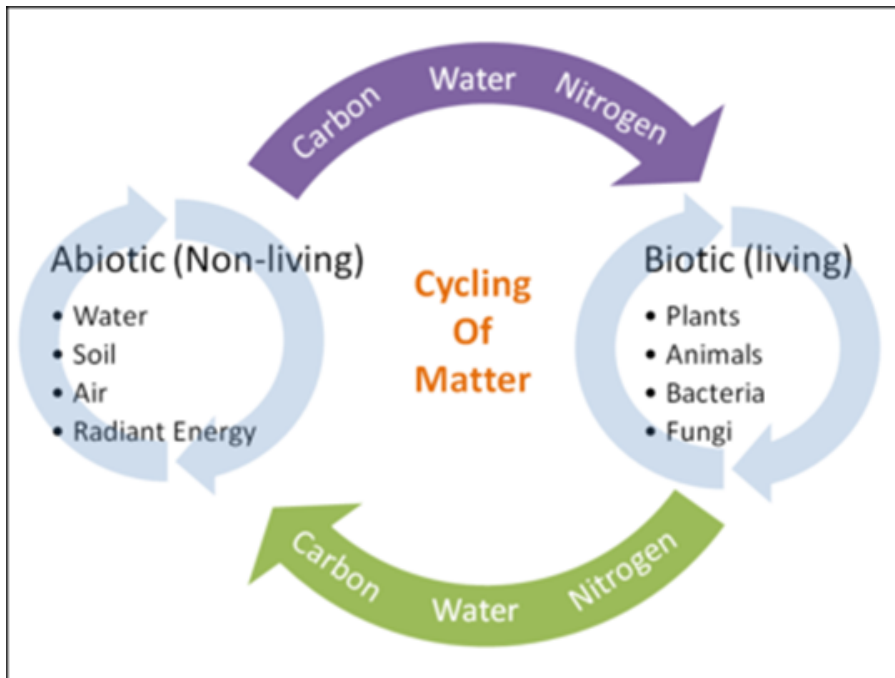


## Outcome 2 – Cycling of Matter in the Biosphere

**Big Picture: Earth is a closed system and the matter found in the biosphere cycles from biotic to abiotic components of the biosphere**



### Concept 1: Biogeochemical Cycles

#### **Curriculum Connections**

20–A2.1k explain and summarize the biogeochemical cycling of carbon, oxygen, nitrogen and phosphorus and relate this to general reuse of all matter in the biosphere

20–A2.2k explain water’s primary role in the biogeochemical cycles, considering its chemical and physical properties; i.e., universal solvent, hydrogen bonding.

#### **Main Questions**

1. What is a **Biogeochemical Cycle**
2. How do the **biogeochemical cycles** work

#### Question 1: What is a biogeochemical cycle?

**Biogeochemical cycle** - the pathway that a molecule or element takes through the biotic and abiotic components of an ecosystem

