AP BIOLOGY
CELLULAR ENERGETICS
ACTIVITY #2

NAME_____

DATE_____HOUR_____

CELLULAR RESPIRATION

SUMMARY EQUATION

STEPWISE REDOX REACTION

Oxidation:
Reduction:
$Xe^- + Y \rightarrow X + Ye^-$
$CH_4 + 2O_2 \rightarrow CO_2 + H_2O + energy$
$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + energy$

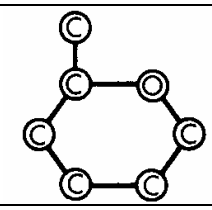
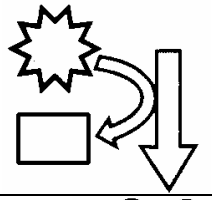
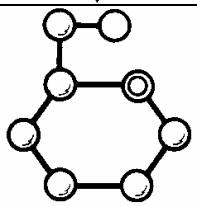
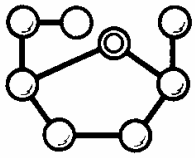
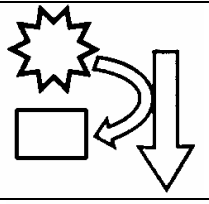
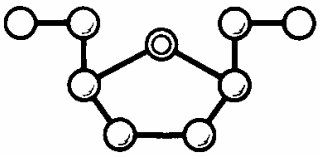
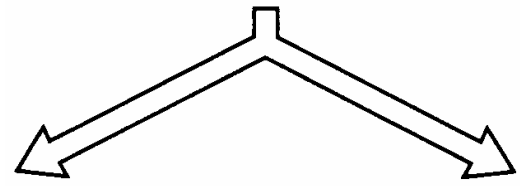
ROLE OF NAD+

PHOSPHORYLATION

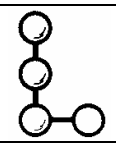
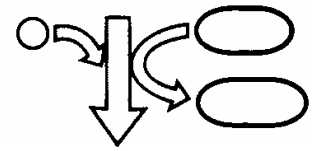
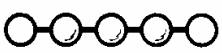
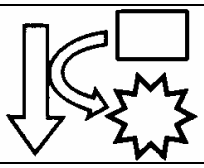
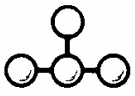
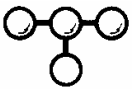
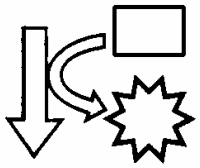
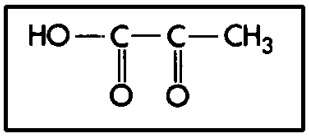
SUBSTRATE LEVEL	OXIDATIVE

STRUCTURE OF MITOCHONDRION

GYCOLYSIS

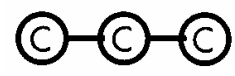
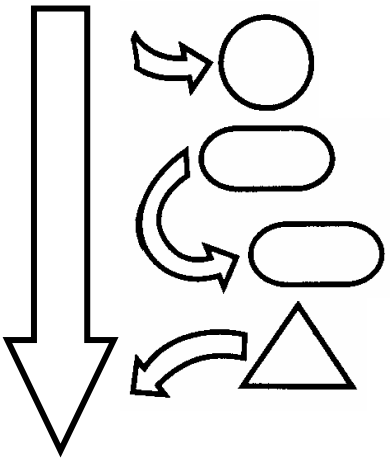
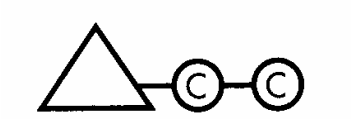
GLYCOLYSIS

GLYCOLYSIS SUMMARY

ENERGY INVESTMENT	
ENERGY YIELDING	
IN	**OUT**

KREBS CYCLE – ACETYL COA PREP

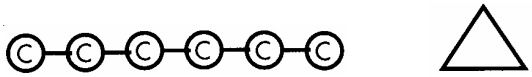
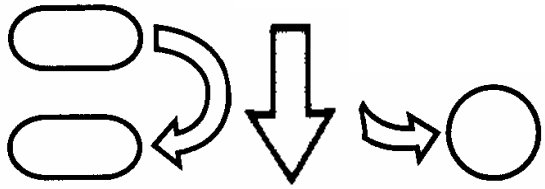
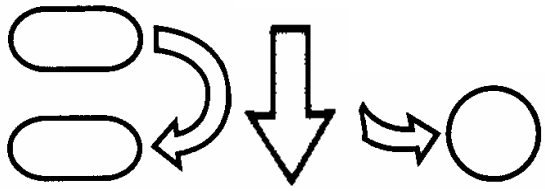
ACETYL CO A PREP PER PYRUVATE

