



**PTS Reading Week Question Series 2021
Renal and Skin**

Disclaimer:

Peer Teaching Society and the authors are not liable for any misleading/ false information within this mock exam. The following paper has been written for students by students and bears no reflection on the real exam. This is a learning tool that has not been reviewed by the University of Sheffield and therefore the use of this paper for learning are at the student's discretion.

Editor

Faith Solanke

Question contributor

Gill Cottrill

Alice Bilton

1. The proliferation of cystic cells in the collecting ducts appears to be under the control of cAMP and activated by ADH, leading to new medications to be trialled for treating PKD. Which of the following genes is most commonly responsible for causing ADPKD?
 - a. GANAB
 - b. DNAJB11
 - c. PKD1
 - d. PKD2
 - e. WT1

2. The WT1 gene is required to function correctly in order for normal development of the genito-urinary system. Which of the following is not a commonly associated disorder with WT1 mutation?
 - a. Wilms Tumour
 - b. Aniridia
 - c. Ambiguous genitalia in boys
 - d. Gonadoblastoma
 - e. Turner's syndrome

3. Filtration takes place within the glomerular capillary of the nephron. Forces determining fluid and solute movement across the capillary wall are the hydrostatic pressure of the blood and the oncotic pressure of plasma protein. Which of these statements regarding contribution to Glomerular Filtration Rate (GFR) is untrue?
 - a. The hydrostatic pressure in the capillaries is usually constant along the length of the capillary at around 45mmHg.
 - b. The osmotic pressure in either space refers to the concentration of protein solutes. In Bowman's space, this should be negligible because we do not expect to have any protein in the urine.
 - c. The difference between the hydrostatic pressure and the osmotic pressure is what pushes fluid into Bowman's space.
 - d. Podocyte foot processes have a weak positive charge, preventing positively charged albumin from crossing into Bowman's space.
 - e. As you get closer to the efferent arteriole then that pressure gradient becomes less and less so there is not so much filtration.

4. The proximal convoluted tubule is responsible for bulk reabsorption of Na⁺, Cl⁻ and other solutes. Reduced blood flow to this area causes significant damage. Explain why. (2 marks)

5. 2 key cell types found in the collecting ducts are Principal cells and Intercalated cells. Describe, briefly, the role of each. (2 marks)

6. Tonicity is the measurement of the effective osmotic pressure gradient of a solution. Define hypertonic and hypotonic. (1 mark)
7. From which germ layer does the urogenital system arise?
- Notochord
 - Intermediate mesoderm
 - Endoderm
 - Ectoderm
 - Somatoderm
8. Pronephros, Mesonephros and Metanephros are terms used to describe embryological development stages of the kidney. From which week of gestation does the metanephros function?
- Day 5 to week 5.
 - Week 5 to week 12.
 - Week 12 to week 24.
 - Week 12 onwards.
 - It does not function until after birth, as the placenta is responsible for excretion of waste until then.
9. The medical definition of acid-base balance can be 'The state of equilibrium between proton donors and proton acceptors in the buffering system of the blood that is maintained at approximately pH 7.35 to 7.45 under normal conditions in arterial blood.' What then is meant by 'base excess'?
- Quantity of acid required to return pH to normal under standard conditions
 - The serum concentration of Cl^- , obtained by ABG sampling
 - Disorder tending to make blood more acid than normal
Disorder tending to make blood more alkaline than normal
 - The bicarbonate concentration standardised to pCO_2 5.3kPa
10. What is the cause of the following patients' acid-base disturbance? (Normal ranges given).
- ▶ 20 year old male. Recent lethargy, thirst, polyuria. Presents with collapse.
 - ▶ pO_2 : 10.1 kpa (9.5–12)
 - ▶ pCO_2 : 3.5 kpa (4.6–6.0)
 - ▶ pH: 7.11 (7.36–7.44)
 - ▶ Std HCO_3^- : 9 mmol/L (22–26)
 - ▶ Base excess: -19.7 mEq/L (0–2)
 - ▶ Glucose 53 mmol/L (3.3–6.0)

- a. Respiratory acidosis
- b. Metabolic acidosis
- c. Respiratory alkalosis
- d. Metabolic alkalosis
- e. None of the above

11. Micturition is the process of urine excretion from the urinary bladder. Most of the time, the urinary bladder is used to store urine. As it fills, the rugae distend and a constant pressure in the bladder (intra-vesicular pressure) is maintained. Passing of urine is under parasympathetic control. Which of the following is briefly the correct sequence?