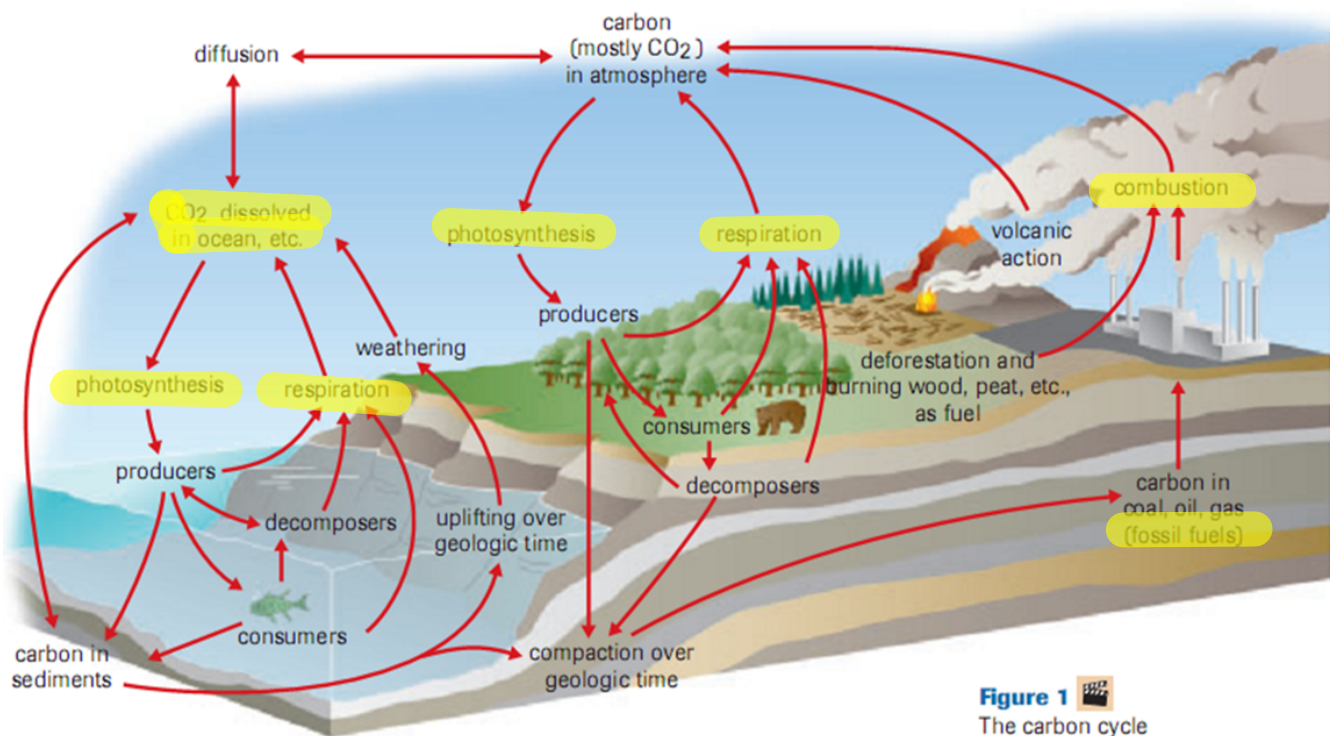
There are 4 biogeochemical cycles we will examine:

- Carbon cycle**
- Oxygen cycle**
- Nitrogen cycle**
- Phosphorous cycle**

## Question 2: How do the Biogeochemical Cycles Work?

### The Carbon Cycle

- the carbon cycle is the movement of carbon from an inorganic form (carbon in ionic compounds) to an organic form (carbon in molecules made by living things), then back again
- organic carbon is found in living things or once living (decomposing) things
- most organic carbon in living things is returned to the atmosphere as CO<sub>2</sub> from body waste and decay
- some is delayed and forms fossil fuels (coal, oil, natural gas)
- this carbon is returned when it is burned (combustion)

