

Name _____

Student number _____

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

Final Exam, April 21, 1997.

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 31-39 directly on the question paper.

Questions 1-30 have a weight of 1 mark each

30 marks

Questions 31-37 have marks as indicated

30 marks

=====

60 marks

31-32	33-34	35	36-37	
/ 7	/ 8	/ 7	/ 8+1	/ 30 + 1

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Answer questions 1-30 on the computer scoring sheet.

Value 1 mark each

1. Which of the following **sugar phosphates** is **not** a **substrate or product of transketolase**?
A) Ribulose-5-P B) Xylulose-5-P C) Ribose-5-P
D) Erythrose-4-P E) Fructose-6-P
1) A B C D E

2. The carrier of the 3-carbon **aldol group in transaldolase** is:
A) Thiamine pyrophosphate B) A lysine side chain of the enzyme
C) Pyridoxal phosphate D) Biotinyllysine
E) A thioester bond
2) A B C D E

3. **NADH for gluconeogenesis can be provided by:**
A) Mitochondrial malate dehydrogenase.
B) Cytoplasmic malate dehydrogenase.
C) Mitochondrial pyruvate dehydrogenase.
D) Cytoplasmic glucose-6-phosphate dehydrogenase.
E) Mitochondrial isocitrate dehydrogenase.
3) A B C D E

4. **The potential futile cycle of hexokinase and glucose-6-phosphatase is prevented by:**
A) Cyclic AMP activation. B) ATP inhibition.
C) AMP activation. D) Fructose-2,6-bisphosphate
E) Release of glucose product into the endoplasmic reticulum.
4) A B C D E

5. **How many ATP molecules are made per glucose** in the second half of the gluconeogenesis pathway?
A) None B) One C) Two
D) Three E) Six
5) A B C D E

6. Given the condition **[ATP] low in muscle**, which of the following states is **highly unlikely**?
A) Phosphorylase **b** active.
B) Phosphofructokinase 1 active.
C) Pyruvate kinase active.
D) Isocitrate dehydrogenase active.
E) PEP Carboxykinase active.
6) A B C D E

7. After the **liver**, which organ is **next most active in gluconeogenesis**?
A) Kidney B) Muscle C) Adipose tissue
D) Brain E) Heart
7) A B C D E

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8. Given the condition of **no recent food input, moderate energy demand**, e.g. easy walking, and **acyl CoA levels high**, which of the following metabolic states is **most likely**?
- A) Pyruvate carboxylase active.
 - B) Citrate lyase active.
 - C) Glucose-6-phosphate dehydrogenase active.
 - D) Acetyl CoA carboxylase active.
 - E) Pyruvate dehydrogenase active.
- 8) A B C D E
9. **Which of the following is not a part of the fatty acid synthase I complex?**
- A) Hydroxyacyl dehydrogenase.
 - B) Enoyl reductase.
 - C) Dehydratase.
 - D) Thioesterase.
 - E) Malonyl transferase.
- 9) A B C D E
- Strictly speaking some of these names should include ACP or CoA, but that might give the game away!
10. **Biotin is linked to its carrier protein by:**
- A) An amide link to lysine.
 - B) A phosphate diester bond to serine.
 - C) An amide bond to glutamate.
 - D) An amide bond to asparagine
 - E) Non-covalent bonding.
- 10) A B C D E
11. At **moderate working rates**, the **major glucose consumer** in the body is:
- A) Adipose tissue
 - B) The liver
 - C) Muscle
 - D) The heart
 - E) The brain
- 11) A B C D E
12. **Hemoglobin S protein can be detected easily by observing:**
- A) The increased size of the S-mutant β -globin on SDS-polyacrylamide gels.
 - B) The increased binding affinity of Hemoglobin-S for O_2 .
 - C) The decreased binding affinity of hemoglobin-S for O_2 .
 - D) The reduced negative charge and higher isoelectric point of hemoglobin-S.
 - E) Increased polarity of the peptide fragment containing the mutation.
- 12) A B C D E
13. **β^0 Thalassemia is not always lethal because:**
- A) α_4 hemoglobin functions adequately.
 - B) The other β globin gene takes over.
 - C) γ -globins continue to be expressed in adult life.
 - D) The body makes do with myoglobin provided no strenuous activity is undertaken.
 - E) It is never observed.
- 13) A B C D E

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14. **The Cori cycle can be described as:**

- A) Gluconeogenesis in liver coupled to anaerobic glycolysis in muscle.
- B) Glycolysis in the liver coupled to gluconeogenesis in muscle.
- C) Anaerobic glycolysis in muscle coupled to aerobic glycolysis in liver.
- D) Glycolysis in muscle coupled to TCA cycle in liver
- E) Glycogen synthesis in liver coupled to glycolysis in muscle.

