

## 2.2 Nutrient Cycles in Ecosystems

**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**

**C**

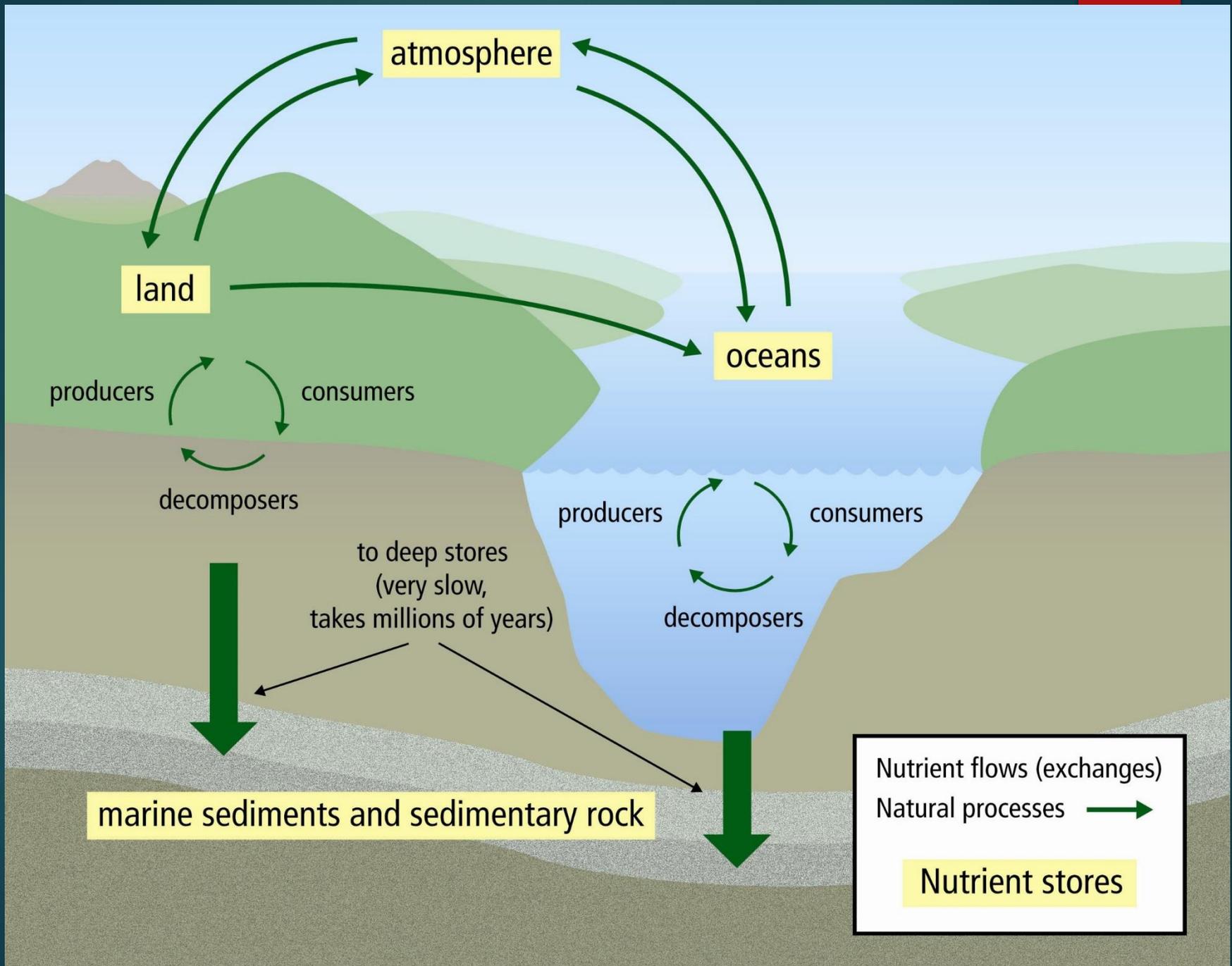
**N**

**P**

**HYDROGEN AND OXYGEN**

**H**

**O**



# CARBON CYCLE



## A. Carbon Facts:

- ▶ Carbon is found in all living matter.
- ▶ Places that carbon is found are called stores or sinks

