Earth Science

Name _____

Date _____ Hour ____

The Carbon and Oxygen Cycles

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. These nutrients are recycled; passed back and forth between living and nonliving components of the ecosystem in processes called biogeochemical cycles (water, carbon, oxygen, and nitrogen cycles).

The prime focus of this plate is on the arrows that show how carbon and oxygen travel among components of the biosphere. You should use darker colors for the arrows.

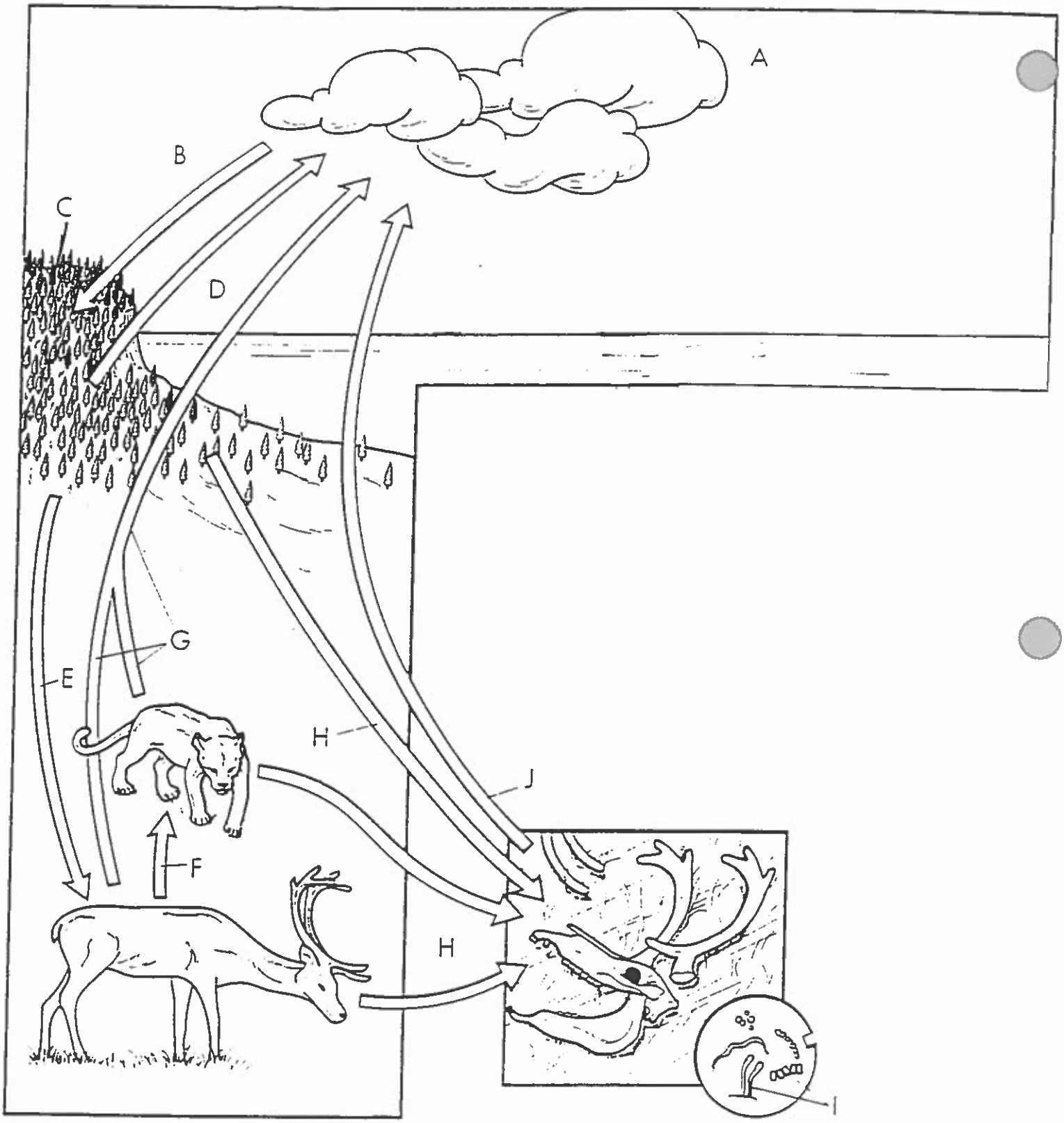
Nutrients are taken in by producers and are made into organic compounds. The producers are then eaten by consumers, and decomposers are ultimately responsible for releasing the nutrients back into the nonliving environment (soil, air, and water).

We will begin our study of the carbon and oxygen cycles with the **atmosphere (A)**, which is Earth's major reservoir of carbon, in the form of carbon dioxide, and oxygen. Carbon enters the living part of the ecosystem through **photosynthesis (B)**. Use a green color for the arrow. Plants of the **forest (C)** take the carbon in carbon dioxide and use it to make organic compounds such as glucose, starch, cellulose, and other carbohydrates. **Respiration in plants (D)** returns oxygen to the atmosphere; an arrow shows this process.

We have seen how carbon enters the cycle of living things through photosynthesis, and we will now see how it passes through various life forms.

Plants are producers. In the course of **plant consumption (E)** (when plants are eaten), carbon passes into consumers, the animals. When **animal consumption (F)** (animals are eaten) occurs, carbon passes from the first-level consumer to the second-level consumer and on up the food chain. **Respiration (G)** (breathing) takes place in cells the cells of the consumers (animals), oxygen released by the plants and from the atmosphere are taken in and carbon is released back into the environment as carbon dioxide.

