University of York

Department of Biology

B. Sc Stage 1 Degree Examinations 2017-18

Molecular Biology and Biochemistry - Part II

Time allowed: 1 hour and 30 minutes
Total marks available for this paper: 50

- Answer all questions in the spaces provided on the examination paper
- The marks available for each question are indicated on the paper

For marker use only:

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Answer all questions in the spaces provided

**Multiple Choice Questions**

Only circle one answer per question.

+1 mark for every correct answer, -1/3 mark for every incorrect answer. If a candidate does not choose any answer, there will be no penalty.

1. ATP carries energy because:
   
   a) breaking the bond between its last two phosphate groups generates a low energy state.
   
   b) it can easily phosphorylate phosphoenolpyruvate during gluconeogenesis.
   
   c) the ribose moiety in ATP is generated by the pentose phosphate pathway.
   
   d) it is one of the main energy stores in the human body.

2. Fatty acids are converted into glucose in humans:
   
   a) to allow quicker ATP production during exercise.
   
   b) fatty acids cannot be converted into glucose in humans.
   
   c) when blood glucose levels are low.
   
   d) to prevent muscle loss during starvation.

3. Why is NADH rather than NADPH produced as an electron carrier during glycolysis?
   
   a) Because NADH can be phosphorylated by 1,3-bisphosphoglycerate kinase in the process to give NADPH.
   
   b) Because glycolysis is an ATP producing catabolic process, and hence needs NADH as electron carrier.
   
   c) The question is not correct, since NADH and NADPH can both be produced during glycolysis.
   
   d) Because NADH has a significantly larger redox potential that allows it to generate more ATP.
4. When glucose conversion to pyruvate is routed through the pentose phosphate pathway, the amount of ATP produced per glucose:

   a) is more than the amount produced during glycolysis
   b) is the same as produced during glycolysis
   c) is less than the amount produced during glycolysis
   d) can be more or less than that produced in glycolysis dependent on the presence of oxygen.

5. During starvation the brain:

   a) is fed by excess glucose generated from ketone bodies.
   b) does not produce any CO$_2$ because it cannot obtain glucose.
   c) still uses a significant proportion of the body’s energy expenditure.
   d) starts to use fatty acids delivered to it through the blood stream.

6. FAD:

   a) is a permanent cofactor of complex II in the electron transport chain.
   b) does not have enough redox-power to oxidise a -OH group, but can oxidise a carbon-carbon single bond.
   c) is a major energy carrier between beta-oxidation and the electron transport chain.
   d) all of the above are true.

7. A short sprint produces the same amount of CO$_2$ per second as a long sprint because:

   a) sprinting preferentially uses fatty acids as a fuel source.
   b) during sprinting the muscles use fermentation to produce ethanol.
   c) energy generation during sprinting is done anaerobically.
   d) the pentose phosphate pathway cannot generate NADH from NAD$^+$.

8. The reversible reactions in glycolysis are:

   a) also used in gluconeogenesis in the liver.
   b) used to make sure glycolysis is tightly regulated.
   c) not really reversible, this is just an artifact of considering the standard Gibbs free energy ($\Delta G^0$) rather than the actual $\Delta G$.
   d) ensuring that fermentation can produce CO$_2$.
9. Fermentation in yeast is essential when no oxygen is present, otherwise:
   a) NADH would accumulate to high levels and inhibit glycolysis.
   b) the food industry would have to use bacterial systems for producing beer.
   c) pyruvate kinase would be inhibited.
   d) all of the above are correct.

10. Glucose-6-phosphate is an important metabolite in humans because:
   a) it is the main product of glycogen degradation.
   b) it traps glucose in the cell and can initiate several different glucose utilizing pathways.
   c) it is a key intermediate in glycolysis whose production can tightly regulate this pathway.
   d) it can be generated from ribose-5-phosphate through the pentose phosphate pathway.

11. The term beta-oxidation refers to:
   a) the second carbon after the carbonyl group in a fatty acid ester being oxidised.
   b) a process in which a double bond is formed to then generate an -OH group that can be oxidised, reminiscent of the first half of the TCA cycle.
   c) the production acyl-CoA from fatty acids.
   d) the process in which dogs metabolise fat to excrete its products in their urine.

12. Ketone bodies are:
   a) generated from glucose during starvation to allow more sustained feeding of the brain with energy.
   b) used to generate energy via catabolism through glycolysis and the TCA cycle.
   c) the reason why a low-carb diet allows weight loss, as they allow the brain to catabolise fat.
   d) not generated from pyruvate because the reaction catalyzed by pyruvate dehydrogenase is irreversible.
13. The following are statements comparing α-ketoglutarate dehydrogenase (KDH) and pyruvate dehydrogenase (PDH). Which one is correct?

   a) KDH and PDH are both multienzyme complexes that combine two different enzymatic activities to convert their substrate to its product.
   b) KDH and PDH both oxidize their substrate and thereby generate $\text{FADH}_2$ that is sent to the electron transport chain.
   c) The enzymatic reaction catalysed by these two enzymes releases four of the six carbons of glucose as $\text{CO}_2$.
   d) Both enzymes are part of the TCA cycle, which is why this cycle can produce so much energy.

