Renal MCQS Answers

Red-false

Green-true
1a. most of the calcium filtered at the glomerulus is reabsorbed at the distal tubule.

- 98% of calcium is filtered at the glomerulus, 60% of them is absorbed at the proximal tubule, 40% at the loop and distal tubule under the influence of parathyroid hormone.
1b. 1; 25-dihydroxycalciferol plays a role in calcium absorption in intestine.

- It induces synthesis of 2 forms of calcium binding protein.
1c. increased PTH will increase renal calcium excretion
1d. is present in the skeletal system as hydroxyapatite, phosphates and carbonates.
1e. plasma calcium is 2.5mmol/L
2a. composition of CSF is same as that of brain ECF.
2b. the total volume of CSF is about 150 ml in human body
2c. most of CSF absorbed directly into cerebral venules.

• 90% of the CSF produced is absorbed by arachnoid villi and 10% directly into cerebral venules.
2d. produced at the rate of 0.5 ml/min
2e. CSF is formed only from choroid plexuses.

- CSF is produced from choroid plexuses, around blood vessels and along ventricular walls. It is normally produced by ultrafiltration as well as secretion.
- CSF in the ventricles flows through the foramen of magendie and luschka to subarachnoid space and is absorbed through the arachnoid villi into veins.
3a. in resting humans average blood flow in gray matter is more than white matter.

- Average blood flow in gray matter is about 69ml/100g/min compared with 28ml/100g/min in the white matter.
3b. during stereotyped speech there is no noticeable increase in blood flow in broca’s and wernicke’s area
3c. cerebral vascular resistance = CPP/CBF
3d. there is a linear relationship between PaCO2 and CBF in the range of partial pressures from 3.5 to 10.0 kPa.
3e. chronic hypertension shifts the cerebral autoregulation curve to the right
4a. is a cofactor in many enzymatic pathways

- magnesium intake averages (240-370mg/day) in adults. Factors known to increase magnesium reabsorption in the kidneys include hypomagnesemia, parathyroid hormone, hypocalcaemia, ECF depletion and metabolic alkalosis. Factors known to increase renal excretion include hypermagnesemia, acute volume expansion, hyperaldosteronism, hypercalcaemia, ketoacidosis, diuretics, phosphate depletion and alcohol ingestion. Normal plasma Magnesium conc. is 0.7-1 mmol/L.
4b. 70% of magnesium is contained within the bone.
4c. 30% of oral intake of magnesium is absorbed daily.
4d. ascending limb of loop of henle plays a significant role in absorption of filtered magnesium.

- 25% of filtered magnesium is reabsorbed in the proximal tubule while 50-60% is reabsorbed in the thick ascending loop of henle.
4e. magnesium is normally absorbed in terminal ileum.

- only 30-40% absorbed in distal small bowel. it is eliminated renally.
5a. hyper-reflexia

- It is a calcium antagonist. It competes with calcium for binding sites on sarcoplasmic reticulum. It inhibits both the presynaptic release of Ach and post junctional potentials. It inhibits release of catecholamines. It is a cerebral vasodilator and a powerful tocolytic and a diuretic.
5b. skeletal muscle weakness
5c. myocardial depression
5d. peripheral vasodilatation
5e. prolongation of PR interval
6a. all preganglionicic neurons
6b. parasympathetic postganglionic neurons
6c. anatomically sympathetic postganglionic neurons which innervate sweat glands
6d. anatomically sympathetic neurons which end on blood vessels in skeletal muscle
adrenal medulla is essentially a sympathetic ganglion in which the postganglionic cells have lost their axons and secrete norepinephrine, epinephrine and some dopamine directly into the bloodstream.
7a. is synthesized in posterior pituitary

- all post pituitary hormones are synthesized in the cell bodies of the supraoptic and paraventricular nuclei and transported down the axons of these neurons to their endings in posterior lobe.
7b. receptors are G-protein coupled
7c. increases the permeability of water in the collecting ducts of kidney
7d. will decrease the effective osmotic pressure of body fluids

- ADH is responsible for retention of water by the kidney. It increases the permeability of the collecting ducts of the kidney, so urine becomes concentrated and its volume decreases, therefore there is retention of water in excess of solute, consequently effective osmotic pressure of the body fluids decrease.
in excess will lead to increase in osmolality of body fluids
8a. are derived from megakaryocytes

- production is under the control of thrompopoietin. young platelets are stored in spleen for 36 hours before release. normal life span is about 7-10 days.
8b. contain alpha granules

- alpha granules contain platelet factor4, thromboglobulin, thrombospondin and fibrinogen.
8c. contain dense bodies

- Dense bodies contain ADP, ATP and serotonin.
8d. platelet antibodies may be found in patients after multiple transfusions.
8e. time taken for the stem cell to produce platelets is approximately 20 days.

