

Biochemists are scientists who study the type of chemical compounds that are found in living things. They study the interaction of these compounds in an attempt to understand how life works at the chemical level. The work of biochemists has led to the realization that living organisms are composed of some of the same elements that are found in the air, water and soil.

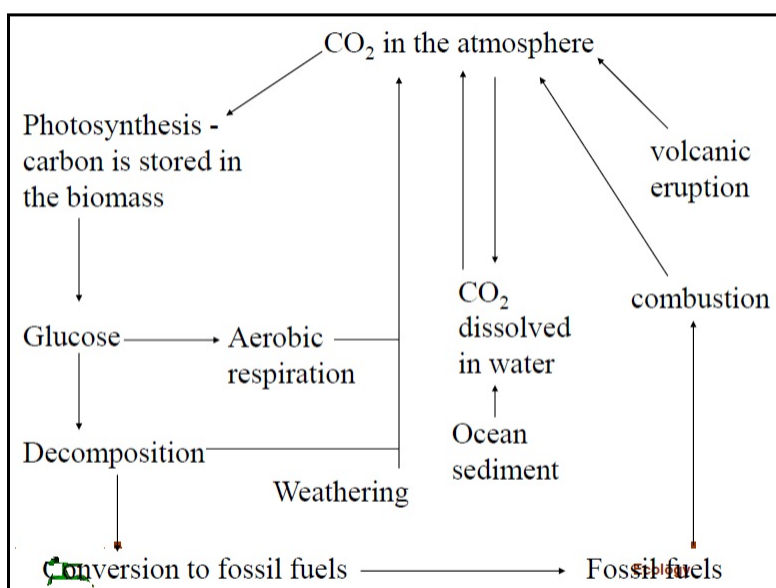
Inorganic nutrients such as Carbon, Nitrogen and Oxygen, are recycled continually through ecosystems.

1) Carbon Cycle

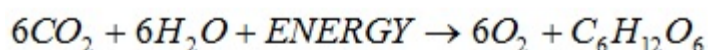
In the carbon cycle we use CO₂ from both biotic and abiotic sources:

Biotic: aerobic respiration (in the presence of O₂), and decomposition.
Here, the organic reservoirs (storage areas) for carbon are the bodies of living things.

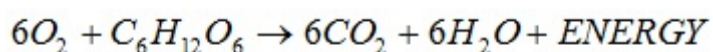
Abiotic: combustion and geological activity
Here, the inorganic reservoirs for carbon are the atmosphere, the oceans, and the Earth's crust.



Plants extract carbon dioxide and water from their environment. They use the energy they capture from the sun to carry on a process known as **photosynthesis** which converts the atoms in the carbon dioxide and water into sugar and oxygen



The oxygen, released as a byproduct of photosynthesis, generally passes into the atmosphere. The sugar (known as glucose) serves a food for all consumers in the ecosystem. The consumers carry on a metabolic process known as **cellular respiration**. During cellular respiration, oxygen is taken in from the atmosphere and used to break down the sugar resulting in a release of energy and the molecular products, carbon dioxide and water.



As you can see from the equations, photosynthesis and cellular respiration are complementary processes. Provided these processes occur in balance, the amount of carbon dioxide and oxygen are maintained in equilibrium. This balance is called the carbon-hydrogen-oxygen cycle (or simply carbon cycle for short).

As a result of human activity (cutting trees, using fossil fuels..etc) the amount of carbon dioxide is being produced at a faster rate than nature can recycle it. As a result of this imbalance, the amount of carbon dioxide in the atmosphere is increasing. As a result the earth is presently undergoing an enhanced **greenhouse effect** in which the atmosphere is gradually heating up.

