# Chemistry 333
# Principles of Biochemistry
# Fall 2009
# Third Exam
# December 2, 2009

NAME: KEY

1. _____/12 points
2. _____/12 points
3. _____/16 points
4. _____/18 points
5. _____/12 points
6. _____/30 points

7. _____/3 points (EXTRA CREDIT)

**TOTAL: _____/100 points**

1. **Matching: Match the terms with as many terms in the alphabetized list as are applicable. Some may be used more than once and others not at all. There are 24 total answers. You will lose points for any additional/extraneous answers, so be careful! Wrong answers will not count against you. SORRY, CHRIS!**

**(12 points)**

**Triacylglycerols** D, O, P, K

**Glycogen** F, G, R

**Phospholipids** C, E, O

**Sphingomyelins** C, E, M

**Sucrose** N

**Cholesterol** C, E, S, Q

**Integral membrane proteins** I, C, A

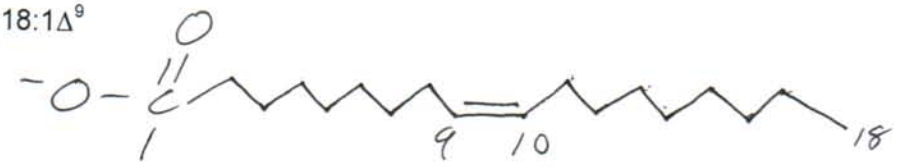
**Lipases** B

**Peripheral membrane proteins** H, C

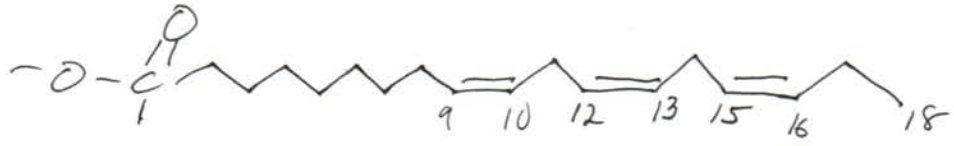
A. Transporters or channels
B. Enzyme that catalyzes the hydrolytic release of fatty acids from triacylglycerols
C. Exist as parts of or associated with biological membranes
D. Found stored in adipocytes
E. Polar lipids
F. Polysaccharide
G. Glucose storage in animal cells
H. Easy to remove from membranes with salt or change in pH
I. Difficult to remove from membranes – need detergents
J. Monosaccharide
K. Non-polar lipids
L. Fat substitute
M. Insulate nerve axons
N. Disaccharide
O. Contain a glycerol backbone
P. Lipid that serves as energy storage in the cell.
Q. Can both increase and decrease membrane fluidity
R. Highly branched
S. Steroid-like

2. **Draw the following fatty acid structures at pH 7.5. Be sure any double bonds are in the correct configuration: (12 points)**

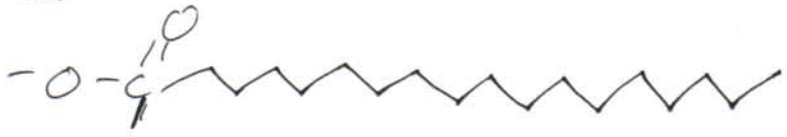
A. $18:1\Delta^{9}$




B. $18:3\Delta^{9,12,15}$




C. 18:0



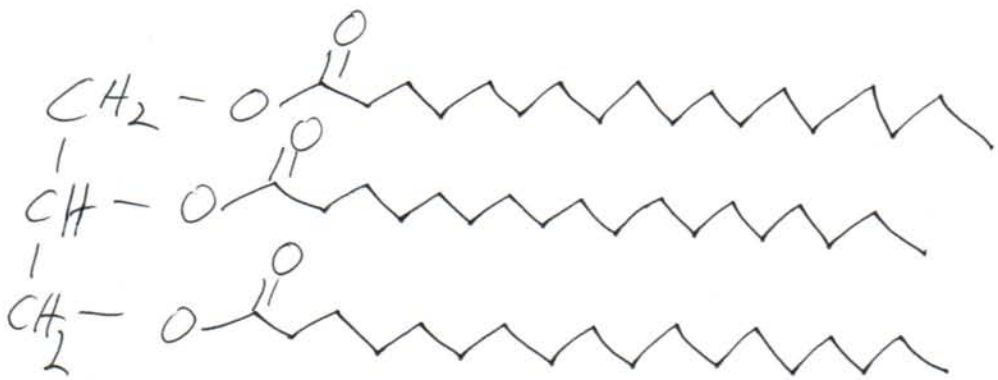
D. Which of the above fatty acids would you expect to have the lowest melting temperature and why?