- a. Neurons of the **pontine micturition centre** excite the sacral preganglionic neurons -> parasympathetic stimulation to the Pelvic Nerve (S2-4) -> detrusor muscle contraction
 - i. Finally, a **sub-conscious** reduction in **involuntary** contraction of the **internal** urethral sphincter from the cerebral cortex allows for distention of the urethra and the passing of urine.
- b. Neurons of the **pontine micturition centre** excite the sacral preganglionic neurons -> parasympathetic stimulation to the Pelvic Nerve (S2-4) -> detrusor muscle contraction
 - i. Finally, a **conscious** reduction in **voluntary** contraction of the **internal** urethral sphincter from the cerebral cortex allows for distention of the urethra and the passing of urine.
- c. Neurons of the **pontine micturition centre** excite the sacral preganglionic neurons -> parasympathetic stimulation to the Pelvic Nerve (S2-4) -> detrusor muscle contraction
 - i. Finally, a **conscious** reduction in **voluntary** contraction of the **external** urethral sphincter from the cerebral cortex allows for distention of the urethra and the passing of urine.
- d. Neurons of the **Onuf's Nucleus** centre excite the sacral preganglionic neurons -> parasympathetic stimulation to the Pelvic Nerve (S2-4) -> detrusor muscle contraction
 - i. Finally, a **sub-conscious** reduction in **involuntary** contraction of the **internal** urethral sphincter from the cerebral cortex allows for distention of the urethra and the passing of urine.
- e. Neurons of the **Onuf's nucleus** centre excite the sacral preganglionic neurons -> parasympathetic stimulation to the Pelvic Nerve (S2-4) -> detrusor muscle contraction
 - i. Finally, a **conscious** reduction in **voluntary** contraction of the **internal** urethral sphincter from the cerebral cortex allows for distention of the urethra and the passing of urine.

12. What anatomical position does the renal artery typically leave the abdominal aorta?

- a. L1 (distal to SMA)
- b. L1 (Proximal to SMA)
- c. L3 (At Coeliac Axis)

- d. T12 (Immediately below diaphragm)
- e. L5 (Branching off the Internal Pudendal Artery)

13. Melanocytes are responsible for melanin production and pigment formation. Individuals with darker skin have increased melanin production, not an increased number of melanocytes.

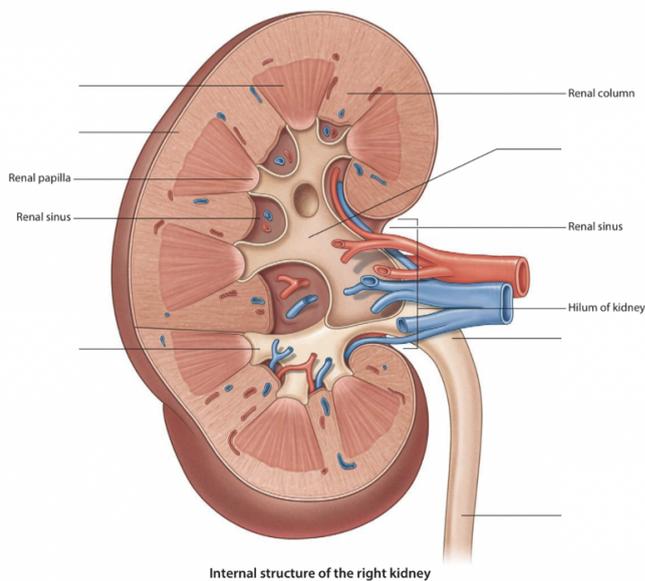
In which layer of the skin are Melanocytes found?

