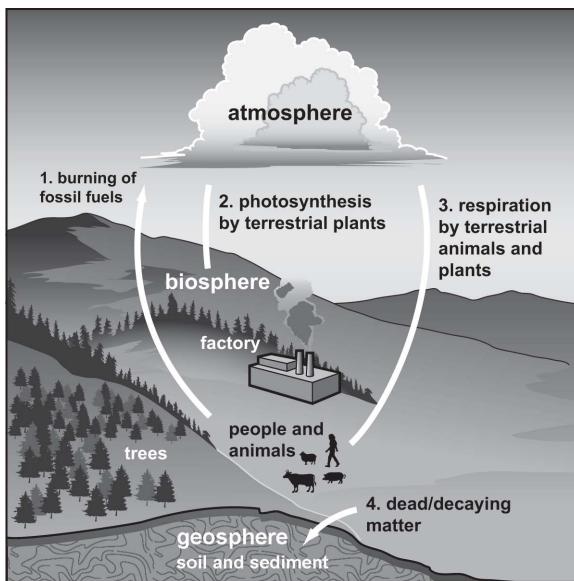


Unit Test: Matter and Energy in Living Systems

Read each question. Circle the letter of the correct answer.

1. Ocean ecosystems act as a carbon sink removing atmospheric carbon dioxide, which is dissolved in the seawater. Which biological process would then utilize this dissolved carbon dioxide?
 - A. photosynthesis by oceanic fish
 - B. photosynthesis by phytoplankton
 - C. aerobic respiration by marine mammals
 - D. anaerobic respiration by marine protozoa
2. Brenda ran a 5 km race. During the race, she began to breathe heavily, and some of her muscles began to burn. Which of these explains why Brenda felt a burning in her muscles during the race?
 - A. The cells did not have enough oxygen, so they used fermentation as a source of energy.
 - B. The cells did not have enough glucose, so they used fermentation as a source of energy.
 - C. The cells had too much glucose, so they used aerobic respiration as a source of energy.
 - D. The cells had too much carbon dioxide, so they used aerobic respiration as a source of energy.
3. Which best details the movement of energy through aerobic cellular respiration?
 - A. Heat energy is absorbed as chemical potential energy is transferred from oxygen molecules to ATP molecules.
 - B. Heat energy is released as chemical potential energy is transferred from oxygen molecules to ATP molecules.
 - C. Heat energy is released as chemical potential energy is transferred from glucose molecules to ATP molecules.
 - D. Heat energy is absorbed as chemical potential energy is transferred from ATP molecules to glucose molecules.
4. Alicia is developing a model of photosynthesis and respiration. Part of her model includes the inputs and outputs of each process. Which of these describes inputs and outputs of Alicia's model?
 - A. Water is an input for both respiration and for photosynthesis.
 - B. Oxygen is an output for both respiration and for photosynthesis.
 - C. Glucose is an input for respiration and an output for photosynthesis.
 - D. Carbon dioxide is an input for respiration and an output for photosynthesis.
5. *Gracilaria verrucosa* is a type of algae that can live in a salt marsh, which is sometimes covered by ocean water, or in a subtidal habitat, which is usually covered by ocean water. It was discovered that the *G. verrucosa* living in the subtidal habitat had a photosynthetic rate 5 to 10 times higher than the same species living in the salt marsh habitat. Which statement best explains this difference?
 - A. There is more oxygen available in the subtidal habitat.
 - B. There is more carbon dioxide available in the salt marsh habitat.
 - C. The *G. verrucosa* in the subtidal habitat contains more chlorophyll.
 - D. The *G. verrucosa* in the salt marsh habitat contains more mitochondria.

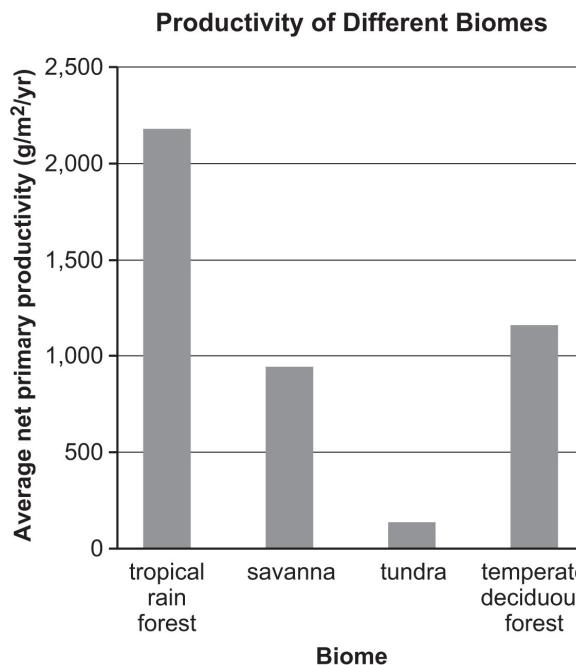
6. This incomplete diagram shows carbon cycling through the atmosphere, biosphere, and geosphere.



