Key

Practice Energy Unit Test

1. The fact that glycolysis has been observed in all species studied supports all the following conclusions, EXCEPT
A. glycolysis is a metabolic process fundamental to survival
B. glycolysis was present in a universal common ancestor
C. glycolysis is an efficient cellular process that removes most of the energy from glucose
D. all living species share a common ancestor

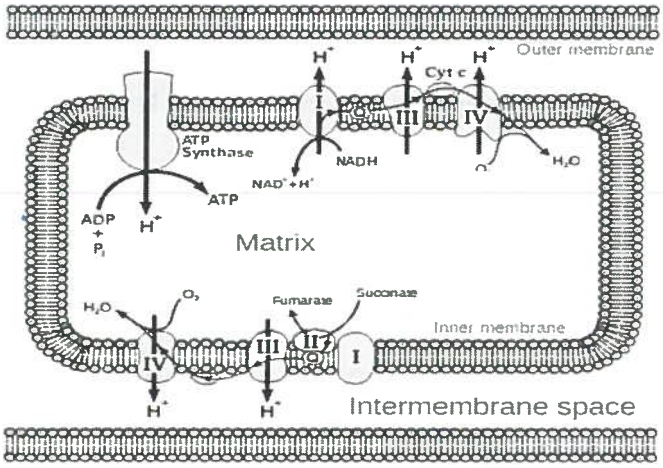
2-3. Some plant species have specialized processes for taking in carbon dioxide unlike those seen in "normal plants" or C3 plants. There are two main types of adaptations that vary slightly but have many overlapping features. In C4 plants, carbon dioxide is first reacted with a 3-carbon molecule forming a 4-carbon compound. This compound is then transported into a separate cell where carbon dioxide can then be released. Biologists believe this process arose as a method of avoiding photorespiration- a process that occurs in warm, oxygen rich environments. Tropical plants such as sugar cane exhibit this process. In photorespiration rubisco, the enzyme responsible for fixing carbon dioxide from the air reacts with oxygen instead, forming a hazardous byproduct instead of glucose sugar. A similar process is observed in CAM plants. However, in these plants carbon dioxide is fixed into the 4-carbon sugar during the night and then is released during the day instead of being released in a separate cell. This allows plant leaves to close their stomata during the day in hot, arid environments, thus minimizing water loss, and open their stomata at night.

2. Based on this information, which of the following is most reasonable to conclude?
A. CAM and C4 plants are more closely related to each other than to other C3 plants
B. CAM and C4 plants arose by polyploidy
C. CAM and C4 plants are the result of genetic drift
D. CAM and C4 plants are unrelated to other plants

3. Based on the information provide, CAM and C4 plants differ from C3 plants in the process of
A. cyclic electron flow B. the Krebs cycle C. the light reactions D. the Calvin cycle

4. The entropy of the Earth is not increasing, which appears to violate the 2nd law of thermodynamics. Which of the following allows order to form on Earth?
A. The fact that Earth is an isolated system
B. A large input of energy from the sun
C. Specialized mechanisms in living things to prevent entropy
D. Earth does violate the 2nd law of thermodynamics

5. The animal on the left requires more food per kg of body mass than the animal on the right because
A. they must generate a lot of heat to make up for heat loss
B. they are less efficient at cellular respiration than other animals
C. they more tightly regulate body temperature than do the animals on the right
D. they generally live in warmer climates and must prevent overheating



11. The diagram above represents

A. A chloroplast B. The cytosol C. A bacterial cell D. A mitochondrion

12. The process represented above can best be described as

A. Glycolysis B. The Krebs cycle C. Oxidative phosphorylation D. The light reactions

13. Hydrogen ions cannot travel directly through the membrane and require a carrier molecule, as shown in the diagram above, due to their

A. Size B. Charge C. Hydrophobic properties D. Affinity for lipids

14. The pH would be expected to be lowest

A. Inside the membrane B. In the matrix

C. In the intermembrane space C. Outside of the organelle

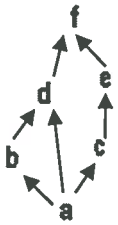
15. Which of the following best explains why aerobic cellular respiration produces more energy than anaerobic respiration?

