Name _____ Date _____

The Nitrogen Cycle

Nitrogen is an important element that is found in both the organic (living things) and the inorganic (nonliving) parts of the Earth system. Most of the nitrogen on Earth is found in the atmosphere. It comprises approximately 80% of our atmosphere where it exists as N2 gas. Nitrogen can also be found in a variety of forms in plants, animals, soils, ocean, and other reservoirs in the environment. All plants and animals need nitrogen to make amino acids, proteins, and DNA, but the nitrogen in the atmosphere is not in a form that they can use. This gas must first be converted into a usable form during a process known as nitrogen **fixation**. Only specialized bacteria in soil and certain types of algae in water can fix nitrogen. Lightning strikes can also result in some nitrogen fixation.

Plants get the nitrogen that they need from the soil or water in which they live. This nitrogen is usually in the form of inorganic **nitrate (NO^{3-})** . Nitrate is easily dissolved in water and often leaches out of the soil. Animals get the nitrogen that they need by consuming plants or other animals which contain nitrogen within organic molecules. When organisms die, their bodies decompose bringing the nitrogen into soil or into the oceans. As these dead organisms decompose, nitrogen is converted into inorganic forms such as **ammonium salts (NH^{4+})** by a process known as **mineralization**. These ammonium salts are absorbed by the clay in the soil and are chemically altered by bacteria into **nitrite (NO^{2-})** and then **nitrate (NO^{3-}).** The different paths in which nitrogen may follow as it cycles throughout the earth is known as the **nitrogen cycle**.

Human activities have had a huge impact in global nitrogen cycles by causing changes in the amount of nitrogen stored in reservoirs. The use of nitrogen-rich fertilizers can lead to nitrates from the fertilizers washing into waterways. This increase in nitrate level can cause the rapid growth of aquatic plants during a process known as **eutrophication**. These plants will eventually die, decompose and deplete the water of available dissolved oxygen which can have disastrous effects on the entire food chain. Additionally, humans are altering the nitrogen cycle by burning fossil fuels and forests, which release nitric oxide, nitrous oxides, and other by-products into the atmosphere where they combine with water to form acid rain and enhance the greenhouse effect.

Draw a sketch of the Nitrogen Cycle. Be sure to include all components

Important terms:

Denitrifying bacteria:

Nitrifying bacteria:

Mutualism:

Nitrification:

Assimilation:

Legume:

The Carbon Cycle

All living organisms are based on the **carbon** atom. Unique among the common elements of the earth's surface, the carbon atom has the ability to form bonds with as many as four other atoms (including other carbon atoms) and to form double bonds to itself. Carbon compounds can be solid, liquid, or gas under conditions commonly found on the earth's surface. Because of this, carbon can help form solid minerals (such as limestone), 'squishy' organisms (such as plants and animals), and can be dissolved in water or carried around the world through the atmosphere as carbon dioxide gas. The attributes of the remarkable carbon atom make possible the existence of all organic compounds essential to life on earth.

Carbon atoms continually move through **living organisms**, the oceans, the atmosphere, and the crust of the planet. This movement is known as the carbon cycle. The paths taken by carbon atoms through this cycle are extremely complex, and may take millions of years to come full circle

Through **photosynthesis,** the oxygen from the CO_2 molecule was released back into the air and the carbon atom was removed from the CO_2 molecule and used to build a molecule of sugar.

The process of **burning** released the energy stored in the carbon compounds in the coal and reunited the carbon atom with oxygen to form CO_2 again

The CO_2 was released to the atmosphere through the smokestack and the journey continues. Many other paths are possible, some taking only hours or days to trace, others, like the one above, many millions of years.

The aggregation of the possible paths of carbon, where it may be stored for extended periods (**the "sinks"),** where it is likely to be released to the atmosphere (**the "source"),** and what triggers those sources (**the "release agents"),** together defines the carbon cycle.

Carbon sinks include long-lived trees, limestone (formed from the carbon-containing shells of small sea creatures that settle to the ocean bottoms and build up into thick deposits), plastic (a modern invention, but very long-lived), and the burial of organic matter (such as those that formed the fossil fuels we use today). **Carbon sources** include the burning of fossil fuels and other organic matter, the weathering of limestone rocks (which releases CO_2), and the respiration of living organisms. **Release agents** include volcanic activity, forest fires, and many human activities.

Draw a sketch of the Carbon cycle. Be sure to include all components

Important Terms:

Combustion:

Biosphere:

Global Carbon Budget:

Decomposers:

Autotrophs:

Heterotrophs:

The Water Cycle

Water covers three-fourths of the surface of the earth. This fact makes our planet very special. The earth has more water than any other planet. It is the only planet where water exists in all three forms: gas (vapour), liquid, and solid (ice).

Earth has its own water recycling system. It is called the **water cycle**. The actual *amount* of water on our planet does not change. In fact, there is the same amount of water on earth today as there was in the time of dinosaurs! In the water cycle, water simply changes its *form* and *location*. It is a never-ending cycle. In this cycle, water travels from the ground into the atmosphere and then back down to the ground again. This is why water is known as a **recyclable resource**.

In the water cycle, water continually changes between all three of its forms (gas, liquid and solid). Water on the ground changes to a gas as it warms from the sun's heat. This process is called **evaporation**.

As heat from the sun warms the earth, water on the surface will evaporate again into the atmosphere. This process forms a continuous cycle. The sun supplies the energy needed to power the cycle. Most water that flows through the pipes of our houses has gone through the **water cycle** many times. The **hydrologic cycle** is another name for the water cycle.

Ocean water, or sea water, is **saltwater**. Ocean water makes up about 97% of all water on the earth. In the **water cycle**, the water that evaporates from the oceans will leave the salt and other minerals behind. It will come back to the earth as **precipitation**. Water that returns as precipitation is **freshwater**.

Draw a sketch of the water cycle. Be sure to include all components

Important terms:

Hydrolic cycle

Evapotranspiration

Precipitation

Infiltration

Aquifer

Sublimation

Condensation

Precipitation

Interception

Percolation

Test Your Understanding

1. Livestock farming creates large amounts of animal waste. How would this affect the nitrogen cycle?

2. What would happen if a framer used too much fertilizer? What adverse affects can this have on the environment? Be specific!

3. How can burning fossil fuels affect the nitrogen cycle?

4. What is the role of nitrogen in plant growth?

5. Explain why you think naturally available nitrogen is the main limiting nutrient for plants.

6. Describe the steps in the Nitrogen Cycle.

7. Explain the 4 main stages in the carbon cycle.

8. List two important 'sinks' (things that store carbon), two important 'sources' (things that release carbon), and one important 'release agent' (things that trigger sources) for carbon.

9. We are currently worried that CO_2 sources are out of balance with CO_2 sinks. If sources produce more CO_2 than sinks can remove, CO_2 in the atmosphere increases, possibly leading to global warming. What might happen if the reverse were true and sinks took up more CO_2 than sources?

10. Explain how understanding the carbon cycle helps atmospheric scientists understand and prepare for global climate changes.

11. What happens to water during the **water cycle**?

12. What are two types of **precipitation**?

13. What supplies the energy needed to power the **water cycle**?

14. What is another name for the **water cycle**?

15. What is the name of the process in the water cycle where water is released by clouds and falls back to the earth?

16. What is the difference between **precipitation** and **evaporation**?

17. What is **transpiration**?

18. How much of the earth's water is too salty to drink?

19. What does the phrase "Water is a **recyclable resource**" mean?