- platelets are produced from pluripotent stem cell in approx 10 days.
9a. glomeruli are located in the cortex

- Glomeruli/proximal tubules/distal tubules are in the cortex
- Loop of henle and collecting ducts extend into medulla
- 15% are juxtamedullary nephrons – have long loops that pass deep into medulla
the size of kidneys in various species is determined by the number of nephrons they contain.
9c. In a normal kidney, in the cortex, the A-V O2 difference is >4%.

- It is only 1-2%.
- Receives far more O2 than it requires.
- Main function of blood supply is to provide flow for glomerular filtration and O2 for Na reabsorption.
- Renal blood flow needs to be <150ml/min/100g to increase the A-V difference in O2.
9d. the human proximal convoluted tubule is about 40mm long.

• 15mm long.
9e. efferent arterioles are portal vessels.

- Carry blood from glomerular capillaries to peritubular capillaries

- **Renal artery** at hilum $\rightarrow$ **interlobar arteries** $\rightarrow$ **arcuate arteries** which pass along the boundary between cortex and medulla $\rightarrow$ **interlobular arteries** travel at right angles $\rightarrow$ **afferent arterioles** $\rightarrow$ **glomerular capillaries** $\rightarrow$ **efferent arteriole**
10a. Endothelial cell lining of the glomerular capillaries forms the main filtration barrier

• 3 layers

1) **Endothelial cell lining** – circular fenestrations called pores ≈60nm

2) **Glomerular basement membrane** – large amounts of heparan sulphate proteoglycans – filter as per size/shape/charge

3) **Epithelial cells of Bowman’s capsule**
   >podocytes – trabeculae and pedicles – slit pores
   >pedicles have negative charge (sialoglycoproteins)
10b. GFR is 7.5 litres/hour in a normal healthy adult

- Or 180 L/day
10c. Molecular weight cut off for the filter is 7,000 Daltons

- Is 70,000 Daltons
- Albumin is 69,000 – mainly inhibited by negative charge
10d. GFR remains the same in males and females
10e. Hydrostatic pressure in glomerular capillaries is about 32 mmHg

- Is about 45 mmHg – due to second resistance vessel, the efferent arteriole
11a. Colloid osmotic pressure in Bowman’s capsule is high

• Is virtually zero as only very small amounts of proteins enter it
11b. Filtration fraction is about 20%

- Blood flow is about 1100ml/min
- Plasma flow is about 600ml/min
- GFR is about 120ml/min = 20%
Colloid oncotic pressure in efferent arteriole is lesser than in afferent arteriole

- Afferent – 25mmHg
- Efferent – 35mmHg
Anionic molecules are easily filtered through the basement membrane

- Heparan sulphate proteoglycans in basement membrane and sialoglycoproteins in pedicles have negative charge
11e. Mesangial cells in the glomerular tuft are phagocytic

- Prevent accumulation of macromolecules
- Structural role
- Behave like smooth muscles
12a. clearance of a substance is the volume of blood that is cleared of that substance in unit time

- Volume of plasma
- \( C = U \times \frac{V}{P} \)
12b. Inulin clearance is used to measure GFR

- 5500 Daltons
- Not reabsorbed/secerted/synthesised/metabolised
12c. Inulin is present in small amounts in the body

- It is a polysaccharide with MW 5500 daltons.
- It is not a normal constituent of the body.
12d. Para-aminohippuric acid (PAH) clearance is used to measure GFR

- Also secreted by proximal tubules
12e. PAH is completely removed from plasma

- Some is filtered at glomerulus
- Most is secreted into proximal tubule
- Tm is 10mg/100ml
13a. Renal blood flow is not autoregulated

- Autoregulated between MAP of 90 - 200
13b. Renal prostaglandins produce vasoconstriction

• They vasodilate afferent arterioles
13c. Angiotensin-II causes efferent arteriolar vasoconstriction

• Hence it increases filtration fraction
13d. In volume depleted patients, NSAIDS increase GFR

- Prevent synthesis of prostaglandins and hence further reduce GFR
13e. In hypovolaemic states, renal blood flow remains unchanged as long as MAP is in the autoregulatory range.