Short-term Stores	Long-term Stores
Living things in water and on land	Underground (oil, gas, natural gas and coal)
Rotting tissue of plants/ animals	Sedimentary rock (limestone: $\text{CaCO}_3$ )
Atmosphere (air)	Ocean floor (old shells)
Ocean (dissolved in water)	

## 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 or Rotting**

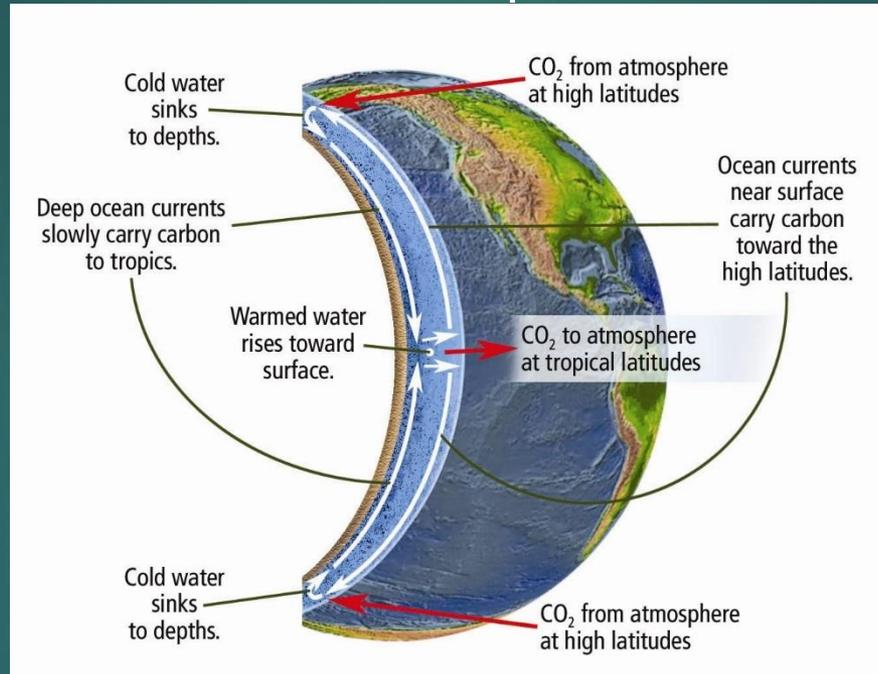
(by bacteria/fungi)



