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FOCUS: Cycling of Matter Through an Ecosystem

ESSENTIAL QUESTION: Can you describe and explain the various processes involved in the cycling of matter through an ecosystem as it relates to each of the following cycles: Water Cycle? Nitrogen Cycle? Carbon Cycle? Photosynthesis/Respiration?

What have we learned about the Cycling of Matter?

- The same matter that cycled through ecosystems millions of years ago is the same matter that is cycling through our ecosystems today.
  - Law of Conservation of matter: Matter is never created or destroyed. It is simply transferred from one system to another.
- The matter that cycles through ecosystems is used by living organisms for nutrients and for extracting energy from food. The matter that all organisms need includes:
  - Carbon (usually in the form of CO_2)
  - Oxygen (usually in the form of O_2)
  - Nitrogen (usually exists as N_2, but is only useful to organisms as NO_2, NO_3, NH_3, and NH_4)
  - Water (or H_2O)

Water Cycle Summary

- Water is needed by all living things on Earth.
- Earth's water is always moving and changing state between its solid, liquid, and gas forms.
- The water cycle or hydrologic cycle describes the continuous movement of water on, above, and below the surface of the Earth.

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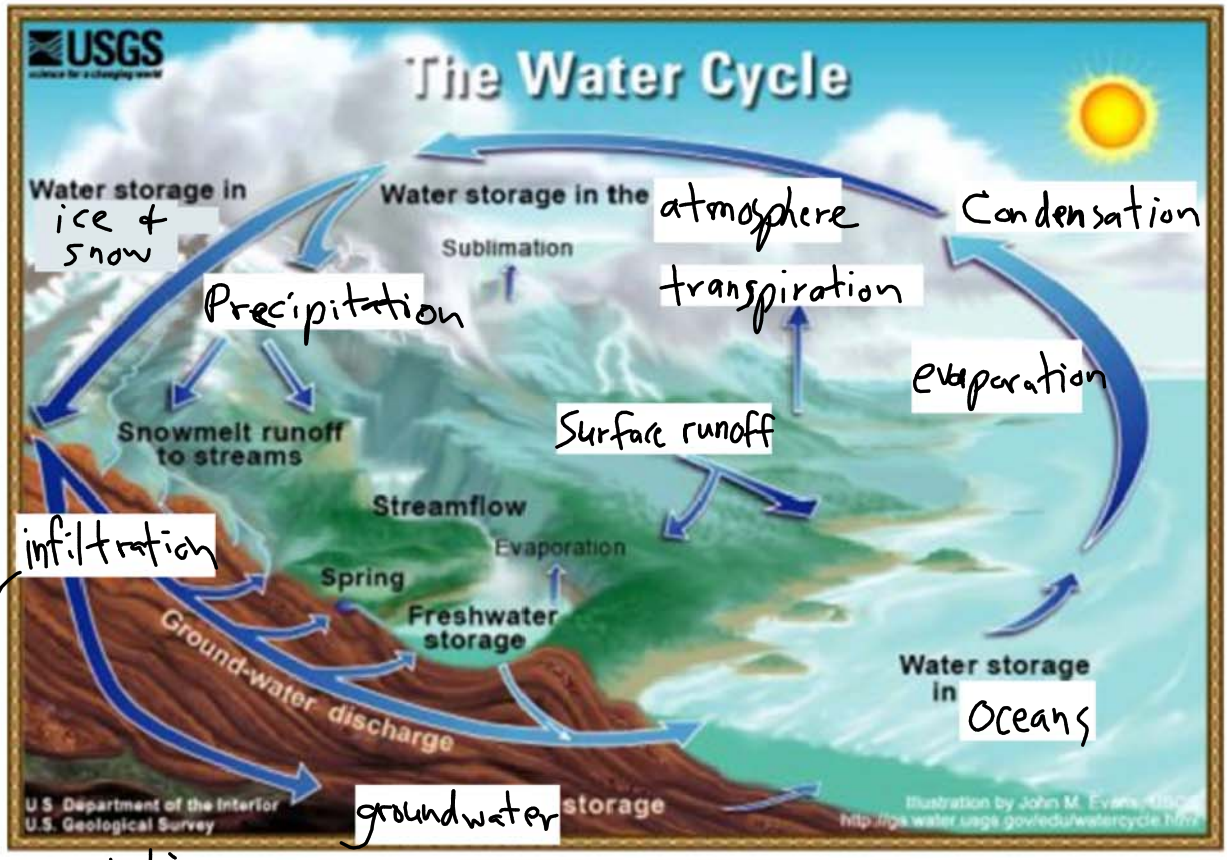

Carbon Cycle Summary

- All living things are made of carbon.
- Carbon is also found in the ocean, air, rocks, and soil.
- Carbon is constantly on the move between biotic and abiotic reservoirs within an ecosystem.
  - In the atmosphere, it is found as Carbon dioxide (CO_2).
  - ~~CO_2 is used by plants to make~~ food (with the help of sunlight) through the process of photosynthesis. Plants also return CO_2 to the atmosphere through the process of cellular respiration.

