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-s-haped renal pyramids separated by renal columns, renal papilla point toward centre of kidney
drainage system fills renal sinus cavity	cuplike structure (mino 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 erythropoieitin & 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 fissue 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 reccta

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 glomerus 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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