

Name _____ Date _____ Hour _____

Directions: Color and make a key for each cycle. Then complete the questions that accompany the reading.

The Water Cycle

Water is the most abundant substance in living things. The human body, for example, is composed of about 70% water, and jellyfish are 95% water. Water participates in many important biochemical mechanisms, including photosynthesis, digestion, and cellular respiration. It is also the habitat for many species of plants, animals, and microorganisms, and it participates in the cycling of all of the materials used by living things. Water is distributed through the biosphere in a cycle known as the water, or hydrological cycle.

We begin by looking at the atmosphere, which includes the clouds. When water vapor cools it condenses and falls to Earth as rain. For instance, look at the arrow labeled **(A)**, or **precipitation** over land; gravity draws the water back to Earth in the form of rain, sleet, and snow. Precipitation also occurs over oceans. **(B)**.

The living things on Earth are represented in our diagram by the trees. Water is absorbed by the roots of the trees and used in photosynthesis, but it is also lost from their leaves through the process of **transpiration (C)**. Water also returns to the atmosphere through evaporation from the soil and from numerous other sources. In general, the amount of precipitation received by an area helps determine what types of plants will grow there. The nature of the vegetation, in turn, determines the types of animals that inhabit a region.

Water from the land enters the ocean through **seepage from the ground (D)**; it percolates from the surface down to the water table. This water saturated zone of soil and rock is called an aquifer, and water seeps from the aquifer to the ocean. Water also reaches the ocean as **runoff from the surface (E)**. Runoff from the surface includes flow from rivers as well as melting snowfields and glaciers.

The major reservoirs of water on Earth are the oceans. Oceans cover about three-quarters of Earth's surface and contain about 97% of its water. Solar radiation causes water's **evaporation from the ocean (F)**. Over 80% of the evaporated water in the hydrological cycle enters the atmosphere in this way, and about 52% of this falls back into the oceans in the form of rain. The remainder remains in the atmosphere as clouds, ice crystals, and water vapor and then precipitates over land.

1. What 3 life processes require water? _____

2. How is water distributed through the biosphere? _____

3. How does water enter the ecosystem from the atmosphere? _____

4. How does water leave the ecosystem into the atmosphere? _____

5. What determines the type of plant growth in any given ecosystem? _____

6. Describe two ways water is returned to the oceans? _____

7. How much "evaporated" water falls back to Earth over land? _____

The Carbon Cycle

Energy flows from the sun into the biosphere, but nutrients do not enter the biosphere from an outside source. Essentially, the same pool of nutrients has circulated for the billions of years that the Earth has been in existence. Some nutrients, called macronutrients, are used by organism in large quantities, while others, micronutrients, are used only in trace amounts. Macronutrients include carbon, hydrogen, oxygen, nitrogen, and phosphorus; micronutrients include iodine, iron, zinc and some others. Both macronutrients and micronutrients are recycled; they are passed back and forth between living and nonliving components of the ecosystem in process that we call biogeochemical cycles. Carbon is incorporated into organic compound by primary producers. Primary producers are then consumed by primary and secondary consumers, and decomposers are ultimately responsible for releasing the material back into the nonliving environment.

We will begin our study of the carbon cycles with the **atmosphere (A)**, which is Earth's major reservoir of carbon, in the form of carbon dioxide. Carbon enters the biotic (living) part of the ecosystem through **photosynthesis (B)**. Plants of the **forest (C)** take the carbon in carbon dioxide and fix it in organic compounds such as glucose, starch, cellulose, and other carbohydrates. **Respiration in plants (D)** returns carbon dioxide to the atmosphere.

Plants are primary producers. During **plant consumption (E)**, carbon passes into primary consumers, animals. When **animal consumption (F)** occurs, or when the primary consumer is eaten, carbon passes to a secondary consumer, represented by the lion in the picture. **Respiration (G)** takes place in cells of the primary and secondary consumers, and carbon is released back into the environment as carbon dioxide.

When the primary and secondary consumers die, their organic matter enters the soil through the process of **decay (H)**. It is broken down by the decomposers, or **detritus feeders (I)**, which are small animals and microorganisms that subsist on decaying matter such as fallen leaves, dead bodies, and animal waste. Earthworms, mites, centipedes, insects, and crustaceans are detritus feeders. Thus, **respiration in detritus feeders (J)** also returns carbon to the atmosphere.

