University of Guelph  
Department of Chemistry and Biochemistry  
19-356  
Structure and Function In Biochemistry

Final Exam, April 22, 1998. Time allowed, 120 min.

Answer questions 1-30 on the computer scoring sheet provided.

Only one option is correct for each of these questions.

Use pencil to fill in the circles representing your chosen answer; and erase cleanly if you make an error.
Do not use ink or white-out on the computer scoring sheet.

You may mark your answer on the question paper for your own records, however in case of a discrepancy between question paper and the computer scoring sheet, the choice shown on the computer sheet will be taken as final.

Answer questions 31-34 directly on the question paper.

Questions 1-30 have a weight of 1 mark each 30 marks
Questions 31-34 have marks as indicated 30 marks

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60 marks total
1. Which of the following properties of hemoglobin is not part of the Bohr effect?
   A) Decreased O₂ binding at lower pH.
   B) Protonation of histidines near the C-terminus of globin.
   C) Decreased O₂ binding in presence of elevated CO₂ levels.
   D) Decreased O₂ binding at high altitude.
   E) Formation of carbamate derivatives at the N-terminus of globin.

2. Glycogen phosphorylase is an allosteric enzyme with T and R states; which of the following is not true?
   A) Phosphorylase a is preferentially in R state without requiring allosteric effectors.
   B) Phosphorylase b is preferentially in T state in the presence of Glucose-6-P.
   C) Muscle phosphorylase b is preferentially in T state in the presence of 5’AMP.
   D) Phosphorylase b is preferentially in T state in the presence of ATP.
   E) Liver Phosphorylase a is preferentially in T state in the presence of Glucose.

3. Which enzyme is not a component of fatty acid synthase I?
   A) Condensing enzyme
   B) Acetyl CoA carboxylase
   C) Thioesterase
   D) Malonyl Transferase
   E) Hydroxyacyl dehydratase

4. Which of the following sugar phosphates is not a substrate or product of transaldolase?
   A) Sedoheptulose-7-P
   B) Glyceraldehyde-3-P
   C) Ribose-5-P
   D) Erythrose-4-P
   E) Fructose-6-P

5. Which of the following is not a positive or negative allosteric regulator of phosphofructokinase?
   A) Citrate
   B) Fructose-2,6-bisphosphate
   C) ATP
   D) 5’AMP
   E) Glucose

6. The balance of various ionic substance inside and outside cells is quite characteristic. Which of the following ionic conditions would be abnormal?
   A) [Ca²⁺] lower inside
   B) [phosphate esters] lower inside
   C) [Na⁺] lower inside
   D) [Mg²⁺] higher inside
   E) [K⁺] higher inside

7. Which of the following properties or actions of the pentose phosphate pathway is untrue?
   A) Causes CO₂ release from glucose without directly consuming O₂.
   B) Generates NADPH for reduction in biosynthetic pathways
   C) Interconverts different forms of sugar phosphates
   D) Generates ribose-5-P for nucleotide synthesis
   E) Generates ATP via oxidative phosphorylation of NADPH.
8. Which of the following lipids has net negative charge?
   A) Phosphatidyl choline   B) Phosphatidyl serine
   C) Phosphatidyl ethanolamine   D) Triacylglycerol
   E) Diacylglycerol

9. The coenzyme generally required for carboxylation reactions is:
   A) Thiamine pyrophosphate   B) NAD\(^+\)
   C) Biotin
   D) Coenzyme A   E) NADPH

10. Which factor is beneficial if injected within 30 minutes into a stroke victim?
    A) Vitamin K   B) Fibrinogen
    C) Tissue plaminogen activator
    D) Factor VIII   E) Factor IX

11. Which substance is beneficial as a preventative of stroke?
    A) Vitamin K   B) Warfarin
    C) Prothrombin
    D) Factor VIII   E) Factor IX

12. Which of the following substances can be transported across membranes by simple diffusion?
    A) Glucose   B) ATP
    C) Simple amino acids
    D) CO\(_2\)   E) K\(^+\)

13. Nitrotyrosine is a modification of natural tyrosine formed by exposure to tetranitromethane, and has the following effect in aspartate transcarbamylase:
    A) Causes breakup of ATCase into c\(_3\) and r\(_2\) components.
    B) Allows c\(_3\) and r\(_2\) components to rejoin into c\(_6\)r\(_6\).
    C) Causes a shift to the R state.
    D) Causes a decrease in sedimentation coefficient.
    E) Changes absorbance in response to change from T to R.

14. During intense physical activity:
    A) the liver synthesizes fatty acids from glucose.
    B) the liver recycles lactate from blood into glucose.
    C) the liver carries out glycolysis to make ATP which can be sent to the muscles.
    D) the liver synthesizes glucose from stored fatty acids.
    E) the liver takes up excess glucose from blood.