How should the diagram be completed in order to demonstrate the flow of carbon in the system?

- A. Arrow 2 should point toward the biosphere, and arrow 3 should point toward the atmosphere.
- B. Arrow 2 should point toward the atmosphere, and arrow 3 should point toward the atmosphere.
- C. Arrow 2 should point toward the biosphere, and arrow 3 should point toward people and animals.
- D. Arrow 2 should point toward the atmosphere, and arrow 3 should point toward people and animals.

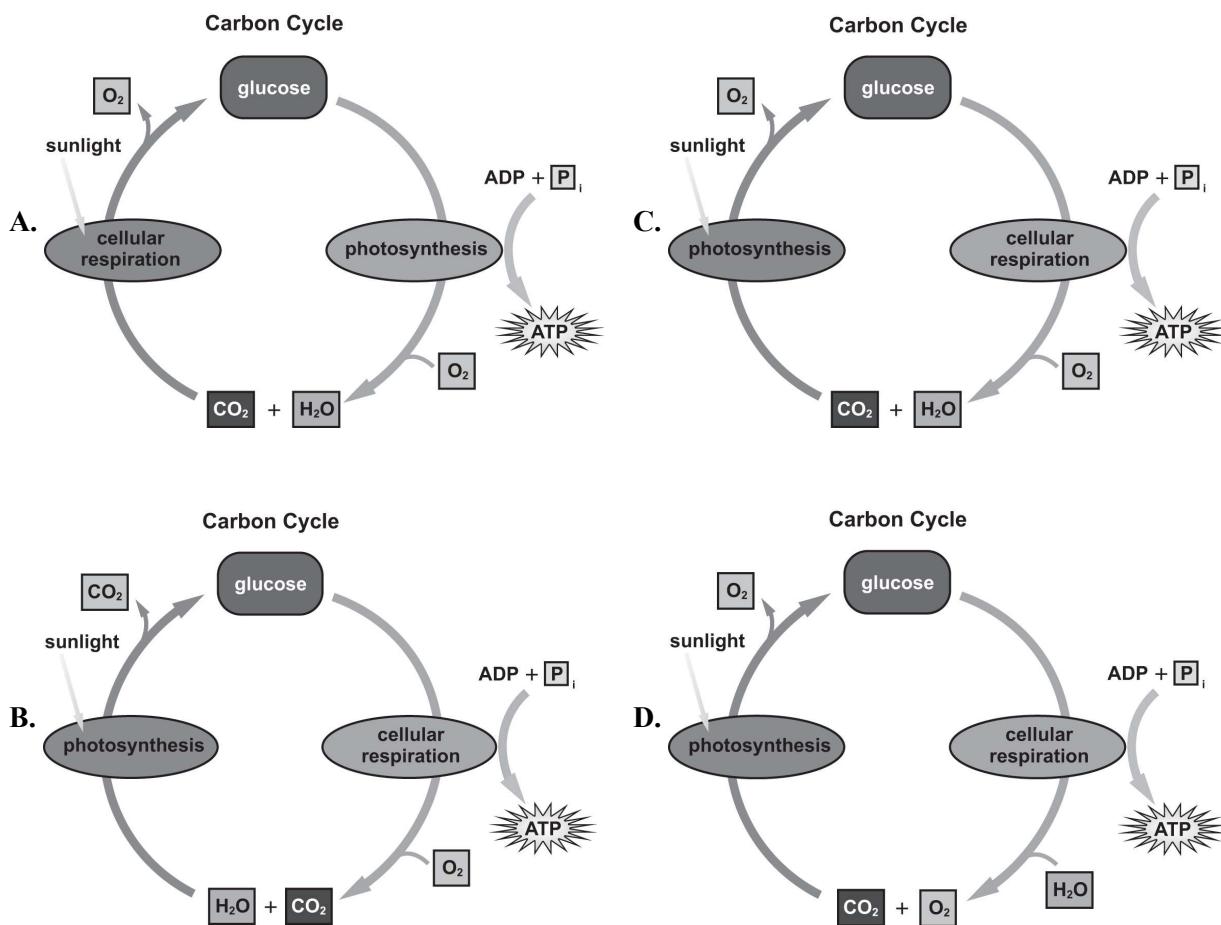
7. The primary productivity of an ecosystem is defined by the rate at which the producers in the ecosystem can convert inorganic substances to organic substances in the form of biomass. The graph shows the primary productivity of four different biomes in grams per square meter per year ($\text{g/m}^2/\text{y}$).



Which statement explains the data presented in the graph?