## 4. : Ocean Processes

**Ocean mixing** moves  $\text{CO}_2$  around the world

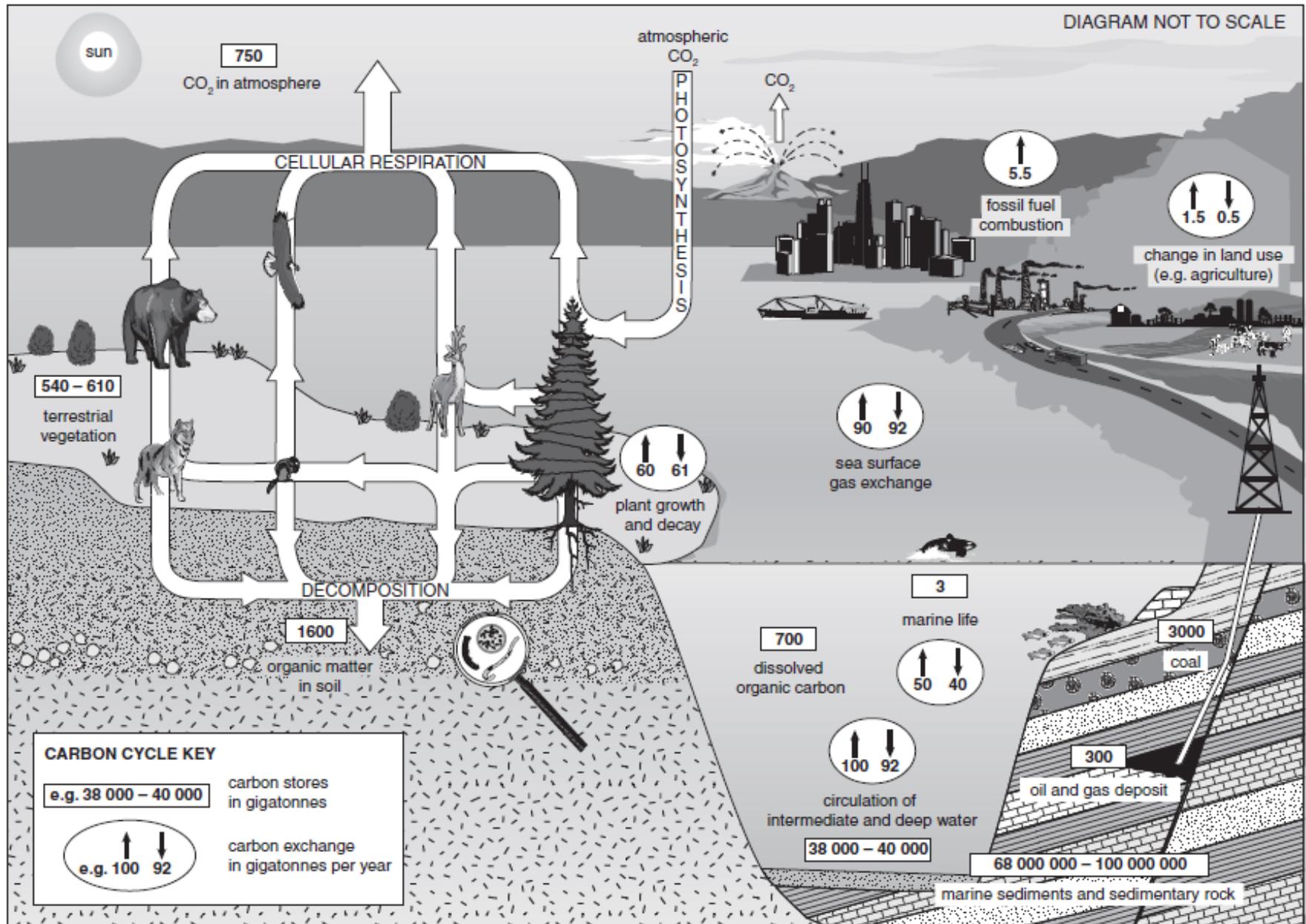
-  $\text{CO}_2$  sinks in cold ocean waters → flows to the warm equator and evaporates into the air.



**5. Combustion:** burning, engines, volcanoes, forest fires  
fossil fuels +  $\text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{ENERGY}$   
(oil, gas, natural gas, coal)



# THE CARBON CYCLE



Different sources will provide varying information.

# Human Activities & CO<sub>2</sub>

## 1. Burning Fossil Fuels

- CO<sub>2</sub> 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<sub>2</sub> is also a **greenhouse gas** and traps heat in atmosphere

## 2. Removing Trees

- Trees absorb CO<sub>2</sub>, so when they are cut down, CO<sub>2</sub> is released into the air.
- Other crops don't remove as much CO<sub>2</sub>

