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General Certificate of Education  
 June 2004  
 Advanced Level Examination



**BIOLOGY (SPECIFICATION A)**  
**Unit 6 Physiology and the Environment**

**BYA6**

Tuesday 22 June 2004 Morning Session

**No additional materials are required.**  
 You may use a calculator.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
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Total (Column 1)		→	
Total (Column 2)		→	
TOTAL			
Examiner's Initials			

Time allowed: 1 hour 30 minutes.

**Instructions**

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

**Information**

- The maximum mark for this paper is 75.
- Mark allocations are shown in brackets.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.
- You are reminded that this test requires you to use your knowledge of Modules 1, 2, 4 and 5 as well as Module 6 in answering synoptic questions. These questions are indicated by the letter **S**.

Answer **all** questions in the spaces provided.

**1** Two theories have been put forward to explain the upward movement of water in the xylem in a tree.

- the cohesion-tension theory
- the root pressure theory

(a) Describe **one** piece of evidence that supports the root pressure theory and explain how it supports this theory.

Evidence .....

Explanation .....

(2 marks)

(b) The diameter of a tree is less during the day, when the tree is transpiring, than it is at night.

Explain how this

(i) supports the cohesion-tension theory;

.....

(ii) does not support the root pressure theory.

.....

(3 marks)

5

2 Gas exchange surfaces allow efficient diffusion of gases. Fick's law states:

Rate of diffusion is proportional to  $\frac{\text{surface area} \times \text{difference in concentration}}{\text{thickness of exchange surface}}$

(a) In the gill of a fish, describe how

(i) a large surface area is provided;

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.....  
(1 mark)

(ii) a concentration gradient is maintained.

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.....  
(2 marks)

(b) Land-dwelling insects lose water from their gas exchange surface. Use Fick's law to explain why they lose less water when the air is humid.

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(2 marks)

5

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ▶

- 3 The desert rat is a small mammal which can survive long periods in a hot desert without drinking any water. In an investigation, groups of desert rats were given either unlimited water or no water at all. They were fed either a high protein diet or a high carbohydrate diet. This is summarised in the table.

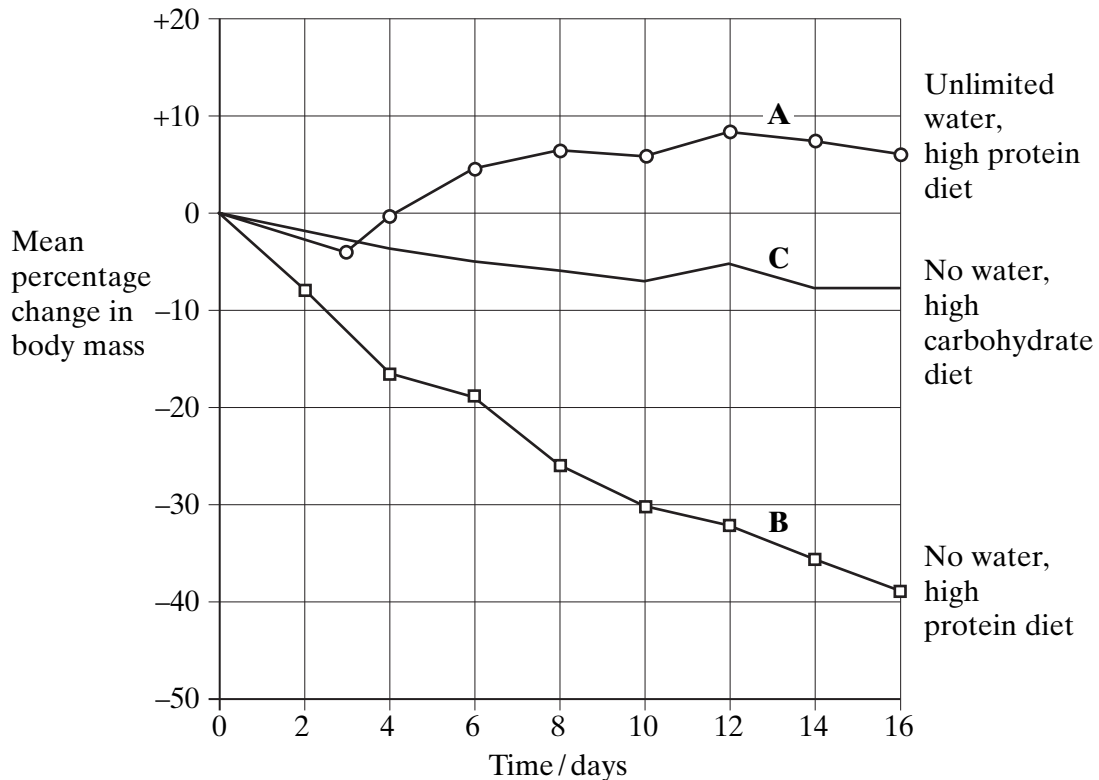
Group	Water allowed	Diet
A	Unlimited	High protein
B	None	High protein
C	None	High carbohydrate