B, most Double bonds, packs least well, fewest interactions

F. Name the type of bond that connects the fatty acids to the #1, #2 and #3 positions of glycerol in triacylglycerols?

Ester

E. Draw a triacylglycerol that contains all 18:0 fatty acids.



**3. Answer the following questions concerning the TCA cycle: (16 points)**

1. What enzyme is responsible for the reaction in the TCA cycle shown above?

malate dehydrogenase

2. Name the SUBSTRATE of the reaction:

malate

3. Name the PRODUCT of the reaction:

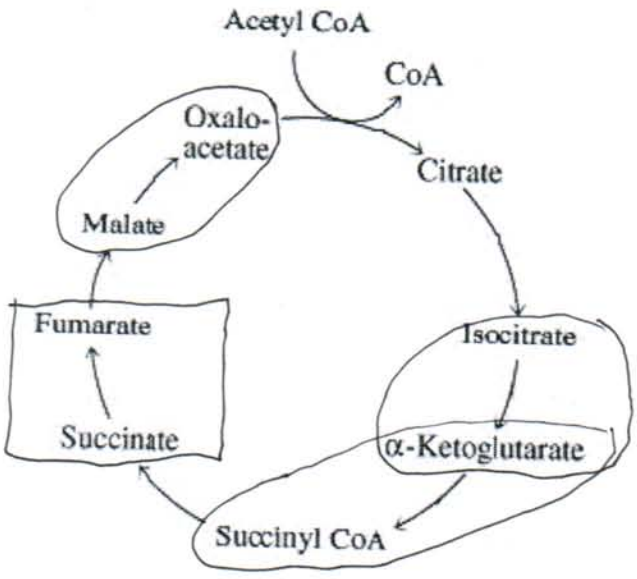
oxaloacetate

4. What co-factor is necessary for this reaction to proceed?

NAD+ [illegible]

5. Is this a regulated step? Circle one:

YES (NO)




6. **CIRCLE** the step(s) in the TCA cycle where NADH is made (Include the names of the substrate and product in your circle)?

7. **BOX** the step(s) in the TCA cycle where $FADH_2$ made. (Include the names of the substrate and product in your box)?

8. You set up an experiment under aerobic conditions and test how much ATP is made in cells in the presence of an inhibitor. You find that from **3** moles of glucose, only **51** moles of ATP are generated.

   a. How many moles of ATP would you expect to generate in the **absence** of the inhibitor?

   96

   b. Name the **enzyme** in the TCA cycle that was affected by adding the inhibitor.

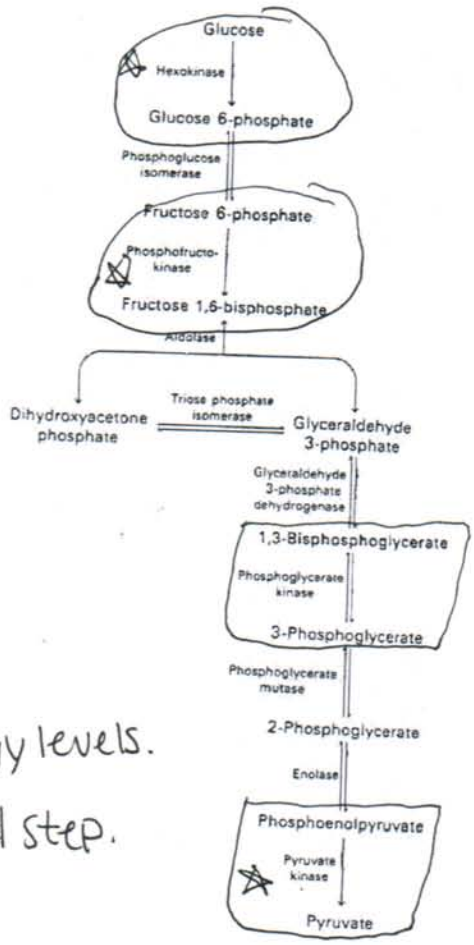
   α-Ketoglutarate dehydrogenase

**4. Answer the following questions on glycolysis shown to the right: (18 points)**

a. Place a **BOX** around the step(s) during which ATP is synthesized.

b. **CIRCLE** the step(s) in which ATP is consumed.

c. If appropriate, put **STARS** next to **regulated** enzymes.




e. Why is it advantageous for **citrate**, the product of reaction 1 of the TCA cycle, to **inhibit** the glycolytic enzyme **phosphofructokinase**?