Throughout history, much carbon has been **converted to fossil fuel (K)**. High pressure and temperature transform carbon-containing organic matter into coal, oil, and natural gas. **Fossil fuel processing (L)** follows. There are many **uses for fossil fuels (M)**. Some power plants generate electricity using fossil fuels, and automobiles are powered by gasoline. The **products of the combustion (N)** of fossil fuels include carbon dioxide and other carbon compounds that enter the atmosphere. Carbon also enters the environment from the burning of wood and plants that occurs during **forest fires (O)**.

A final aspect of the carbon cycle that we will examine is **exchange with oceans (P)**. Some carbon dioxide from the air dissolves in oceans and combines with calcium to form calcium carbonate, which is incorporated into the shells of mollusks and other creatures. When these shells decay, they transform into limestone, which, over time, dissolves as it is exposed to water. Carbon is released from the limestone and may return to the atmosphere.

8. What are macronutrients? What are micronutrients? _____

9. Where is most of the Earth's carbon located and in what form? _____

10. How does carbon enter the biotic portion of the ecosystem? _____

11. How does carbon return to the atmosphere? (2 different ways) _____

12. How do detritus feeders contribute to the carbon cycle? _____

13. What is a fossil fuel, how are they formed? _____

14. How does carbon cycle through the ocean? _____

The Nitrogen Cycle

An important process in ecosystems is the recycling of nitrogen through its living (biotic) and nonliving (abiotic) components. The living components, or biota, of the ecosystem participate in the nitrogen cycle in many ways. Approximately 78% of the air is composed of diatomic nitrogen. Nitrogen is essential to life because it is a key component of amino acids and nucleic acids. Even ATP, the basic energy currency of living things, contains nitrogen.

Neither plants nor animals can obtain nitrogen directly from the **atmosphere (A)**. Instead, they must depend on a process called **nitrogen fixation (B)**. Key players in nitrogen fixation are **legumes (C)** and the symbiotic bacteria that are associated with their root nodules. Legumes include clover, peas, alfalfa, and soybeans. The bacteria associated with their root nodules are **nitrogen-fixing bacteria (D)**. These bacteria convert nitrogen in the soil to ammonia (NH_3), which can be taken up by some plants. The bacteria and the plant are in a symbiotic relationship. Cyanobacteria are also nitrogen-fixing bacteria; they are prominent in aquatic ecosystems.

Nitrogen is fixed into the soil through the actions of free-living bacteria and, as we mentioned above, through bacteria that's associated with root nodules of legumes. Both methods of fixing nitrogen lead to its incorporation into ammonia (NH_3) in the process known as **ammonification (E)**. The soil is a major reservoir for ammonia and other nitrogen-containing compounds. After nitrogen has been fixed, other bacteria convert it into nitrate, in a process called **nitrification (F)**. In the first step of **nitrification, (G) and (H) bacteria convert nitrogen to nitrate**. The nitrate (NO_3) is then **consumed by plants (I)**, as the diagram shows. ·

But not all plants consume nitrate; as we mentioned before, some plants are able to use the ammonia from the soil. In both cases, nitrogen enters the primary producers in the biotic community. The plants may then be **consumed by animals (J)**. Herbivores are the primary consumers, and the nitrogen of the plants is used for the synthesis of key organic compounds such as amino acids, proteins, and nucleic acids. The final aspect of the nitrogen cycle is the process of **denitrification (K)**. This process is performed by a variety of microscopic bacteria, fungi, and other organisms. Nitrates in the soil are broken down by these organisms, and nitrogen is released into the **atmosphere (A)**.