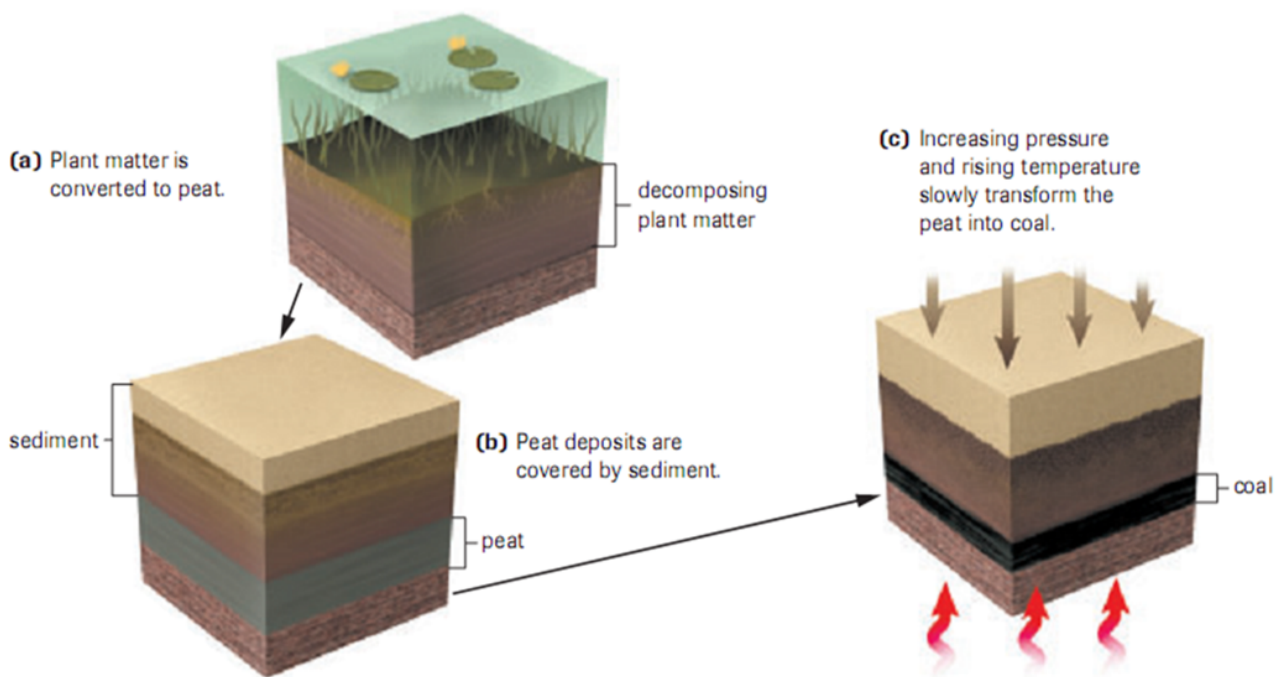


## Inorganic Carbon Reservoirs

- inorganic carbon is found in 3 main reservoirs
  - ↳ not in living things
  - atmosphere as  $\text{CO}_{2(g)}$
  - the oceans as dissolved  $\text{CO}_2$ 
    - some of this forms  $\text{CaCO}_3$  which is used by organisms to make shells
  - the earth's crust as limestone (this is the largest reservoir)
    - carbon is held here for millions of years
    - limestone is made from the shells of living organisms

## Organic Carbon Reservoirs

- organic carbon is held in the **bodies of living things**
- when living things die, decomposers return the carbon to the air as  $\text{CO}_2$
- some dead matter gets buried in places like bogs and covered in sediment
- over millions of years the organic carbon in dead matter is converted to fossil fuels