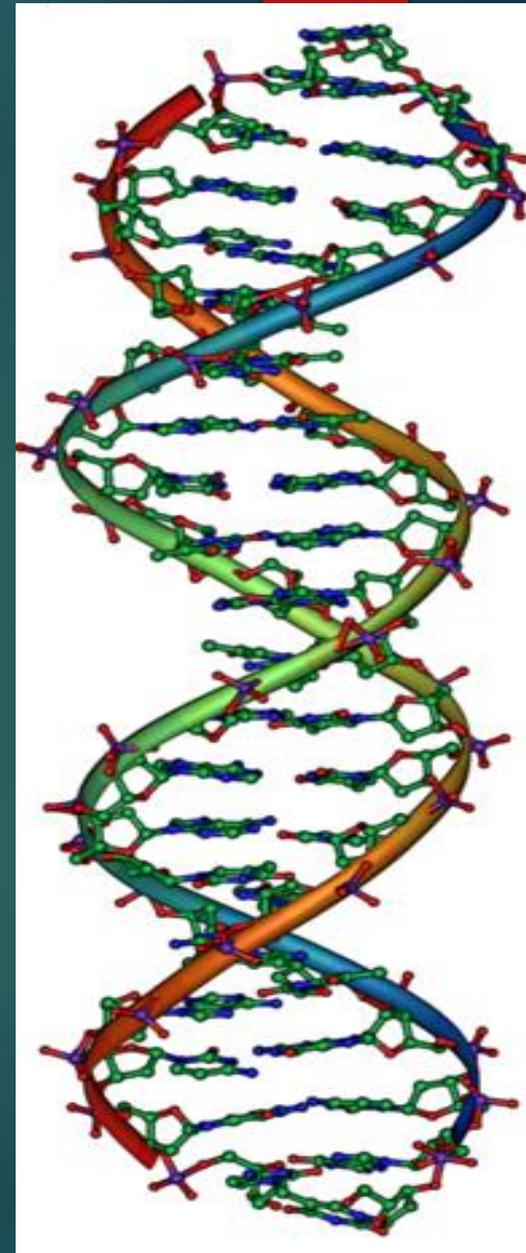
# Nitrogen Cycle

## A. Nitrogen Facts

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

## Where is Nitrogen Found?

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



## B. How Nitrogen Changes Form:

- $\text{N}_2$  is not usable by plants or animals, so it has to be converted to other forms ( $\text{NH}_4^+$  and  $\text{NO}_3^-$ ).
- Plants can use  $\text{NO}_3^-$  (nitrate) and  $\text{NH}_4^+$  (ammonium)

### 1. Nitrogen Fixation

- ▶ Lightning changes  $\text{N}_2$  (nitrogen gas)  $\rightarrow$   $\text{NO}_3^-$  (nitrate)

Rain washes nitrate into soil. (small amount)

- ▶ Bacteria in soil (*rhizobium*) & cyanobacteria in water

change  $\text{N}_2$  (nitrogen gas)  $\rightarrow$   $\text{NH}_4^+$  (ammonium)

## 2. Nitrification (done by nitrifying bacteria)



## 3. Uptake

$\text{NO}_3^-$  is sucked into plants & used for growth.