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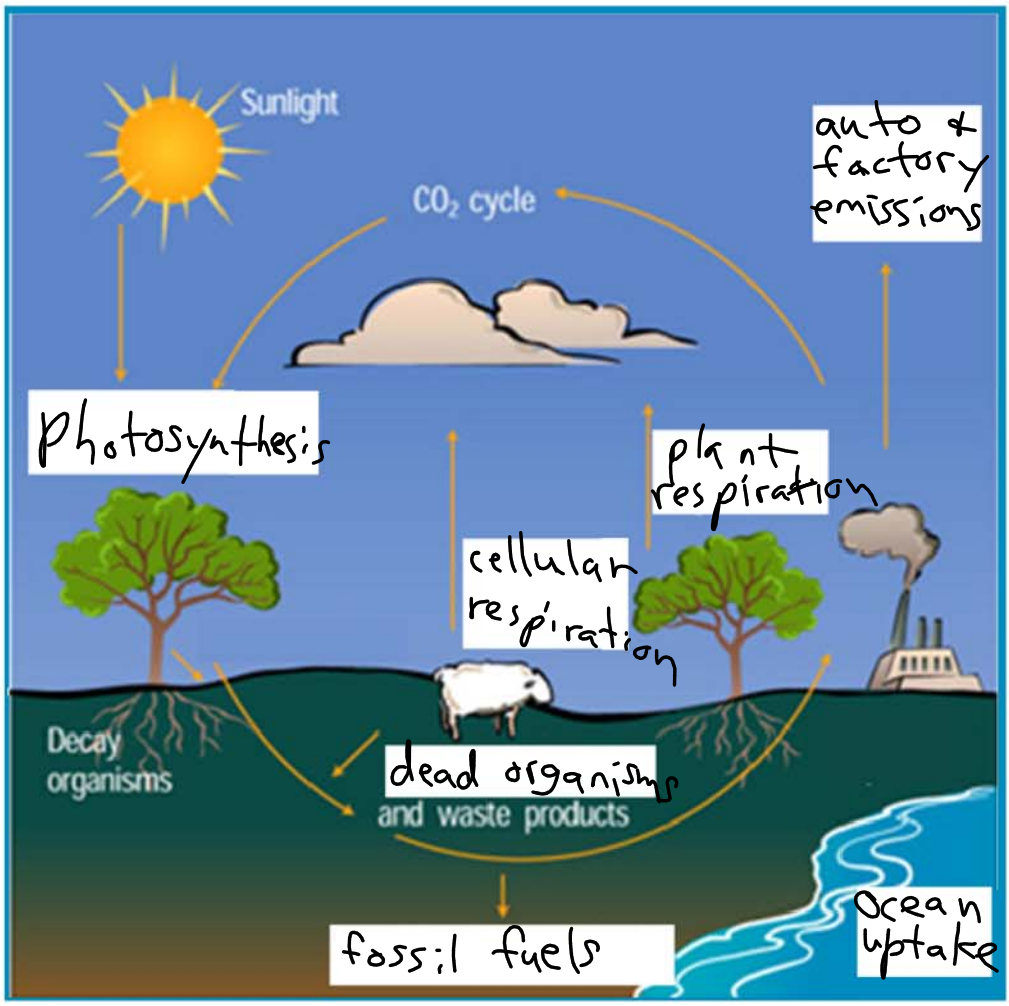
- When plants (and animals that eats the plants) die, the carbon in their bodies is returned to the soil.
- Carbon in the soil is either released back into the atmosphere or buried for millions of years to become a fossil fuel, such as oil or coal or natural gas.
- CO_2 in the atmosphere can also be cycled through Earth's oceans where phytoplankton use it in the process of photosynthesis.