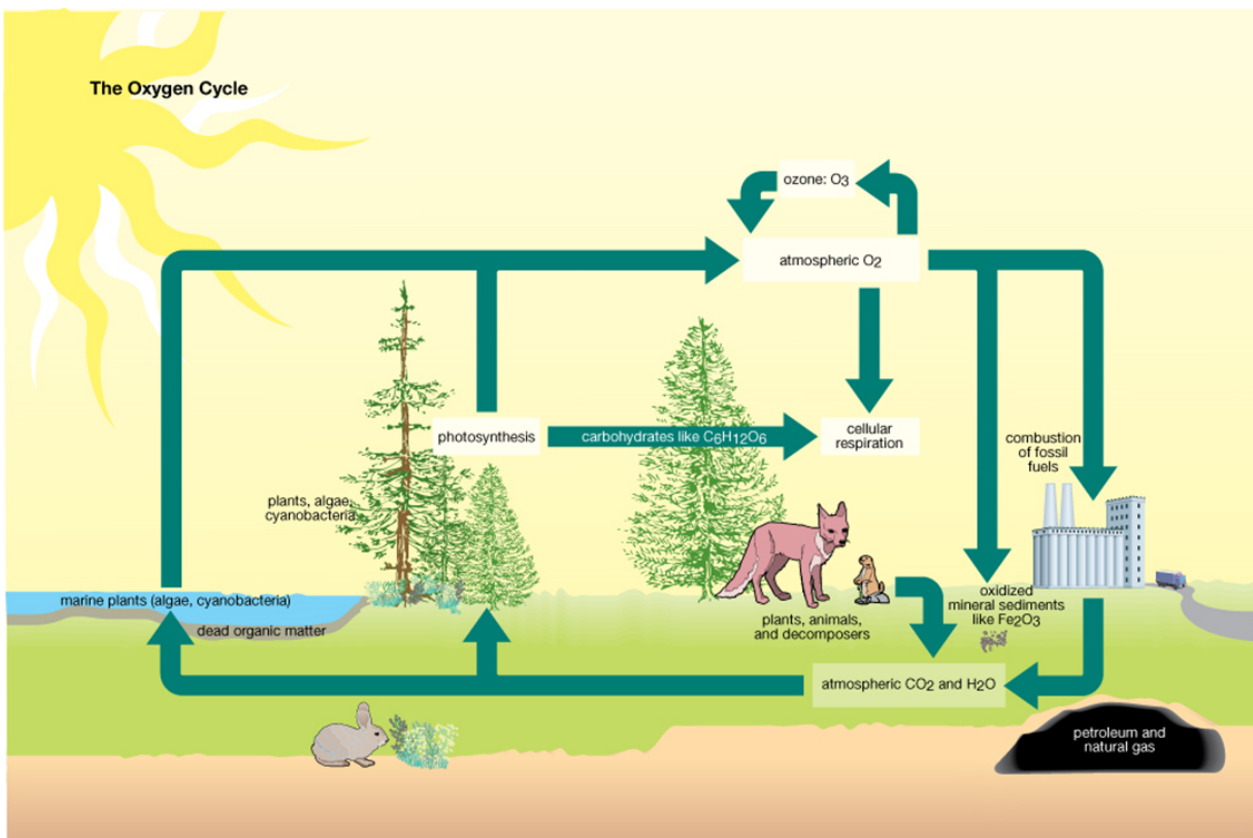


**Figure 3**

Coal is a reservoir of organic carbon that can be stored in Earth's crust for millions of years before cycling again into carbon dioxide.

## The Oxygen Cycle

- describes the movement of oxygen within its three main reservoirs: the atmosphere (air), the total content of biological matter within the biosphere (the global sum of all ecosystems), and the lithosphere (Earth's crust).
- The oxygen cycle has much in common with the carbon cycle
  - o the sinks for carbon are the sources for oxygen, and vice versa.
  - o In both cases, the main processes responsible for cycling through ecosystems are photosynthesis and cellular respiration.
- total oxygen system also involves the cycling of other nutrients, such as sulfur, phosphorus, and nitrogen
  - o to simplify the diagram below only shows the connection with carbon



## Carbon and Oxygen Cycle Questions

Read pgs 49-54

1. Explain the importance of decomposers in the carbon cycle.
2. The oceans are often described as a carbon reservoir. In what ways is carbon held within the oceans?
3. Explain how the burning of fossil fuels by humans affects the carbon cycle.
4. Carbon cycles more quickly through some ecosystems than others.
  - (a) Explain why carbon is cycled more slowly in northern ecosystems than in the tropics.
  - (b) Explain why carbon is cycled more rapidly in grassland communities than in peat bogs and swamps.

**Table 1** Carbon Cycle

Carbon movement	Mass of carbon per year ( $10^{13}$ kg)
from atmosphere to plants	120
from atmosphere to oceans	107
to atmosphere from oceans	105
to atmosphere from soil	60
to atmosphere from plants	60
to atmosphere from burning of fossil fuels	5
to atmosphere from net burning of plants	2
to oceans from runoff	0.4

5. Study Table 1
  - (a) Calculate the amount of carbon entering the atmosphere as carbon dioxide every year and the amount of carbon leaving the atmosphere. Is atmospheric carbon dioxide increasing or decreasing?
    - (b) Draw a bar graph showing factors that increase and decrease atmospheric carbon dioxide levels.
    - (c) The burning of forests contributes 2 1013 kg of carbon yearly, but its impact on creating a carbon imbalance is even greater than the carbon dioxide released from the burning plants. What other factor would be affected by burning forests?
    - (d) Provide a list of suggestions that would reduce the flow of carbon dioxide into the atmosphere. How would the suggestions affect your life? Which of your suggestions do you think you could help with?
6. In 2016, the provincial government of Alberta introduced a "carbon tax" on gasoline.
  - (a) Would a carbon tax reduce the amount of carbon dioxide entering the atmosphere? Give reasons for your answer.
  - (b) What businesses would be affected by the tax? Explain how they would be affected.
  - (c) What other groups or individuals would be affected by the tax? Would it apply equally and fairly to everyone?
  - (d) Based on your analysis, who would you expect to oppose the tax? Who would you expect to support the tax?