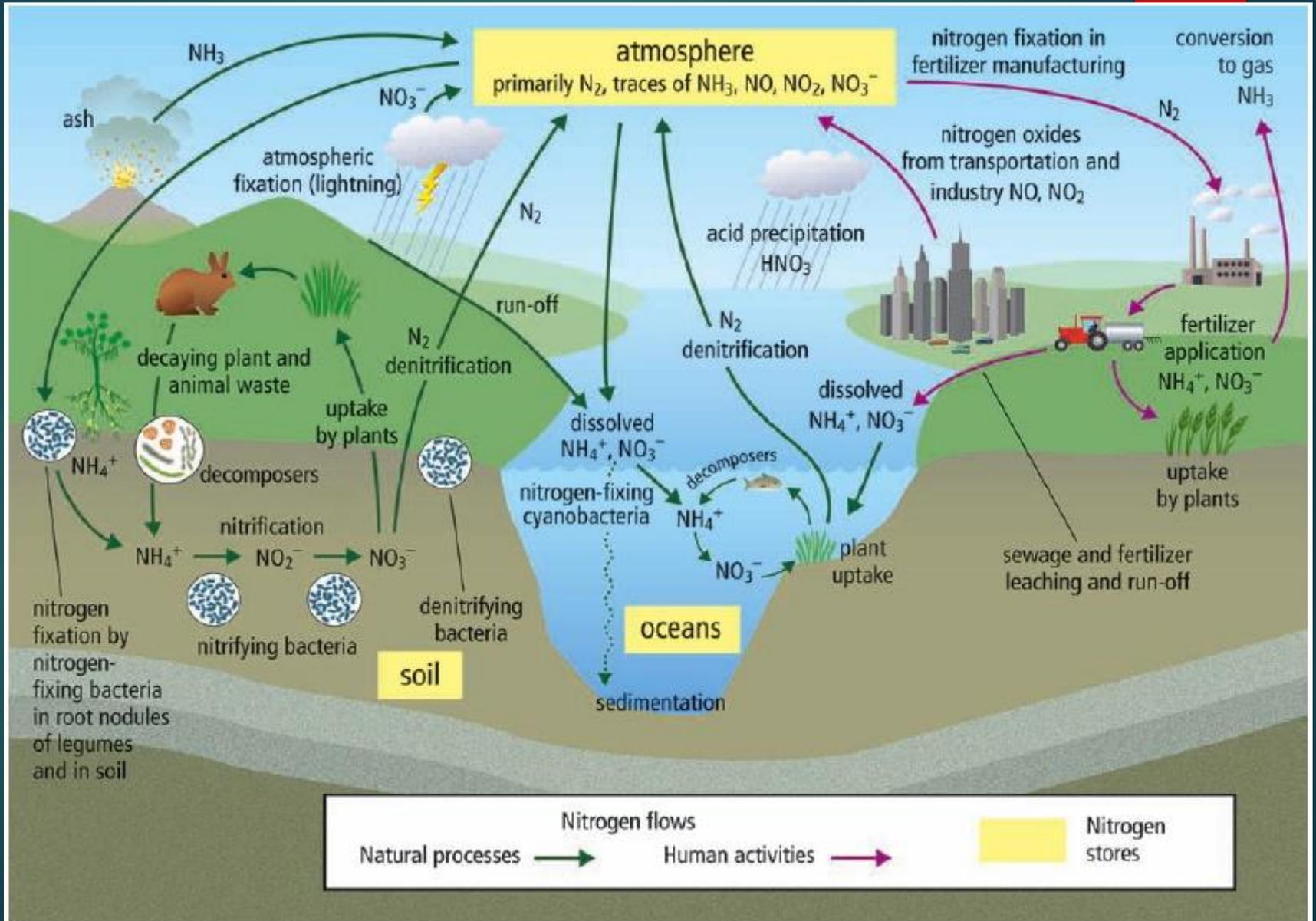
Herbivores eat plants & use **N** for making proteins & **DNA**.

