A-Level Biology

Digestion and Absorption

Question Paper

Time available: 78 minutes
Marks available: 55 marks

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1. (a) The action of endopeptidases and exopeptidases can increase the rate of protein digestion. Describe how.

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(2)

(b) As humans age, there is a decrease in body protein.

Give the name of **one** body protein that could have resulted in:

reduced muscle power _____

reduced immunity _____

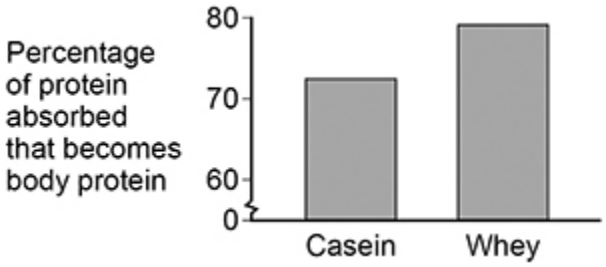
(2)

Scientists investigated the effect of two types of dietary protein on the ability of old men to produce body proteins.

The table below shows information about the two types of dietary protein investigated.

Physiological factor	**Name of dietary protein**	
	Casein	**Whey**
Rate of absorption of dietary protein / mmol dm^{-3} amino acids in blood plasma h^{-1}	3.05	4.33
Stimulation of protein synthesis	Higher rate	Lower rate
Breakdown of body proteins	No effect	Inhibitory effect

The figure below shows the percentage of protein absorbed that becomes body protein in old men following a meal of casein or whey.



A statistical test confirmed that the difference between the results shown in the figure above was significant.

(c) Suggest which type of dietary protein would be better for old men to eat to cause a **net** gain of body proteins. Use the information provided to explain your answer.

(3)

(Total 7 marks)

2. (a) Describe the role of enzymes in the digestion of proteins in a mammal.

(4)

Scientists investigated how the diet of rabbits affected their digestion and absorption of protein. The scientists fed rabbits an identical mass of food but varied the percentage of protein in the food.

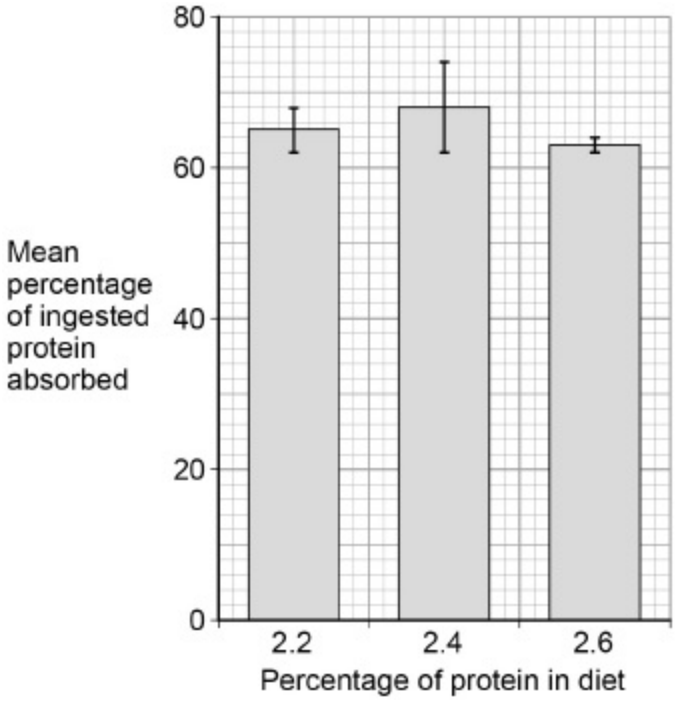
The scientists measured the mean mass of protein fed to the rabbits that was absorbed, which they then expressed as a percentage value.

The scientists' results are shown in **Figure 1**.

The error bars show ± 2 standard deviations.

± 2 standard deviations cover 95% of the data.