Activity 1:

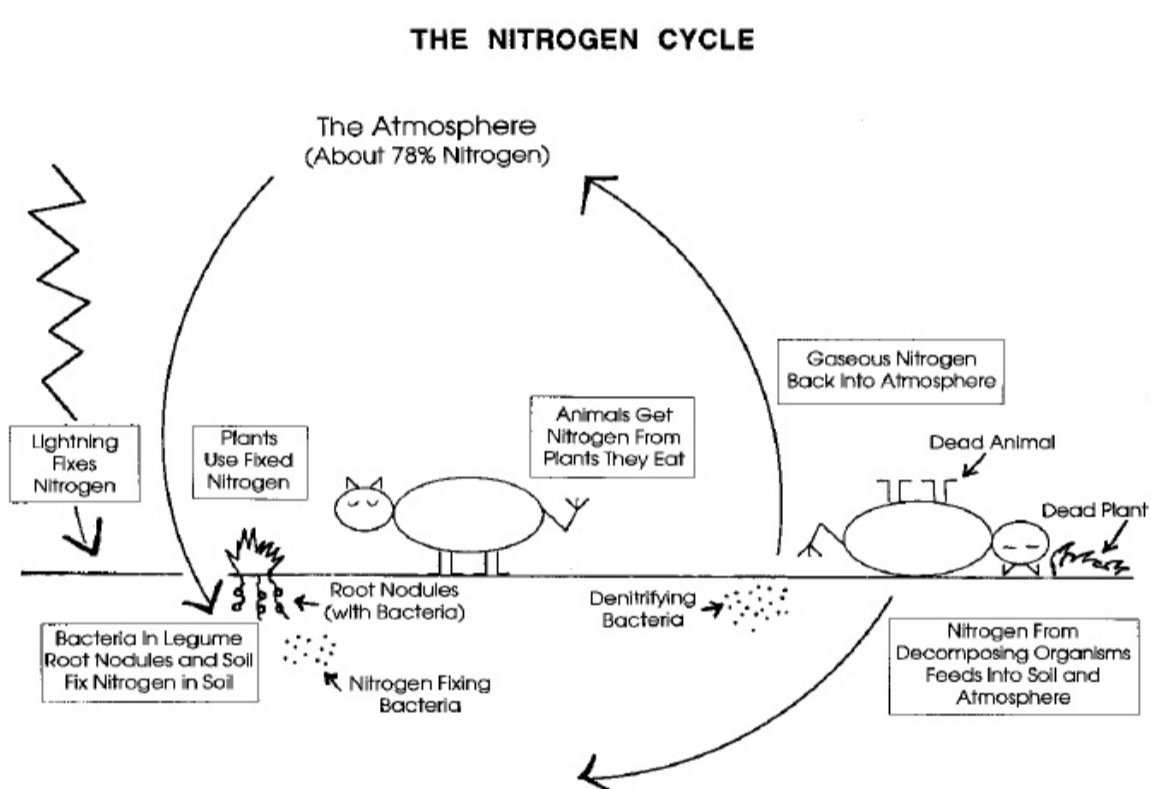
Read 2.5 "The Carbon Cycle" on pages 62 - 65. Answer questions 1 - 7 from "Understanding Concepts" and "Making Connections" on page 65.

2) Nitrogen Cycle

The movement of nitrogen through the ecosystems, the soil, and the atmosphere is called the nitrogen cycle. Nitrogen gas composes 79% of the Earth's atmosphere.

- Nitrogen is required to make proteins and DNA which is the genetic material found in every cell.

- In order for nitrogen to be useful to organisms, it must be available as a nitrate ion (NO_3^-). Atmospheric nitrogen is converted into nitrates by the process of nitrogen fixation, or nitrification, either by lightning or by bacteria in the soil.



Most nitrogen is found in the atmosphere. The nitrogen cycle is the process by which atmospheric nitrogen is converted to ammonia or nitrates.

Nitrogen is essential to all living systems. To become a part of an organism, nitrogen must first be fixed or combined with oxygen or hydrogen.

Nitrogen is removed from the atmosphere by lightning and nitrogen fixing bacteria. During electrical storms, large amounts of nitrogen are oxidized and united with water to produce an acid which is carried to the earth in rain producing nitrates. Nitrates are taken up by plants and are converted to proteins.