High levels of citrate mean high energy levels. Glycolysis is not needed → Phosphofructokinase is the committed step.

f. What **compound** in glycolysis will **accumulate** when **phosphofructokinase** is inhibited and from what you know, describe the most likely **fate** of the accumulated molecule if the cell has a large supply of energy.

Fructose-6-phosphate (or Glucose-6-phosphate) F6P will isomerize into Glucose-6-phosphate. Under high energy conditions, this will be stored as glycogen.

g. Glucose is frequently administered intravenously to patients as a food source. A new resident at a hospital where you are working suggests administering glucose-6-phosphate instead. You consider the possibility that this procedure might save the patient energy. Should you use the resident's suggestion? **Why or why not.**

NO.

Glucose-6-phosphate cannot enter the cell. Glucose is transported into the cell and then phosphorylated to keep it inside.

5. **Below are three membrane transporters, their substrates, and their pictures in the membrane. For each one,** **(12 points)**

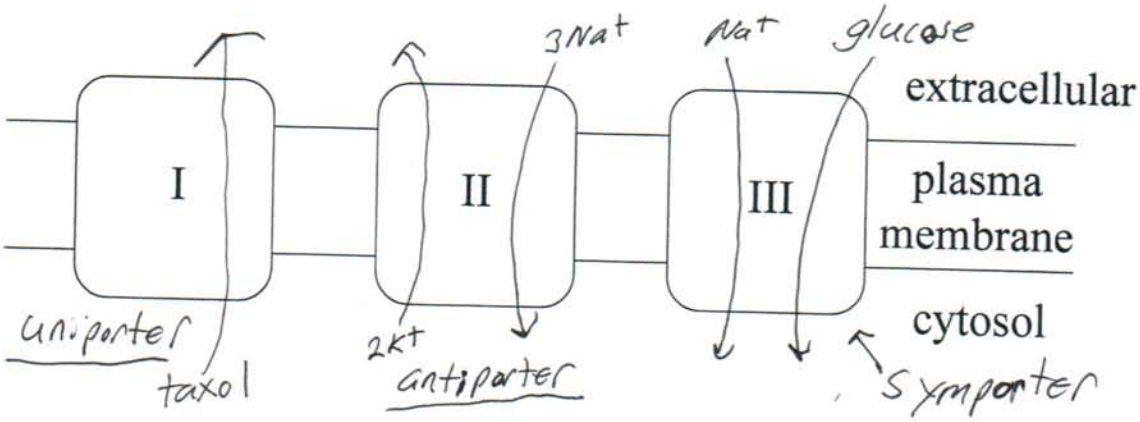
(6 points) Name the type of transporter
(Pick from uniporter, symporter and antiporter)

(5 points) Draw what transport through the transporter would look like using arrows and the names of the substrates.

i. P-glycoprotein – transports taxol (a chemotherapeutic drug) out of the cell

ii. Na+/K+ transporter– transports three $Na^+$ into the cell and two K+ out of the cell.

iii. Na+-glucose transporter – transports one Na+ into the cell when transporting a glucose molecule into the cell



6. **MULTIPLE CHOICE: (2 points each) (30 total points)**

1. In most tissues, an <u>increase</u> in the following ratio directly causes a **decrease** in TCA cycle activity:

   A. $FAD/FADH_2$

   B. ADP/ATP

   C. GDP/GTP

   D. $NAD^+/NADH$

   E. NADH/NAD

2. **The process by which ATP is formed directly in glycolysis is:**

   A. substrate-level phosphorylation

   B ATP hydrolysis

   C. oxidative phosphorylation

   D. isomerization

   E. none of the above

3. **When undergoing strenuous anaerobic exercise the Cori Cycle is functioning. Which of the following compounds is being delivered to muscle tissue from the liver as part of this cycle?**

   A. Glucose

   B. Lactate

   C. Galactose

   D. Pyruvate

   E. Alanine

4. **The majority of the enzymes in the TCA cycle are located:**

   A. in the cytosol

   B. in the Golgi apparatus

   C. in the mitochondrial matrix

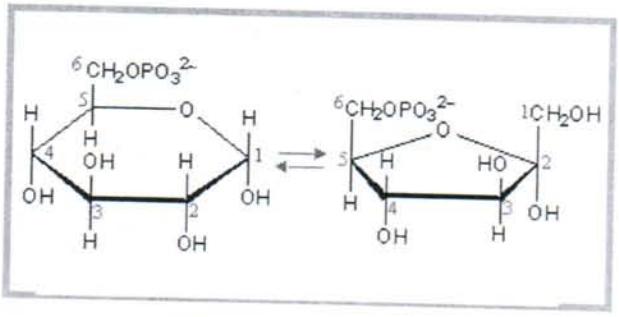
   D. in the endoplasmic reticulum

   E. in the nucleus

5. **Your body uses hormones to regulate blood glucose concentrations. When blood glucose levels rise, the pancreas secretes _____ and as a result blood glucose levels decline. When blood glucose levels are low, the pancreas secretes _____ and as a result blood glucose levels rise.**