- (a) All the rats that were fed the high protein diet produced a glomerular filtrate in their nephrons with a higher concentration of urea than those fed the high carbohydrate diet. Explain why.

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 .....

(1 mark)

- (b) The mean percentage change in body mass of each group was calculated over sixteen days. The results are summarised in the graph.



Explain the difference in the change in mass over the sixteen days between

(i) groups **A** and **B**;

.....  
.....  
*(1 mark)*

(ii) groups **B** and **C**.

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*(2 marks)*

**S** (c) Explain how a more concentrated blood plasma could cause dehydration of cells in the thirst centre of the hypothalamus.

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*(1 mark)*

5

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ▶

4 S (a) Haemoglobin is a protein with a quaternary structure. What is meant by a *quaternary* structure?

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.....

(1 mark)

(b) Explain how oxygen in a red blood cell is made available for respiration in active tissues.

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(3 marks)

(c) Haemoglobin is broken down in the liver. One product of this breakdown is amino acids. Give **one** use in the body of these amino acids.

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(1 mark)

5

5 The larva of the large white butterfly obtains most of its carbohydrates in the form of starch stored in the leaves that it eats. The adult eats only nectar which is a solution of sugars.

S (a) Explain the benefits of storing carbohydrates in the form of starch.

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(2 marks)

(b) Explain why nectar is an adequate diet for the adult butterfly.

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(3 marks)

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**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ▶

6 (a) Explain how a Pacinian corpuscle produces a generator potential in response to external pressure.

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(2 marks)

(b) In the eye of an older person, the ciliary muscles do not contract with as much force as in the eye of a younger person. Explain why this might make reading a book difficult for an older person.

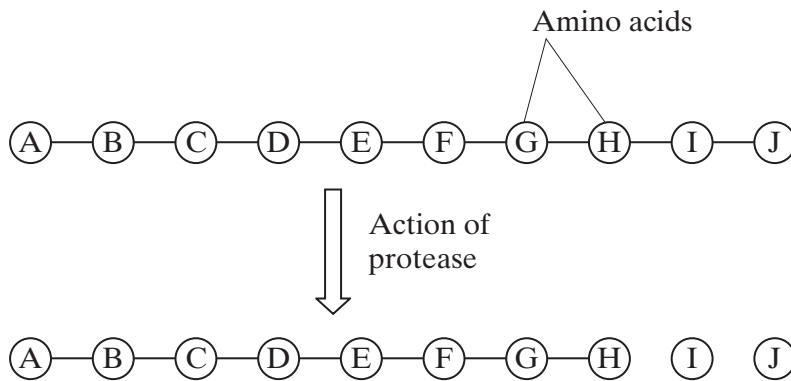
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(3 marks)

5



7 (a) **Figure 1** shows the action of a protease on a small peptide.



**Figure 1**

(i) Which type of protease has acted on the peptide? Explain your answer.

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(2 marks)

S (ii) Name and describe the process by which the protease has produced the amino acids from the peptide molecule.

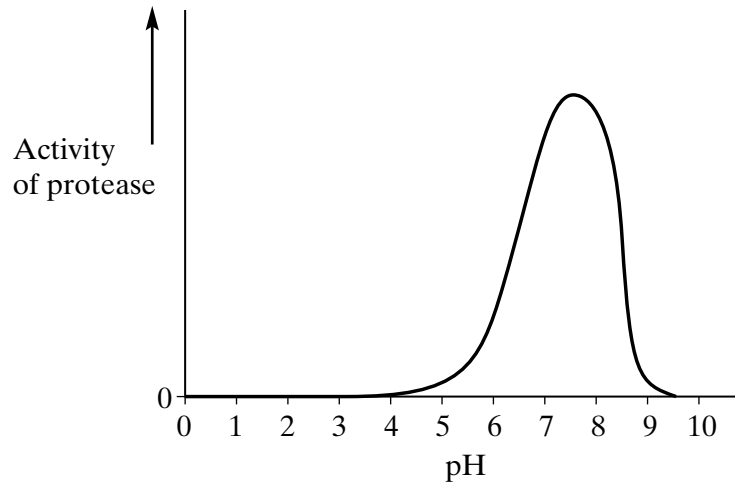
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(3 marks)