- Sympathetic vasoconstriction – to maintain systemic MAP
14a. Na K ATPase accounts for majority of O2 consumption in kidney

- Enables nephrons to reabsorb >99% of filtered sodium
14b. Secretion occurs across the Bowman’s capsule

- Filtration occurs across Bowman’s capsule
- Secretion is the transport of solutes from peritubular capillaries, across the tubular cells (through or between), into the tubular fluid
14c. Paracellular movement is energy dependant

- Down concentration /osmotic gradients
14d. Water absorption is passive

- Follows solute absorption
Aquaporins are involved in paracellular absorption of water

- Water channel proteins involved in transcellular transfer
- AQP-2 is the ADH sensitive channel
15a. Movement of sodium from tubular lumen into proximal tubular cells is an active process

- Passive
- Down electrical and also chemical gradient – as Na concentration is <30mmol
15b. In proximal tubular cells, 80% of sodium is antiported with H⁺ ions

• H⁺ ions move into the luminal space
15c. Extrusion of sodium from tubular cells is an active process

• Na+ K+ ATPase
• 3Na+ out for 2K+ in
Glucose re-absorption is Tm-limited

- Tm = Tubular maximum
- Tm is 380mg/min
15e. glucose absorption in the kidneys is similar to glucose absorption in the intestine

- SGLT2 carrier -> luminal -> cells
- GLUT2 carrier -> cells -> intestinal fluid
16a. Phosphate absorption into tubular cells is Tm-limited

- Usually <20% is excreted
- More if plasma conc. is >1.2mmol/L
- Normal is ≈ 1mmol/L
16b. Nearly 100% of the filtered urea is excreted

- 40 – 50% is reabsorbed in the proximal tubule
- Plasma conc. is 2.5 – 7.5 mmol/L
16c. only 20% of filtered water is reabsorbed in the proximal tubule

• Nearly 60 – 70%
16d. Amino acids entry into the proximal tubule cells from the lumen is a co-transport process

- Amino acids go as cotransport with sodium, driving force being the sodium gradient
16e. About 90% of the filtered HCO₃ ion is reabsorbed in the proximal tubule

- HCO – 90%
- Glucose - 100%
- Amino acids – 100%
- Phosphate - 80%
- Urea – 40-50%
- Water – 60-70%
17a. originates in the cortex

- Only loop goes into medulla
17b. tubular fluid is diluted during its passage through the loop

- Isotonic when it enters – 290 mosm/KgH2O
- Hypotonic when it leaves – 100 mosm/KgH2O
17c. loop of Henle continues as collecting duct

- As distal tubule
17d. Only the thick segment of Ascending loop is impermeable to water

• Both the thin and the thick
the thin descending loop is primarily responsible for the extrusion of sodium

- Thin segment has little Na+K+ATPase
- Most happens in the thick segment
18a. loop diuretics act mainly at the descending limb of loop of henle

- Act at the thick ascending limb
18b. the interstitial osmolality is highest near the tip of the loop of henle

- Around 1400 mosm/KgH2O
- Around 600 nearer the top
18c. cortical nephrons have long loops of henle

- 85% barely reach the medulla
18d. Juxtamedullary nephrons are mainly responsible for producing the medullary interstitial gradient.

- 15% - have long loops
18e. All collecting tubules pass through the medulla
19a. Permeability of collecting tubule for water is dependent on ADH

• Relatively impermeable to water/NaCl/Urea
19b. Cortical collecting tubule is permeable to urea

- Only medullary collecting tubule
- Under the influence of ADH
19c. Urea diffuses across both limbs of loop of henle

• Helps develop the high interstitial osmolality by countercurrent multiplication
19d. vasa recta washes away the solutes responsible for medullary hypertonicity

- Acts as countercurrent exchanger due to its hairpin loop
- This also makes the exchange of O2 and CO2 very inefficient – medulla very susceptible to effects of reduced perfusion
19e. ADH decreases urine osmolality

- Increases absorption of water
20a. normal urine osmolality is 300-500 mosmol/KgH2O

- Around 1.5 l of urine is produced every day with an osmolality around 300-700 mosmol/KgH2O
20b. ADH directly influences water absorption at loop of Henle

- Mainly collecting ducts
20c. about 15% of GFR reaches collecting tubules

- Around 23 l/day
20d. ADH secretion is controlled by osmoreceptors present in the pituitary gland

- Osmoreceptors in supra-optic and paraventricular areas of anterior hypothalamus
20e. ADH is synthesised in the posterior pituitary gland

- In supra-optic nucleus of hypothalamus
- Transported down via the hypothalamophyseal tract
- Stored in secretory granules at nerve terminals in posterior pituitary
21a. ADH acts directly on aquaporin-2 water channels

• Acts on V2- ADH receptors on the basal membrane
• G protein coupled receptors
• Activate adenylate cyclase
• Increase cAMP formation from ATP
• Activates protein kinase
• Phosphorylates controlling proteins in water channel
21b. half-life of ADH is 24hrs

- About 15 min
- Removed by liver and kidney
21c. Desmopressin acts on V2 receptors

• Is a synthetic analog of ADH
ADH levels are normal or high in nephrogenic diabetes insipidus

- Problem is at the level of the kidney
21e. adrenal insufficiency reduces the affect of ADH on water permeability

• Also impairs the renal response to water loading – dilute urine cannot be produced
22a. sodium salts are the main osmotically active solutes in ECF
response of ADH release is slow in correcting effective circulating volume (ECV)

- Within minutes
- Emphasis is correction of ECV
22c. Renin granules are present in the macula densa cells of juxtaglomerular apparatus

• Renin is present in renin containing granular cells in the walls of the afferent arterioles
22d. macula densa is present in the wall of the early distal tubule forming part of the juxtaglomerular apparatus.

