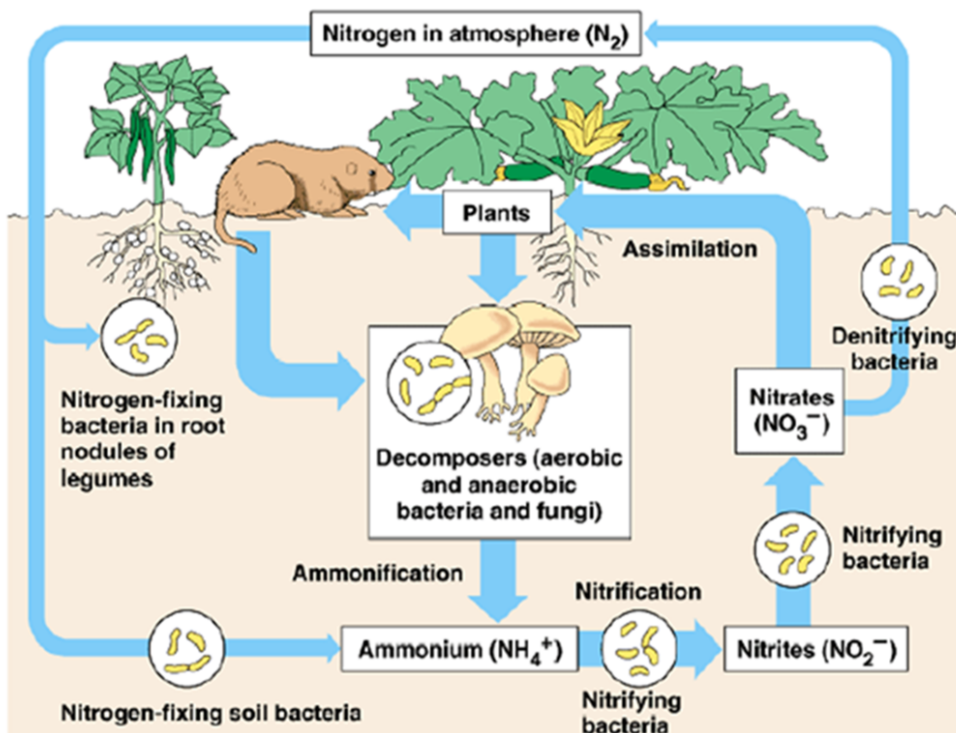


The Nitrogen Cycle

- the cycling of nitrogen through the biosphere
- Nitrogen is plentiful in our atmosphere as $N_{2(g)}$
- However, nitrogen can only be used by plants in the form of the **nitrate ion (NO_3^-)**
- There are two ways that nitrate is formed
 -
 -
- **nitrogen fixation** is the process in which atmospheric or dissolved nitrogen is converted into nitrate ions



Lightning

- energy from lightning produces nitrates by **combining N₂ and O₂ to make NO₃⁻**
- the nitrate ions dissolve in rain water and enter the soil where they are taken up by plant roots (assimilation)
- the plant then makes **DNA or amino acids**
- amino acids are then made into **proteins**

Nitrogen Fixing Bacteria

- some bacteria species in soil can take N₂ and make NO₃⁻ from it
- sometimes the bacteria are found in nodules on the root of the plant
- occurs in legumes; this is a symbiotic relationship



nodules on root of legume plant



nitrogen starved corn plant

Nitrogen and Decomposition

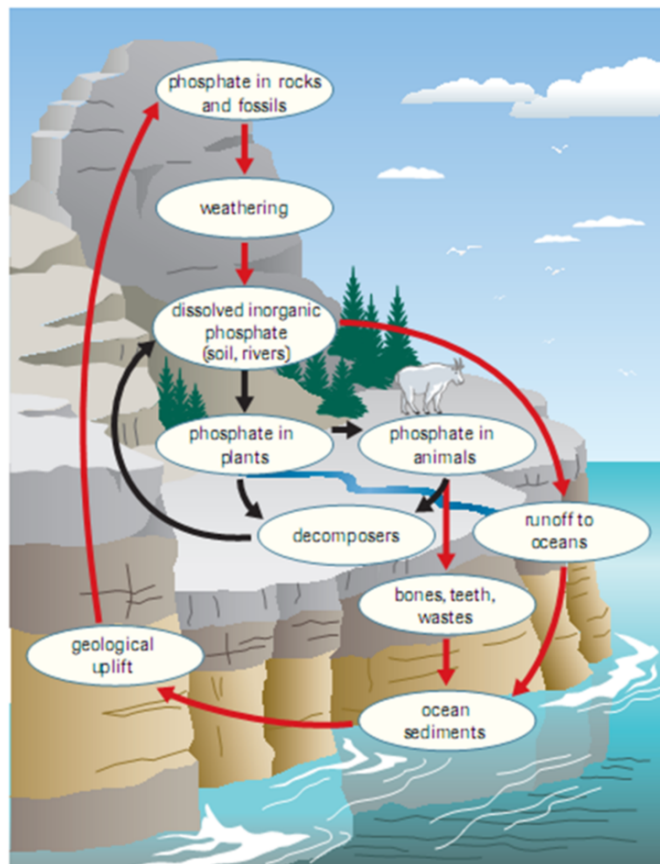
- when waste or dead matter is decomposed, the nitrogen it contains is converted back into N₂ through a series of steps called denitrification