15. What percentage of air is composed of N_2 (diatomic nitrogen)? _____

16. Why is nitrogen essential to life? _____

17. How do plants and animals obtain nitrogen? _____

18. Which organisms are responsible for this process? _____
19. Where in the ecosystem is nitrogen mainly stored? _____

20. Why do consumers need nitrogen? _____

21. How does nitrogen return to the atmosphere? Who performs this process? _____

The Phosphorus Cycle

Although nitrogen and carbon exist as gases, certain elements that cycle in the biosphere do not exist in gaseous form. These elements accumulate in rocks and soil, and participate in what are called biogeochemical cycles. Among the elements that undergo sedimentary cycles are calcium, sulfur, magnesium, and phosphorus. As you will see in this plate, phosphorus is one of the key elements in organic matter. Phosphorus is one of the critical elements in biological molecules. For example, it is a component of adenosine triphosphate (ATP) and the coenzyme NADP, which are used in important cellular processes such as photosynthesis. Phosphorus is also present in the sugar-phosphate backbone of nucleic acids, and is an essential element of phospholipids, which make up the cell membrane.

The main reservoir of phosphorus is rock and soil, so we will begin the cycle with **erosion from rocks (A)**. Erosion occurs as water rushes over rock, dissolving phosphorus and washing it into rivers and streams. Phosphorus unites with oxygen to form phosphate and enters a major body of water, depicted here as a lake. In the picture, we see plants growing along the border of the lake. Here, the water gives up its phosphates, which are **absorbed by the plants (B)** and used in the synthesis of organic molecules. Some of the phosphates also enter the soil along the margins of the lake. Dissolved phosphate is readily absorbed by the roots of plants, concentrated by cyanobacteria and protists such as *Euglena*, and then incorporated into organic molecules.

The plant is the primary producer in the phosphorus cycle. The phosphate is **concentrated in plant tissues (C)**, and then the **plant is consumed (D)** by an animal, which is seen **grazing (E)**. Phosphates are returned to the lake when the plants and animals die. **Plant waste (F)** and **animal waste (G)** return phosphate to the water. Once again it may be reabsorbed by plants that line the lake, and it enters the cycle again.

Large amounts of phosphorus are carried by rivers and streams as **runoff to the ocean (H)**. Phosphorus exists in the form of phosphate here, as it does on land. Much of this phosphate then concentrates in **marine sediment (I)**. Some of the phosphate is eventually incorporated into the bodies of marine animals such as fish. For example, the scales and bones of bony fish contain phosphorus. As is the case on land, primary producers in the ocean incorporate phosphates into organic compounds. These primary producers are eaten by fish and other invertebrates. For instance, sea birds consume the fish and return phosphorus to the ocean in the form of excrement.

As we have seen, the atmosphere is not involved in the phosphorus cycle. In order for the phosphorus to leave the oceanic environment, geologic up thrust must occur. Up thrust is the process through which once-submerged sedimentary rock rich in phosphorus is exposed because of the movement of the Earth's plates. This rock then enters the terrestrial ecosystem and begins to weather, participating in the phosphorous cycle.