14) A B C D E

15. **The negatively charged polysaccharide heparin is an anticoagulant because:**

- A) It is a serine protease inhibitor.
- B) .It is a plasmin activator.
- C) It inhibits antithrombin III.
- D) It promotes the action of antithrombin III.
- E) It binds to phospholipid membranes.

15) A B C D E

16. **Which of the following is most likely to be able to cross a membrane without help of a transporter protein?**

- A) Ethanol
- B) acetyl-SCoA
- C) Glyceraldehyde-3-phosphate
- D) Glucose
- E) Na⁺.

16) A B C D E

17. **The Bohr effect is the reduced affinity of hemoglobin for O₂**

- A) Due to binding of 2,3-bisphosphoglycerate
- B) Due to high altitude.
- C) Due to lower pH
- D) In fetal hemoglobin.
- E) Resulting from the hemoglobin S mutation.

17) A B C D E

18. **ATP acts on aspartate transcarbamoylase:**

- A) By providing energy for the reaction.
- B) By phosphorylating the substrate.
- C) As a homotropic effector
- D) As a feedback inhibitor.
- E) By binding and stabilizing the R state of the enzyme.

18) A B C D E

19. **The normal human adult expresses:**

- A) Four α -globin and two β -globin genes
- B) Two α -globin and two β -globin genes.
- C) Two α -globin and four β -globin genes.
- D) Two α -globin and one β -globin gene.
- E) One α -globin and two β -globin genes.

19) A B C D E

20. **Glucose transport into animal cells is the result of:**

- A) An ATP driven glucose transporter.
- B) Symport with Na⁺.
- C) Antiport in exchange for Na⁺.
- D) Symport with K⁺.
- E) Antiport in exchange for K⁺.

20) A B C D E

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21. **The brain consumes glucose primarily for:**

- A) Fatty acid biosynthesis. B) Glycogen synthesis.
 C) Pentose phosphate pathway. D) Energy supply to muscles.
 E) Energy to maintain ion gradients.

21) A B C D E

22. **Which of the following would be an abnormal ionic condition in the cell?**

(‘High’ implies higher than outside, ‘low’ implies lower than outside.)

- A) Low intracellular Na. B) High intracellular K⁺
 C) High intracellular Mg²⁺ D) High intracellular Ca²⁺
 E) High intracellular phosphates

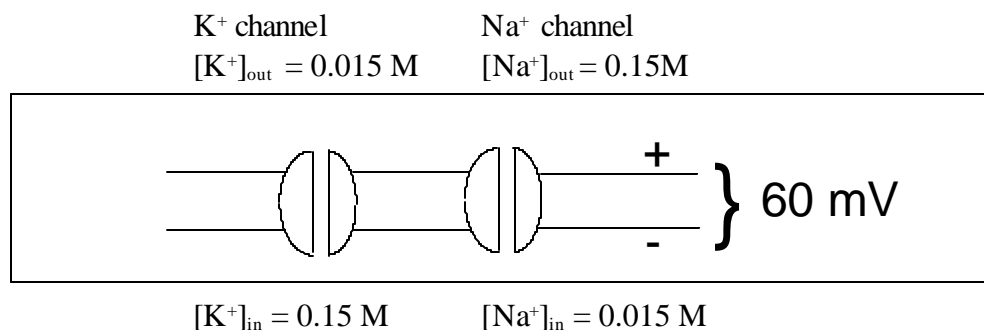
22) A B C D E

23. **Which of the following effects or states is not a consequence of caffeine ingestion:**

- A) Persistently elevated cyclic AMP levels. B) Active glycogen phosphorylase.
 C) Inactivated Glycogen synthase. D) Activated adenylate cyclase.
 E) Elevated blood glucose.

23) A B C D E

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 two kinds of ion selective channel, one for Na⁺ and one for K⁺.



Predict what happens if both ion channels open together under the conditions shown above:

- A) Na⁺ crosses inwards, K⁺ does not cross.
 B) K⁺ crosses outwards, Na⁺ does not cross.
 C) Both ions cross, K⁺ outwards and Na⁺ inwards.
 D) Neither cross because the concentration ratios are in equilibrium with membrane potential.
 E) Neither ion can cross without ATP hydrolysis.