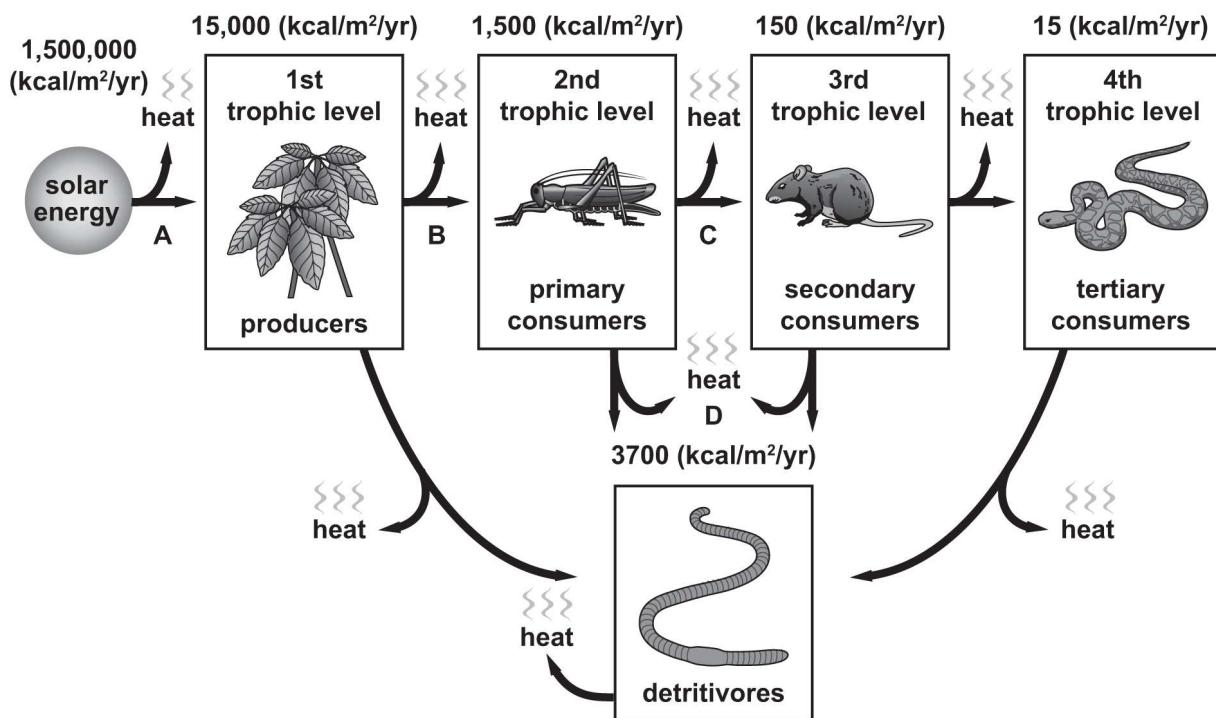
- A. There is more assimilation occurring in the tropical rainforest than in the savanna.
- B. There is more denitrification occurring in the tundra than in the tropical rainforest.
- C. There is more assimilation occurring in the savanna than in the temperate deciduous forest.
- D. There is more denitrification occurring in the temperate deciduous forest than in the savanna.

8. Which diagram shows the relationship between the reactants and products of photosynthesis and cellular respiration?



9. The model shows the one-way flow of energy through a series of trophic levels in the food chain.

A Food Chain



Which mathematical relationship best describes the trends shown in the model?

- A. energy at lower trophic level = $0.1 \times$ energy at next trophic level
- B. energy at lower trophic level = $0.15 \times$ energy at next trophic level
- C. energy at lower trophic level = $10 \times$ energy at next trophic level
- D. energy at lower trophic level = $15 \times$ energy at next trophic level

Read each question. Follow the instructions to answer the questions.

10. Write the letter of the words in the correct box to show whether it is an input or an output of glycolysis. Some letters may be used more than once or not at all.

Input of glycolysis	Output of glycolysis

A. energy
B. oxygen
C. 3-carbon sugar
D. 6-carbon sugar

- 11.** A scientist is studying how certain human activities affect the phosphorous cycle. One of those activities is the use of fertilizer, which contains phosphorous. This phosphorous can end up in a watershed through the process of runoff. Write one letter in each blank to correctly complete the sentences.

Since phosphorous is a limiting factor in aquatic ecosystems, the direct result of excess phosphorous in the watershed is an increase in the amount of **1.** _____ in the habitat. When these organisms eventually die, decomposers break down the carbon-based molecules in their bodies through the process of **2.** _____. This process removes a large amount of the **3.** _____ from the water, which leads to the deaths of other aquatic organisms.

1. A. producers B. herbivores C. carnivores D. scavengers	2. E. nitrification F. decomposition G. photosynthesis H. nitrogen fixation	3. I. oxygen J. nitrogen K. phosphorous L. carbon dioxide
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- 12.** The area where the Mississippi River empties into the Gulf of Mexico contains little to no oxygen. This is caused by an excess of nutrients, including nitrogen, from various sources, such as agricultural runoff. Which activities could a farmer in this region do to help decrease the amount of nitrogen added into the Mississippi River? Write each letter in the box beneath the correct heading.

Decreases nitrogen amounts	Increases nitrogen amounts	
		A. adding manure to the soil B. planting corn in a nitrogen-rich field C. adding nitrogen gas-releasing bacteria to the soil D. adding commercial fertilizer to the soil

- 13.** Write one X for each activity to show whether the activity would add carbon to or remove carbon from the atmosphere.

