

EXAM 3 CH339K (Dr. Robertus) Spring 2003

Name: _____

SSN: _____

SHOW WORK FOR ALL COMPUTATIONAL PROBLEMS OR NO CREDIT!

1 cal = 4.18 J and therefore: $R = 8.314 \text{ J/mole K} = 1.99 \text{ cal/mole K}$

Avagadros number = 6×10^{23}

Faradays constant = $23.1 \text{ Kcal/molV} = 96.5 \text{ KJ/molV}$

Assume $T=25 \text{ }^\circ\text{C}$ in all problems, unless otherwise stated.

1. [5] What is the rough pH of the stomach ? _____ During digestion, a protease active in the stomach is _____. Several proteases are synthesized in the pancreas as inactive precursors, called _____ before being shipped to the site of action. Name an active protease that cleaves ingested proteins at aromatic amino acids _____. The class of enzymes which begin hydrolysis of lipids are called _____.

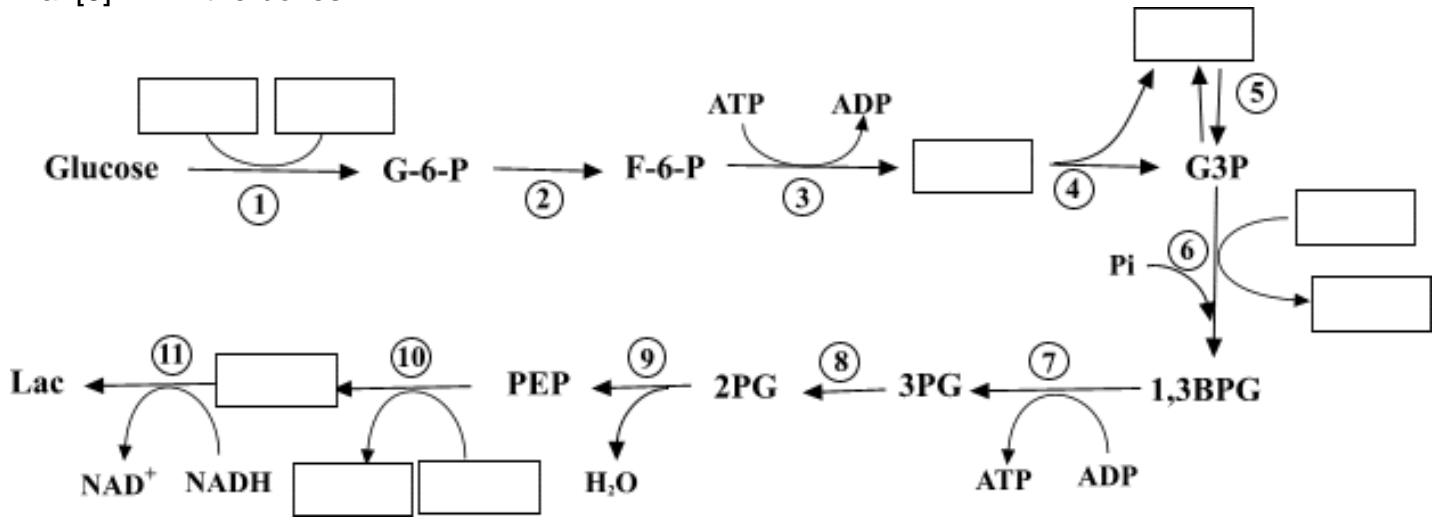
2. [3] **Free-Energy Change for Triose Phosphate Oxidation** The oxidation of glyceraldehyde 3-phosphate to 1,3-bisphosphoglycerate, catalyzed by glyceraldehyde 3-phosphate dehydrogenase, proceeds with an unfavorable equilibrium constant ($K_{eq} 0.08$; $G^\circ 6.3 \text{ kJ/mol}$), yet the flow through this point in the glycolytic pathway proceeds smoothly. How does the cell overcome the unfavorable equilibrium?

