Medical Chemistry and Biochemistry – Example of the Entrance Exam Test

Calculations

1. A buffer solution was prepared from 150 mL of 0.2 mol/L acetic acid and 100 mL of 0.25 mol/L sodium acetate. What is pH of this buffer after the addition of 10 mL of 0.3 mol/L HCl? **(1p)**
($pK_a = 4.75$)

2a. Iron is present in the organism both as ferric, Fe(III) and ferrous, Fe(II), oxidation state. In order to estimate total serum iron, the iron is converted to Fe(II) and reacted with complex-forming agents. Write the chemical equation for reduction of ferric cation into ferrous cation using the tin(II) cation (producing tin(IV) cation). Calculate how many moles of the tin(II) cation are needed for reduction of 1 mol of ferric cation. **(1p)**

2b. 5 mL of a patient´s serum contains 7 µg of iron. The physiological values are from 7 to 29 µmol/L of iron. Calculate the mass concentration of iron in the patient´s serum and determine if this value is within the physiological range. **(1p)**

Ar: Fe=55; Ar: Sn= 118.7

3. Calculate osmolarity of a solution prepared by mixing 50 mL of sodium chloride solution of mass concentration 5.8 g/L with 50 mL of calcium chloride solution of mass concentration 11 g/L. **(1p)**

$Ar_{Na} = 23$; $Ar_{Cl} = 35.5$; $Ar_{Ca} = 40$

General chemistry

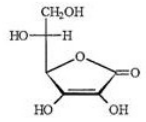
4. Well-known poisons are found among cyanides. Binding of cyanide anion to some enzymes in the respiratory chain causes blockage of oxidative phosphorylation in the mitochondria. Potassium cyanide is a poison, but still commonly used in the lab. Using this compound is quite safe when: **(1p)**

(choose the best answer)
a) cyanide is not oxidized
b) cyanide is not in contact with organic compounds
c) cyanide is not in contact with an acid
d) cyanide is not in contact with an alcohol
e) cyanide is not in contact with a hydroxide

5. Vitamins bind to and deactivate radicals produced in organisms. The place of their action depends on their polarity. The hydrophobic ones bind radicals in membranes while hydrophilic ones bind predominantly in the cytoplasm.

Choose the vitamin that is **the most hydrophilic** and therefore best suited for binding and deactivation of radicals in a polar aqueous solution. **(1p)**

A



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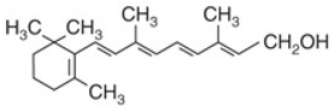

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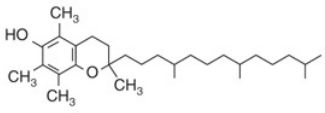

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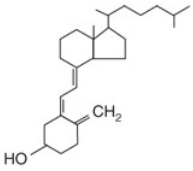
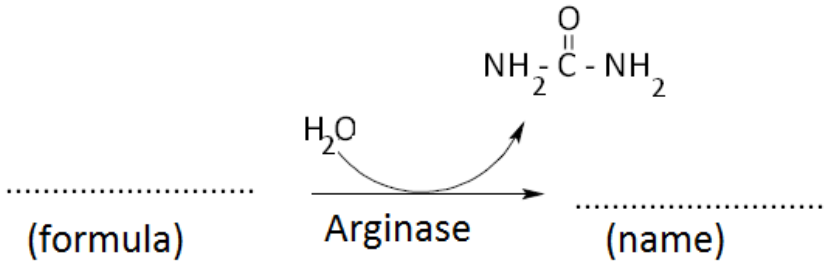


Biochemistry

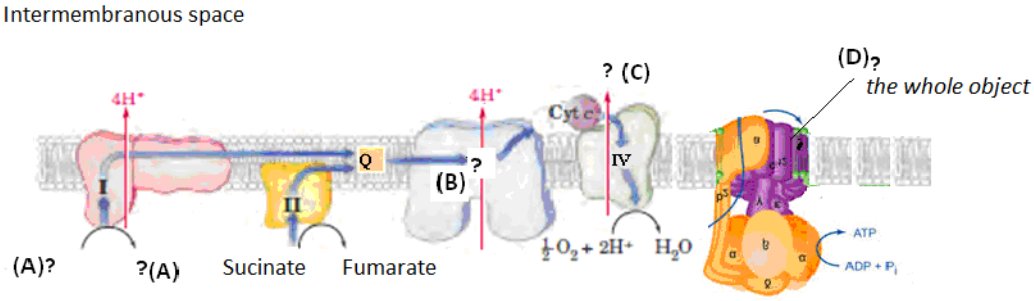
6. Draw the condensed or semi-structural formula of dinucleotide UA connected with the phosphodiester bond**.** **(1.5p)**

In the formula above label the adenine atoms that form hydrogen bridges in the double strand of nucleic acid.