- Part in contact with both afferent and efferent arteriole
22e. increased renal sympathetic tone decreases rennin secretion

• Increases release of renin
23a. Angiotensin-II is an octapeptide

- Angiotensin I - decapeptide
23b. Angiotensin-II acts on zona glomerulosa of the adrenal cortex

- Releases aldosterone
Angiotensin-II is a potent vasodilator

- Main action is on efferent arterioles
Angiotensin-II promotes the release of Renin from the JG apparatus

- It inhibits as part of negative feedback
23e. Angiotensin-II increases sodium reabsorption in the proximal tubule
24a. normal pH range corresponds to an H+ range of 45-35 nmol/l.
24b. Buffer solutions consist of a weak acid and its conjugate base.
24c. Bicarbonate buffer is the most important throughout the body fluids

- Bicarbonate/CO2
- Haemoglobin (HHb/Hb+ and HHbO2/HbO2)
- Phosphate (H2PO4+/HPO4--)
- Plasma proteins (Hprotein/protein-)
24d. 90% of the filtered HCO$_2^-$ is reabsorbed in the proximal tubule.
24e. pK of the bicarbonate buffer system is 6.3

• pK is the pH at which the weak acid is half dissociated
25a. micturition reflex is an autonomic spinal reflex
25b.detrusor muscle is a smooth muscle
25c. external urethral sphincter is a smooth muscle

• Skeletal muscle
25d. Efferent nerves controlling bladder contraction are sympathetic nerves.

- Pelvic nerves constitute the afferent limb and parasympathetic fibres the efferent limb.
25e. pudendal nerve supplies external urethral sphincter
26a. erythropoietin is secreted by kidneys

- About 90%
- 10% by liver
- In response to hypoxia
26b. kidney produces the inactive precursor of Vit D

- 1,25-dihydrocholecalciferol is an active form
- Hydroxylation at 1 occurs in kidney
26c. kidneys can synthesise glucose from amino acids

- In prolonged fasting states
26d. calcium is secreted by kidneys

- 99% of filtered is reabsorbed
26e. parathormone decreases reabsorption of calcium by kidneys
27a. RBF can be measured by the clearance of PAH

• Gives renal plasma flow
• \( \text{RBF} = \frac{\text{RPF}}{\text{HCT}} \times 100 \)
27b. kidneys receive around one fifth of the resting cardiac output

• 20 – 25%
27c. as cardiac output increases, the renal blood flow increases

• autoregulated
27d. RBF is maintained within narrow limits by auto regulation

• Between MAP of 90 - 200
27e. increased renal sympathetic activity increases renal blood flow

- Causes afferent arteriole constriction
28a. urine pH is greater than that of plasma under normal conditions

• Usually slightly acidic (4.5 – 7.0)
28b. urine normally contains no measurable quantity of proteins

- Proteins have negative charge
28c. in healthy people osmolality ranges from 200 – 300 mosmol/KgH2O

- Around 300 – 500 mosm/KgH\textsubscript{2}O
28d. calcium excretion is increased by parathormone
28e. glucose is excreted in urine when plasma concentration is <11mmol/L in healthy people

• Only when > 11 from a few nephrons
• >22 from all the nephrons
29a. is a glycoprotein

- Mainly in kidneys – 90%
- MW of 34,000 Daltons
29b. is secreted by bone marrow

• Kidneys and liver
29c. secretion is decreased in hypoxic states

- Increased – is main stimulus
29d. prolongs life span of RBC

- Increases erythroblast formation
29e. secretion increases about 5 days after exposure to hypoxia

- Immediate
- Peaks in 24 hrs or so
- By about 5 days maximum increase in erythroblasts is seen
30a. is inversely related to urinary concentration

- Directly

- \( C = \frac{UV}{P} \)
30b. is directly related to urine flow

- $C = UV/P$
30c. is directly related to plasma concentration

- $C = \frac{UV}{P}$
30d. is expressed in units of ml/min
30e. a solute that is freely filtered, but then reabsorbed, will have a clearance more than inulin

- Less clearance
- Inulin is not reabsorbed – measures GFR