3. [6] The pyruvate dehydrogenase complex is a geometric arrangement of at least 3 enzymes that convert pyruvate to AcCoA. Write the overall reaction catalyzed by this complex.

The complex involves the use of 5 vitamin-derived cofactors. Name them (appropriate abbreviations are OK).

4. Below is a scheme of the glycolytic pathway.

a. [6] Fill in the boxes.



b) (5) Which numbered step is the main regulatory one? _____ The enzyme catalyzing this step is _____.

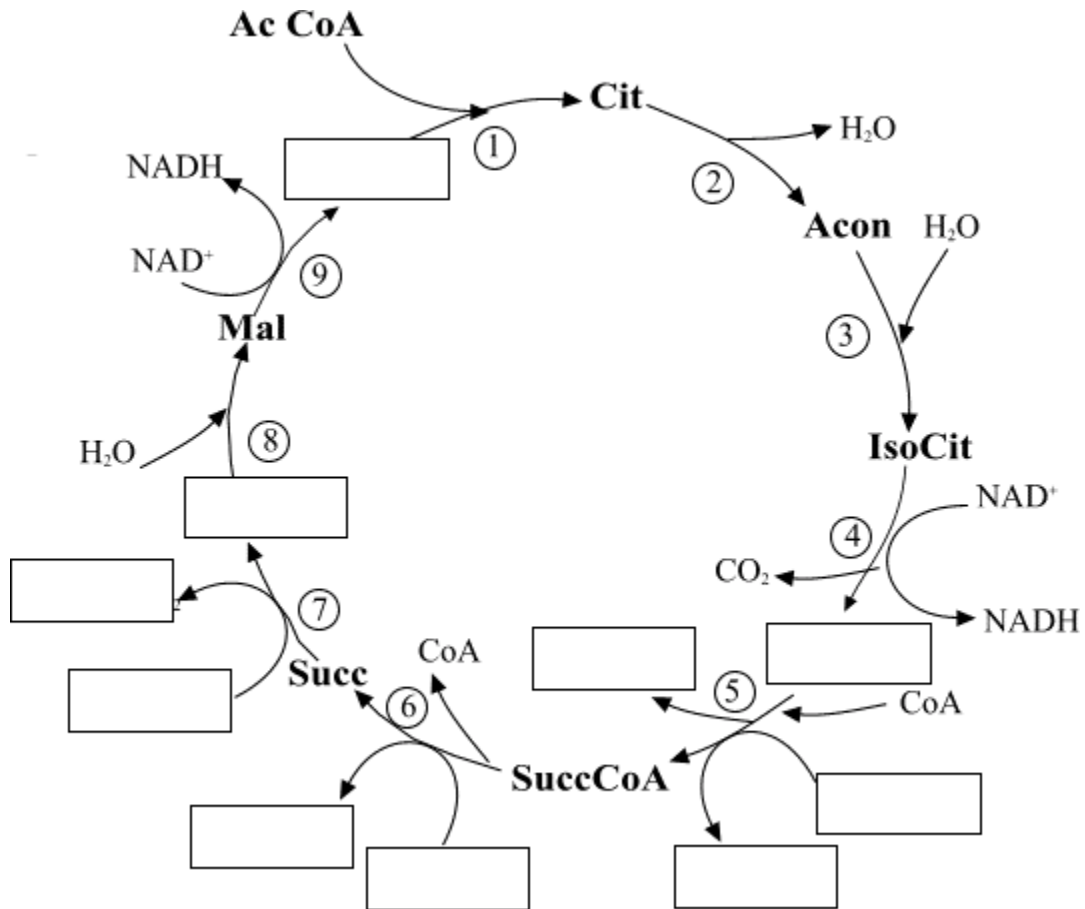
The enzyme is regulated by “energy level symbols”; it is activated by _____ and inhibited by _____. In addition, the main activator is the compound _____.

c) (2) Which steps (numbers) in the pathway are effectively irreversible?