7. Complete the condensed or semi-structural formula of the substrate below and name the product of the reaction. **(1.5p)**



8. There is a diagram of the respiratory chain below. **(3p)**
Fill in the correct names of the compounds (instead of " ? ").



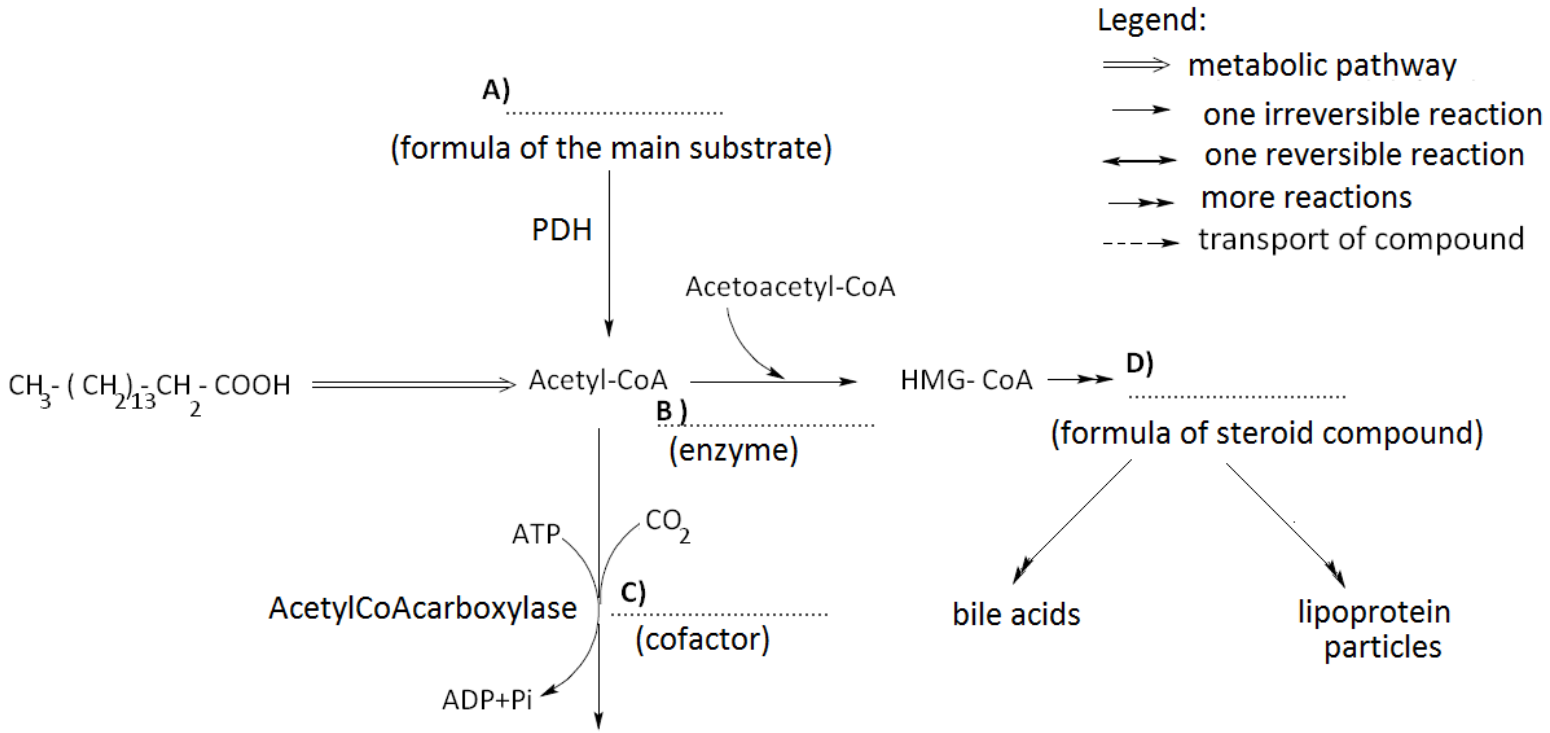
Answers:
(A) ……
(B) ……
(C) ……
(D) ……..
(E) The diagram depicts the mechanism of ATP production in the respiratory chain. Processes in the respiratory chain are connected where the first process causes the second one. Put the processes written below into the correct order, so that one process leads to the second one.