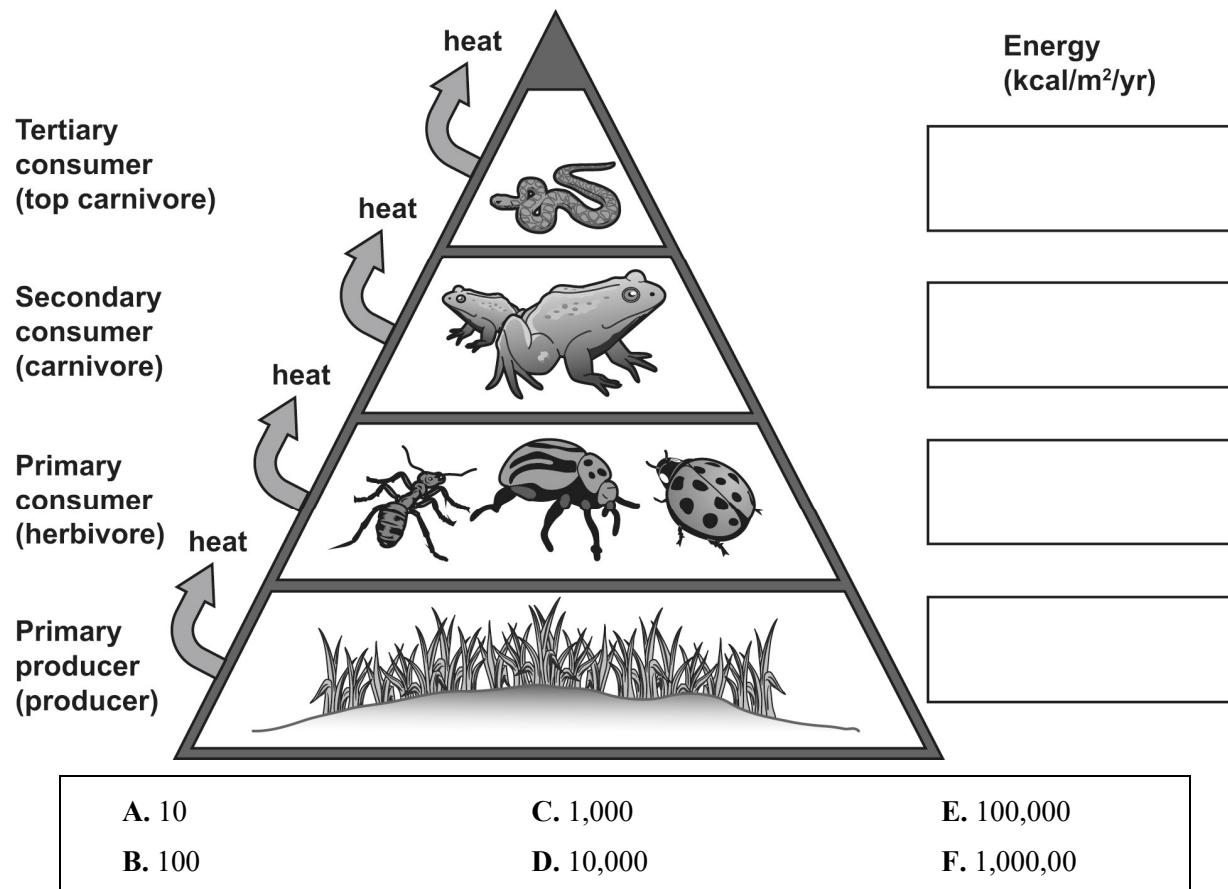
Activity	Adds carbon to the atmosphere	Removes carbon from atmosphere
A. a dead tree decomposing		
B. a factory burning fossil fuels		
C. a bush undergoing photosynthesis		
D. a caterpillar undergoing respiration		

- 14.** A student is making a model of the inputs and outputs of cell respiration. Write one letter in each blank to correctly complete the passage about changes in matter and energy during the process of cellular respiration.