14. Electrons donated to the mitochondrial respiratory chain by succinate are transferred to oxygen via:

   a) PSII and PSI plus intermediate redox components
   b) PSII and Plastocyanin
   c) Complexes II, III and IV
   d) Complexes I, II, III and IV

15. Aldolases in the Calvin cycle catalyse:

   a) transfer of a five-carbon to rubisco
   b) the reduction of phosphoglycerate
   c) a two-carbon unit from a ketose to an aldose
   d) a condensation reaction between two compounds that each contain three carbons

16. The electron acceptor of Complex III in the mitochondrial electron transport chain is:

   (a) Cytochrome C
   (b) Plastocyanin
   (c) Succinate
   (d) Ubiquinone
17. The difference between light harvesting chlorophylls and reaction centre chlorophylls is:

a) the former transfer light energy in the form of redox energy, the latter in the form of vibrational energy
b) the former transfer light energy in the form of resonance energy, the latter in the form of vibrational energy
c) the former transfer light energy in the form of resonance energy, the latter in the form of redox energy
d) the former transfer light energy in the form of redox energy, the latter in the form of resonance energy

18. If reaction (1), Succinate → Fumarate ($E^\circ = 0.03 \text{ V}$) and reaction (2), $\text{FADH}_2 \rightarrow \text{FAD}^+ + 2\text{H}^+ \ (E^\circ = -0.22 \text{ V})$, are coupled, then:

a) reaction (1) would proceed from left to right and is an oxidation
b) reaction (2) would proceed from left to right and is an oxidation
c) reaction (1) would proceed from right to left and is a reduction
d) reactions (1) and (2) would proceed from left to right and are an oxidation and a reduction respectively

19. The colour(s) light primarily absorbed by chlorophyll are:

a) Blue and Red
b) Green and Red
c) Green and Blue
d) Yellow and Red

20. Plants can harvest energy from light with wavelengths other than the above because:

a) They have multiple chlorophyll pigments with varying absorption spectra
b) Many chlorophylls are bound to proteins that absorb light at different wavelengths
c) Plants have other pigments that absorb light that is passed on by chlorophylls.
d) Plants have other pigments that absorb light at other wavelengths.
21. Cyclic electron transport:
   a) involves cycling of electrons between Photosystem II and the Cytochrome b6f complex and produces NADPH but not ATP
   b) involves cycling of electrons between Photosystem I and Plastocyanin and produces NADPH but not ATP
   c) involves cycling of electrons between Photosystem II and the Cytochrome b6f complex and produces ATP but not NADPH
   d) involves cycling of electrons between Photosystem I and Plastocyanin and produces NADPH but not ATP

22. Mitochondrial and chloroplast complexes contain the following transition element(s):
   a) Cu, Fe, Mn
   b) Fe, Cu
   c) Cu, Mn, Zn
   d) Cu, Fe, Mg

23. Transition elements in these complexes are directly involved in:
   a) the transport of protons across the membrane
   b) providing structure in the form of cytochromes
   c) the transport of electrons

24. What are the two constituents of the proton motive force (PMF) and where would you find a PMF in a plant cell?
   a) PMF is made up of an electrical component (membrane potential or delta psi) and a chemical component (the proton gradient or delta pH) and is found across the mitochondrial inner membrane and thylakoid membrane.
   b) PMF is made up of an electron gradient (membrane potential or delta psi) and a chemical component (the proton gradient or delta pH) and is found across the mitochondrial inner membrane and plasma membrane.
   c) PMF is made up of an electrical component (membrane potential or delta psi) and a chemical component (the proton gradient or delta pH) and is found across the mitochondrial inner membrane, thylakoid membrane and plasma membrane.
   d) PMF is made up of a chemical proton gradient (or delta pH) and a chemical ATP gradient and found across the mitochondrial inner membrane and thylakoid membrane.
25. a) Which two reactions can be catalysed by Rubisco?  

b) Which one of the two is not deemed beneficial? Explain why (2 marks)

26. Explain in one or two sentences why, and in which direction, the pH of thylakoid lumen changes when plants are moved from the dark to the light.  

(2 marks)

27. Some plants have facultative CAM metabolism. In 2-3 lines, explain in what conditions such plants are likely to change from C3 to CAM metabolism and what advantage that would bring.  

(3 marks)
28. a) Rank the fuels glucose, fatty acids and glycogen for efficiency and preference. (3 marks)

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b) The two rank orders do not agree. Explain why. (6 marks)
29. Here is the open-chain form of D-Glucose:

D-Glucose

(i) Draw the open-chain form of L-Glucose. (1 mark)

(ii) D-Allose is a C3 epimer of D-Glucose. Draw the structure of D-Allose. (1 mark)
30. Compare and contrast the structures and functions of cellulose and chitin. (5 marks)

31. For the following phospholipid:

(i) Name the head group. (1 mark)

(ii) Using the alphanumerical system, name the unsaturated fatty acid. (1 mark)