Figure 1

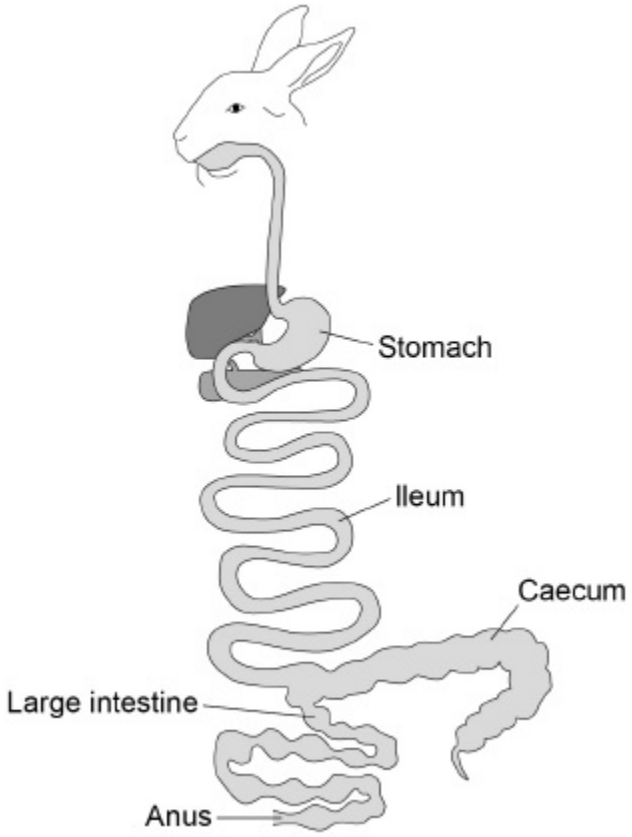


(b) What can you conclude about the absorption of the products of protein digestion as the percentage of protein increased in the rabbits' food?

(3)

The digestive system of a rabbit is shown in **Figure 2**.

Figure 2



(b) The food eaten by a rabbit is digested mainly by microorganisms in its caecum. The caecum is a section of intestine attached between the ileum and the large intestine. The resulting semi-digested material leaves the anus of a rabbit as soft, caecal droppings. The rabbit then eats these caecal droppings.

Use this information and **Figure 2** to suggest how eating its own caecal droppings helps a rabbit's digestion and absorption of dietary protein.

(3)

(Total 10 marks)

3. A student investigated the effect of chewing on the digestion of starch in cooked wheat.

He devised a laboratory model of starch digestion in the human gut. This is the method he used.

1. Volunteers chewed cooked wheat for a set time. The wheat had been cooked in boiling water.
2. This chewed wheat was mixed with water, hydrochloric acid and a protein-digesting enzyme and left at 37 °C for 30 minutes.
3. A buffer was then added to bring the pH to 6.0 and pancreatic amylase was added. This mixture was then left at 37 °C for 120 minutes.
4. Samples of the mixture were removed at 0, 10, 20, 40, 60 and 120 minutes, and the concentration of reducing sugar in each sample was measured.
5. Control experiments were carried out using cooked wheat that had been chopped up in a blender, not chewed.

(a) What reducing sugar, or sugars, would you expect to be produced during chewing? Give a reason for your answer.

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(2)

(b) In this model of digestion in the human gut, what other enzyme is required for the complete digestion of starch?

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(1)

(c) What was the purpose of step 2, in which samples were mixed with water, hydrochloric acid and pepsin?

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_____

(1)

(d) In the control experiments, cooked wheat was chopped up to copy the effect of chewing.

Suggest a more appropriate control experiment. Explain your suggestion.