A. Substrate level phosphorylation occurs during glycolysis

B. Allosteric enzymes affect the reaction rate

C. An initial input of energy is required in glycolysis

D. Glucose is oxidized completely to carbon dioxide and water in aerobic respiration



16. In the food web to the left, which population has the least amount of free energy?

A. a B. b or c C. d or e D. f

17. Which letter represents a species that requires carbon dioxide?

A. a B. b or c C. d or e D. f

18. All of the following suggest that glycolysis was present in an early universal common ancestor EXCEPT

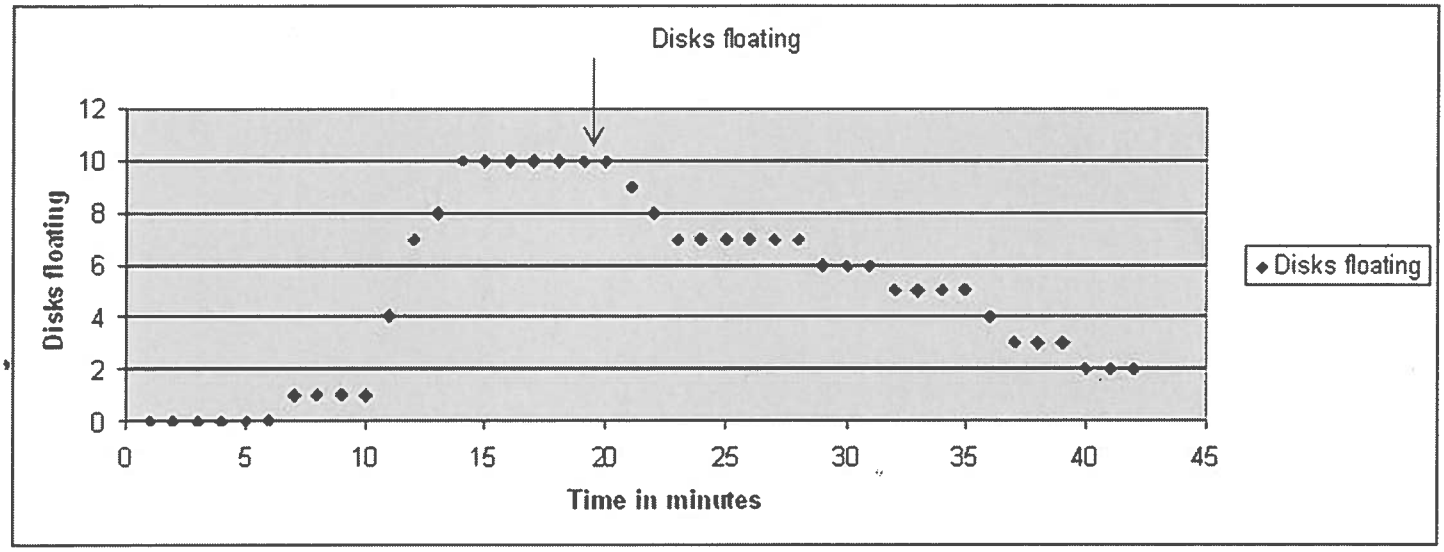
A. glycolysis is found in very different species that appear distantly related

B. glycolysis does not require a specialized organelle and can occur in prokaryotes

C. glycolysis produces the NADH and FADH2 necessary for oxidative phosphorylation

D. glycolysis occurs in the absence of oxygen and could have taken place before oxygen was present

An experiment was performed on spinach leaf disks that were vacuum-filled with a sodium bicarbonate solution and placed in a cup of bicarbonate solution under artificial light. The following graph was obtained:



