle penetrating only into outer portion of medulla

juxtamedullary nephron has glomerulus deep in cortex close to medulla, long loop of Henle stretches through medulla & almost reaches renal papilla.

corpuscle = site of plasma filtration, glomerulus is capillaries where filtration occurs & Bowman's capsule is double-walled epithelial cup that collects filtrate

tubule = PCT, loop of Henle dips down into medulla, DCT

collecting ducts & papillary ducts drain urine to renal pelvis & ureter

- number of nephrons remains constant from birth - any increase in kidney size is size increase of individual nephrons & if injured, no replacement occurs. Dysfunction is not evident until function declined by 25% of normal. Removal of one kidney causes enlargement of remaining until it can filter at 80% of normal rate of 2 kidneys.

glomerular filtration

- BP produces glomerular filtrate

- filtration fraction is 20% of plasma

- 48 gallons/day filtrate reabsorbed to 1-2 qt. urine

- filtering capacity is enhanced by: thinness of membrane & large SA of glomerular capillaries, glomerular capillary BP is high due to small size of efferent arteriole

GFR = amount of filtrate formed in all renal corpuscles of both kidneys/minute.

average adult male = 125mL/min

Homeostasis requires GFR that is constant as if it is too high, useful substances are lost due to speed of fluid passage through nephron & if it is too low, sufficient waste products may not be removed from the body.

Changes in net filtration pressure affect GFR - filtration stops if GBHP drops to 44mm Hg, functions normally with mean arterial pressure 80 - 180 mm Hg



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