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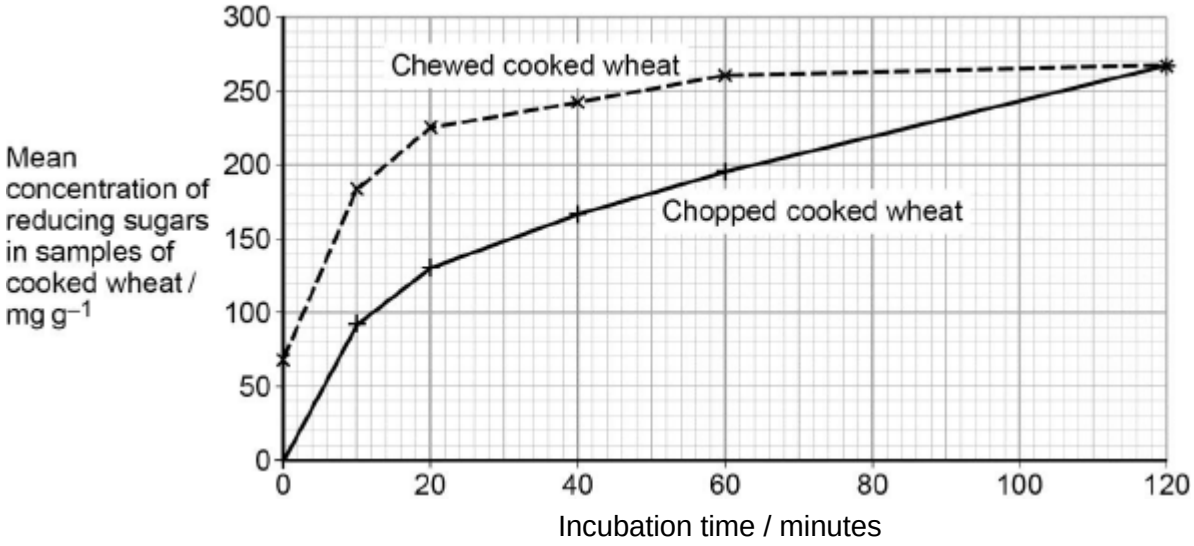
(2)

(e) The figure below shows the student's results.



Explain what these results suggest about the effect of chewing on the digestion of starch in wheat.

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(3)

(Total 9 marks)

4. (a) Endopeptidases and exopeptidases are involved in the hydrolysis of proteins.

Name the other type of enzyme required for the complete hydrolysis of proteins to amino acids.

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(1)

(b) Suggest and explain why the combined actions of endopeptidases and exopeptidases are more efficient than exopeptidases on their own.

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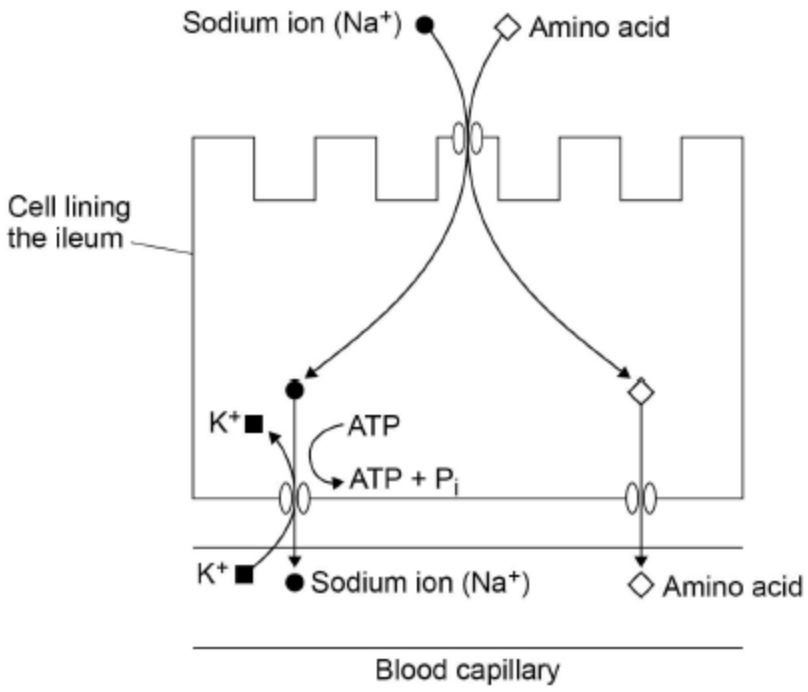
(2)

(c) The diagram shows the co-transport mechanism for the absorption of amino acids into the blood by a cell lining the ileum.



The addition of a respiratory inhibitor stops the absorption of amino acids.

Use the diagram to expain why.