## 4. Denitrification

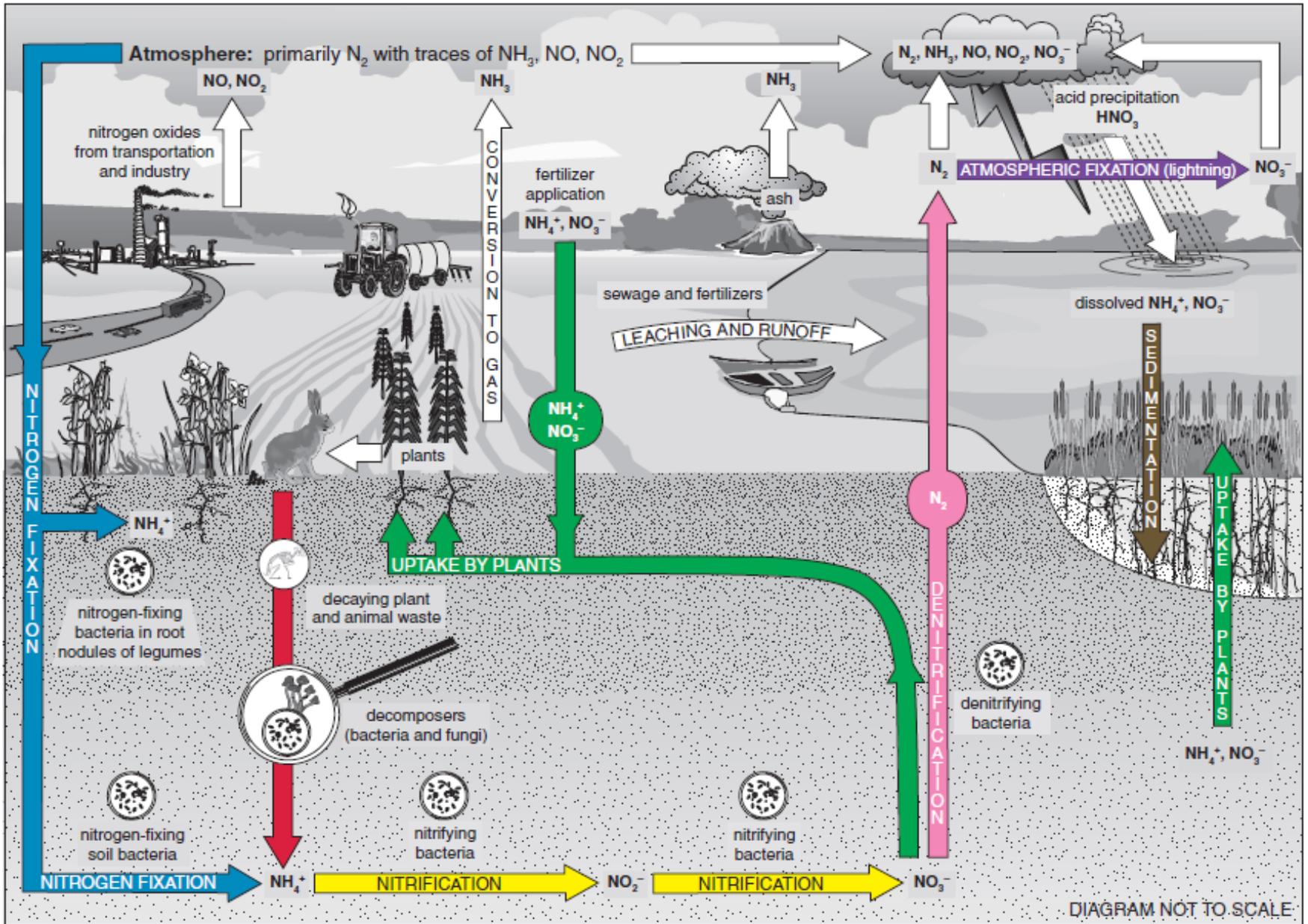
(done by denitrifying bacteria & volcanic eruptions)



# Nitrogen Cycle



# THE NITROGEN CYCLE



# C. Human activities affect the nitrogen cycle

*The amount of nitrogen in the ecosystem has doubled in 50 years due to:*

1. **Burning fossil fuels** & sewage treatment
  - ▶ NO & **NO<sub>2</sub>** are byproducts
2. **Land-clearing** by burning
  - ▶ acid rain is formed which contains nitric acid (HNO<sub>3</sub>)
3. **Overfertilization**
  - ▶ **NH<sub>4</sub><sup>+</sup>** & **NO<sub>3</sub><sup>-</sup>** leach into soil & waterways
  - ▶ huge growth in aquatic algae = **eutrophication**
  - ▶ These **algal blooms** use up all **CO<sub>2</sub>** & O<sub>2</sub>, block sunlight & produce neurotoxins which poison and kill many aquatic organisms.