22. Why is phosphorus an important biological element? _____

23. Where is most of the Earth's phosphorus stored? _____

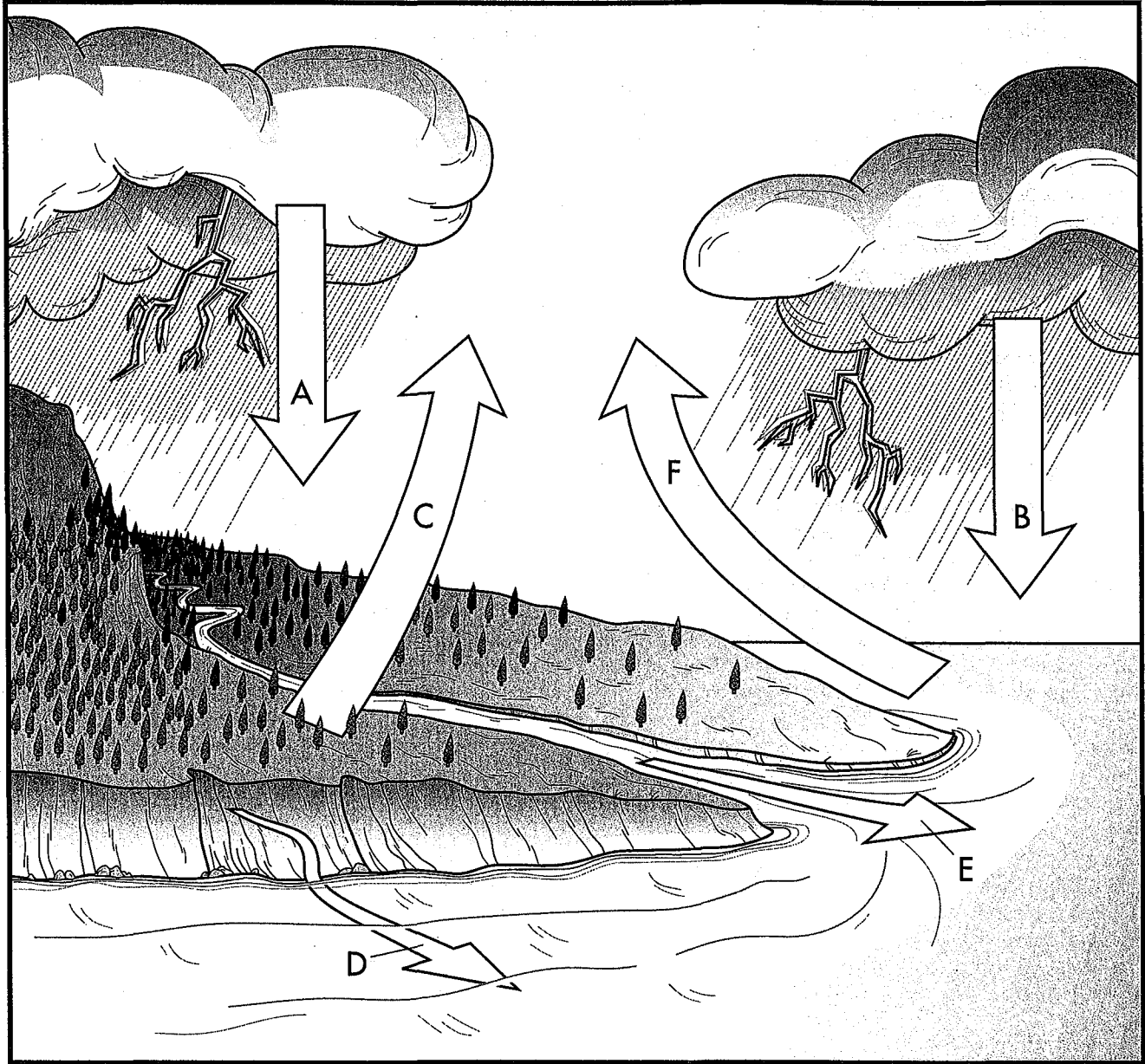
24. How does phosphorus enter the biotic portion of the ecosystem? _____