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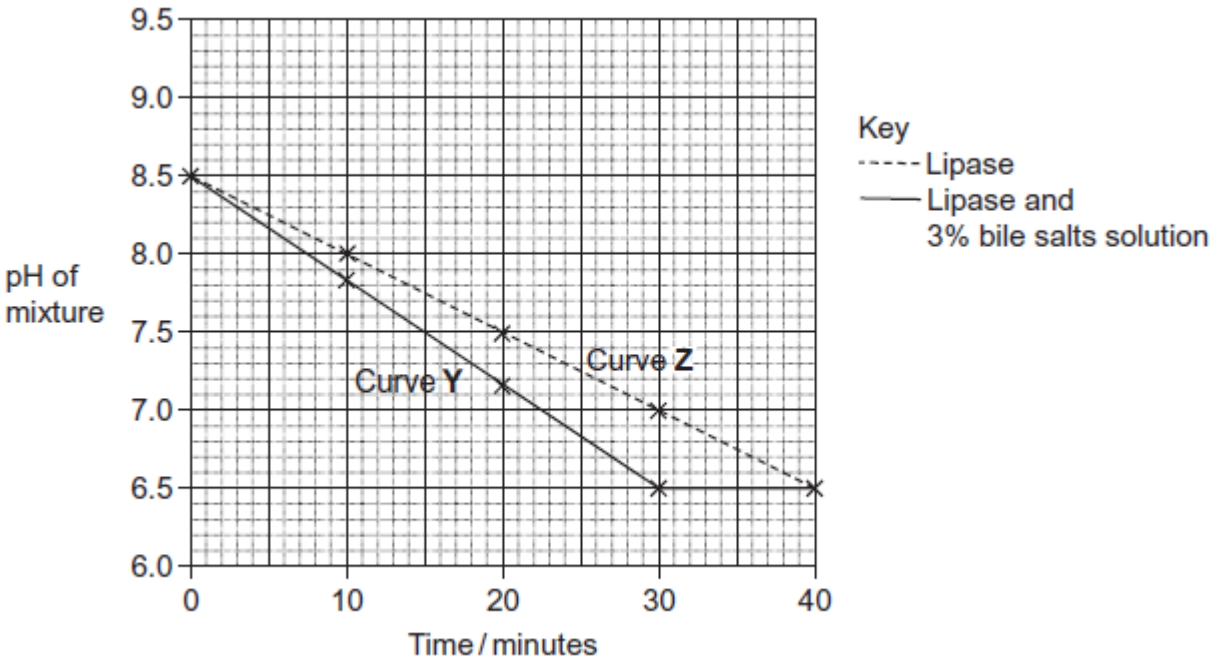
(3)

(Total 6 marks)

5. Scientists investigated the effect of lipase and a 3% bile salts solution on the digestion of triglycerides. The graph below shows their results.



The scientists also incubated triglycerides with different concentrations of bile salts. After 30 minutes they measured the diameter of the triglyceride droplets. They used the results to calculate the mean radius of the droplets at each concentration. The table below shows their results.

Concentration of bile salts /%	0	1	2	3	4	5
Mean radius of triglyceride droplet / μm	6	5	4	3	2	1

(a) Describe how you would use a microscope to find the mean diameter of triglyceride droplets on a slide.

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(3)

(b) (i) The ratio of mean radius of triglyceride droplets in bile salts at a concentration of 0% to the mean radius in bile salts at a concentration of 3% is 2 : 1.

What is the ratio of their surface areas? Show your working.

You can calculate the surface area of a droplet from the formula

$$A = 4\pi r^2$$

Where A = surface area
r = radius
π = 3.14

(2)

(ii) Use the data in the table to explain the difference between curves **Y** and **Z** in the graph.

(3)

(Total 8 marks)

6. (a) Describe the role of the enzymes of the digestive system in the complete breakdown of starch.