**QUESTION 7 CONTINUES ON THE NEXT PAGE**

**Turn over** ►

(b) The graph shows the effect of pH on the activity of a protease.



Suggest the region of the human gut in which this protease would be active. Explain your answer.

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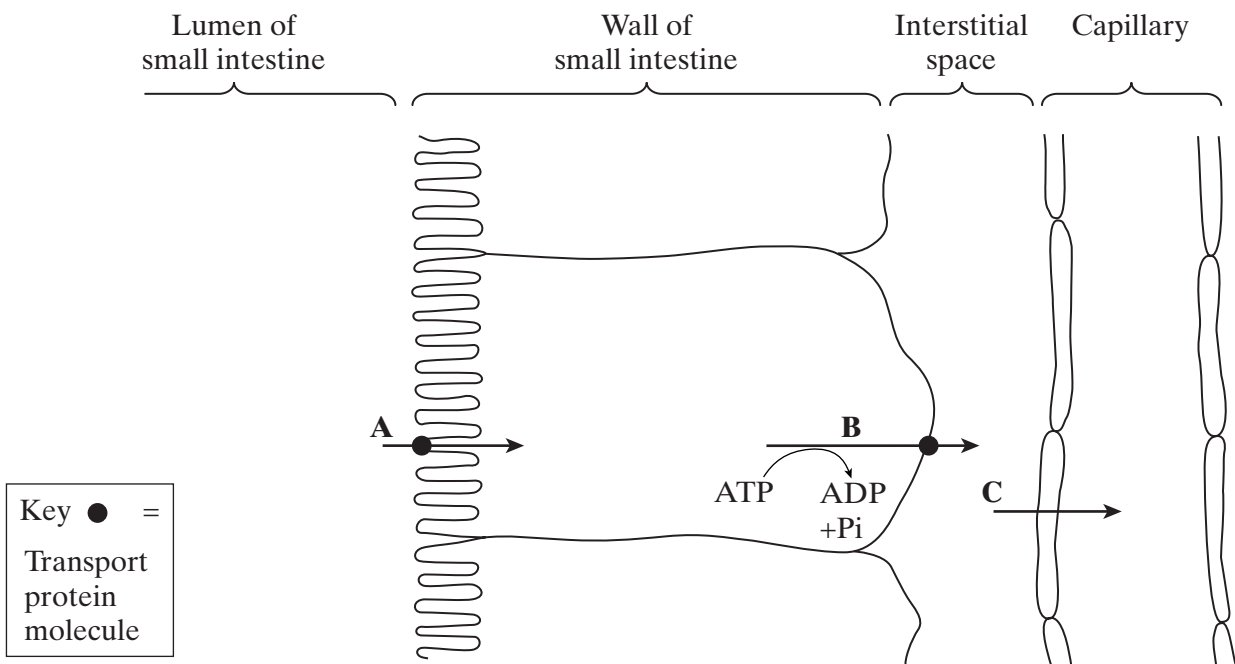
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(3 marks)

S (c) **Figure 2** shows the processes involved in absorbing amino acids into a capillary from the small intestine.



**Figure 2**

(i) Why is a capillary **not** described as an organ?

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(2 marks)

(ii) Name processes **A**, **B** and **C**. In each case, give the evidence for your answer.

**A** Process .....

Evidence .....

.....

**B** Process .....

Evidence .....

.....

**C** Process .....

Evidence .....

.....

(3 marks)

(iii) Explain how process **B** creates the conditions for process **A** to occur.

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(2 marks)

**8** (a) The autonomic nervous system consists of the sympathetic and parasympathetic divisions.

**S** (i) Give **two** effects of increased sympathetic stimulation that, together, increase pulmonary ventilation.

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2 .....