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Nitrogen Cycle Summary

- Nitrogen is essential to all life on Earth. It is needed for the production of:
  - Proteins
  - DNA & RNA
  - Chlorophyll needed for photosynthesis
- The nitrogen found in our atmosphere is Nitrogen gas (N_2), which can't be used by most living things because the two atoms are bonded together with an extremely strong triple bond.
- N_2 must be "fixed" before it is useable by living organisms.
- Nitrogen fixation can be done by: (1) lightning in the atmosphere or (2) bacteria in the soil.
- Some plants are adapted to "fix" their own nitrogen through a Symbiotic relationship with bacteria living on their roots.
  - These include legumes (Ex: peas, beans, peanuts)
- Once nitrogen passes through the stages of Nitrogen fixation, Ammonification, Nitrification, and Denitrification, it is returned to the atmosphere as N_2.
- The Nitrogen Cycle can be disrupted by humans when too many nitrogen fertilizers are added to crops or Sewage / manure washes into water sources and causes algal blooms.

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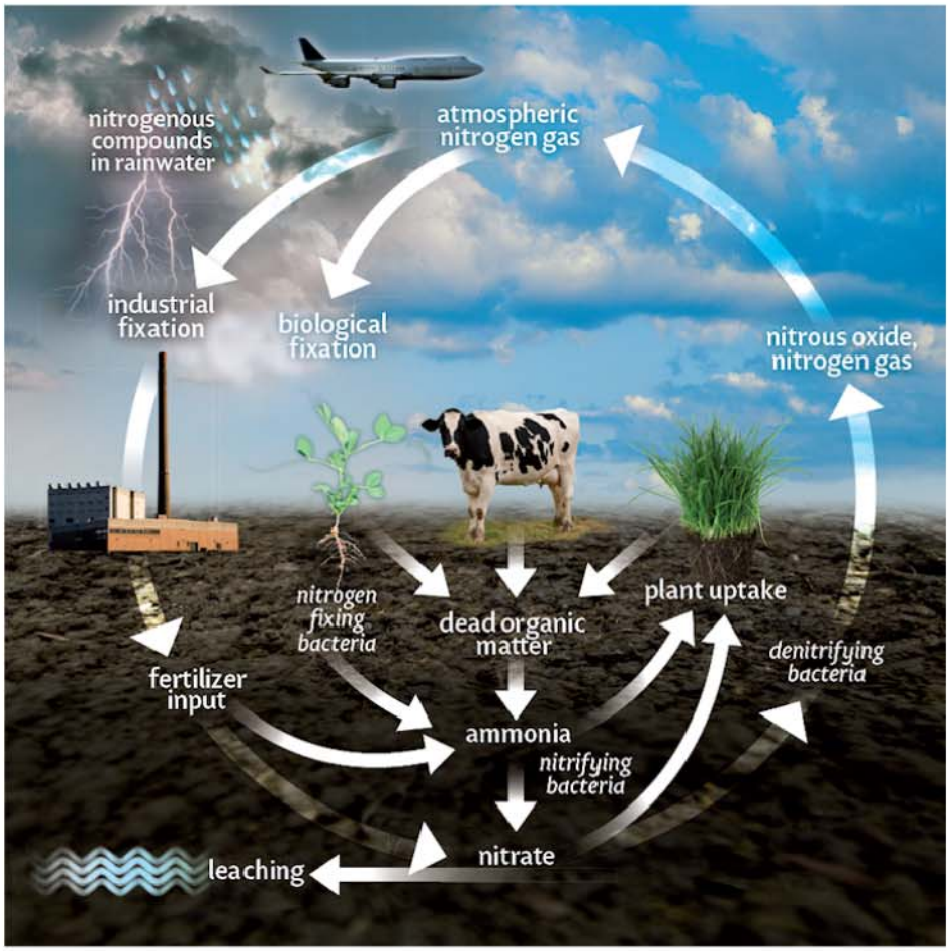

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Photosynthesis & Cellular Respiration Summary

- Photosynthesis & Cellular Respiration are reactions that Complement each other and are involved in the cycling of Carbon dioxide and Oxygen in an ecosystem.
- ~~Photosynthesis & Cellular Respiration are essentially the~~ Same reaction ~~but occurring in~~ reverse.

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- ***Photosynthesis:***

$6CO_2 + 12H_2O \xrightarrow{LIGHT} C_6H_{12}O_6 + 6O_2 + 6H_2O$

six molecules of carbon dioxide

twelve molecules of water

one molecule of glucose (plant biomass)

six molecules of oxygen

six molecules of water

- Since 6 of the water molecules cancel out, you will most often see the equation written as follows:

$6CO_2$ Carbon dioxide + $6H_2O$ Water $\xrightarrow{Light}$ $C_6H_{12}O_6$ Sugar + $6O_2$ Oxygen

- ***Respiration:***

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + energy$

Glucose Oxygen Carbon dioxide Water

- Plants carry out photosynthesis. Both plants & animals use cellular respiration to extract energy from their food.