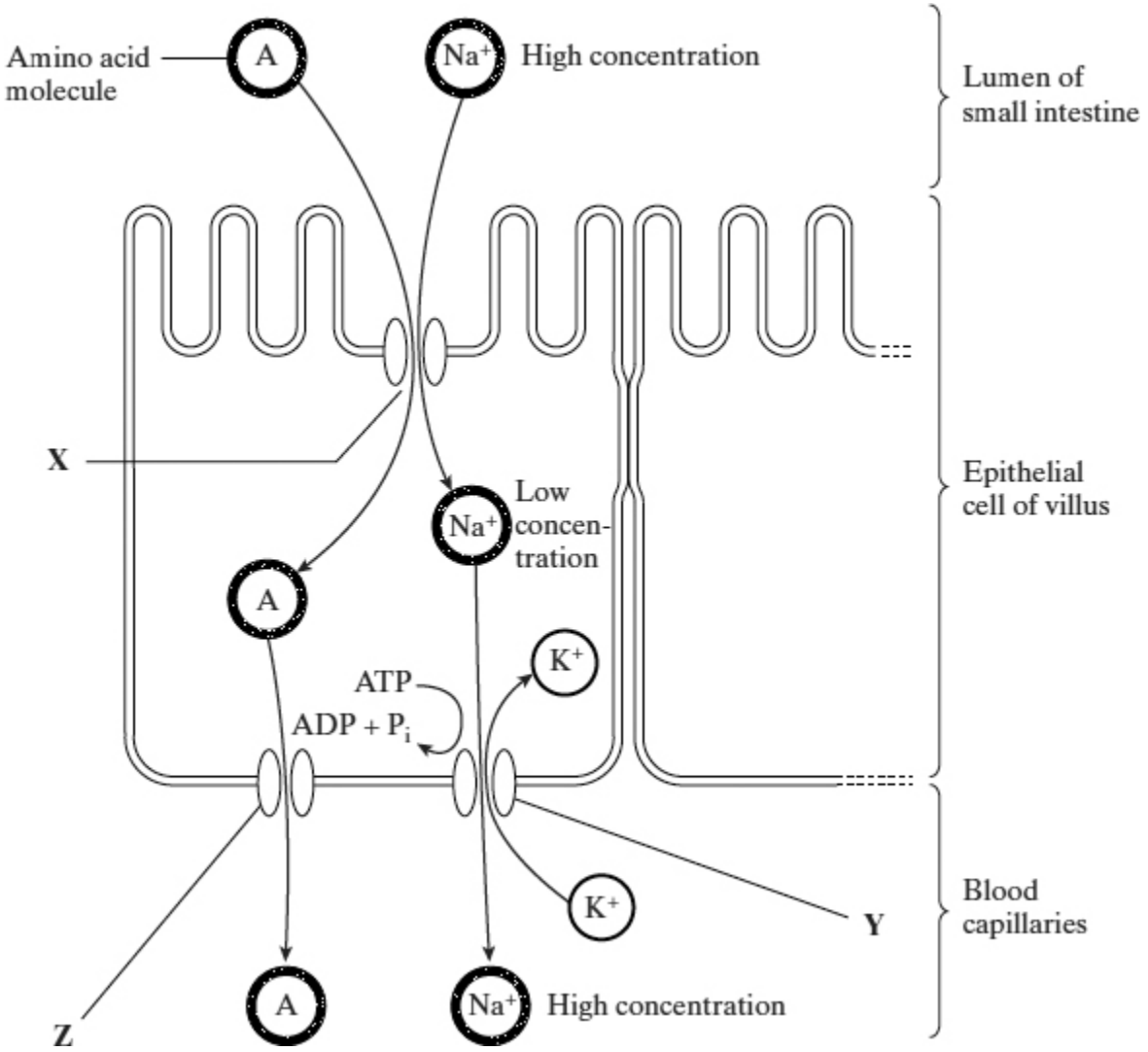
(5)

(b) Describe the processes involved in the absorption of the products of starch digestion.

(5)

(Total 10 marks)

7. The diagram shows one method by which amino acids are absorbed from the small intestine into the blood. They are co-transported into the epithelial cell with sodium ions (Na^+) at point **X** on the diagram. Normally, the concentration of sodium ions inside the epithelial cell is low.



Source: adapted from M. ROWLAND, *Biology (University of Bath Science 16-19)* (Nelson Thornes) 1992.

Dinitrophenol (DNP) prevents oxidative phosphorylation. When treated with DNP, the sodium-potassium pump at **Y** no longer works. As a result, the concentration of sodium ions in the cell rises and amino acid absorption stops.

(i) Explain why pump **Y** will **not** work in the presence of DNP.

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(2)

(ii) Explain why sodium ions and amino acids are **not** absorbed from the lumen of the small intestine in the presence of DNP.

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(2)

(iii) By what mechanism would amino acids leave the epithelial cell at point **Z**?

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(1)

(Total 5 marks)