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(2 marks)

**S** (ii) Explain how dilating the arterioles which lead into the heart muscle allows an increased cardiac output.

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(4 marks)

(iii) The sympathetic and parasympathetic divisions act antagonistically. Use your knowledge of the control of heart rate to explain what is meant by *act antagonistically*.

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(1 mark)

(b) Secretion of neurotransmitters into a synaptic cleft may produce an action potential in a postsynaptic neurone.

(i) Explain how the release of acetylcholine at an excitatory synapse reduces the membrane potential of the postsynaptic membrane.

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*(2 marks)*

(ii) Explain what causes transmission at a synapse to occur in only one direction.

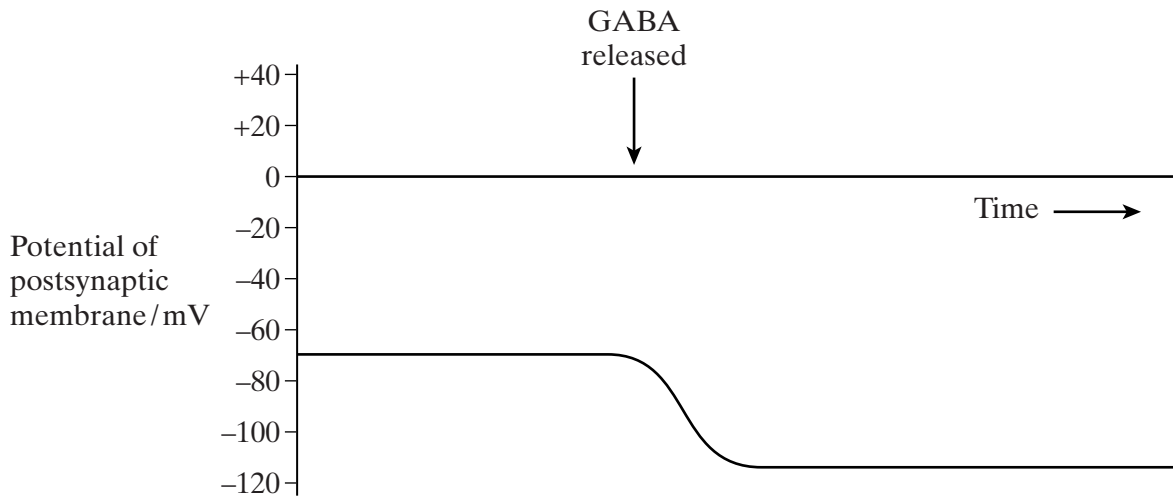
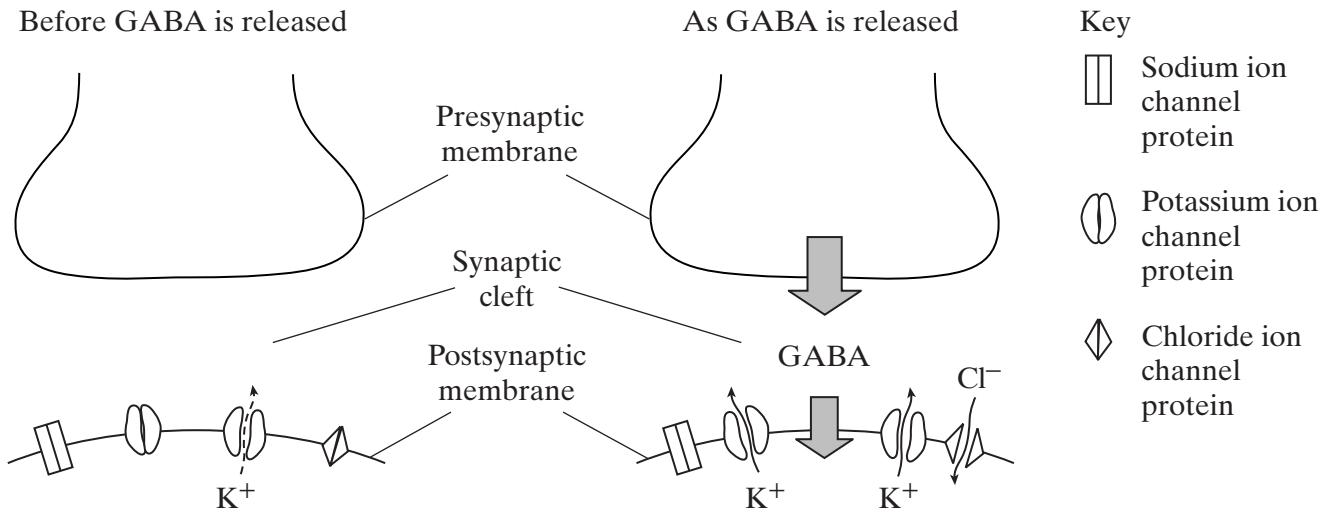
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*(2 marks)*

