

## Application of knowledge and exam technique practice (H420/01, 2017, Q22)

Resource made by Chris Graham, Hills Road Sixth Form College, using an OCR exam paper question published online.

- 1) Do the exam question (from H420/01, 2017, Q22 – included here without images because of copyright reasons)  
Access the paper here: <https://www.ocr.org.uk/Images/471872-question-paper-biological-processes.pdf>  
Access the insert here: <https://www.ocr.org.uk/Images/471874-question-paper-biological-processes-insert.pdf>
- 2) Look at “How to approach the question” support and adjust your answer if necessary
- 3) Use the mark scheme to check your answers – read extra notes on mark scheme carefully
- 4) Summarise the key points you need to think about when answering questions like these

**22 (a)** Fig. 22.1, **on the insert**, is a cross section of part of the cortex of a mammalian kidney.

(i) Which letter identifies the region with the highest hydrostatic pressure?  
..... [1]

(ii) Which **two** letters identify regions that **do not** contain plasma proteins?  
..... [1]

(b) Studies of the cell surface membranes of the **distal** convoluted tubule have provided the following evidence:

- Sodium-potassium pumps:
  - move potassium ions from the blood to the tubule fluid
  - move sodium ions from the tubule fluid to the blood
  - use ATP in these processes.
- Sodium-calcium co-transport proteins:
  - move calcium ions from the tubule fluid to the blood
  - move sodium ions into the tubule fluid
  - use the electrochemical gradient of sodium ions to drive this process.

(i) Using this information and your own knowledge, compare the processes occurring in the **proximal** and **distal** convoluted tubules.  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
..... [3]

- (ii) Nephrogenic diabetes insipidus is a disease of the kidney that affects the regulation of water potential in the blood. One cause is lithium poisoning. Lithium ions enter the kidney tubules through sodium channels.

This prevents the cells of the collecting duct from responding to ADH in the blood.

State and explain **one** symptom you would expect to observe as a result of nephrogenic diabetes insipidus.

.....  
.....  
.....  
.....  
..... [2]

- (c) Fig. 22.2 shows a podocyte from the kidney. The many gaps between the microscopic processes form fenestrations in the Bowman's capsule.

- (i) Explain why podocytes are usually unable to undergo mitosis.

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.....  
..... [3]

- (ii) Studies show that after damage by infection or injury, it is possible for nephron tissues to be regenerated. Adult stem cells are involved in this process.

What features of adult stem cells make them suitable for regeneration of tissues in the kidney?

.....  
.....  
.....  
.....  
..... [2]

# How to approach the question

22 (a) Fig. 22.1, on the insert, is a cross section of part of the cortex of a mammalian kidney.

(i) Which letter identifies the region with the highest hydrostatic pressure? [1]

(ii) Which **two** letters identify regions that **do not** contain plasma proteins? [1]

Be careful that you follow instructions precisely:  
 "two"  
 "do not"

When hydrostatic pressure is mentioned in relation to the kidney you should immediately think about the efferent and afferent arterioles and the glomerulus – the system has evolved to generate a high hydrostatic pressure for ultrafiltration.

You have to bring your knowledge of identifying components of the nephron and associated blood vessels, as well as the characteristics / role of each component.

You need to bring the same knowledge as from the first part of the question.

When plasma proteins are mentioned in relation to the kidney your first thought should be in relation to ultrafiltration. These are the molecules that don't pass through into the filtrate whereas smaller (RMM less than 69000) molecules do.

So you are looking for two parts that contain the filtrate (and so after ultrafiltration) rather than blood (and so before ultrafiltration).

(b) Studies of the cell surface membranes of the **distal** convoluted tubule have provided the following evidence:

- Sodium-potassium pumps:
  - move potassium ions from the blood to the tubule fluid
  - move sodium ions from the tubule fluid to the blood
  - use ATP in these processes.
- Sodium-calcium co-transport proteins:
  - move calcium ions from the tubule fluid to the blood
  - move sodium ions into the tubule fluid
  - use the electrochemical gradient of sodium ions to drive this process.

ATP and "pumps" indicates active transport.

"cotransport" a key word here.

In this question you are provided with novel information about the distal convoluted tubule and asked to compare it with your own knowledge of the proximal convoluted tubule.

(You are not expected to know this level of detail about the distal convoluted tubule which is why the information is provided).

(i) Using this information and your own knowledge, compare the processes occurring in the proximal and distal convoluted tubules.

..... [3]

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Three marks for "compare" may well require at least one similarity and one difference. Write at least 3 separate points but try to get 4 or 5 to be safe.

Lots of space is provided and it's 3 marks so consider lots of small logical steps in your answer with lots of little bits of detail.

In terms of exam technique the most important word in this question is "compare".

This is instructing you to make every sentence a comparison.

You need to think about similarities as well as differences.

e.g. Both A and B use...  
 or A uses .... whereas B uses...

The next most important word is "processes".

This is instructing you to talk about things that happen in these tubules and not structures that they have or don't have.