24. From 0 to 15 minutes the leaf disks began to float. Which of the following best explains why they floated?

A. as oxygen was removed from the leaves fermentation began to occur

B. as photosynthesis occurred there was a buildup of oxygen gas in the leaves

C. as carbon dioxide was consumed the leaf disks had less mass

D. over time oxygen gas was consumed which pulled water into the leaf disks

25. Which of the following actions most plausibly occurred at the time indicated by the arrow?

A. More leaf disks were added to the cup

B. More bicarbonate was added to the cup

C. The artificial light was turned off

D. The enzymes in the leaf got so hot that they denatured

26. Which of the following best explains the amount of leaf disks floating between 20 and 40 minutes?

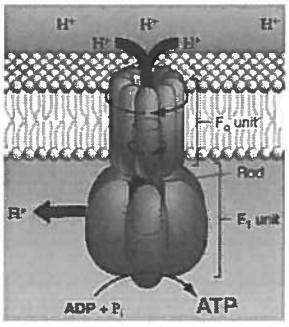
A. photosynthesis and cellular respiration were occurring at equal rates

B. the enzymes of the leaf disk were unable to catalyze any chemical reactions so the disks began to sink

C. there was an excess buildup of carbon dioxide gas

D. the disks began using the oxygen they had synthesized in aerobic cellular respiration

27. The diagram to the right represents



A. a method in which ATP is produced in both photosynthesis and aerobic respiration

B. a method in which small amounts of ATP are synthesized without the presence of oxygen

C. a universal energy releasing process that occurs in all living cells

D. a process that allows ions to be pumped against their concentration gradient

28. The purpose of fermentation is to

A. increase the amount of energy that can be drawn from a molecule of glucose

B. allow glycolysis to continue occurring in the absence of oxygen

C. generate NADH for further use in ATP production

D. provide necessary reactants for oxidative phosphorylation

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Question 4

In many ways, all organisms in a food web can be said to be solar-powered. The producer level of the food web is responsible for the transformation of the solar energy into a form that can be used by other living organisms.

(a) Discuss the role of green plants in transforming the Sun's energy into a form that can ultimately be used by heterotrophs. **(6 points maximum)**

Required (Student cannot earn the maximum of 6 points without earning these 3 points)

- Energy transformation (photosynthesis -> chemical energy/glucose/G3P/ PGAL/starch/carbohydrate/chemical bonds)
- Chlorophyll or chloroplast required ("green pigment" not credited)
- Function of chlorophyll—light/energy capture concept

Parts of photosynthesis (in context or with explanation) (3 points maximum)

- Photolysis (splitting of water)—oxygen and/or electrons released
- Chemiosmosis (or explanation)
- ATP production
- NADPH production/reduction
- Photosystems II and I in correct order
- Calvin Cycle
- CO_2 fixation
- Products of light-dependent reactions used in light-independent (dark) reactions

(b) Discuss the flow of energy from producers through top carnivores in a food web in terms of the laws of thermodynamics. **(6 points maximum)**

Required (Student cannot earn the maximum of 6 points without earning these 2 points)

- Statement/definition of 1st Law of Thermodynamics
- Statement/definition of 2nd Law of Thermodynamics (definitions must be correct, but students are not penalized for misnumbering the laws)

Concepts of energy flow (in context or with explanation) (4 points maximum)

- 10 percent rule/Not all energy transferred to next level/Very little energy transferred to next level/energy lost at each level
- Explanation of energy loss (e.g., used in metabolism, locomotion, etc.)
- Lost energy as heat/entropy/2nd law illustrated as heat loss or inefficiency
- Energy pyramid (explained)
- More energy at producer level than at consumer levels
- Scarcity of energy at higher trophic levels
- Limited number of consumer levels
- Very few top carnivores
- 1st law illustrated as conversion of solar energy to chemical energy or as conversion of chemical energy to chemical energy (e.g., Glucose to ATP)