- a. Hypodermis
- b. Papillary
- c. Dermis
- d. Epidermis
- e. Reticular

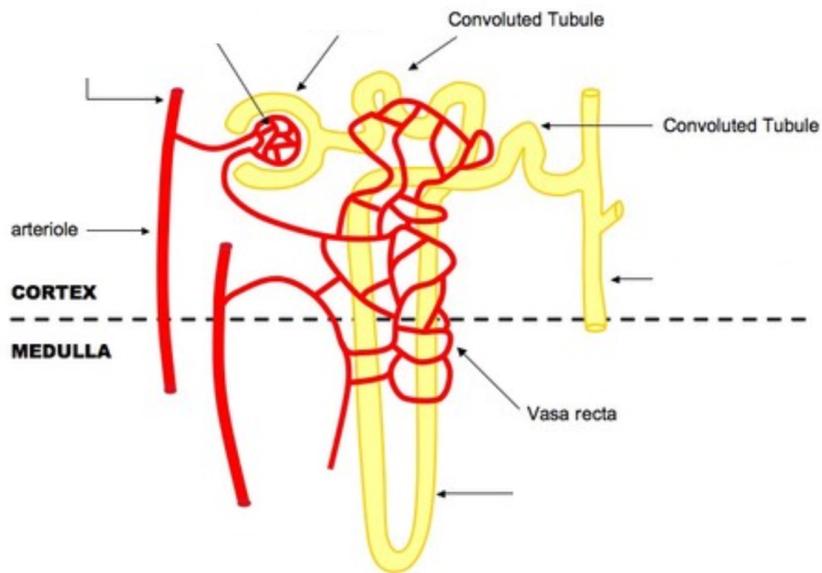
14. The skin is an essential barrier between the body and the external environment. Which layer of the epidermis reflects UV radiation, thus reducing the potentially harmful exposure dose?

- a. Stratum basale
- b. Stratum spinosum
- c. Stratum granulosum
- d. Stratum lucidum
- e. Stratum corneum

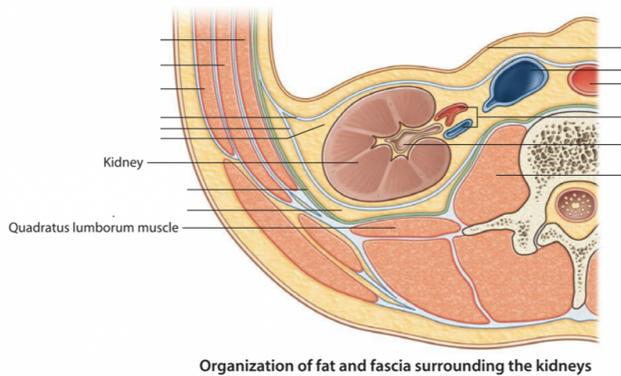
15. Label the image



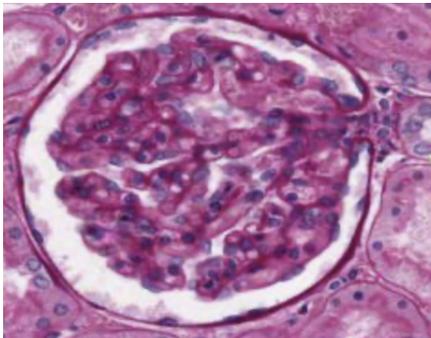
16. Label the image



17. Name the 5 protective layers, in order, separating the kidney from the quadratus lumborum muscle, both labelled. (5 marks, picture for reference only)



18. This is a histological slide showing the basement membrane within the glomerulus. Which type of staining process was used? (1 mark)



19. Describe the action of ADH. (4 marks)

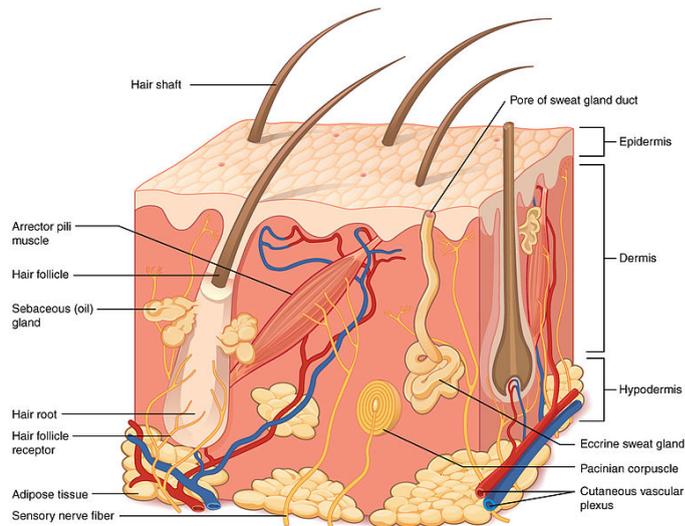
20. What does an increase in angiotensin II not cause?