Then the nitrogen passes through the food chain from plants to herbivores to carnivores. When plants and animals eventually die, the nitrogen compounds are broken down giving ammonia (**ammonification**). Some of the ammonia is taken up by the plants; some is dissolved in water or held in the soil where bacteria convert it to nitrates (**nitrification**). Nitrates may be stored in humus or leached from the soil and carried to lakes and streams. It may also be converted to free nitrogen (**denitrification**) and returned to the atmosphere

Activity 2:

Read 2.6 "The Nitrogen Cycle" on pages 66 - 67. Answer questions 1 - 6, 8 - 11, and 13 - 14 (omit questions 7 and 12) from "Understanding Concepts," "Making Connections," and "Reflecting" on page 69.

PART A : MULTIPLE CHOICE

1. What is the process in which materials and nutrients are broken down by micro-organisms so that the nutrients are available to be re-used?
 - (A) Rotting
 - (B) Scavenging
 - (C) Decomposition
 - (D) Recycling
2. Which represents a major storage location for organic carbon?
 - (A) Atmosphere
 - (B) Lithosphere
 - (C) Hydrosphere
 - (D) Living things
3. Which of the processes listed below will remove CO₂ from the air?
 - (A) Denitrification
 - (B) Respiration
 - (C) Photosynthesis
 - (D) Nitrification
4. Oxygen found in the atmosphere is mainly produced by which process?
 - (A) Bacterial decay
 - (B) Volcanic eruptions
 - (C) Cellular respiration
 - (D) Photosynthesis
5. Carbon is recycled in the earth by way of the Carbon dioxide. What is the main environmental concern of the carbon cycle?
 - (A) Carbon dioxide is being put into the atmosphere faster than it can be taken out.
 - (B) Carbon dioxide is being removed from the atmosphere faster than it can be replaced.
 - (C) Carbon is stored in the shells of shell fish. As we catch more and more shell fish there is nowhere to store carbon.
 - (D) There is a growing concern that carbon will soon be replaced by silicon.
6. The single largest source of carbon for the carbon cycle is
 - (A) The respiration of plants.
 - (B) The burning of fossil fuels.
 - (C) The respiration of animals.
 - (D) The decay of plants and animals.
7. The process of photosynthesis is described as
 - (A) carbon dioxide + oxygen → sugar + water.
 - (B) carbon dioxide + sugar → oxygen + water.
 - (C) carbon dioxide + water → sugar + oxygen.
 - (D) sugar + oxygen → carbon dioxide + water.
8. Humans have increased the quantity of carbon dioxide found in the Earth's atmosphere and oceans by
 - (A) Burning fossil fuels.
 - (B) Cutting down forests.
 - (C) Altering natural ecosystems.
 - (D) All of the above.

9. The process by which most living things generate useful energy, by combining sugars and oxygen to produce carbon dioxide and water is called:
- (A) Photosynthesis
 - (B) Cellular respiration
 - (C) Combustion
 - (D) Denitrification
10. The carbon cycle is best responsible for
- (A) Rain
 - (B) Respiration and photosynthesis
 - (C) Production of nitrates for plant and animal growth
 - (D) Organic material decomposing and returning to the soil
11. Which converts nitrates and nitrites back into nitrogen gas?
- (A) Decomposers
 - (B) Denitrifying bacteria
 - (C) Nitrogen fixing bacteria
 - (D) Producers
12. Biogeochemical cycles can be disturbed by
- (A) Pesticides
 - (B) Natural events such as drought
 - (C) Human events such as logging
 - (D) All of the above
13. Which organism has the most important role in the nitrogen cycle?
- (A) Worms
 - (B) Nitrogen-fixing bacteria
 - (C) Fungi
 - (D) Scavengers
14. Before nitrogen can be used by living organisms, it must be converted to:
- (A) Ammonia
 - (B) Nitrates
 - (C) Cyanides
 - (D) Nitrogenous wastes
15. The nitrogen cycle is most likely to contain which substances:
- (A) CO; CO₂; Na₂CO₃
 - (B) C₆H₁₂O₆; CO₂; H₂O
 - (C) N₂; NH₄; NO₃
 - (D) H₂O vapour; liquid H₂O; CO₂
16. What is the name of the process of breaking down animal wastes into ammonia?
- (A) Ammonification
 - (B) Nitrification
 - (C) Denitrification
 - (D) Nitrogen fixation