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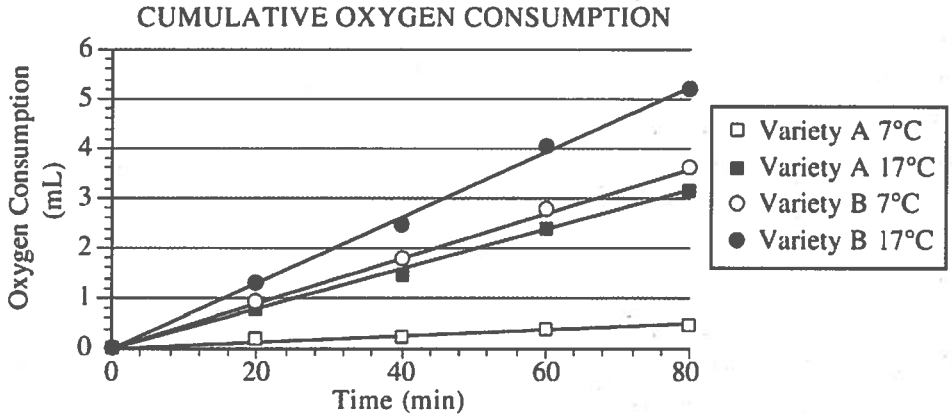
Question 2

An agricultural biologist was evaluating two newly developed varieties of wheat as potential crops. In an experiment, seedlings were germinated on moist paper towels at 20°C for 48 hours. Oxygen consumption of the two-day-old seedlings was measured at different temperatures. The data are shown in the graph below.



(a) **Calculate** the rates of oxygen consumption in mL/min for each variety of wheat at 7°C and at 17°C. **Show** your work (including your setup and calculation).
(3 points maximum)

- **1 point** for using the rate formula (D*y*/D*x*)
- **1 point** for using appropriate data to calculate the slope for at least three treatments
- **1 point** for giving answers in decimal format of mL/min

Note: Setup can choose <u>any</u> pair of points for the rise-over-run calculation of rate. The values used in the calculations can be greater or less than those shown in the examples below. Units of mL/min are implied by the question stem and need not be specifically shown.

Variety A at 7°C	(0.5 – 0 mL)/(80 – 0 min) = 0.0062 mL/min
Variety A at 17°C	(3.2 – 0 mL)/(80 – 0 min) = 0.040 mL/min
Variety B at 7°C	(3.6 – 0 mL)/(80 – 0 min) = 0.045 mL/min
Variety B at 17°C	(5.2 – 0 mL)/(80 – 0 min) = 0.065 mL/min

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Question 2 (continued)

(b) **Explain** the relationship between metabolism and oxygen consumption. **Discuss** the effect of temperature on metabolism for each variety of seedlings.
(4 points maximum)

Explanation of relationship (1 point)

- As metabolism increases, oxygen consumption increases.
  OR,
- As metabolism decreases, oxygen consumption decreases.

Discussion (1 point per bullet; 3 points maximum)

Interpretation of graph

- General statement that increasing temperature increases metabolic rate/oxygen consumption (no specific mention of variety A or B).
  OR,
- Variety A: rate of metabolism/oxygen consumption increases with an increase in temperature.
- Variety B: rate of metabolism/oxygen consumption increases with an increase in temperature.

Comparison of varieties

- Variety B has a higher metabolism/oxygen consumption than variety A at either temperature.
- Variety B has better metabolism/oxygen consumption at lower temperatures than variety A.

Elaboration of temperature

- Kinetic energy increases with temperature.
- Enzyme reaction rates increase with temperature.
- Effects on electron transport chain (ETC)/system.

(c) In a second experiment, variety A seedlings at both temperatures were treated with a chemical that prevents NADH from being oxidized to NAD^+. **Predict** the most likely effect of the chemical on metabolism and oxygen consumption of the treated seedlings. **Explain** your prediction.
(5 points maximum)

Prediction (1 point each; 2 points maximum)

- Metabolism/respiration stops/declines/decreases/slows down.
- Oxygen consumption stops/declines/decreases/slows down.

Explanation (1 point each; 3 points maximum)

- Glycolysis/Krebs cycle/ETC will stop.
- ATP levels will drop/decline/decrease.
- Oxygen cannot accept electrons from ETC.