Missing processes:

- transport of protons against concentration gradient
- proton gradient
- transport of electrons

⇨ leads to…/ results in / causes

9. Fill in the four missing blanks in accordance with the legend. **(3p)**



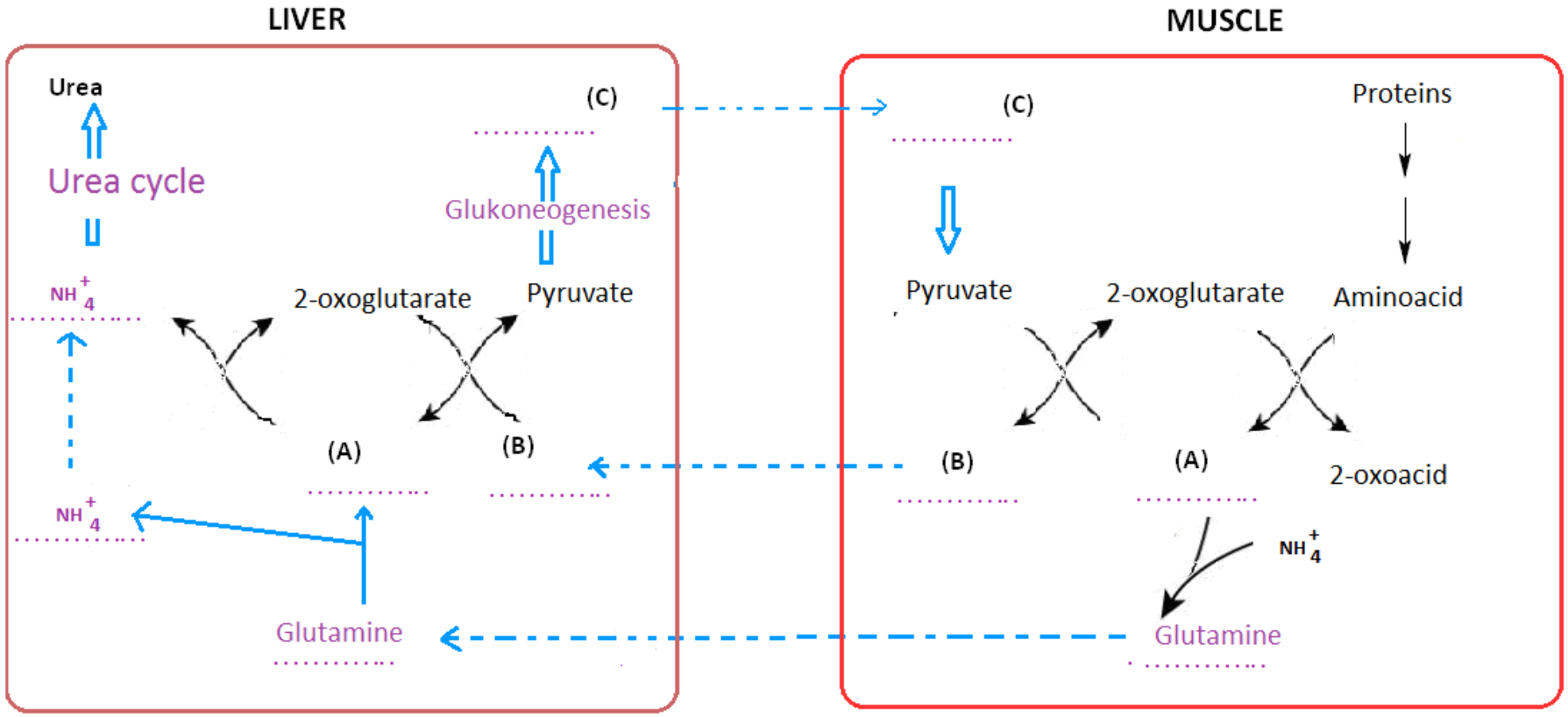
A) structural formula of the compound:

B) name of the enzyme .....

C) name of the cofactor .....

D) condenses structural formula of the compound:

10. Fill in the blanks with the missing compound in the diagram. The same letter represents the same compound in both diagrams. **(3.5p)**



(A) formula:

(B) name. …….

(C) formula

(D) The diagram above shows the circulation of metabolites between the liver and muscles. How will the circulation change when a person is deprived of food for a longer period of time? Choose **the most probable** answer!

a) circulation will decrease
b) circulation will increase
c) circulation will not change