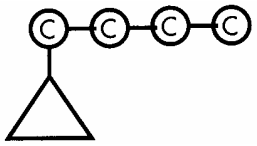
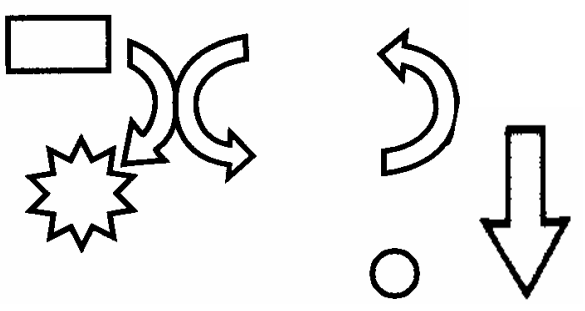
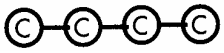
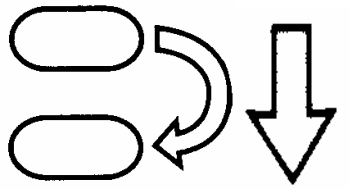
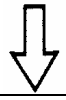
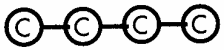
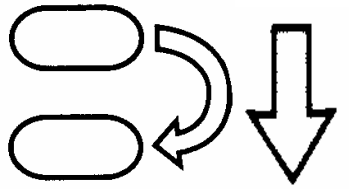
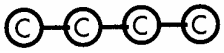
In	OUT