# The Phosphorous 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.

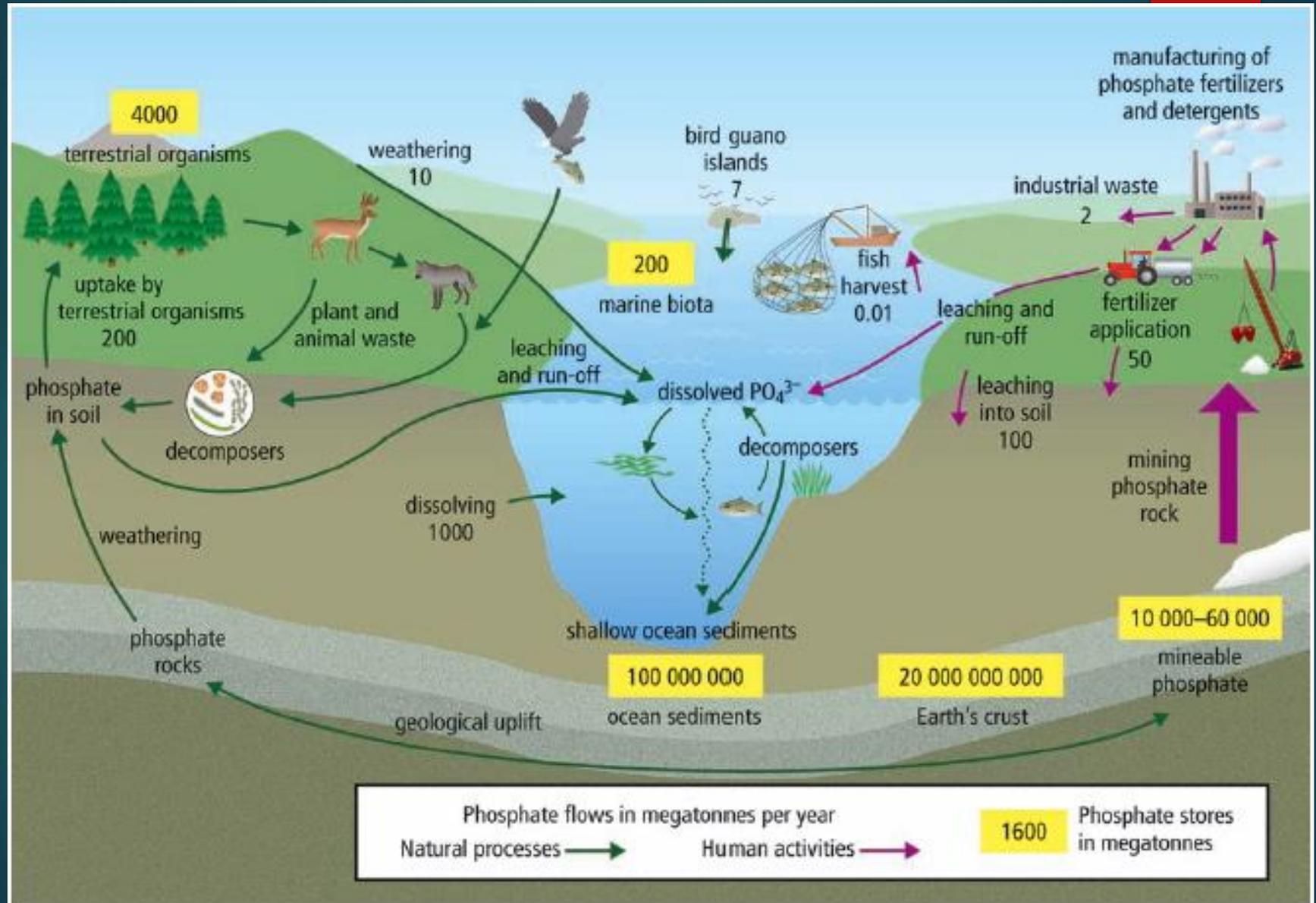
## Where is Phosphorous is Found?

- ▶ Not in atmosphere, but **in phosphate rocks** ( $\text{PO}_4^{3-}$ ,  $\text{HPO}_4^{2-}$ ,  $\text{H}_2\text{PO}_4$ ) and sediments on the ocean floor.

