Examination in Technical Biology (7.5 p)

December 20, 2008, kl 8.00-13.00. MA10. Points required to pass the exam 22 p.
Grading: (22-27.5) p = grade 3; (28-34.5) p = grade 4; (35-50) p = grade 5

Note: Hand in your answer in two separate cover paper according to:
A = Questions 1-4
B = Questions 5-13

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1. Describe the composition of Gram-negative cell walls of eubacteria. Specify two physiological roles of the bacterial wall. (3p)

2. Discuss the reason why a microbial culture might have a long lag phase after inoculation. (1p)

3. Determining the amount of bacteria by counting the number of colonies (CFU) is regarded as a relatively sensitive method, with a certain ability to identify specific bacterial families. Explain how counting the CFUs can be used to demonstrate low amounts of bacteria in the air, and what determines the specificity of the method, i.e. which bacterial families are demonstrated by the method. (4p)

4. Why do mutations that cause changes in the reading frame often have more serious consequences for the organism than missense mutations? (1p)

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5. Proteins are constructed of 20 different amino acids. These amino acids can be divided into different groups according to the properties of their side chains (the R-group). For each of the following groups, write the chemical structure of one representative amino acid:
   (a) Acidic amino acids
   (b) Basic amino acids
   (c) Aromatic amino acids
   (d) Aliphatic amino acids (4 p)

6. Proteins have four levels of structures: primary, secondary, tertiary and quaternary. (3 p)
   (a) What are the most common secondary structures of proteins?
   (b) Describe how non-covalent interactions contribute to stabilize the secondary structures of proteins.

7. Suppose you are trying to produce an enzyme using a bacterium host. You need to design a protocol for the separation and purification of the target enzyme. (3 p)

(a) In your laboratory work, histidine-tagged lactate dehydrogenase (LDH) was produced in *E. coli*. Use the histidine-tagged LDH as an example, describe briefly the different steps that are used in the separation and purification process.
(b) Why do you need to measure the specific activity of your protein product at different steps?

8. Enzymes as biological catalysts: (3 p)
   (a) What are the most special characteristics of enzymes?
   (b) In which ways the control of enzyme activity in living systems can be achieved?
   (c) What is the difference between competitive and non-competitive inhibition?

9. During carbohydrate catabolism, glucose is converted into pyruvate by glycolysis. The pyruvate formed is converted into Acetyl-CoA before it enters the Citric Acid Cycle. (3 p)
   (a) Why Citric Acid Cycle is also called Tricarboxylic Acid Cycle?
   (b) To what compound is Acetyl-CoA added to start the Citric Acid Cycle?
   (c) Write the chemical structure of the following important intermediates: citrate, β-ketoglutarate, oxaloacetate.

10. During oxidative phosphorylation, NADH and $FADH_2$ are oxidized to NAD^+ and FAD, providing free energy to form ATP from ADP. This process involves a series of electron transport. (3 p)
    (a) Where does the electron transport take place?
    (b) Explain how the electron transport from NADH to O_2 is coupled to ATP synthesis.

11. β-oxidation of fatty acids consists of four repetitive reaction steps. During one cycle of β-oxidation, two co-factors are reduced for future ATP synthesis through oxidative phosphorylation. Describe briefly the four reaction steps of β-oxidation for the following fatty acid:

    $R - CH_2 - CH_2 - CH_2 - CO - S - CoA$ (2 p)

12. Photosynthesis is composed of a Light reaction and a Dark reaction. Describe briefly what happens in the two different reaction processes? (3 p)

13. Gene technology: (3 p)
    (a) What are the most important fields of application for gene technology (in which areas are gene technolgy mostly used)? Give at least four different areas.
    (b) Which risks are linked with the use of gene technology?