ACETYL CO A PREP PER GLUCOSE

In	OUT

KREBS CYCLE

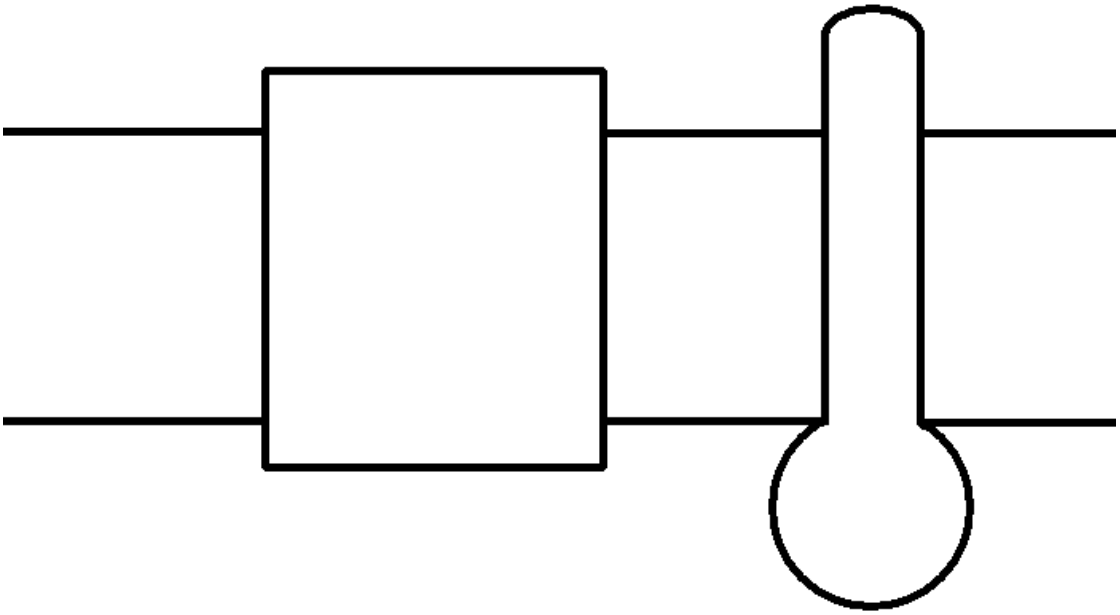
KREBS CYCLE SUMMARY PER PYRUVATE

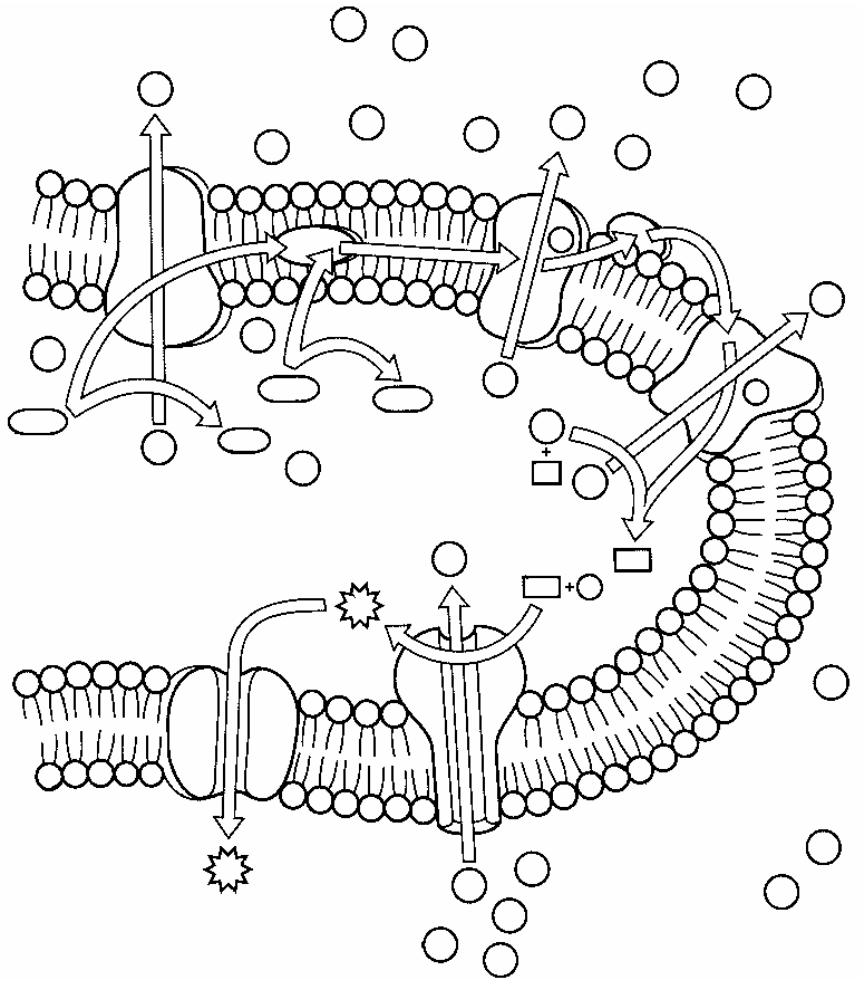
KREBS CYCLE IN	KREBS CYCLE OUT