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



The Carbon and Oxygen Cycles

O Atmosphere.....A
O Photosynthesis.....B
O Forest.....C
O Respiration in Plants.....D
O Plant Consumption.....E
O Animal Consumption.....F
O Respiration in Animals.....G
O Decay.....H
O Decomposers.....I
O Respiration in Decomposers.....J

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The Nitrogen Cycle

An important process in ecosystems is the recycling of nitrogen through it living and nonliving components. The living components of the ecosystem participate in the nitrogen cycle in a number of ways, as you will see in the plate.

If you look closely at the plate, you will notice that we show the various ways in which nitrogen cycles through nature. As you color the plate, the arrows should be emphasized.

Approximately 78% of the air is composed of nitrogen. Nitrogen is essential to life. 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.

We have seen how nitrogen is brought into the living component of the ecosystem by nitrogen-fixing bacteria. We will now focus on how nitrogen is cycled through the living aspects of the ecosystem.

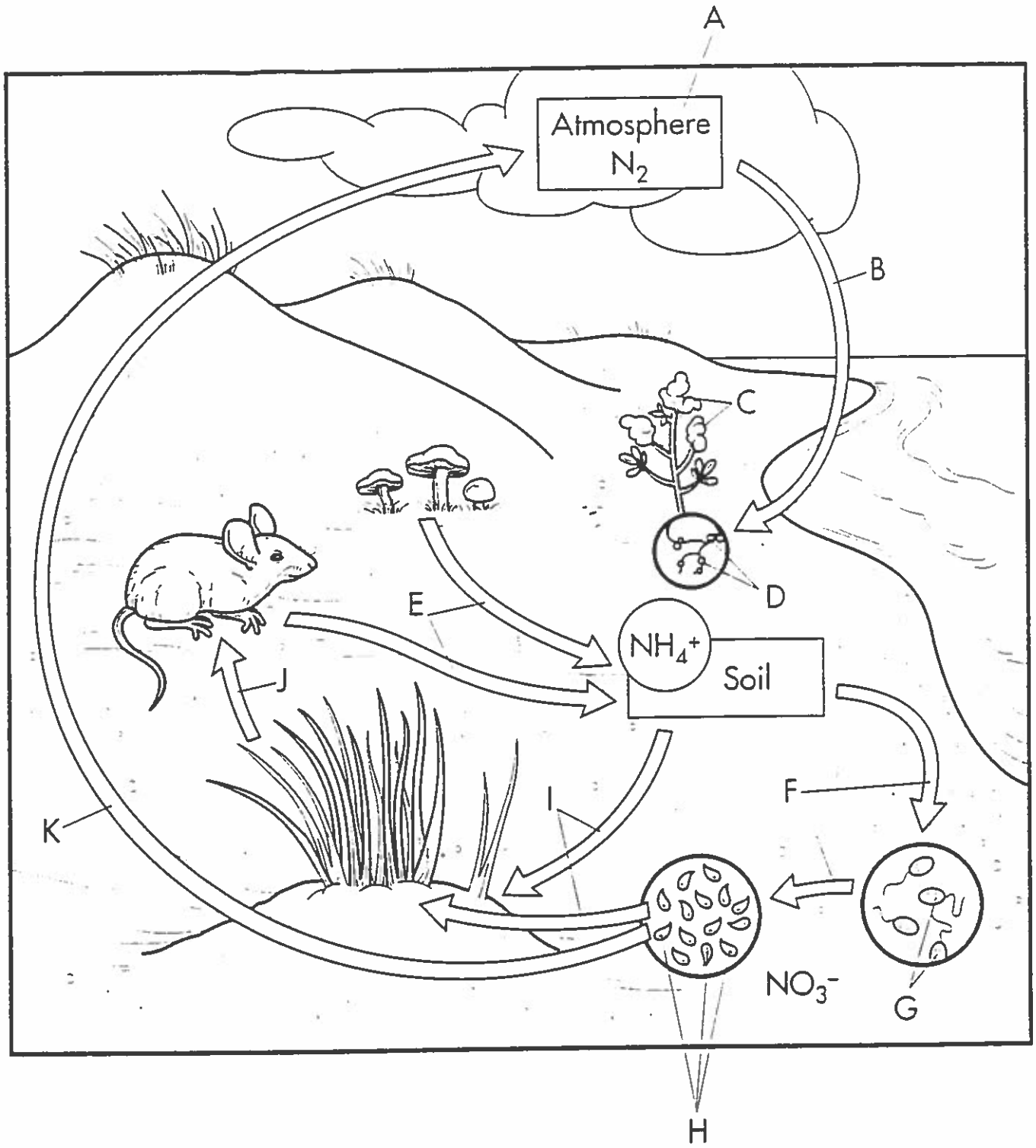
Nitrogen is fixed into the soil through the actions of free-living bacteria and, as we mentioned above, through bacteria that's associated with root nodules of legumes. Both of these methods of fixing nitrogen lead to its incorporation into ammonia (NH_3) in the process known as **ammonification (E)**. 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, **Nitrosomonas (G)** convert ammonia to nitrite (NO_2), and in the second step, nitrite is converted to nitrate (NO_3), by **Nitrobacter (H)**. 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 producers in the living 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.

We have seen how nitrogen is fixed in the soil and eventually utilized by plants and then animals. We will now complete the cycle of nitrogen by showing how it returns to the atmosphere.

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.

These organisms break down nitrates in the soil, and nitrogen is released into the atmosphere (A). This completes the nitrogen cycle.



The Nitrogen Cycle

- ○ Atmosphere .....A
- ○ Nitrogen Fixation.....B
- ○ Legume Plant C
- ○ Nitrogen-Fixing Bacteria .....D
- ○ Ammonification .....E
- ○ Nitrification.....F
- ○ *Nitrosomonas* .....G
- ○ *Nitrobacter*.....H
- ○ Consumption by Plants I
- ○ Consumption by Animals.....J
- ○ Denitrification.....K