- a. Increased sympathetic activity
- b. Aldosterone secretion
- c. Arteriolar vasodilation
- d. ADH secretion
- e. Increased tubular K^+ excretion

Answers and Explanations

1	C - PKD1 accounts for ~85% of PKD PKD2 for ~15%. GANAB and DNAJB11 can sometimes contribute but in negligible amounts, and WT1 is required for normal development of GU system but is not usually associated with PKD.
2	E - Turner's syndrome is not associated with WT1 mutation, but in girls with 45 chromosomes, where one X chromosome is missing (or partially missing) - usually denoted by 45X or 45XO.
3	D - Podocyte membranes actually have a weak negative charge, preventing negatively charged albumin from crossing.
4	The absorption of these electrolytes etc is very energy intensive, and the proximal convoluted tubule has many active transport pumps, and the cytoplasm of the endothelial cells here is rich in mitochondria. Lack of blood supply means that less ATP can be produced so these transport pumps cannot function, so the renal tubules are damaged. (Mark per sentence)
5	Principal cells are the main Na ⁺ reabsorbing cells and are the site of action of aldosterone. Intercalated cells are involved in acid-base balance by mediating H ⁺ and HCO ₃ ⁻ secretion and K ⁺ and Cl ⁻ reabsorption. (Mark per sentence)
6	Hypertonic = concentration of solutes is higher outside the cell than inside. Hypotonic = concentration of solutes is higher inside the cell than outside.
7	B - (E is made up).
8	D - The pronephros is non-functioning, develops at week 4 and disappears by week 5. The mesonephros may function for a short period, develops in week 4 and has a duct connecting it to the cloaca (which in males persists into adulthood). Although the placenta is responsible for excretion of waste until birth, the kidneys have multiple other functions.
9	A - Acidosis = Disorder tending to make blood more acid than normal Alkalosis = Disorder tending to make blood more alkaline than normal Standard bicarbonate is the bicarbonate concentration standardised to pCO ₂ 5.3kPa and temp 37. (B was made up).
10	B - this is diabetic ketoacidosis
11	C - Regulation of Micturition: Passing of urine is under parasympathetic control. Bladder afferents signals ascend through the spinal cord and then project to the pontine micturition centre and cerebrum. Upon the voluntary decision to urinate,

	<p>neurons of the pontine micturition centre fire to excite the sacral preganglionic neurons.</p> <p>There is subsequent parasympathetic stimulation to the Pelvic Nerve (S2-4) causing a release of ACh, which works on M3 muscarinic ACh receptors on the detrusor muscle, causing it to contract and increase intra-vesicular pressure. The pontine micturition centre also inhibits Onuf's nucleus, with a resultant reduction in sympathetic stimulation to the internal urethral sphincter causing relaxation.</p> <p>Finally, a conscious reduction in voluntary contraction of the external urethral sphincter from the cerebral cortex allows for distention of the urethra and the passing of urine. In the female, urination is assisted by gravity, while in the male, bulbospongiosus contractions and squeezing along the length of the penis helps to expel all of the urine.</p>
12	A
13	<p>D - The epidermis is the most superficial layer of the skin, and is largely formed by layers of keratinocytes undergoing terminal maturation. This involves increased keratin production and migration towards the external surface, a process called cornification.</p> <p>There are also several non-keratinocyte cells that inhabit the dermis: Melanocytes - responsible for melanin production and pigment formation (Individuals with darker skin have increased melanin production, not an increased number of melanocytes). Langerhans cells - antigen-presenting dendritic cells. The main function of dendritic cells is to process antigen material and present it on the cell surface to the T cells of the immune system. They act as messengers between the innate and the adaptive immune systems. Langerhans cells are found in the basal and suprabasal layers of the epidermis and in the epithelia of the respiratory, digestive and urogenital tracts. They specialise in antigen presentation and belong to the skin immune system (SIS). Merkel cells - sensory mechanoreceptors. They are located in the basal epidermal layer of the skin. Also known as Merkel-Ranvier cells or tactile epithelial cells, are oval-shaped mechanoreceptors essential for light touch sensation</p> <p>B and E are layers of the Dermis: The dermis is immediately deep to the epidermis and is tightly connected to it through a highly-corrugated dermo-epidermal junction. The dermis has 2 layers which are less clearly defined than the layers of the epidermis. Papillary layer and Reticular layer (deeper) Thick bundles of collagen fibres that provide more durability.</p>



14 E - The epidermis can be divided into layers (strata) of keratinocytes - this reflects their change in structure and properties as they migrate towards the surface. From the deepest to the most superficial, these are:

