

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-1,6-bisphosphate?

B) Which enzyme(s) will be affected?

C) You have measured the concentrations of all intermediates in glycolysis and calculated  $\Delta G$  for all reactions. To your surprise, according to your measurements and calculation, one reaction seems to have a positive value of  $\Delta G$ . How would you explain this since you observe a continuous flux from glucose to pyruvate?

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” (3p)

B) What is the “force” used by ATP:ase for formation of ATP, what are the components constituting this force? (3p)

C) How will the process be affected if subjected to cyanide, what complex is the target? (2p)

D) 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. Describe schematically the processes involved in the complete oxidation of pyruvate during aerobic conditions. Which enzyme is catalysing the initial step of pyruvate oxidation? Describe the reaction (substrates and products) and give the name of the enzyme. How is the oxidised product of this reaction further oxidised? Give the name of the collective processes and which products are formed from 1 pyruvate (10p))

4. Explain why the glyoxylate cycle is a necessity for sustained growth on two-carbon substrates and for the ability to form carbohydrates from fatty acids. How are these two processes, growth on two-carbon compounds and formation of carbohydrates from fatty acids, related? (4p)

5. Fermentation of glucose to ethanol is a redox neutral process. Still, ethanol is more reduced than glucose. Explain how this process can still be redox neutral. (3p)

6. Photosynthesis is a very important process for life on earth. (8p)

A) Explain how oxygen is formed during the light reaction.

B) There are many similarities with the oxidative phosphorylation process in mitochondria. Give example of one similarity and one difference between the two processes.

C) An important role of the light reaction is to produce NADPH. Give one example of another pathway very important for production of NADPH

D) Why are some plants called C4 plants? How do they differ compared to plants having only the Calvin cycle for CO<sub>2</sub> fixation?

7. Below is a short explanation of different expressions and phenomena used in biology. Indicate with one or two words what is described. (9p)

a) Synthesis of carbohydrates from non-carbohydrates sometimes referred to as glycolysis running backwards

b) Wasteful consumption of ATP. No net change apart from consumption of ATP

c) The theory that mitochondria and chloroplasts originate from prokaryotes that has been incorporated in eukaryotes

d) An end-product in a pathway will inhibit an enzyme in the beginning of the same pathway

e) Bacteria that can obtain energy by oxidising inorganic substrates

f) Amino acids that we need but can't make ourselves and therefore must be obtained from the diet

g) Transformation of inaccessible  $N_2$  to accessible  $NH_3$  by certain specialized bacteria

h) Enzymes with binding sites for metabolites (not substrate) that will affect their activity positively or negatively.

i) 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