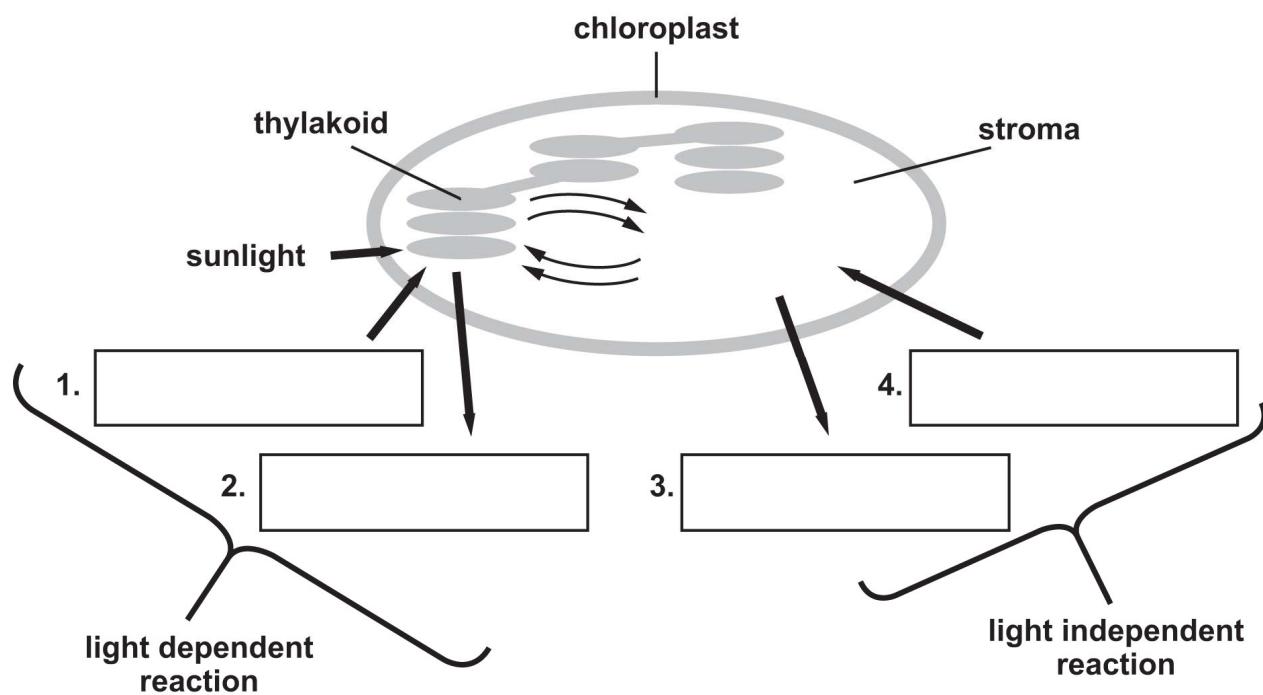
The inputs of cellular respiration are glucose and 1. _____, and bonds in these molecules are broken. The outputs of cellular respiration are 2. _____ and water, and new bonds are formed in these molecules. The energy stored in one molecule of glucose leads to many molecules of 3. _____. In the process of cellular respiration, energy is 4. _____.

1. and 3.	2.	4.
A. ATP B. oxygen C. carbon dioxide	D. oxygen E. glucose F. carbon dioxide	G. created H. destroyed I. conserved

- 15.** The energy pyramid model shows the movement of energy in an ecosystem. In this ecosystem, the primary consumers have available to them about 10,000 kilocalories per square meter per year ($\text{kcal/m}^2/\text{yr}$) from plants. About 10% of the energy at each trophic level is passed on to the next level. How much energy is available at each trophic level? Write the letter of the energy values in the correct boxes in the energy pyramid.



16. The process of photosynthesis includes multiple steps. Write one letter in each box in the diagram to create a model of the process of photosynthesis.