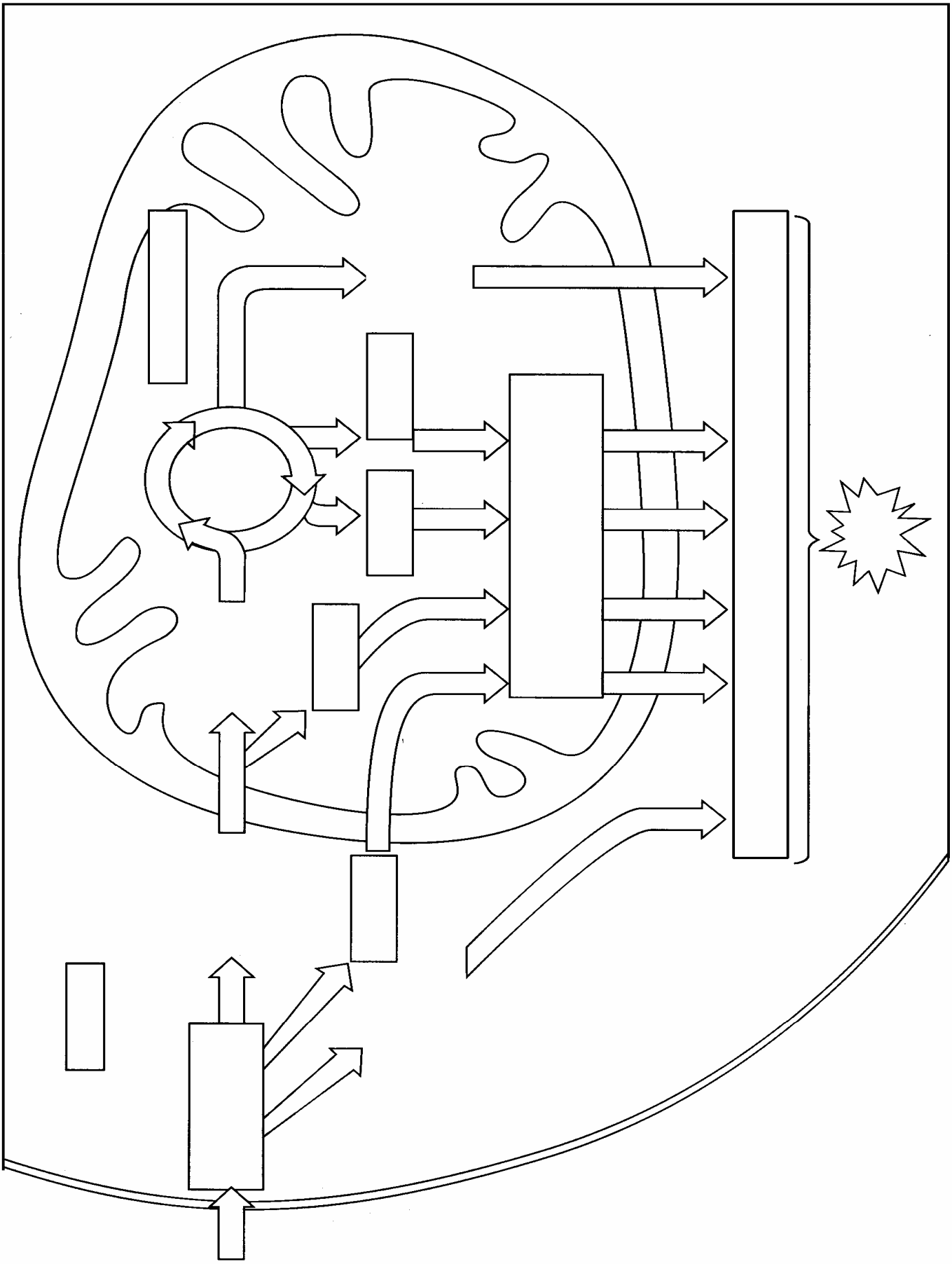
KREBS CYCLE SUMMARY PER GLUCOSE

KREBS CYCLE IN	KREBS CYCLE OUT

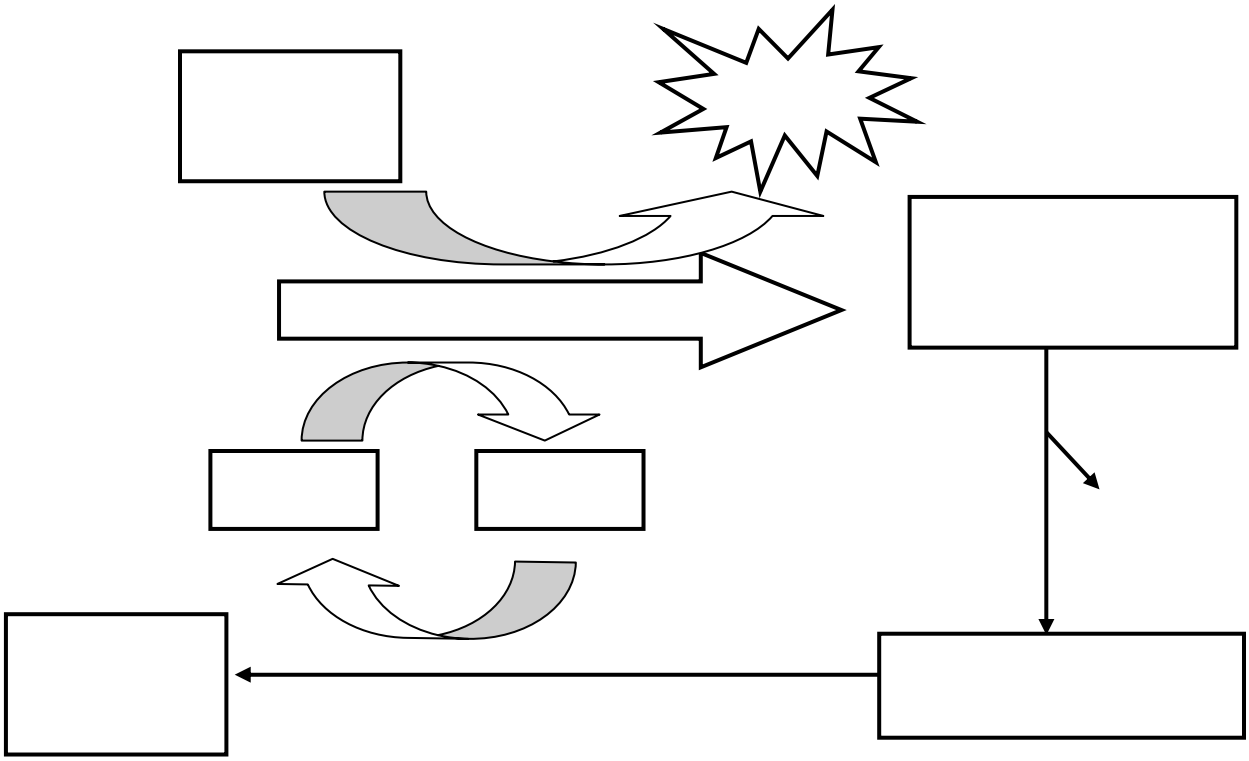
ELECTRON TRANSPORT & OXIDATIVE PHOSPHORYLATION