**\*\*Review from Nitrogen/Phosphorous Cycles Lesson\*\***

Where do we find a large amount of unusable nitrogen?

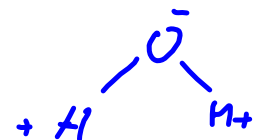
What are two ways that this nitrogen can become usable?

What takes part in the short cycle of phosphorous cycle?

**\*\*Today's Lesson\*\***

**What is Water?**

- water is a **molecular** compound made from two hydrogen atoms and one oxygen atom
- it is a **polar** molecule; it has a positive end and a negative end
- water molecules are attracted to each other by **hydrogen bonding**
- can exist as vapour, liquid or ice

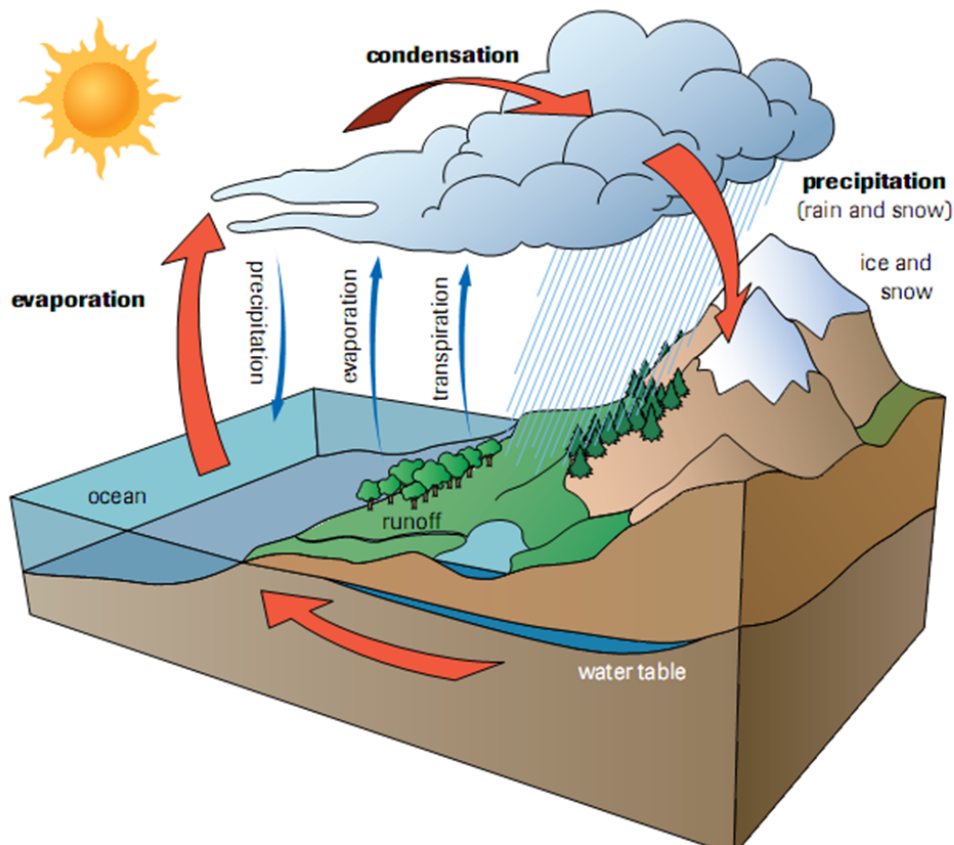


**Queson:** Why is water important?

- has the ability to absorb and release large amounts of energy
  - this helps moderate temperature fluctuations
  - desert vs. coastal temp fluctuations
- makes up over 60% of a cell's mass
- is the medium in which metabolic reactions take place
- essential to photosynthesis
  - provides oxygen atoms to make O<sub>2</sub>
  - its hydrogen atoms are used to make ATP and NADPH