(ii) Nephrogenic diabetes insipidus is a disease of the kidney that affects the regulation of water potential in the blood. One cause is lithium poisoning. Lithium ions enter the kidney tubules through sodium channels.

This prevents the cells of the collecting duct from responding to ADH in the blood.

State and explain **one** symptom you would expect to observe as a result of nephrogenic diabetes insipidus.

..... [2]

.....

.....

.....

.....

The first paragraph is context (new knowledge setting the scene for a question). These context paragraphs often have important information needed to answer the question that follows, however, in this question the information you really need is in the second paragraph (the sodium channels statement looks like it might be relevant but it turns out it isn't).

When the collecting duct and ADH are mentioned you should immediately think of osmoregulation, aquaporins, and the volume and concentration of urine produced.

"State and explain" for a 2 mark question must mean one mark for each. State = Describe the symptom. Do it in full in case the mark scheme is restrictive. Explain = talk about what is causing the symptom.



# Annotated mark scheme

22	(a)	(i)	A ✓	1	mark the first letter only IGNORE name unless contradicts a stated letter
	(a)	(ii)	B, D ✓	1	If more than two letters given, 0 mark IGNORE names unless contradicts a stated letter
22	(b)	(i)	<p><i>similarities</i></p> <p>S1 both use <u>active transport</u> ✓</p> <p>S2 both involve , co-transport / described ✓</p> <p>S3 both involve <u>selective</u> reabsorption ✓</p> <p>S4 both involve use of , sodium ions / Na<sup>+</sup> ✓</p> <p><i>differences</i></p> <p>D1 DCT involves use of , calcium ions / Ca<sup>2+</sup> ✓</p> <p>D2 (co-transport in) DCT involves ions only ✓</p> <p>D3 PCT involves ions and (named) molecules ✓</p>	3 max	<p>maximum two marks for similarities or differences</p> <p>IGNORE sodium / Na</p> <p>e.g. glucose / amino acid(s) IGNORE calcium / Ca</p>
	(b)	(ii)	<p><i>symptom</i></p> <p>high volume of / excess , urine OR always thirsty / AW ✓</p> <p><i>explanation</i></p> <p>fewer / AW , aquaporins in the membrane (of collecting duct cells) ✓</p>	2	<p>ALLOW large amount / lots , of urine IGNORE reference to , dilute urine / water potential / frequency of urination</p> <p>ALLOW <u>protein</u> water channels for aquaporins</p>

It's the glomerulus (the network of capillaries within the Bowman's capsule)

B and D are after ultrafiltration and contain the filtrate  
B = proximal convoluted tubule  
D = Bowman's capsule  
Can't be A or C as they have blood in them  
C = Afferent or Efferent arteriole

You won't get the marks unless it is clear you are talking about "ions" (in MP S4 and D1)

Similarities all start with "both".  
This mark scheme appears to be a bit forgiving on how to phrase differences but often it isn't this forgiving.

It is unclear why high volume is allowed but dilute is not.  
Overcome these issues with mark schemes by always writing "a large volume of dilute urine" – this gets this mark.

22	(c)	(i)	<p>1 have already / are , differentiated / specialised (so cannot divide) ✓</p> <p>2 are in , G<sub>0</sub> (phase of cell cycle) / resting phase ✓</p> <p>3 <i>idea that</i> shape is (too) , irregular / asymmetrical (so cannot divide) ✓</p> <p>4 cytoskeleton cannot function / spindle (fibres) cannot form ✓</p> <p>5 (if mitosis occurred) it would alter , number / size , of the , gaps / fenestrations ✓</p> <p>6 (so) <i>idea that it would</i> alter an aspect of ultrafiltration ✓</p>	3 max	<p>ALLOW cannot pass G1 checkpoint / cannot go into S phase / remains in G<sub>1</sub></p> <p>e.g. (podocyte) has projections (so cannot divide)</p> <p>ALLOW for aspect of ultrafiltration e.g. different sized molecules can pass through e.g. no / less : ultrafiltration e.g. changes rate of ultrafiltration e.g. changes composition of filtrate</p>
	(c)	(ii)	<p>(adult stem cells) are <u>multipotent</u> ✓</p> <p>(differentiate to) become any <u>cell type</u> within , kidney / nephron (tissue) ✓</p>	2	<p>DO NOT ALLOW totipotent / pluripotent ALLOW (adult stem cells) can , differentiate / specialise</p>
<b>Total</b>				12	

MP1 is stating the general principle  
MP2 is adding in some detail  
MP3 is a general principle of many specialised cells but is particularly clear in this context and shows in the image provided.  
MP4 is adding detail (not an obvious mark point though)  
MP5 and 6 are talking about this context and answering the question in a slightly different way. These MPs are not about what's preventing them doing mitosis but why aren't they "allowed" to do mitosis.  
MP6 is following on the logical storyline from MP5

Try to think of different ways to answer questions to clock up more mark points.

This mark point requires a context specific part to it and not just differentiating in general.

Multipotent is the key word that you need to link to "adult" stem cells.

## Key points to remember from this task