

# Examination

## **Biochemistry and Molecular Biology (KBB032)**

**Date and place:** Wednesday, October 28-2020, fm

**Teachers:** Christer Larsson 0707 754061 / Michaela Wenzel

**”Grade limits”:** 50% = 3; 65% = 4; 80% = 5

**Name:**

1. Glycolysis is one of the most central metabolic pathways in a cell. (6p)

A) How do you think the rate of glycolysis will be affected by high concentrations of Fructose-2,6-bisphosphate?

B) Which enzyme(s) will be affected?

C) Some reactions in glycolysis have a positive  $\Delta G^{\circ}$ , still there is a continuous flux through glycolysis from glucose to pyruvate. How can this be explained?

2. Formation of ATP via oxidative phosphorylation is an extremely important process in the cell.

A) Describe the process that “liberates energy” and what factors that determines the amount of energy “liberated” (2p)

B) What is the “force” used by ATP:ase for formation of ATP, what are the components constituting this force? (2p)

C) Where in the cell does this process take place, in a eukaryote and a prokaryote, respectively (2p)

D) How will the process be affected if subjected to 2,4-DNP? What complex is the target? (2p)

E) Substrate level phosphorylation is another mechanism used for formation of ATP. Describe this process and mention the main difference compared to oxidative phosphorylation (2p)

3. Acetyl-CoA is a key compound that is involved in the TCA- as well as the glyoxylate cycle.

A) How will Acetyl-CoA be converted in the respective cycle (what end-product will be formed) (2p)

Why is the glyoxylate cycle a necessity for growth on 2-carbon compounds and for the ability to convert fatty acids to carbohydrates? (2p)

4. The pentose phosphate pathway can be divided in an oxidative and non-oxidative part, respectively. Explain how these parts will be regulated and how the end-products from the non-oxidative part will be used if the purpose would be: (4p)

A) Production of nucleic acids/nucleotides

B) Formation of reducing power in the form of NADPH

5. Photosynthesis and its light reaction in green plants is a very important process for life on earth. (6p)

A) For what reason are there so many different photosynthetic pigments?

B) What is the origin of electrons that will finally reduce NADP to NADPH?

C) How will the light reaction be regulated if the main purpose is to produce ATP rather than NADPH?

6. Would it be possible for a cell to convert one molecule of glucose into two molecules of glycerol? Why or why not? (3p)

7. You are working for a biotechnology company that would like to produce as much as possible of the amino acid glutamate. As a molecular biologist you have the tools to increase and decrease activity of different enzymes. Suggest three different enzymes whose activity you would like to change in order to maximize production of glutamate. Motivate your suggestions and indicate whether you want to decrease or increase the activity. (5p)



8. Below is a short explanation of different expressions and phenomena used in biology. Indicate with one or two words what is described. (12p)

- a) A molecule such as, *e.g.* cAMP, that will initiate an intracellular response following an external stimulus
- b) Synthesis of carbohydrates from non-carbohydrates sometimes referred to as glycolysis running backwards
- c) Wasteful consumption of ATP. No net change apart from consumption of ATP
- d) The theory that mitochondria and chloroplasts originate from prokaryotes that has been incorporated in eukaryotes
- e) An end-product in a pathway will inhibit an enzyme in the beginning of the same pathway
- f) Bacteria that can obtain energy by oxidising inorganic substrates
- g) Amino acids that we need but can't make ourselves and therefore must be obtained from the diet
- h) Oxidation of fatty acids, two carbons at the time
- i) Transformation of inaccessible  $N_2$  to accessible  $NH_3$  by certain specialized bacteria
- j) Enzymes with binding sites for metabolites (not substrate) that will affect their activity positively or negatively.
- k) Enzymes that will catalyze essentially the same reaction but small differences in amino acid composition will result in different kinetics and/or co-enzyme preference
- l) A protein that is dependent on GTP rather than ATP for activity

9. Name the individual building blocks of DNA and describe their role in DNA structure and function. Which building blocks are different in RNA? How does DNA and RNA differ in their secondary structure?  
(5 points)

10. Name three different types of DNA damage and explain how they are problematic for the cell. Briefly describe the DNA repair mechanisms involved in repairing them.

(3 points)

11. Describe the principle of the polymerase chain reaction. Which components are needed for the reaction to be successful and what is the role of each component? What are the individual phases and what happens in each phase? What could be a reason for a PCR not yielding any product? (10 points)

12. Sanger sequencing shares some similarities with a PCR reaction in terms of components and general principle, but there are crucial differences that make sequencing possible. Describe three major differences and how they enable sequencing.

(3 points)

13. Describe what happens during the elongation step of translation in bacteria (including the RNA and protein components involved and their roles). What are the elongation factors involved and what are their functions? Which effects would you observe, if you deleted each individual elongation factor (not all at the same time)?  
(7 points)

14. Gene expression can be regulated on different levels. Name and briefly describe one example for a regulatory mechanism on each DNA, RNA, and protein level.

(3 points)

15. Explain the concept of RNA thermometers. Which genes may be found under their control and why? What are the similarities and differences between RNA thermometers and riboswitches?

(6 points)



16. Explain the differences between general and regulated proteolysis. Describe an example where regulated proteolysis is involved in the regulation of gene expression.  
(3 points)

17. Two farmers grow crops on adjacent fields. One farmer has issues with his plants frequently being eaten by caterpillars, while the other one has mostly healthy plants. Assume that there are no differences between pesticide or fertilizer usage. What could be possible reasons for the different susceptibilities to the caterpillar infestation? Which method for monitoring gene expression would you choose to identify the genetic determinants underlying the different phenotypes and why?  
(10 points)