A. glucagon, insulin
B. epinephrine, glucagon
C. insulin, testosterone
D. insulin, glucagon
E. None of the above

6. **Classify the type of reaction given below:**



A. non-hydrolytic cleavage
B. aldol condensation
C. group transfer
D. isomerization-rearrangement
E. hydrolysis

7. **More ATP is formed from glucose in glycogen than from free dietary glucose because**

A. The glucose from glycogen enters glycolysis as free glucose
B. The glucose bypasses glycolysis and enters the TCA cycle directly
C. The glucose is phosphorylated upon removal from glycogen without using ATP
D. None of the above
E. All of the above

8. **During ethanol metabolism, the ratio of _____ to _____ rises and inhibits fatty acid breakdown leading to fatty liver disease.**

A. acetate/acetaldehyde
B. $NAD^+$/NADH
C. acetaldehyde/acetate
D. $FADH_2$/FAD
E. NADH/$NAD^+$

9. **For a step in a reaction pathway to serve as a control point it should be**

A. irreversible

B. endergonic

C. far from equilibrium

D. both a and c

E. all of the above

10. **How many ATP molecules are produced through substrate-level and oxidative phosphorylation as a result of the conversion of <u>one</u> molecule of 1,3-bisphosphoglycerate into α-ketoglutarate?**

A. 2

B. 4.5

C. 7

D. 9.5

E. 12

11. **Why is the production of NADH and $FADH_2$ important in aerobic metabolism?**

A. they can be oxidized in the process of making ATP via oxidative phosphorylation

B. they are a source of high energy electrons for oxidative phosphorylation

C. they can be reduced in the process of making ATP via oxidative phosphorylation

D. A and B

E. B and C

12. **Which statement explains why many biochemical processes are carried out via multi-step pathways rather than by single-step reactions?**

A. Multi-step pathways allow for more control points to regulate biochemical processes

B. Single step pathways are easier to control

C. There is not sharing of intermediates between pathways.

D. There is no control over the amounts of energy that are consumed or released

E. Multi-step pathways are less efficient at generating energy

13. **The type of motion *least* common in biological membranes is:**

A. flip-flop diffusion of phospholipid from one monolayer to the other.
B. lateral diffusion of individual lipid molecules within the plane of each monolayer.
C. lateral diffusion of membrane proteins in the bilayer.
D. random motion of the fatty acyl side chains in the interior of the phospholipid bilayer.
E. rotational motion of the individual lipid molecules

14. **Membrane lipids in a lipid bilayer are held together primarily by:**

A. hydrophobic interactions
B. hydrogen bonds
C. electrostatic interactions
D. covalent bonds
E. all of the above

15. **A patient comes to the emergency room is lethargic and her liver is enlarged. A liver biopsy test shows large amounts of excess glycogen. She also has lower than normal blood glucose. Why does this patient have low blood glucose?**

A. Low liver glycogen phosphorylase activity
B. Low liver glycogen synthesis activity
C. Low liver phosphatase activity
D. Low liver hexokinase activity
E. All of the above

## 7. EXTRA CREDIT (3 points)

**1 point** Dr. Hrycyna's "son" Stanley ate too many WOW potato chips one day that contained the fat substitute Olestra. The next day he suffered from a bad stomach ache and anal leakage.

**2 point** A 70 kg (154 lb) adult requires a calorie intake of 2,000 kcal (8,360 kJ) of food per day (24 h). The food is metabolized and the free energy is used to synthesize ATP for useful work. [FYI: Each calorie ("Calorie") listed on food labels corresponds to 1.0 kcal in biochemical terms.]

Assuming that the efficiency of converting food energy into ATP is 50%,

Calculate the **weight** of ATP used by this human adult in 24 h and the **percentage** of the person's body weight that this represents?

Hints: The formula weight of ATP is 505 g/mol.
Each mole of ATP is equivalent to 30.5 kJ

$$8360\ kJ \times \frac{1\ mole\ ATP}{30.5\ kJ} \times \frac{505\ g}{mol\ ATP} \times \frac{kg}{1000\ g} \times \frac{1}{2} =$$

**69.2 kg**

$$\frac{69.2\ kg}{70\ kg} = \mathbf{98.9\%}$$