complex nitrogen compounds in organic matter --> NH₃ --> NO₃⁻ --> NO₂⁻ --> N₂

- this is done by bacteria in the soil called denitrifying bacteria

The Phosphorous Cycle

- phosphorous is needed to make **cell membranes, ATP, DNA and the calcium phosphate in bones**
- the phosphorous cycle has 2 parts:
 - **the long cycle involving rocks of Earth's crust (red arrows)**
 - **the short cycle involving living organisms (black arrows)**



- phosphorous found in phosphates (PO_4^{3-}) in rocks gets eroded and absorbed by plants and algae
- the phosphates then get passed up the food chain
- When living organisms decompose, the phosphates can be used by photosynthesizers again or enter the long cycle and form rocks again.

Human Impacts on the Nitrogen and Phosphorous Cycle

Queson: What are some ways humans add nitrogen/phosphorous or take nitrogen/phosphorous from the ecosystem?

- Harvesng crops
 - **takes N and P in plants away from the area**
 - **leaves soil with less N and P for next growing season**

Queson: How can we fix the problem of not enough N and P in the soil?

- Adding ferlizer
 - **adds N and P, in the form of nitrates and phosphates, to soil that needs it**
 - **adding too much can make soil acidic**
 - **excess ferlizer can run off into streams and end up in lakes**
- Runoff from farm operaons
 - **manure can enter water ways and end up in lakes causing algal blooms and speed up eutrophicaon**

Queson: How can cies and towns affect the amount of N and P that may enter rivers and streams?

Nitrogen and Phosphorous Cycle Questions (Read pgs 60-65)

1. Why do the levels of nitrogen and phosphorus in fields decline when crops are harvested?
2. Explain how excess fertilizers might affect decomposing organisms.
3. (a) Why do algal blooms usually occur in spring?

(b) Explain how algal blooms affect other organisms in freshwater ecosystems.
4. What dangers do high levels of nitrates in the drinking water present for infants?
5. If a farmer does not plant a crop in one field, and then plows the field in the fall, how would this help restore nitrogen and phosphorus levels in the soil?
6. Explain why nitrogen is important to organisms.
7. If nearly 79 % of the atmosphere is nitrogen, how could there be a shortage of nitrogen in some soils?
8. How do animals obtain usable nitrogen?
9. Nitrogen-fixing bacteria are found in the roots of bean plants. Explain how the bacteria benefit the plant and how the plant benefits the bacteria.
10. Draw a diagram of the nitrogen cycle for a farm or garden where manure is used.

11. Explain why it is a good practice to aerate lawns.
12. Explain why phosphorus is important to living things.
13. Some farmers alternate crops that require rich supplies of nitrogen, such as corn, with alfalfa. Alfalfa is usually less valuable in the marketplace than corn. Why would farmers plant a crop that provides less economic value?
14. Explain why bogs and swamps are usually low in nitrogen.
15. Speculate about why clover would begin to grow in an older lawn. How would the presence of clover benefit the lawn?
16. Nitrate levels were analyzed from living material and soil samples in three different ecosystems (grassland, temperate rain forest, and tropical rain forest) in the same month. To determine the mass of nitrates in living things, all living plant matter was collected in a study area and the levels of nitrates were determined. The same analysis was conducted for the top layer of soil. The results are listed in Table 1, where each ecosystem is identified by a number.

Table 1 Nitrate Content of Three Ecosystems

Study area	Soil nitrates (kg/ha)	Biomass nitrates (kg/ha)	Soil temperature (°C)
1	30	90	25
2	10	175	19
3	2	270	30
tundra	?	?	?

- (a) In which community does nitrogen cycle most rapidly? Explain your conclusion.
 - (b) Which ecosystem (grassland, temperate rain forest, and tropical rain forest) is study area 1, 2, and 3? Give reasons for your answers.
 - (c) Speculate about the data that might be collected from a tundra ecosystem. Explain your prediction.
17. How is the water cycle important in the cycling of nitrogen and phosphorus?
 18. People have used fertilizers for a long time. Explain why we must begin changing our views on the use of fertilizers so the ecosystems we live in will be sustainable. Why