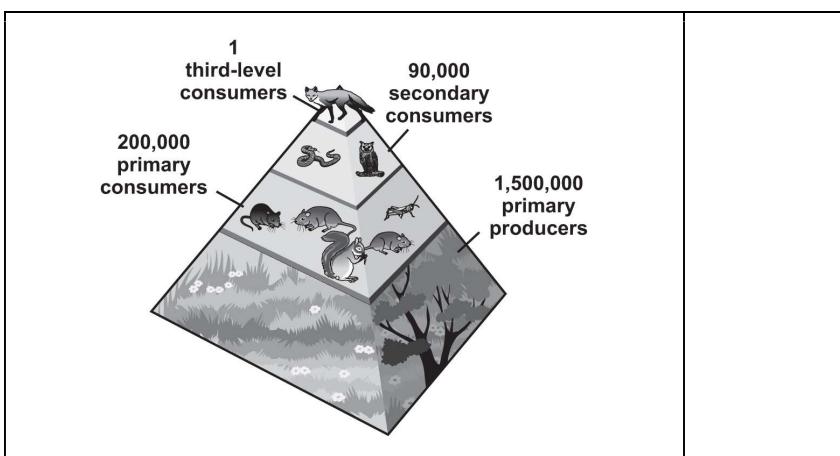
A. oxygen

B. carbon dioxide

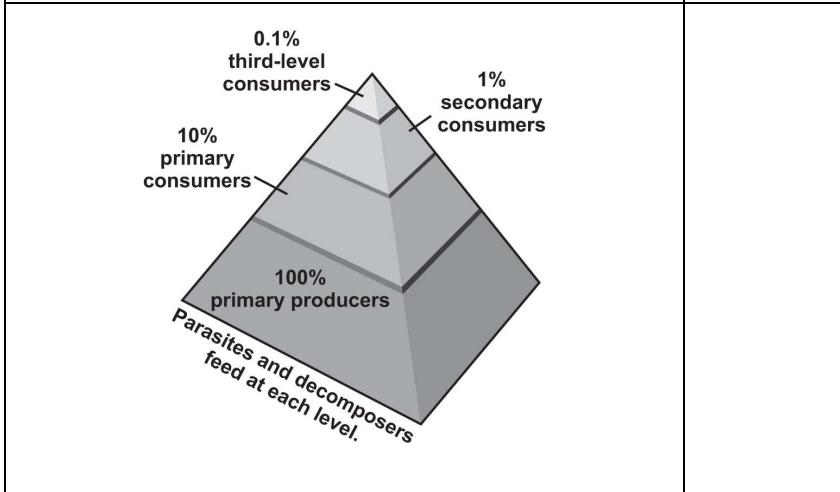
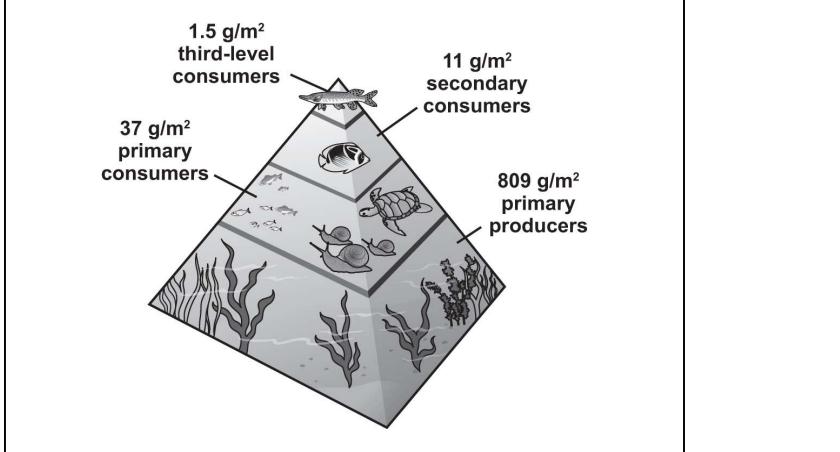
C. water

D. sugar

17. There are three major types of ecological pyramid models used for illustrating matter and energy transfer among organisms in an ecosystem. Write the letter of the terms to correctly label each type of ecological pyramid.



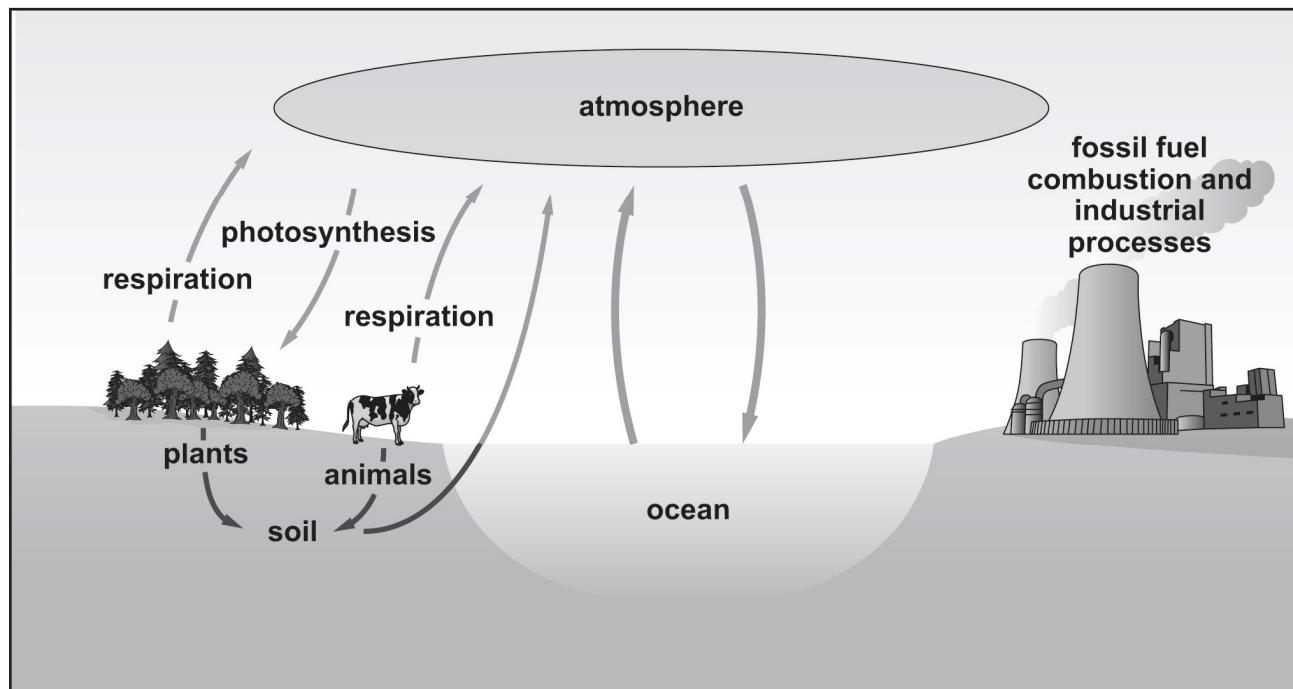
- A.** models energy transfer among trophic levels
- B.** compares the biomass at different trophic levels
- C.** shows how many organisms are present at each trophic level



Read each statement. Write your answer on the lines.