5. [3] As described in class, α -keto acids are of considerable biochemical utility. Write the structural formula for pyruvate, oxaloacetate, and α -ketoglutarate.

pyruvate	OAA	α KG

6. Below is a schematic of the citric acid cycle.
 a. [7] Fill in the blanks.



b) (3) Which numbered step is the main regulatory one? _____

The enzyme name is _____

The enzyme is inhibited _____

c) (2) Which steps (numbers) in the pathway are effectively irreversible?

d) [1] One step in this cycle is highly unfavorable, which number is it? _____

7. [6] The main anaplerotic enzyme is pyruvate carboxylase; write the overall reaction for this enzyme.

What is the required activator of the enzyme?

The TCA intermediate Succ-CoA is used to synthesize what important biological moiety? _____

8. [5] What is the general role of the ketone bodies?

Name the most prevalent ketone body. _____

Under what circumstances can the brain burn ketone bodies?

9. [5] We briefly discussed a degradative pathway for glucose called the pentose pathway. Roughly what fraction of glucose is oxidized by this pathway?

The pathway has 2 major “products” of biological significance. What are they, and why are they important?

10. [6] The hormone glucagon signals that blood glucose is low; it activates a phosphorylation cascade which has a variety of effects. Indicate the effect, DIRECT OR INDIRECT, in **LIVER TISSUE**, on the following enzymes. Use a capital **A** to denote activation and a capital **I** to indicate inhibition.

- a. protein kinase A _____
- b. phosphofructokinase 1 (PFK1) _____
- c. fructose bis phosphatase 1 _____
- d. glycogen phosphorylase _____
- e. glycogen synthetase _____

11. a) [2] In the ETS complex 1 binds NADH and allows its oxidation by passing electrons through its machinery to reduce the mobile carrier called _____. The carrier then binds to complex _____ and passes the electrons to a soluble carrier called _____. Finally the electrons are passed to complex 4 which passes them to the ultimate electron acceptor which is _____.

b) [4] Given that the redox potential for O_2 is +0.82 V, and that of NAD^+ is -0.32 V, how much energy, in KJ/mol, is released when 2 electrons from NADH are “dropped” into atomic oxygen? Show work.

c) [2] Oxidative phosphorylation generates ATP from ADP and P_i using the F_0/F_1 ATPase. This enzyme has _____ major structural conformations that are activated sequentially by contact with the δ protein, which physically rotates. How is this rotation “paid for” in terms of energy?

12.[6] Which high energy cofactors are formed in each normal cycle of β -oxidation?

How many ATPs is each AcCoA “worth”, once it has been oxidized in the TCA cycle and those cofactors reoxidized in the ETS?

Given the above facts, how much energy (as ATP equivalents) can be derived from the oxidation of palmitate?

13) a. [2] Name 2 kinds of photosynthetic pigments, from those we discussed, used to harvest light.

b. [2] Why are so many pigments needed?

c. [3] In the “Z” diagram of higher plants, how many photons are needed to “pump” each electron through the path? _____ What molecule is the ultimate source of these electrons? _____ What is the ultimate receptor of the electrons? _____

d. [1] During the operation of the Z system, what chemical species are pumped into the lumen of the thylakoid sacks? _____

e. [1] ATP is generated in photosynthesis using an enzyme very similar to what mitochondrial protein complex? _____

f. [2] What property of the Mn “water splitter” makes it so valuable to photosynthesis in higher plants?

14. [6] The amine groups from a wide range of amino acids are transferred to α KG to form which amino acid? _____

This reaction involves the participation of which vitamin-derived cofactor?

Write the reaction that describes the removal of amine groups and the creation of ammonia.

15. [5] Once amine groups are removed, the carbon skeletons of amino acids can be catabolized much like carbohydrates. The most common amino acid is alanine; if it is transaminated, what product remains? _____

How much energy, in integral ATP units, can be gained by oxidizing this product?