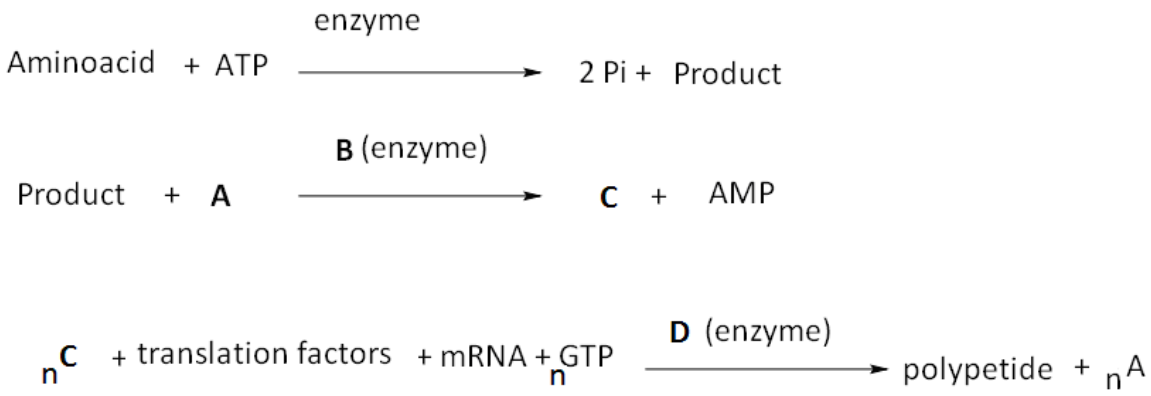
11. Glycogen is present in the liver and in the muscles as well. Its lysis is regulated **differently** in both organs. Write the name of the hormones, that are **the most important** in the regulation of glycogenolysis. **(1p)**
Glycogenolysis in the liver **activates**: ……..
Glycogenolysis in the muscle **activates**: ……

Molecular biology

12. Find the best match for the terms in the left column with the characteristics from the right column. Write the correct **letter** in the boxes. **(1p)**

1. primase	☐	A) RNA polymerase
2. DNA ligase	☐	B) lagging strand
3. δ DNA polymerase	☐	C) proofreading activity
4. restriction endonuclease	☐	D) restriction fragment length polymorphism
5. snRNA	☐	E) mRNA splicing

13. What are the missing components (A-D) of the translation process in the diagram below? **(2p)**



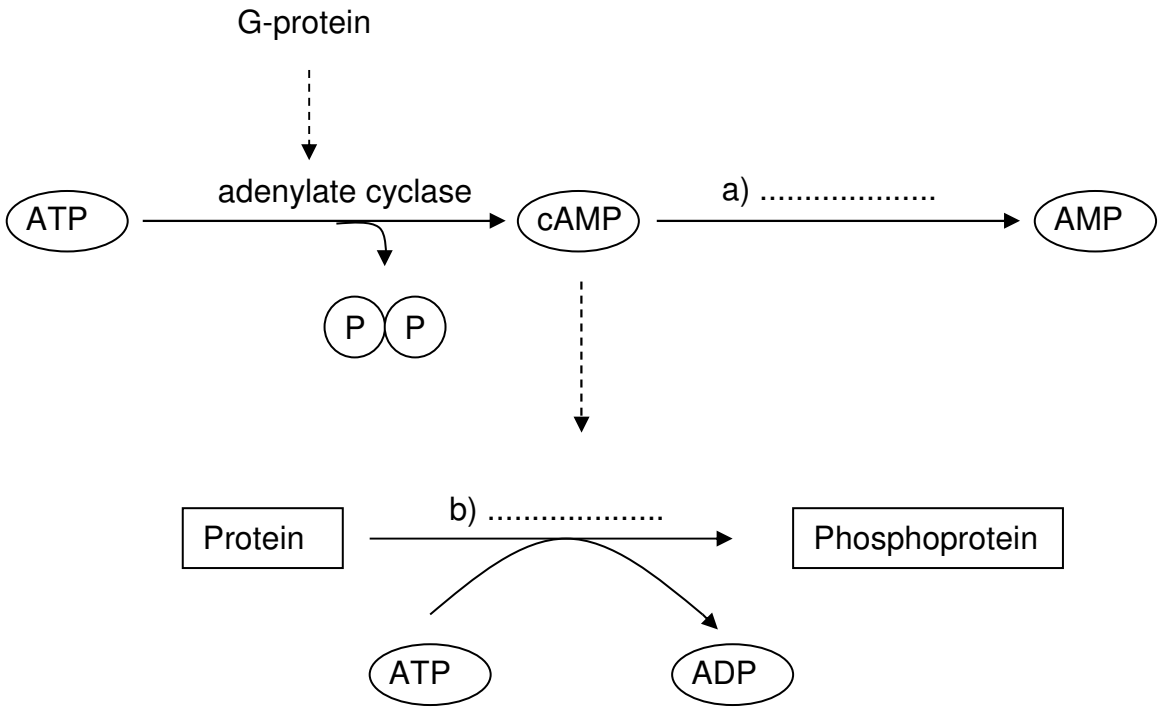
A: ……..

B: ……

C: ……

D: ……

14. Fill-in blanks in the diagram below: **(2p)**



a) Name of the enzyme: .....

b) Name of the enzyme: .....

- Choose the correct statement about substances known as "second messengers":

a) They have a long biological half-life.
b) They transfer the signal of steroid hormones.
c) Changes in their concentration are considered to be signals.
d) They are delivered through bloodstream quickly to their place of action.