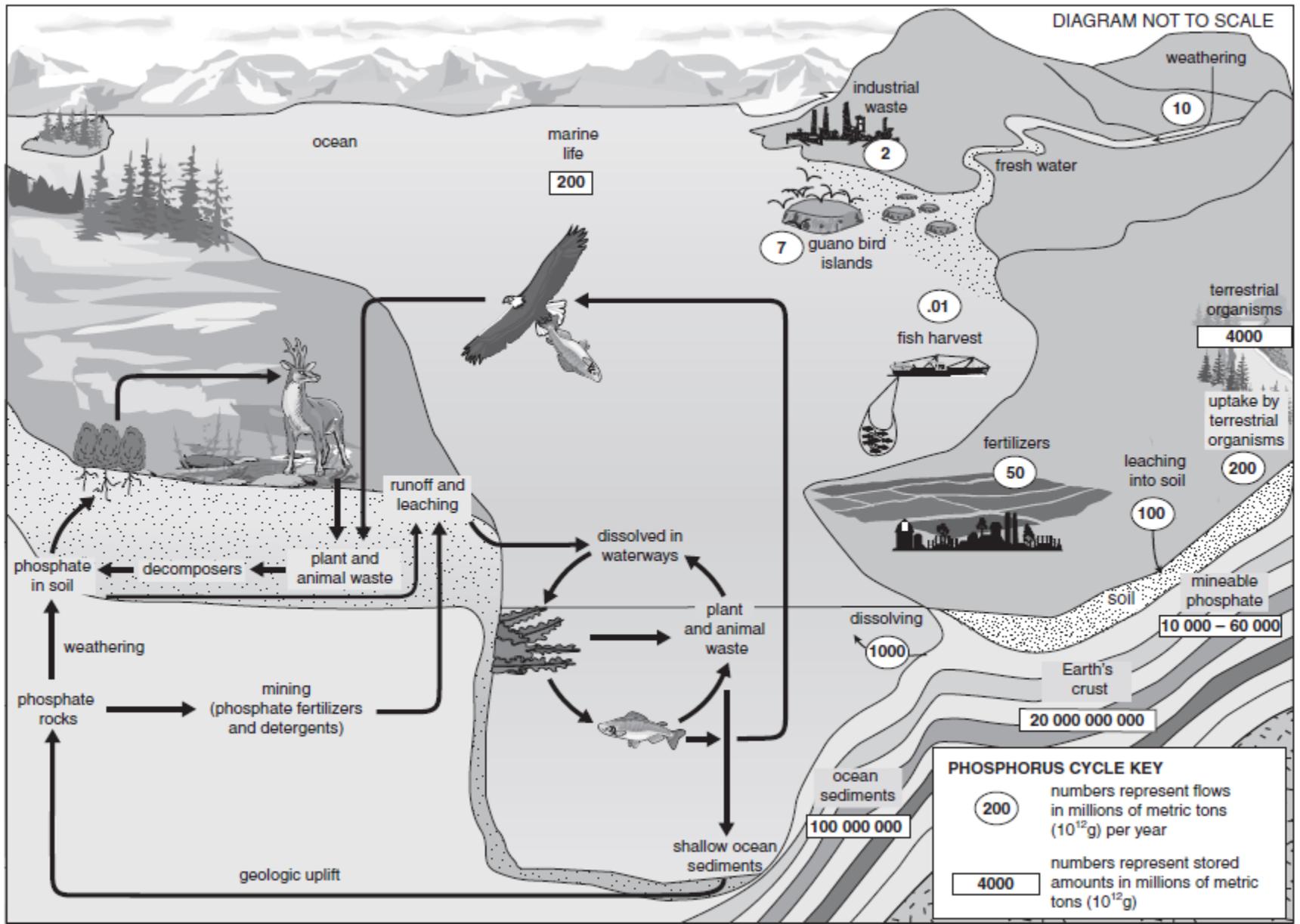
## B. How Phosphorous Changes Form

- Weathering** = *breaking down rock into smaller pieces*
  - Chemical weathering: acid rain or lichens releases  $\text{PO}_4^{3-}$
  - Physical weathering: wind, water and freezing release the  $\text{PO}_4^{3-}$  (**phosphates**)
- Uptake:** plants suck up  $\text{PO}_4^{3-}$ , then are eaten by animals.
- Decomposition:** Bacteria break down organic matter & phosphorous is returned to soil.
- Geologic Uplift:** when rocks under the ground are **pushed up → mountains → weathering**

# The Phosphorous Cycle



# THE PHOSPHORUS CYCLE



**PHOSPHORUS CYCLE KEY**

200	numbers represent flows in millions of metric tons ( $10^{12}$ g) per year
4000	numbers represent stored amounts in millions of metric tons ( $10^{12}$ g)

Different sources will provide varying information.



## C. Human activities affect the Phosphorous Cycle

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

# How Changes in Nutrient Cycles Affect Biodiversity

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

1. **Carbon cycle** changes → 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)