17. What should a farmer do to prevent the denitrification of soil by bacteria?
- (A) Add more fertilizer.
 - (B) Add lime.
 - (C) Aerate the soil by flipping it over.
 - (D) Add pesticides.
18. Which statement is true regarding denitrification by bacteria.
- (A) Denitrifying bacteria grow best in soil that has been aerated.
 - (B) It occurs in oxygen-rich soils.
 - (C) They provides more nutrients for plants.
 - (D) They consume nitrates in the soil and return nitrogen gas back to the atmosphere
19. What statement is true about nitrogen?
- (A) Plants can use nitrogen directly from the atmosphere
 - (B) Our atmosphere is made up of about 15% nitrogen
 - (C) Nitrogen enters animals when they eat plants
 - (D) Plants only use pure nitrogen
20. Nitrogen is removed from the atmosphere by
- (A) Denitrification bacteria.
 - (B) The respiration process.
 - (C) The photosynthesis process.
 - (D) Nitrogen-fixing bacteria.
21. Which process reduces the amount of carbon dioxide in the atmosphere?
- (A) Cellular respiration
 - (B) Burning of fossil fuels
 - (C) Photosynthesis
 - (D) Acid deposition
22. Someone asks if some of the carbon atoms in her/his body may have once made up the living tissues of another person or animal in earlier times. This is
- (A) Possible only if you are a cannibal.
 - (B) Possible since carbon cycles through ecosystems
 - (C) Impossible since carbon can't enter a living system more than once.
 - (D) Highly unlikely since carbon is always tied up in molecules in organisms or minerals
23. Animals get their source of nitrogen
- (A) From their food.
 - (B) Directly from the atmosphere.
 - (C) From nitrates in the soil.
 - (D) From the water they drink.
24. Before nitrogen can be used by plants, nitrogen must be converted to water-soluble:
- (A) Ammonia
 - (B) Nitrates
 - (C) Nitrites
 - (D) Nitrogenous wastes

25. Which step of the nitrogen cycle returns nitrogen gas to the atmosphere?
- (A) Nitrogen fixation
 - (B) Ammonification
 - (C) Denitrification
 - (D) Nitrification
26. Which is the most common element in the atmosphere?
- (A) Carbon
 - (B) Oxygen
 - (C) Hydrogen
 - (D) Nitrogen
27. Nitrogen compounds in detritus are broken down by which bacterial process?
- (A) Nitrogen fixation
 - (B) Ammonification
 - (C) Denitrification
 - (D) Nitrification
28. Some plants have root nodules growing on their roots. What process do the bacteria in these root nodules carry out?
- (A) Nitrogen fixation
 - (B) Ammonification
 - (C) Denitrification
 - (D) Nitrification
29. Ammonium ions are converted to nitrites or nitrates by
- (A) Nitrifying bacteria
 - (B) Denitrifying bacteria
 - (C) Nitrogen-fixing bacteria
 - (D) All of the above
30. The greenhouse gases include all of the following EXCEPT
- (A) Nitrous oxide
 - (B) Methane
 - (C) Carbon dioxide
 - (D) Water

PART B: WRITTEN RESPONSE

1. In your own words, explain why photosynthesis and cellular respiration are considered to be complementary processes.

2. What is the importance of decomposers in the carbon cycle.

3. The oceans are often described as a carbon reservoir. In what ways is carbon held within the oceans

4. Explain how burning of fossil fuels by humans affects the carbon cycle.

5. What is the only form of nitrogen that plants can absorb?

6. What do nitrogen-fixing bacteria do, and where do they live?

7. What role do decomposers play in the nitrogen cycle?

8. Describe what happens during nitrification.