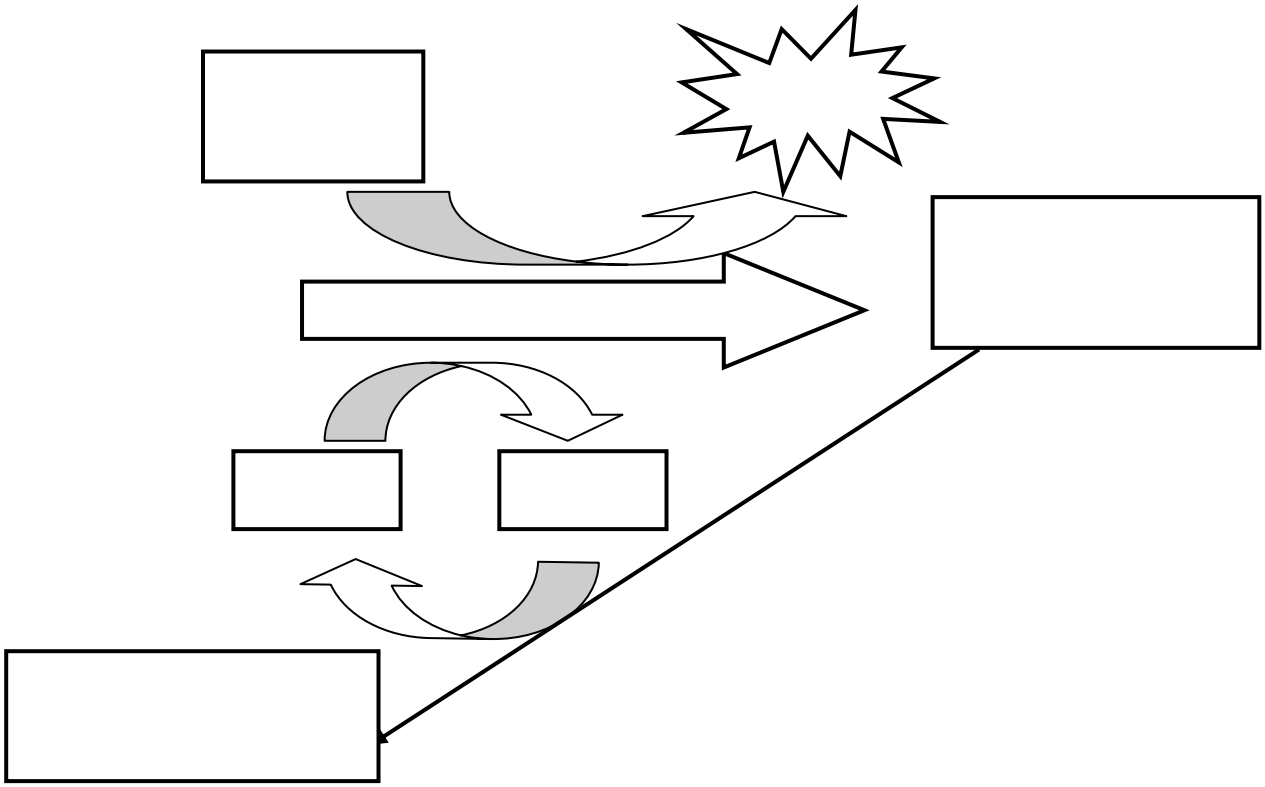




ALCOHOL FERMENTATION



LACTIC ACID FERMENTATION



QUESTIONS

1. Use Figure 9.1 on page 148 in your textbook to answer the following questions.

   a. In general, describe what happens during photosynthesis.

   _____

   b. What are the reactants in photosynthesis?

   _____

   c. What are the products of photosynthesis?

   _____

   d. Where in the cell does photosynthesis occur?_____

   e. In general, describe what happens during cellular respiration.

   _____

   f. What are the reactants in cellular respiration?

   _____

   g. What are the products of cellular respiration?

   _____

   h. What substance(s) is(are) recycled?_____

   i. What substance(s) is(are) not recycled?_____

   j. Which reaction (photosynthesis or cellular respiration) is:

   Anabolic?_____

   Catabolic?_____

   Exergonic?_____

   Endergonic?_____

2. Write the summary equation for cellular respiration.

_____

3. Most commonly glucose is represented as the molecule broken down in the respiration equation. Does this mean that glucose is the only source of energy (fuel) in cellular respiration? Explain.

_____

_____

4. Define:

   a. Oxidation: _____

   b. Reduction: _____

5. Cellular respiration is described as a stepwise redox reaction.

   a. What substance is oxidized?_____

   b. What substance is reduced?_____

6. What happens to the amount of potential energy of electrons as they shift from carbon and hydrogen toward oxygen in cellular respiration?

_____

How is the energy used?_____

7. What is the role of NAD+ in cellular respiration?

_____

8. What are dehydrogenases? _____

_____

What is their role in cellular respiration? _____

_____

9. Indicate if each of the following characteristics / descriptions is true of **S**ubstrate-level and **O**xidative phosphorylation.