18. The model shows how carbon is cycled among Earth's biosphere, atmosphere, hydrosphere, and geosphere.

The Carbon Cycle



Climate predictions and forecasts depend on accurate carbon cycle models.

Describe the important role of producers in the cycling of carbon as represented in the model.

Explain why understanding the carbon cycle is useful in understanding climate change.

19. Hans Krebs set out to discover the intermediate steps in the aerobic portion of respiration by adding certain four-carbon compounds to cells in his laboratory. He hypothesized that if they were a part of the process, adding them to cells would cause respiration to increase. Krebs's results are shown in the table.

**Results of Compounds on
Oxygen Consumption**

Compound added	Oxygen consumed (μ mole)
none	650
fumarate	1,300
malate	1,350
succinate	1,500

Krebs concluded that the substances he added to the cells were a part of respiration.

Use the data in the table to justify his conclusion.

Krebs was surprised to find the substances added were not completely consumed but remained in his reaction vessel at the end of the experiment.

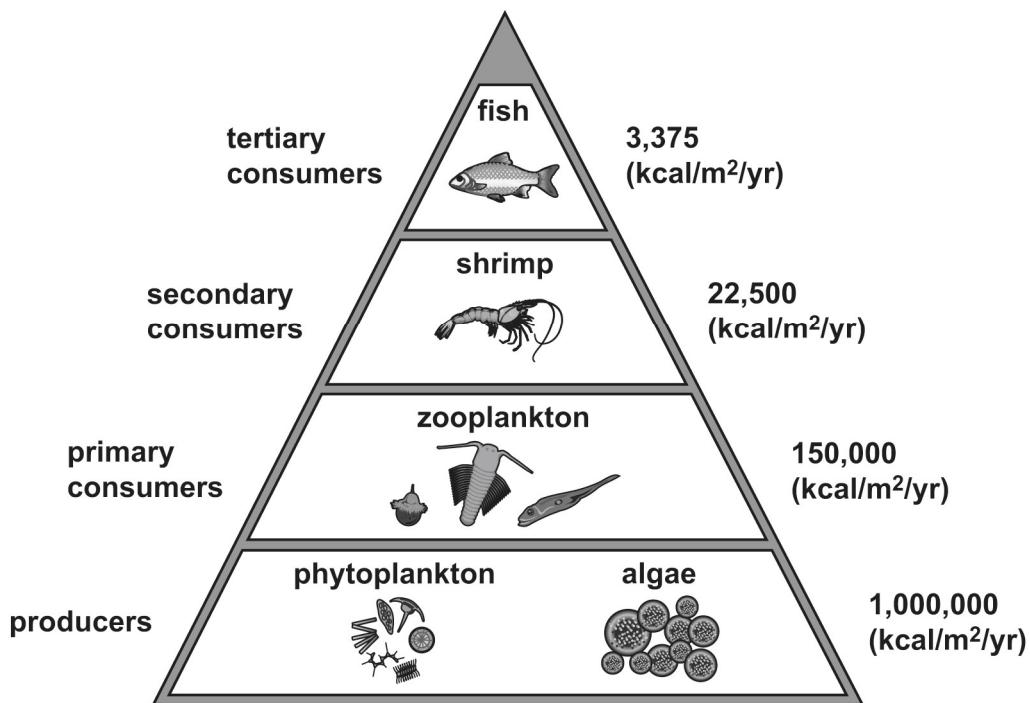
Identify a process that could explain these results.

The mechanism by which cells make large amounts of energy was not discovered until three decades later.

Describe what happens in respiration after the Krebs process and the role oxygen plays.

20. The energy pyramid shows how much energy is stored at each trophic level in an aquatic ecosystem.

Energy Pyramid of an Aquatic Ecosystem



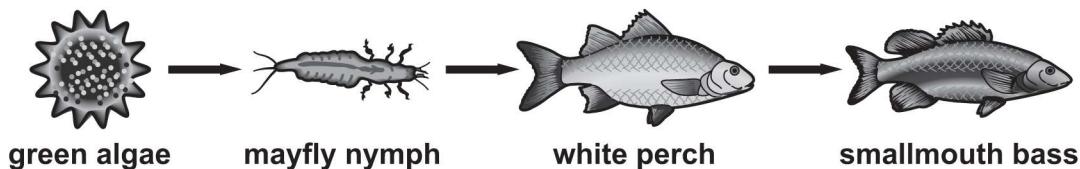
Explain how matter and energy are transferred from one trophic level to another, using producers, primary consumers, and secondary consumers as an example.

Explain how to calculate the energy transfer efficiency based on the energy data in the model.

Predict what might happen if primary production is significantly reduced.