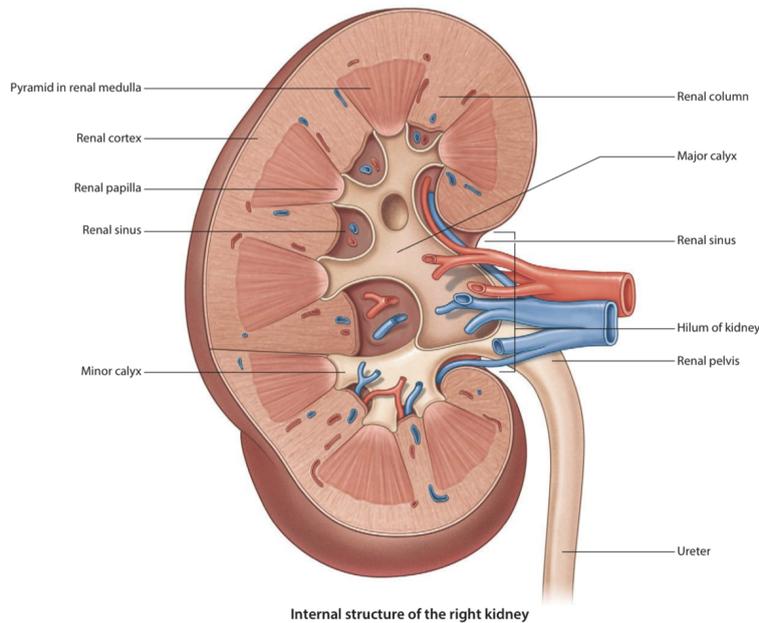
- **Stratum basale** - Mitosis of the keratinocytes occurs in this layer.
- **Stratum spinosum** - Keratinocytes are joined by tight intercellular junctions called desmosomes.
 - ***Desmosomes** are intercellular junctions that provide strong adhesion between cells. Because they also link intracellularly to the intermediate filament cytoskeleton they form the adhesive bonds in a network that gives mechanical strength to tissues.*
- **Stratum granulosum** - Cells secrete lipids and other waterproofing molecules in this layer. Keratinocytes are known as granular cells in this layer, the cell membranes thicken and cells produce large amounts of the proteins keratin (fibrous) and keratohylin; which accumulates as lamellar granules within the cells.
- **Stratum lucidum** - Cells lose nuclei and drastically increase keratin production.
- **Stratum corneum** - Cells lose all organelles but continue to produce keratin. The barrier to percutaneous absorption lies within the stratum corneum, the most superficial layer of the epidermis. The function of the stratum corneum is to reduce water loss, provide protection against abrasive action and microorganisms, and generally act as a permeability barrier to the environment.

Protection of UV Radiation:

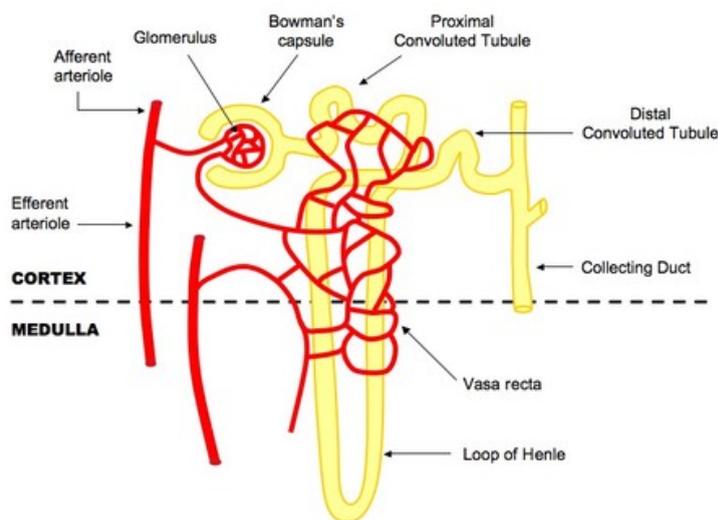
1. The stratum corneum reflects radiation, so reducing the exposure dose.
2. Sun exposure increases the activity of melanocytes, the number of melanosomes produced and the rate of transfer of melanin to the epidermal

keratinocytes. This helps to decrease absorption of UV radiation by DNA and cellular constituents.

