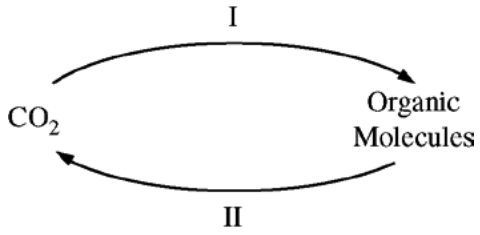
AP® BIOLOGY
2013 SCORING GUIDELINES

Question 4

Matter continuously cycles through an ecosystem. A simplified carbon cycle is depicted below.



(a) **Identify** the key metabolic process for step I and the key metabolic process for step II and briefly **explain** how each process promotes movement of carbon through the cycle. For each process, your explanation should focus on the role of energy in the movement of carbon.

Identification: **1 point maximum**

I = photosynthesis / Calvin cycle AND II = (cellular) respiration / citric acid cycle / Krebs cycle

Explanation: **1 point each row; 2 points maximum**

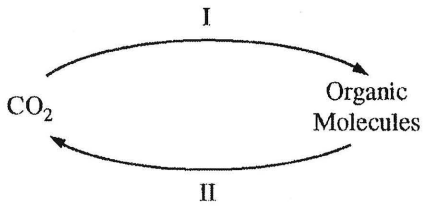
Process	Carbon Input	Role of Energy in the Movement of Carbon	Carbon Output
Photosynthesis	CO_2 is fixed	Uses (light) energy OR ATP from light reactions	Organic molecules
(Cellular) Respiration	Organic molecules are hydrolyzed / broken down	Uses energy for cellular processes such as growth and /or ATP production	CO_2

(b) **Identify** an organism that carries out both processes. **(1 point maximum)**

- Plant
- Algae
- Photosynthetic protist (e.g., Euglena)
- Cyanobacterium
- CO_2 fixing bacterium
- Lichen (not fungus)

4A1

4. Matter continuously cycles through an ecosystem. A simplified carbon cycle is depicted below.



(a) **Identify** the key metabolic process for step I and the key metabolic process for step II, and briefly **explain** how each process promotes movement of carbon through the cycle. For each process, your explanation should focus on the role of energy in the movement of carbon.

(b) **Identify** an organism that carries out both processes.

ANSWER PAGE FOR QUESTION 4

a) Step I is photosynthesis. During photosynthesis, the energy of the sun is used to excite electrons. The movement of these e^- releases this energy, which is then utilized to convert CO_2 into $C_6H_{12}O_6$ (glucose) and other organic molecules which store the energy. In this way, C is moved from CO_2 to organic molecules.

Step II is cellular respiration, in which organic molecules (glucose) are broken down to release energy, which is used to form ATP. CO_2 is a waste product released as a result of the breakdown of $C_6H_{12}O_6$. In this way, C moves from $C_6H_{12}O_6$ to CO_2 again.

b) A plant (such as a pine tree) exhibits both processes described above.

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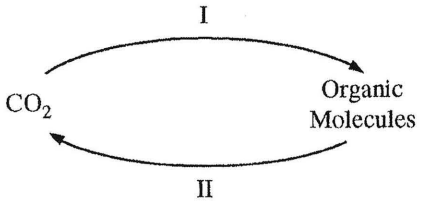

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(b) **Identify** an organism that carries out both processes.

ANSWER PAGE FOR QUESTION 4

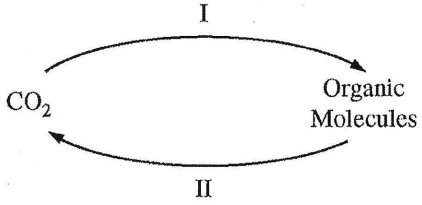
a) The key process for step I would be photo synthesis or the making of organic molecules. The key process for step II would be cellular respiration. In photo synthesis carbon is used to store energy in carbon chains. these chains can be used by many other organisms. In cellular respiration these chains are broken down by mitochondria to release ATP into the organism and CO_2 is released into the atmosphere.

b) One organism that does this is algea. most plants go through photosynthesis during the day and cellular respiration at night.

GO ON TO THE NEXT PAGE.

4C1

4. Matter continuously cycles through an ecosystem. A simplified carbon cycle is depicted below.



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(b) **Identify** an organism that carries out both processes.

ANSWER PAGE FOR QUESTION 4

A: When moving from CO_2 to organic molecules like glucose, the process is generally called photosynthesis. In the steps of photosynthesis, carbon is moved around with the end goal of producing Oxygen (O_2), ~~water (H_2O)~~ glucose ($C_6H_{12}O_6$) & energy in the form of ATP & NADPH. This usually occurs in autotrophs like plants. Heterotrophs, however, continue the cycle through cellular respiration, which converts glucose & oxygen into CO_2, H_2O, & energy. Here, the carbon is broken down into pyruvates & put back together, all for the end goal of producing ATP, or energy.

B: It's possible that a deep-sea organism or something of that kind performs both tasks,

GO ON TO THE NEXT PAGE.

AP® BIOLOGY
2013 SCORING COMMENTARY

Question 4

Question 4 was written to the following Learning Objectives in the AP Biology Curriculum Framework: 1.15, 2.5, 2.9, 4.6, and 4.15.

Overview

Question 4 asks students to use representations and models to explain how energy and matter move through ecosystems. Students were asked to identify the key metabolic processes (photosynthesis and cellular respiration) depicted in a visual representation of a carbon cycle and to explain the role of energy in both processes. Students were also asked to identify an organism that carries out both processes. Students could identify the organism by connecting concepts about energy flow with their general knowledge about organisms in different domains.

Sample: 4A
Score: 4

The response earned 1 point in part (a) for identifying step I as photosynthesis and step II as cellular respiration.

The response earned 1 point in part (a) for explaining that the process of photosynthesis uses the energy of the sun to convert CO_2 into glucose.

The response earned 1 point in part (a) for explaining that the process of cellular respiration breaks down organic molecules to release energy and CO_2.

The response earned 1 point in part (b) for identifying a plant as an organism that exhibits both processes.

Sample: 4B
Score: 3

The response earned 1 point in part (a) for identifying step I as photosynthesis and step II as cellular respiration.

The response earned 1 point in part (a) for explaining that cellular respiration breaks down carbon chains to release ATP and CO_2.

The response earned 1 point in part (b) for identifying "algea [*sic*]" as an organism that carries out both processes.

Sample: 4C
Score: 2

The response earned 1 point in part (a) for identifying the step from CO_2 to organic molecules as photosynthesis and the step from organic molecules to CO_2 as cellular respiration.

The response earned 1 point for in part (a) for explaining that cellular respiration converts glucose into CO_2 and energy to produce ATP.