- 21.** Lake Erie is a freshwater lake located in the Great Lakes region that borders Michigan, Ohio, Pennsylvania, and New York. The food chain shows an example of some of the relationships within this ecosystem.

Great Lakes Food Chain



Describe how carbon enters and exits this specific food chain.

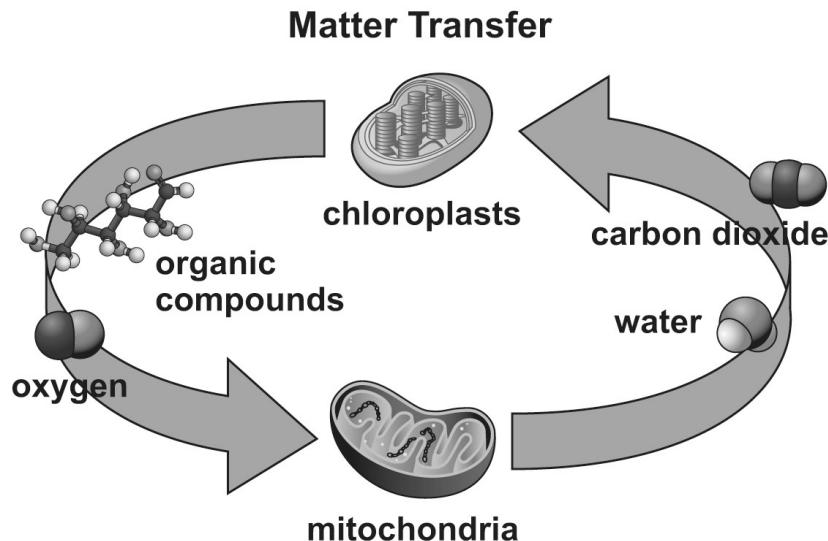
In the 1950s, Lake Erie experienced very low levels of oxygen, which resulted in the disappearance of mayflies from the ecosystem.

Predict how this would alter the flow of carbon in the food chain.

Directions: Read the passage, then answer the questions that follow.

Respiration and the Movement of Matter

A scientist is researching the role that respiration plays in the movement of matter in ecosystems. She has developed the model shown here to illustrate the transfer of matter.



22. The scientist is conducting an experiment on cellular respiration in which she supplies a cell culture with radioactively labeled oxygen gas. After a period of time, she samples the culture. Which of these molecules will contain the radioactive oxygen atoms? Circle the letter of the correct answer.

- A.** ATP
- B.** water
- C.** carbon dioxide
- D.** organic compounds

23. The scientist is studying the processes for which cellular respiration provides work, such as the contraction of muscles. Number the processes from 1 to 5 to show how respiration provides energy to a muscle fiber for contraction to take place. Number 1 should be the first step, and number 5 should be the last step.

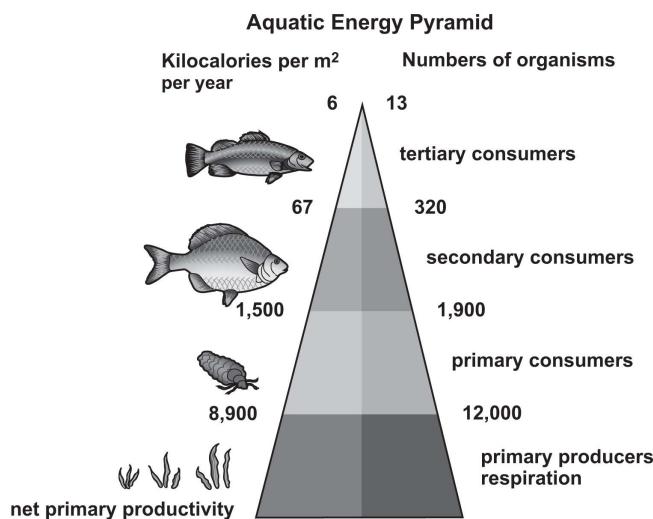
- _____ The energy in ATP is used to make muscle cells contract.
- _____ Glucose molecules are broken down into smaller sugars.
- _____ The electron transport chain is used to produce ATP.
- _____ Energy is captured during the Krebs cycle.
- _____ Glucose molecules in the bloodstream are absorbed by a muscle cell.

- 24.** The scientist places a small organism into a sealed container and the organism is allowed to undergo respiration for a one-hour period. The container holds water, oxygen, carbon dioxide, and nitrogen gas. The scientist measures the amount of each substance in the container both before and after the one-hour period. Write a letter to each substance in the correct box to show whether it would be expected to increase, decrease, or remain the same as a result of respiration.

Increase	Decrease	Remain the same

- A. water
B. oxygen
C. nitrogen gas
D. carbon dioxide

- 25.** As part of her studies, the scientist is researching the ways that respiration and photosynthesis provide the energy for an ecosystem. The diagram illustrates how matter and energy move through an aquatic ecosystem.



Write your answer on the lines.

Explain the apparent loss of matter and energy during photosynthesis and respiration that results in the shape of the energy pyramid.