25. How do consumers obtain phosphorus? _____

26. How does phosphorus leave the biotic portion of the ecosystem and enter the abiotic? _____

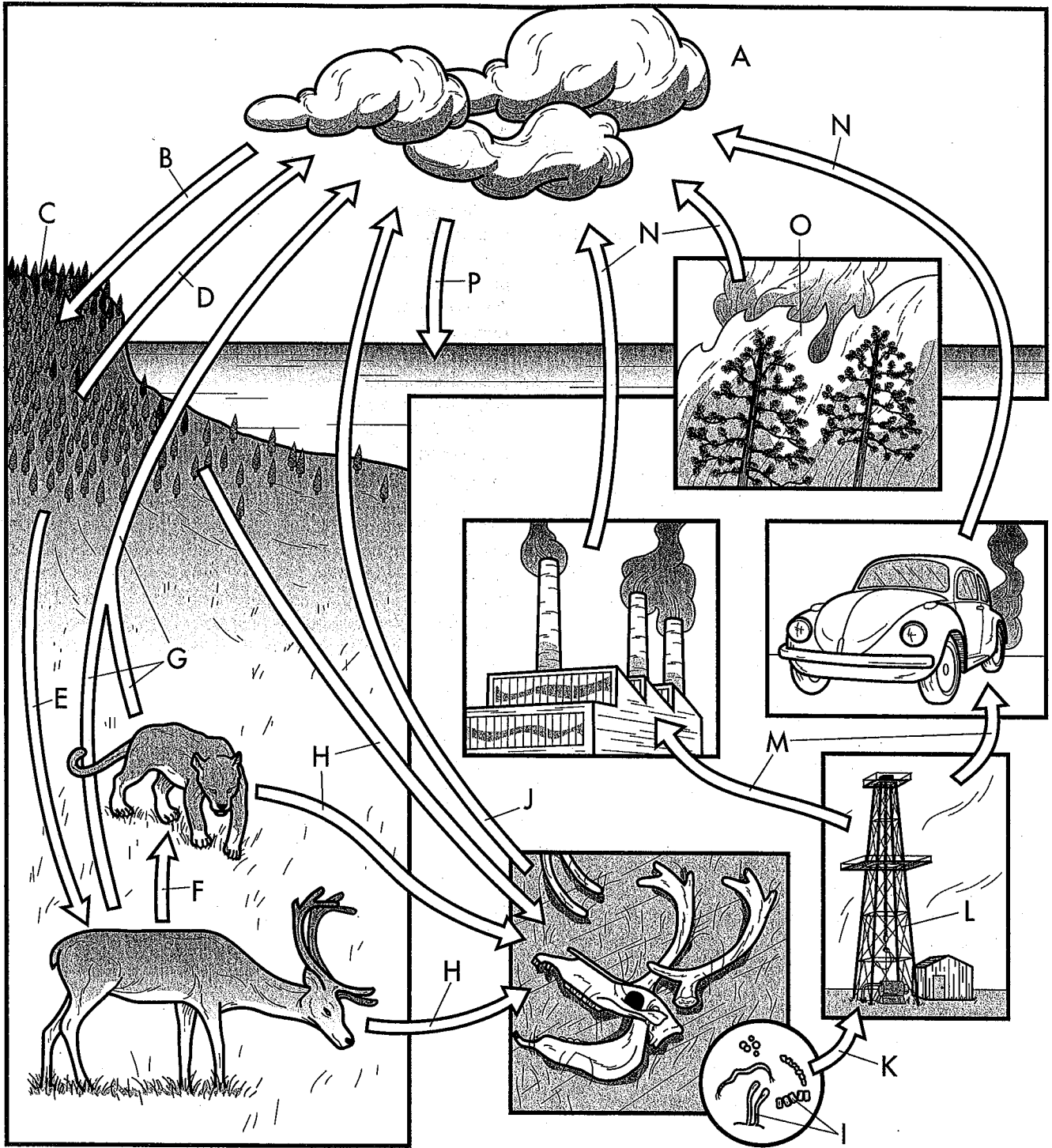
27. How does phosphorus return to the ocean? Where does it end up? _____