_____ Produce ATP by adding a phosphate to ADP

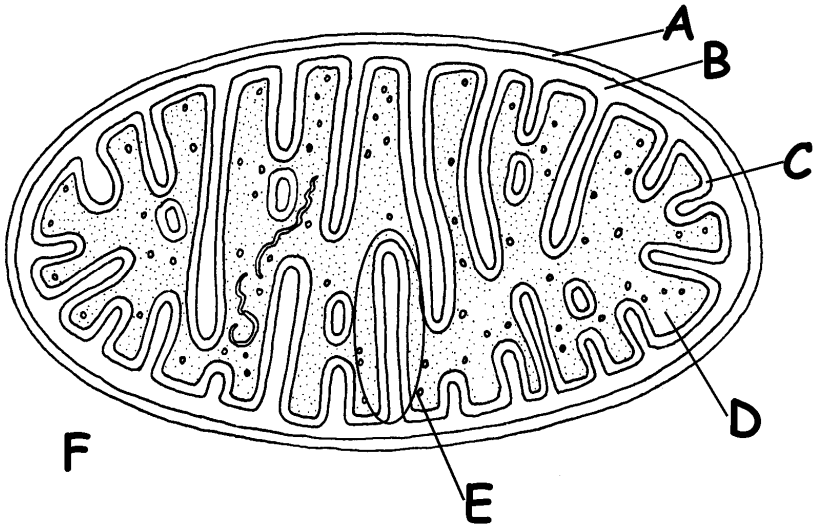
_____ Involves the direct transfer of a phosphate from an intermediate to ADP

_____ Couples the addition of a phosphate to ADP with the exergonic slide of electrons down the electron transport chain

_____ Oxygen used as the terminal electron acceptor

_____ Accounts for 90% of ATP production in aerobic respiration

10. Use the diagram below to answer the questions that follow:



_____ Outer membrane

_____ Inner membrane

_____ Cytoplasm

_____ Matrix

_____ Intermembrane space

_____ Crista

_____ Site of glycolysis

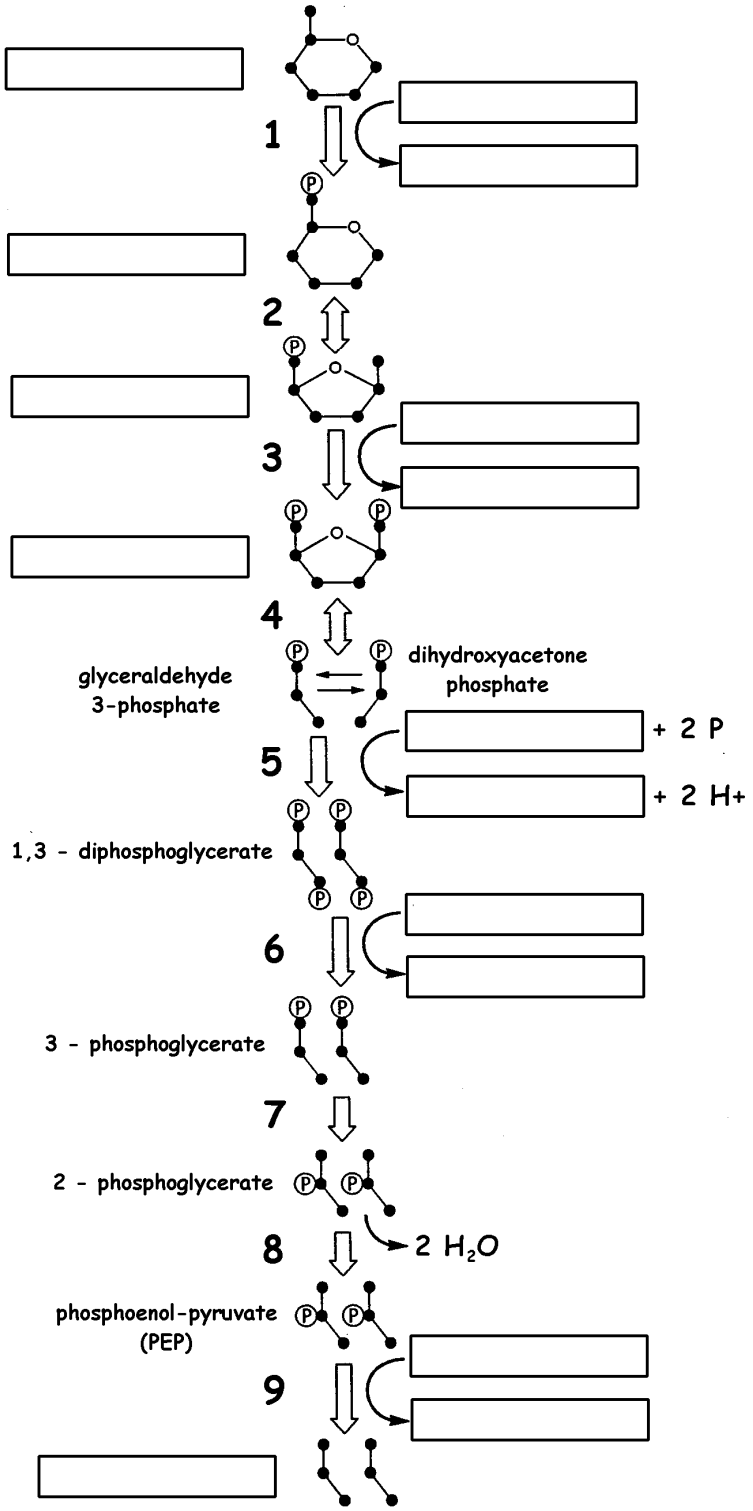
_____ Site of Krebs cycle

_____ Location of electron transport chain

_____ High $[H^+]$

_____ Location of ATP synthase molecules

11. Fill in the missing labels on the diagram below.



12. Use the diagram in Question 11 to answer the following questions.

a. What process is occurring in the diagram?_____

b. Which step(s) show the transfer of a P (phosphate) from ATP to an intermediate?_____