## The Water Cycle

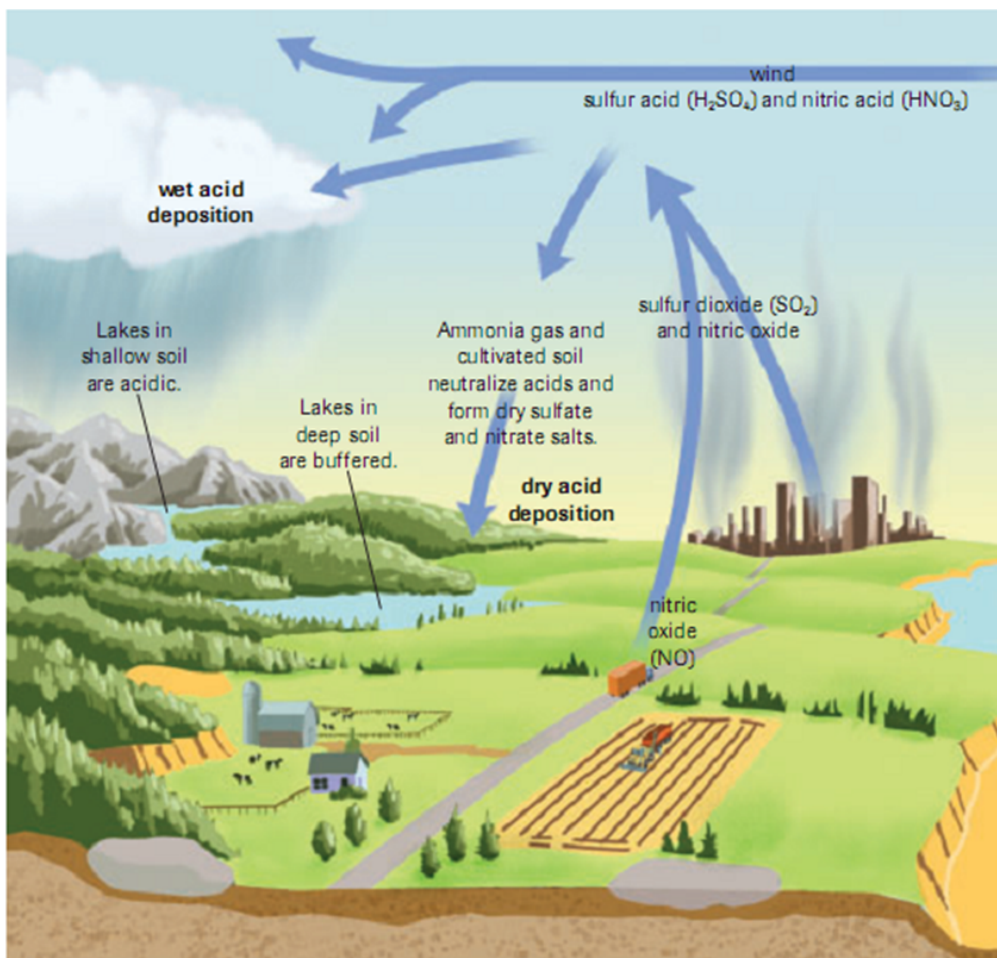
- the water cycle is also called the **hydrological** cycle
- it is the movement of water through the biosphere
- powered by the sun's energy



- **condensaon** - water vapor turning to liquid water (this forms clouds)
- **evaporaon** - when liquid water is turned to water vapor
- **transpiraon** - the loss of water through plant leaves
- **precipitaon** - water falling to earth's surface as rain, snow, sleet or hail
- **runoff** - water that travels over the surface into river, lakes or oceans
- **ground water** - water that sinks below the surface through permeable rock
- **surface water** - water that collects above the ground

## Acid Rain (Acid Deposition)

Queson: What causes acid rain?





### **The Role of Water in Nutrient Cycles**

- In the nitrogen and phosphorous cycle,
  - water erodes rocks releasing phosphates
  - carries nitrates and phosphates into the soil
  - enables roots to absorb nitrates and phosphates
  - leaches nitrogen and phosphorous from the soil in wet ecosystems
- In the carbon and oxygen cycle,
  - water dissolves  $\text{CO}_2$  and  $\text{O}_2$ , making it available to aquatic organisms
  - ocean water stores  $\text{CO}_2$
  - water is essential to photosynthesis and cellular respiration