28. Give an example of how phosphorus enters and leaves an aquatic food chain? _____



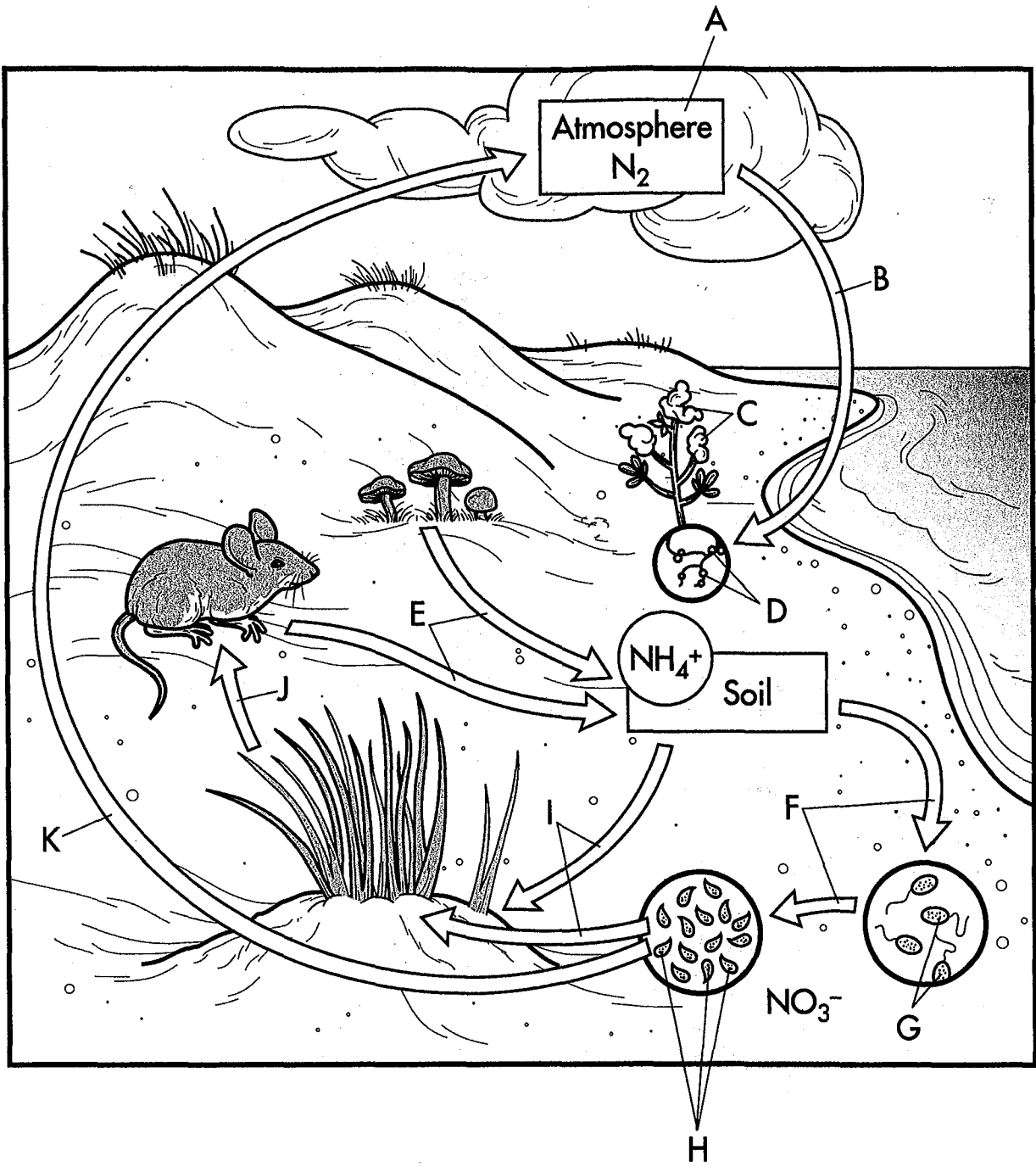
The Water Cycle

- | | | |
|--|---|---|
| <input type="radio"/> Precipitation Over Land.....A | <input type="radio"/> TranspirationC | <input type="radio"/> Runoff From SurfaceE |
| <input type="radio"/> Precipitation Over Ocean.....B | <input type="radio"/> Seepage From GroundD | <input type="radio"/> Evaporation from OceanF |