c. Which step shows a reduction reaction?_____

d. Which steps are included in the energy-investment phase?

_____

e. Which steps are included in the energy-yielding phase?

_____

f. Which step shows the splitting of a 6-C compound into two 3-C compounds?_____

g. How many ATP molecules, per glucose, are used in this series of reactions?_____

h. How many NADH, per glucose, are produced?_____

i. How many ATP, per glucose, are produced?_____

13. Identify whether each of the following occurs during the energy-investment phase (**EI**) of glycolysis or the energy-yielding phase (**EY**).

_____ 2 glyceraldehyde phosphates are oxidized

_____ 2 NAD+ are reduced to 2 NADH

_____ Substrate-level phosphorylation occurs

_____ 4 ADP + 4P → 4 ATP

_____ 2 ATP molecules are used

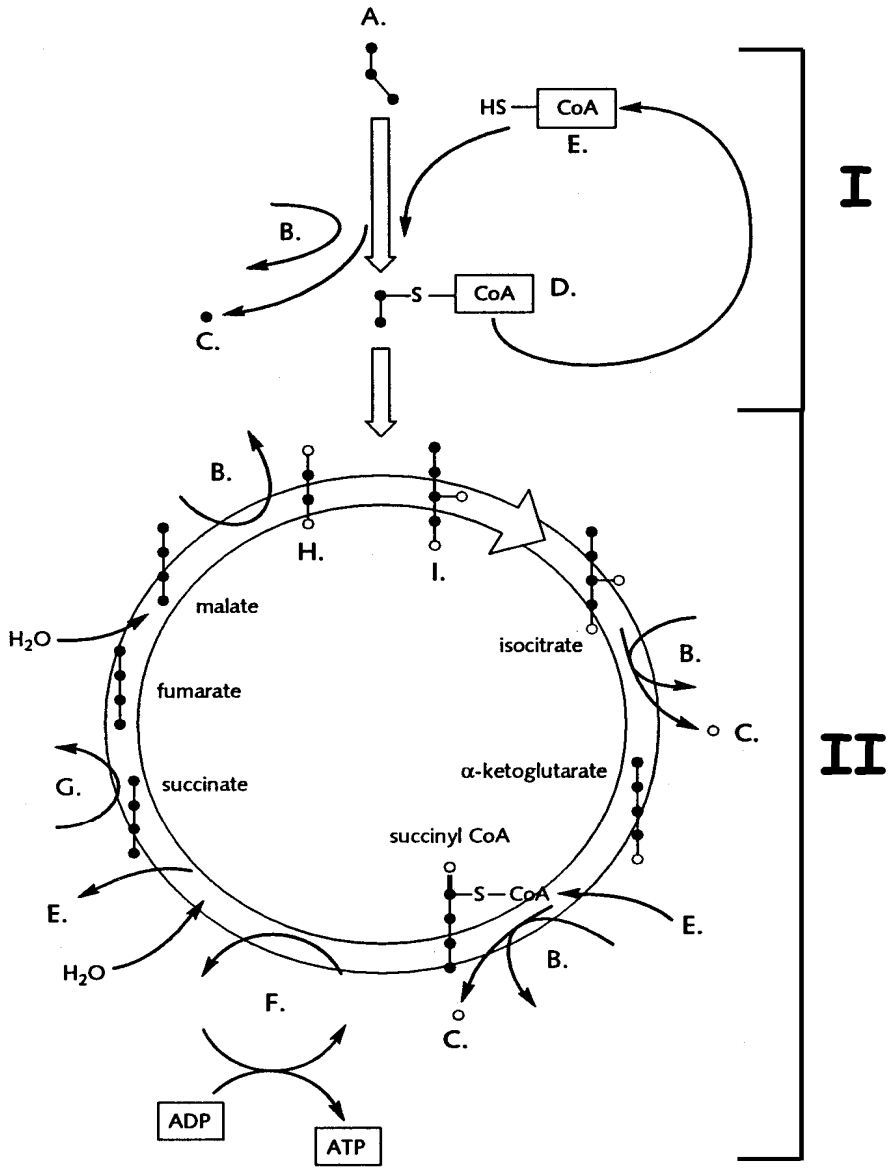
_____ Glucose & intermediate compounds are phosphorylated

_____ Fructose 1,6-diphosphate split into two 3-C compounds

14. List the reactants and products of glycolysis.

Reactants	Products

15. Use the diagram below to answer the questions that follow:



a. Identify the molecule represented by each of the following letters in the diagram.

