InkBiology

ANSWER BOOK

# The kidney: filter everything, then take almost all of it back

Hormonal communication, plant responses and homeostasis · Unit B15

AQA 3.6.4.3 · OCR A 5.1.2 · CAIE 14.1

6 questions · 23 marks

NAVY EDITION


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## SECTION A · Short, 1 to 2 marks

**A1** **B1** the basement membrane, a mesh of collagen and glycoproteins, is the filter. **B1** it holds back plasma proteins, and anything else above about 69 000 relative molecular mass. [2]

## SECTION B · Standard, 3 to 5 marks

**B1** **B1** sodium ions are actively pumped out of the tubule cell at the side facing the blood, which lowers the sodium concentration inside the cell. **B1** sodium ions in the filtrate then diffuse into the cell down that gradient through a co-transporter protein. **B1** glucose is carried in with the sodium, against its own concentration gradient, and then leaves the cell into the blood by facilitated diffusion. **B1** the surface facing the filtrate carries microvilli, giving a large surface area for the carrier and channel proteins the membranes are packed with. **A1** the cytoplasm contains many mitochondria, supplying the ATP that the sodium pumps consume; the ATP is spent on the sodium pump rather than on the glucose. [5]

**B2** **B1** the thick section of the ascending limb actively transports sodium and chloride ions out into the surrounding tissue, and that limb is not permeable to water. **B1** the pump can only ever create a difference of about 200 arbitrary units between the ascending limb and the tissue around it, which is the single effect. **B1** the descending limb is permeable to water, so water leaves it by osmosis into the now more concentrated tissue and the fluid inside becomes more concentrated. **B1** because the two limbs run alongside each other with fluid flowing in opposite directions, that concentrated fluid is delivered to the pump again at a higher starting concentration, so the small difference is multiplied down the loop. **A1** the water itself is reabsorbed later and elsewhere, from the collecting duct running back down through the gradient the loop has built; the loop spends ATP building the gradient rather than reclaiming the water. [5]

**B3** **B1** the efferent arteriole leaving the glomerulus is narrower than the afferent arteriole bringing blood in, so the blood is squeezed into a bottleneck. **B1** the hydrostatic pressure in the glomerular capillaries is therefore much higher than in an ordinary capillary bed, and fluid is forced out through the capillary wall. **B1** the pores of the fenestrated endothelium and the filtration slits between the podocytes are both far too wide to sort molecules, so the basement membrane between them does the sorting. **A1** water, glucose, amino acids, mineral ions and urea are small enough to pass through it, while plasma proteins are too large and stay in the blood. [4]

**B4** **B1** water is lost in sweat, so the water potential of the blood falls and becomes more negative. **B1** osmoreceptors in the hypothalamus lose water by osmosis and shrink, and send impulses along neurones to the posterior pituitary. **B1** the posterior pituitary releases more antidiuretic hormone into the blood, and it binds to receptors on the cells of the collecting duct wall. **A1** vesicles carrying aquaporins fuse with the membrane facing the filtrate, so the wall becomes more permeable and more water leaves by osmosis down the gradient in the medulla, giving a small volume of concentrated urine. [4]

**B5** **B1** a thick medulla holds unusually long loops of Henle. **B1** sodium and chloride ions are pumped out of the ascending limb over a greater depth of tissue, so the single effect is multiplied over more levels and the gradient in the medulla is steeper. **A1** the collecting duct passes down through that steeper gradient, so water leaves it by osmosis all the way down and a smaller volume of more concentrated urine is produced. [3]