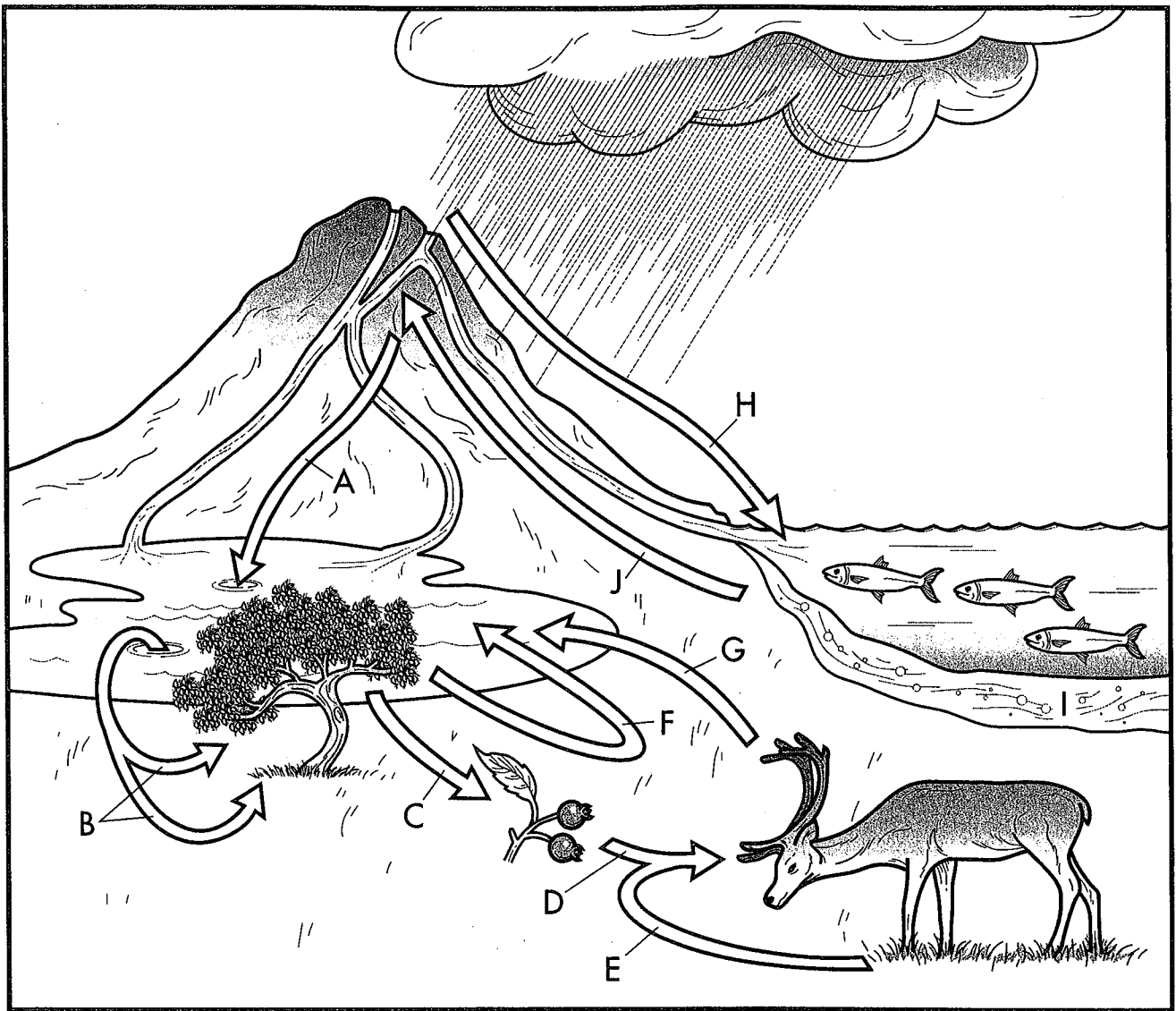
The Carbon Cycle

- | | | |
|----------------------------|---|---------------------------------|
| ○ AtmosphereA | ○ Respiration in Animals.....G | ○ Fossil Fuel ProcessingL |
| ○ PhotosynthesisB | ○ Decay.....H | ○ Uses for Fossil Fuel ..M |
| ○ ForestC | ○ Detritus FeedersI | ○ Products of CombustionN |
| ○ Respiration in Plants..D | ○ Respiration in Detritus Feeders.....J | ○ Forest Fire.....O |
| ○ Plant Consumption.....E | ○ Conversion to Fossil FuelK | ○ Exchange with Oceans ..P |
| ○ Animal ConsumptionF | | |



The Nitrogen Cycle

- | | | |
|---|--|--|
| <input type="radio"/> AtmosphereA | <input type="radio"/> AmmonificationE | <input type="radio"/> Consumption by PlantsI |
| <input type="radio"/> Nitrogen Fixation.....B | <input type="radio"/> Nitrification.....F | <input type="radio"/> Consumption by Animals.....J |
| <input type="radio"/> Legume PlantC | <input type="radio"/> <i>Nitrosomonas</i>G | <input type="radio"/> Denitrification.....K |
| <input type="radio"/> Nitrogen-Fixing BacteriaD | <input type="radio"/> <i>Nitrobacter</i>H | |



The Phosphorus Cycle

- Erosion from RockA
- Absorption by Plants ..B
- Concentration in Plant TissuesC
- Plant ConsumptionD
- GrazingE
- Plant WasteF
- Animal Waste.....G
- Runoff to OceanH
- Marine SedimentI
- Geologic UpthrustJ