

2.2 Nutrient Cycles in Ecosystems - Student Notes

- Nutrient Cycles – the flow of nutrients in and out of the land, ocean, atmosphere and deep rock.
- The health of our ecosystems depends on the balance of:

Carbon, Nitrogen, Phosphorous, Hydrogen and Oxygen
C N P H O

Carbon Cycle:

A. Carbon Facts:

- Carbon is found in all living matter.
- Places that carbon is found are called Stores or STARS

Short-term Stores

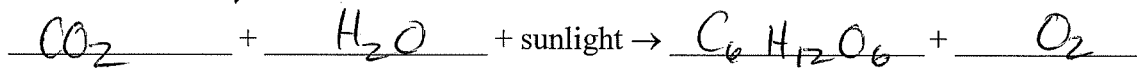
- living things in water & on land
- rotting tissue of plants/animals
- atmosphere (air)
- ocean (dissolved in the water)

Long-term Stores

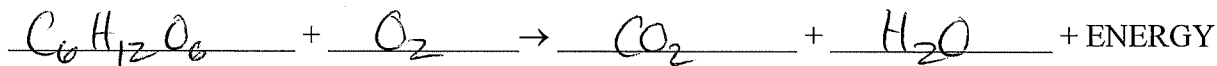
- underground (oil, gas, natural gas and coal)
- sedimentary rock (limestone)
- ocean floor (old shells)

B. How Carbon Changes Form:

1. Photosynthesis (in plants, algae and cyanobacteria)



2. Cellular Respiration (in cells of all living things)



(energy is used for growth, repair etc.)

3. Decomposition – done by bacteria/fungi



4. Ocean Processes:

- Ocean Mixing moves CO₂ around the world
- CO₂ sinks in cold ocean waters \rightarrow flows to the warm equator and evaporates into the air.

5. Combustion: (burning, engines, volcanoes, forest fires)

fossil fuels + O_2 → CO_2 + H_2O + ENERGY
(oil, gas, natural gas, coal)

Human Activities & CO₂

1. Burning Fossil Fuels

- CO_2 in atmosphere has increased 30% in past 160 years.
- In the 160,000 years before that, it only increased 1-3%.
- Carbon is removed from long-term storage as we mine coal & drill for oil and gas.
- CO_2 is also a green house gas, (traps heat in atmosphere)

2. Removing Trees

- Trees absorb CO_2 , so when they are cut down, CO_2 is released into the air.
- Other crops don't remove as much CO_2

Nitrogen Cycle:

A. Nitrogen Facts

- Makes up DNA & proteins (muscle function).
- Help plants grow

Where Nitrogen is Found:

- Atmosphere (78% is N_2)
- Oceans
- Organic matter in soil
- Lakes, marshes, organisms

B. How Nitrogen Changes Form:

- N_2 is not usable by plants or animals, so it has to be converted to other forms.

- Plants can use NO_3^- (nitrate) and NH_4^+ (ammonium)

1. Nitrogen Fixation

- Lightning changes N_2 (gas) → NO_3^- (nitrate).
- Rain washes nitrate into soil. (small amount)
- N_2 gas bacteria in soil (rhizobium) & bacteria in water change $N_2(g)$ → NH_4^+ ammonium. (more)

2. Nitrification (done by nitrifying bacteria):

NH_4^+ ammonium → NO_2^- (nitrite) → NO_3^- (nitrate)

3. Uptake:

NO_3^- is sucked into plants & used for growth. Herbivores eat plants & use N for making proteins & DNA.

4. Denitrification (done by denitrifying bacteria & volcanic eruptions)

NO_3^- \rightarrow N_2

C. Human activities affect the nitrogen cycle.

The amount of nitrogen in the ecosystem has doubled in 50 y. due to:

1. Burning fossil fuels & sewage treatment.
• NO & NO_2 are byproducts

2. Land Clearing by burning.
• acid rain is formed which contains nitric acid (HNO_3).

3. Overfertilization
• NH_4^+ & NO_3^- leach into soil & waterways.
• huge growth in aquatic algae = eutrophication
• These algal blooms use up all CO_2 & O_2 , block sunlight & produce neurotoxins which poison and kill many aquatic organisms.

Phosphorus Cycle:

Phosphorous Facts

- Phosphorous is a part of the molecule that carries energy in cells (ATP).
- Phosphorous helps root growth, stem strength and seed production.
- In animals, phosphorous is important for strong bones.

Where Phosphorous is Found:

- Not in atmosphere, but in phosphorous rocks $(\text{PO}_4)^{3-}$, HPO_4^{2-} , H_2PO_4^- and sediments on the ocean floor.

B. How Phosphorous Changes Form.

1. Weathering (breaking down rock into smaller pieces).
 - a) Chemical weathering:
 - acid rain or lichens releases phosphates (PO_4^{3-})
 - b) Physical weathering:
 - wind, water and freezing release the phosphates
2. Uptake: plants suck up PO_4^{3-} , then are eaten by animals.
3. Decomposition: Bacteria break down organic matter & phosphorous is returned to soil.
4. Geologic Uplift: when rocks under the ground are pushed up → mountains → weathering

C. Human activities affect the Phosphorous Cycle.

1. Mining: increases P in ecosystems quickly.
2. Slash-and-burn: turns P into ash, which runs into waterways.

How Changes in Nutrient Cycles Affect Biodiversity

To Review:

Any significant changes to any of these nutrients (C, H, O, N or P) can greatly impact biodiversity.

1. Carbon Cycle → climate change & global warming.
2. Too much nitrogen can allow certain plant species to out-compete other species.
3. Decreased levels of phosphorous → slow growth of algae (important producers).