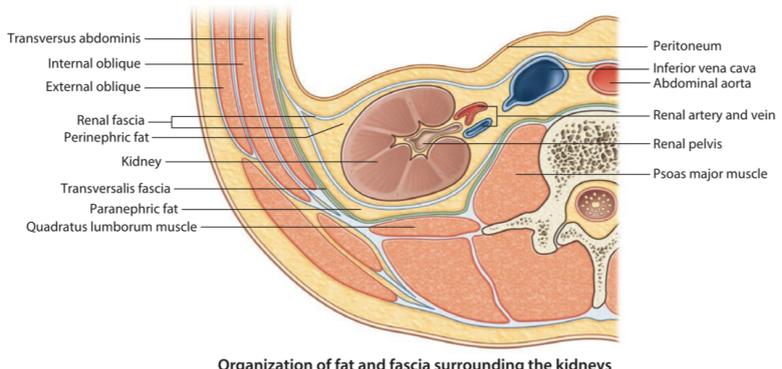
15 Missing labels were: Medullary pyramid (pyramid in renal medulla), cortex, minor calyx, major calyx, renal pelvis and ureter



16 Missing labels were: Afferent arteriole, efferent arteriole, glomerulus, Bowman's capsule, loop of Henle and collecting duct



17 Kidney -> renal capsule, perinephric (or perirenal) fat , renal fascia, paranephric (or pararenal) fat, transversalis fascia -> quadratus lumborum muscle

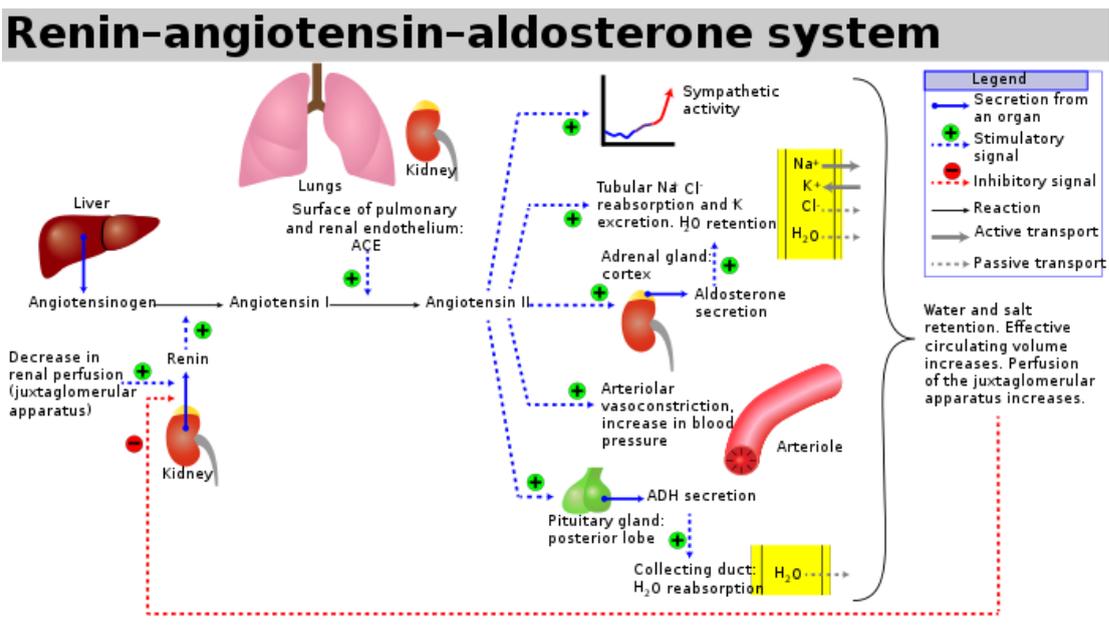


Organization of fat and fascia surrounding the kidneys

18 The glomerular basement membrane and Bowman's capsule are visualised most effectively, histologically, with the Periodic Acid-Schiff (PAS) staining procedure.

19 When the RAAS system is stimulated, ADH is released from the posterior pituitary gland. Where, in the kidney, ADH binds to V2R receptors (G-protein coupled receptors), increasing the transcription of Aquaporin-2 channels and increasing the insertion of these channels into the apical membrane of the principal cells. The permeability of the cells is increased, allowing water to flow down its concentration gradient into the cell and then over the basolateral membrane into the bloodstream through aquaporin-3 and -4 channels. The total blood volume therefore increases, plasma osmolarity is normalised and urine becomes more concentrated. (Marks for receptor involved&location, increase of AQP-2, direction of water movement, overall effect)

20 C, Angiotensin causes arteriolar vasoconstriction which acts to increase blood pressure. The other effects are to stimulate aldosterone and ADH secretion and increase: sympathetic activity, tubular Na/Cl and H₂O reabsorption and tubular K⁺ excretion



We hope you have found these questions useful. Please fill out our feedback form so we can improve;

<https://docs.google.com/forms/d/e/1FAIpQLSfp6LVdcxvKezwk4rib9MDCiNJd9uOH6XxSEe1fe4zz-6AIQ/viewform?vc=0&c=0&w=1&flr=0>