**QUESTION 8 CONTINUES ON THE NEXT PAGE**

**Turn over** 

- (iii) GABA is a neurotransmitter which inhibits the production of action potentials. The diagram and the graph show how the release of GABA from a presynaptic membrane affects the membrane potential of a postsynaptic membrane.



When the postsynaptic membrane is stimulated by acetylcholine, an action potential is less likely if GABA is released at the same time. Explain why.

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*(4 marks)*

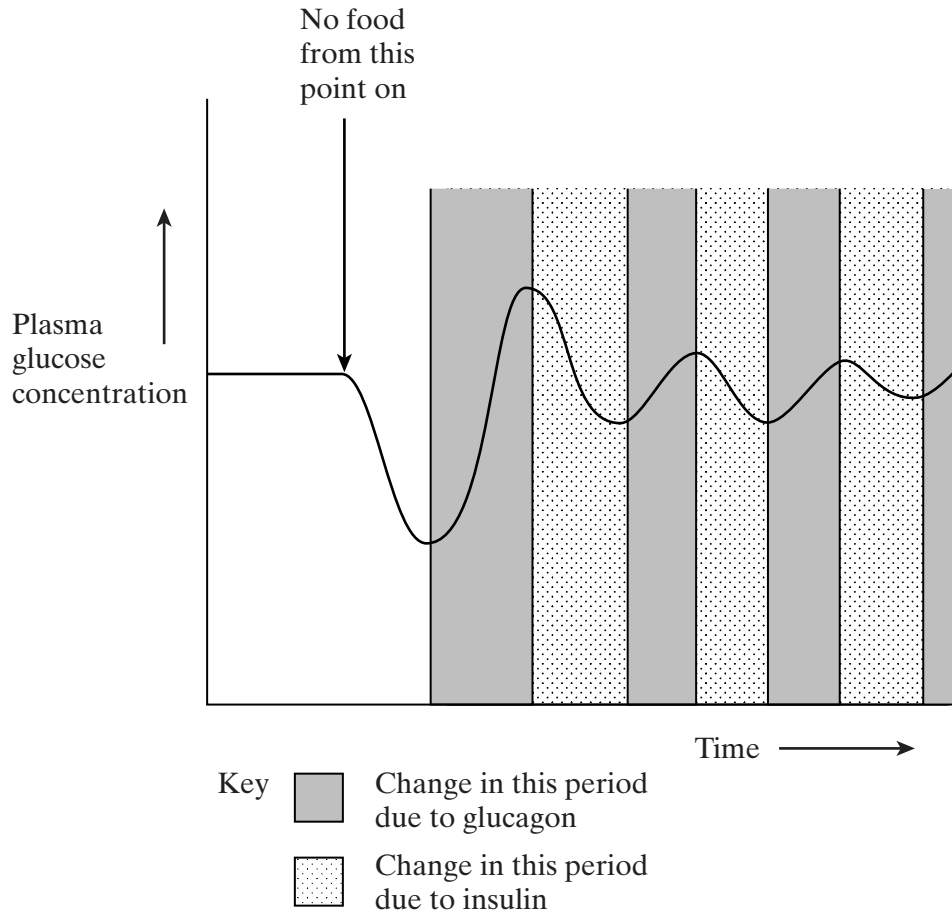
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**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ▶

9 Homeostatic mechanisms maintain a constant environment in the body.

(a) The graph shows changes in plasma glucose concentration that occurred in a person who went without food for some time.



Use evidence from the graph to explain the role of negative feedback in the control of plasma glucose concentration.

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(5 marks)



- (b) (i) Explain how normal core body temperature is maintained when a person moves into a cold room.

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(5 marks)

- S (ii) How does maintaining a constant body temperature allow metabolic reactions in cells to proceed with maximum efficiency?

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(5 marks)

**END OF QUESTIONS**

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