24) A B C D E

25. **Which of the following is a bilayer-forming amphipathic molecule? (R is -C₁₇H₃₅)**

- | | | |
|--------------------------|--|--|
| A) CH ₂ -CO-R | B) CH ₂ -CO-R | C) CH ₂ -CO-R |
| CH -CO-R | CH -CO-R | CH -CO-R |
| CH ₂ -CO-R | CH ₂ -O PO ₃ ²⁻ | CH ₂ -O ₃ P ⁻ O-CH ₂ -CH ₂ NH ₃ ⁺ |

- D) R - CO₂⁻ E) R - CO-SCoA

25) A B C D E

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26. **Which of the following is not a protease of some kind?**
A) Thrombin B) Fibrin C) Plasmin.
D) Pepsin E) Elastase 26) A B C D E
27. **Under normal conditions, the body's energy needs are met primarily by:**
A) Oxidation of fatty acids in muscles B) Pentose phosphate pathway in the liver.
C) Oxidation of glucose in the brain. D) Gluconeogenesis in the liver
E) Anaerobic glycolysis in the muscle. 27) A B C D E
28. **After a starch-rich meal we expect to find:**
A) Elevated blood glucagon. B) High rates of gluconeogenesis in liver.
C) Active glycogen phosphorylase in liver. D) Elevated cytoplasmic citrate in liver.
E) High activity of protein kinase A in liver. 28) A B C D E
29. **Serine proteases of the chymotrypsin family have an active site based on the catalytic triad consisting of :**
A) Serine, Glycine and Aspartate. B) Serine, Glycine and Methionine.
C) Serine, Histidine and Glycine. D) Serine, Histidine and Aspartate
E) Phenylalanine, Tryptophan and Tyrosine. 29) A B C D E
30. **The blood clotting factor that is activated by both intrinsic and extrinsic pathways is:**
A) Factor VIII B) Factor IX C) Factor VII
D) Factor XI E) Factor X. 30) A B C D E

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31. The net cost of making **one glucose** from pyruvate is **6 ATP or GTP**. Identify the reactions that use ATP or GTP. (Name reactants, enzyme and products of these steps; structures not required).

5 marks

i)

ii)

iii)

Which of the above steps is a **glycolysis reaction in reverse**? **i** **ii** **iii**
(circle as appropriate)

32. State the **purpose(s) of the pentose phosphate pathway** in metabolism;
in which organ is this pathway most active?

2 marks

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33. i) **How does TCA cycle regulation lead to appearance of citrate in the cytoplasm?** State **which TCA cycle enzyme is regulated, what the regulating factors are**, and briefly explain **why it's citrate that accumulates** in large quantities rather than another TCA cycle intermediate. 2 marks
- ii) **What is citrate converted to when it reaches the cytoplasm?** State the **immediate product of the first reaction** (enzyme, any other reactants and products by name, structures not required). State **the final product of the pathway**. 2 marks
- iii) Name **an enzyme that is regulated by the presence of cytoplasmic citrate**; state whether it is **positive or negative regulation**. 1 mark
34. Glycogen is broken down to glucose-1-phosphate by glycogen phosphorylase in one step. **Identify the reactions required for the synthesis of glycogen starting from glucose-1-phosphate**. (Name **enzymes, additional substrates/cofactors and products**, as appropriate; structures not required.) 3 marks

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35. Nerve action depends on **ion selectivity and voltage sensitivity** of ion channels in the membrane.

How is ion selectivity determined?

State the basis for **excluding ions that are too large**, and for **excluding ions that are too small**.

2 marks

The key events of the **action potential** are illustrated at right.

What are the time units? **milliseconds**

(circle one) **seconds**

minutes

1 mark

What are the typical voltages at the resting potential _____

and at the peak (just after (C) in the figure), _____

1 mark

A) **How does the process get started?**

B) **What happens at (B)?**

C) **What happens at (C)?**

3 marks

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36. Pyruvate Carboxylase is a three-component enzyme. There are two catalytic components:

Reaction at first catalytic component:

(Show structures of the principal reactant and product; name the prosthetic group.)

2 marks

Reaction at second catalytic component:

(Name the reactants and product.)

2 marks

What is the function of the third component:

Structure of the prosthetic group is a **bonus mark:**

1 mark + 1

37. Your choice: show the **structures (reactants and products)** of either the **oxidative stages of the pentose phosphate pathway** or of the **transaldolase reaction** (including enzyme bound intermediate).

3 marks