A		**F**	
B		**G**	
C		**H**	
D		**I**	
E			

b. What process is occurring in the series of reactions labeled I?

_____

Where do these reactions occur within the cell (be specific)?

_____

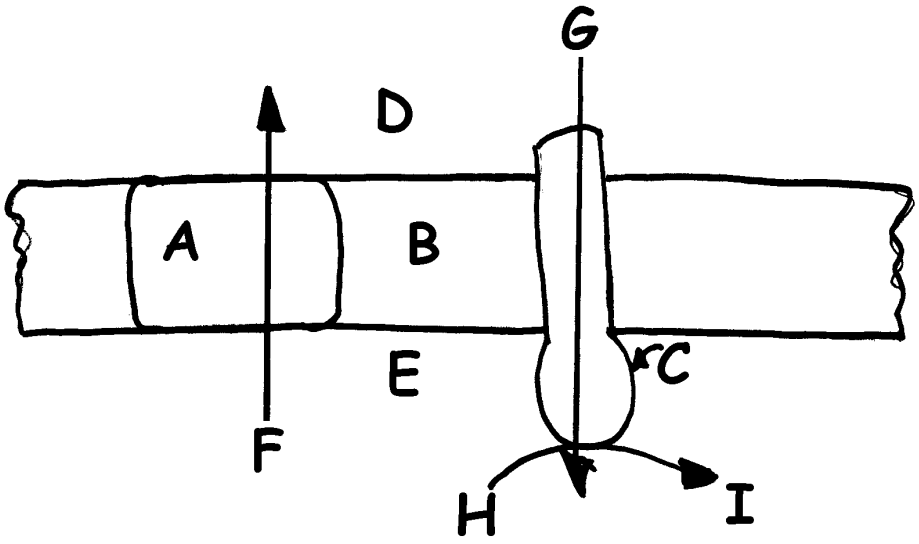
c. Complete the following chart by providing the number of each molecule produced per glucose molecule.

Molecule	**# Produced per glucose**	**Molecule**	**# Produced per glucose**
NADH		**ATP**	
CO_2		**$FADH_2$**	

16. What are the reactants and products of the Krebs cycle?

Reactants	Products

17. Use the diagram below to answer the questions that follow.



a. Identify the molecules/parts represented by each letter in the diagram.

A		**G**	
B		**H**	
C		**I**	
F			

b. Where is this structure located within the cell (be specific)?

_____

c. Which letter represents:

High H+ concentration? _____

Low H+ concentration? _____

Mitochondria matrix? _____

Inner membrane? _____

Intermembrane space? _____

d. Describe what is happening in this diagram.

_____

_____

_____

_____

18. Put the following steps in the correct order. (Use Figure 9-13 p. 158 for help.)

_____ Water forms

_____ NADH oxidized

_____ Flavoprotein oxidized

_____ Fe-S protein oxidized

_____ Flavoprotein reduced

_____ Fe-S protein reduced

_____ Ubiquinone reduced

_____ Oxygen reduced

_____ cyt a_3 passes electrons to oxygen

_____ Ubiquinone passes electrons to cytochromes

_____ Reduced oxygen picks up 2 H+

19. As electrons are transported through the electron transport chain to oxygen, they lose potential energy. This energy is used to do what work?

_____

20. The electrons from 1 NADH results in the production of 3 ATP molecules while the electrons from 1 $FADH_2$ results in the production of 2 ATP molecules. Why is there a difference?

_____

_____

21. Each NADH generated during glycolysis results in the production of 2ATP molecules while each NADH generated during the Krebs cycle results in the production of 3 ATP molecules. Why is there a difference?

_____

_____

22. What are the reactants and products of electron transport & oxidative phosphorylation?

Reactants	Products

23. Account for the 36 ATP molecules produced from the complete oxidation of 1 glucose molecule.

_____

_____

_____

_____

_____

24. Some desert animals such as the kangaroo rat never have to drink water. Explain how kangaroo rats can obtain the water they need to survive from the dry seeds they eat.

_____

_____

25. How is aerobic respiration different from anaerobic respiration?

Aerobic Respiration	Anaerobic Respiration

26. Describe what happens during lactic acid fermentation.

_____

_____

_____

27. Describe what happens during alcohol fermentation.

_____

_____

_____

28. Define the following terms:

Strict Aerobes	
Strict Anaerobes	
Facultative Anaerobes	

29. Carbohydrates, fats, and proteins can all be used as fuel for cellular respiration. Trace the path of each of these food groups from the point of digestion in the intestines to where and in what form they enter cellular respiration.

Carbohydrates	
Fats	
Proteins	