15. The carrier of carboxylate groups in CoA and ACP is:
    A) phosphopantotheine   B) pyridoxal phosphate
    C) biotin
    D) ATP   E) thiamine pyrophosphate
16. Conversion of **pyruvate into PEP** has the following net effect:
(treat ATP and GTP as equivalent for these purposes)
A) Consumes one ATP, makes one NADH
B) Consumes two ATP, makes one NADH
C) Consumes one ATP and one NADH
D) Consumes two ATP and one NADH
E) Consumes two ATP, no net change in overall NADH.  16)  A B C D E

17. The body’s **primary reserve** of energy is in the form of:
A) ATP  B) proteins  C) triacylglycerols  
D) glucose  E) glycogen  17)  A B C D E

18. The body’s **secondary reserve** of energy is in the form of:
A) ATP  B) proteins  C) triacylglycerols
D) glucose  E) glycogen  18)  A B C D E

19. After several hours **without food:**
A) Epinephrine is released to maintain blood glucose levels.
B) Glucagon is released to maintain blood glucose levels.
C) Insulin is released to maintain blood glucose levels.
D) Insulin stimulates fat breakdown to replace glucose.
E) Glucagon stimulates glycolysis rates in liver.  19)  A B C D E

20. **The brain uses glucose primarily for:**
A) Fatty acid biosynthesis.  B) To store as glycogen.
C) Energy to maintain ion gradients.  D) To make ATP to supply to muscles.
E) Pentose phosphate pathway.  20)  A B C D E

21. **Which of the following effects happens after caffeine ingestion:**
A) Persistantly elevated cyclic AMP levels.  B) Protein phosphatase activated.
E) Glycogen phosphorylase activity reduced  .  21)  A B C D E

22. Isocitrate dehydrogenase is under allosteric control by:
A) Activation by ADP  B) activation by ATP
C) Activation by citrate  D) activation by acetyl CoA
E) Activation by cyclic AMP  22)  A B C D E
23. Pyruvate carboxylase is under allosteric control by:
   A) Activation by ADP
   B) activation by glucose-6-P
   C) Activation by citrate
   D) activation by acetyl CoA
   E) Activation by cyclic AMP

24. The Nernst equation allows one to calculate membrane potential: for any monovalent cation, the predicted equilibrium membrane potential is 60 mV for a concentration ratio of 1 to 10.
   The system illustrated below contains an ion selective channel for K⁺.

   ![Diagram of ion channel with concentration ratios and membrane potential]

   Predict what happens if the ion channel opens under the conditions shown above:
   A) K⁺ does not cross because the potential opposes the concentration gradient.
   B) K⁺ crosses outwards towards the higher potential.
   C) K⁺ crosses outwards towards the lower [K⁺].
   D) K⁺ crosses inwards because of the large membrane potential.
   E) K⁺ crosses inwards because of the concentration gradient.

25. People who live at altitude adapt to lower pO₂ by:
   A) Making less 2,3-bisphosphoglycerate to increase O₂ affinity in the lungs.
   B) Making more 2,3-bisphosphoglycerate to increase O₂ affinity in the lungs.
   C) Making less 2,3-bisphosphoglycerate to enhance O₂ release in capillaries.
   D) Making more 2,3-bisphosphoglycerate to enhance O₂ release in capillaries.
   E) By using fetal hemoglobin.

26. Which is the major hemoglobin form made in the embryo during the first month after conception?
   A) α₂β₂
   B) α₂ε₂
   C) ε₁ζ₂
   D) α₂δ₂
   E) ε₂β₂

27. Activation of chymotrypsinogen by trypsin involves
   A) Release of a peptide that blocks access to the active site.
   B) Phosphorylation of a critical serine.
   C) Binding of calcium to γ-carboxyglutamate.
   D) Binding of ATP
   E) Cleavage of a peptide bond to create a positive charged N-terminal Isoleucine.
28. **Fibrinogen** is prevented from clotting by **negative charge in its central region**; part of this negative charge is due to the modified amino acid:
A) tyrosine-O-sulfate  
B) Serine-O-phosphate  
C) γ-carboxyglutamate  
D) nitrotyrosine  
E) threonine-O-phosphate

29. **The product of 6-phosphogluconate dehydrogenase** is
A) 6-phosphogluconolactone  
B) glucose-6-P  
C) ribose-5-P  
D) ribulose-5-P  
E) xylulose-5-P

30. **The normal final product released by human fatty acid synthase I** is
A) $\text{C}_{16}\text{H}_{33}\text{CO}_2^-$  
B) $\text{C}_{15}\text{H}_{31}\text{CO}_2^-$  
C) $\text{C}_{17}\text{H}_{35}\text{CO}_2^-$  
D) $\text{C}_{15}\text{H}_{31}\text{COSCoA}$  
E) $\text{C}_{17}\text{H}_{35}\text{COSCoA}$
31. Explain what is meant by **symport** and **antiport**, and give an example of a specific **antiport** process in the mitochondrial membrane.

**symport:**

**antiport:**

**example:**

What process do cells use to import glucose across the cell membrane? What makes it possible to move glucose from low external [glucose] to high internal [glucose].

**Other than transport, give two other roles for membrane proteins:**
32. Your choice:
either show the cycle of steps involved in the action of the Na/K ATPase pump

or show the six step reaction sequence of fatty acid synthase I. 6 marks
33. How is pyruvate converted to phosphoenolpyruvate in animal cells?
Show structures of the principle reactants and products, but cofactors such as ATP etc. can simply be named; name the enzymes, and indicate regulators of the first step.

enzyme reaction 1
pyruvate +

enzyme reaction 2

enzyme reaction 3

enzyme reaction 4 phosphoenolpyruvate

Reactions 2 and 3 may seem a bit redundant.
What other event occurs between reaction 2 and reaction 3?

8 marks
34. Show the sequence of events that lead to activation of glycogen breakdown and deactivation of glycogen synthesis.

Initial state: fear or stress

7 marks