Objectives:

Outline biogeochemical cycles.

Warm Up:

Water cycle: What effect have people had on the water cycle?

http://earthobservatory.nasa.gov/IOTD/view.php?id=52059

Water cycle video.

Human effects on the water cycle:
Pollution
Diversion/Use – 80% of water is used for agriculture.
Aquifer depletion.
Heating
Acidification
Global Climate Change:

A. **More evaporation**
B. **Change in precipitation patterns.**
C. **Sea surface warming**
D. **Less snow pack**
E. **Less polar ice and sea ice**

CARBON CYCLE

12H20 + 6CO2 + sunlight (visible light energy) → C6H12O6 + 6O2 photosynthesis

C6H12O6 + 6O2 → 12H2O + 6CO2 + ATP (energy rich chemical compound) respiration.

Thus trees (autrophs) & heterotrophs, phytoplankton & the water in the oceans become important “sinks” of carbon dioxide (a greenhouse gas)

2. Dissolved into the world’s oceans AND where it is used to make $CaCO_3$ (Calcium carbonate – sea shells or limestone.) The LARGEST sink is this limestone!

Carbon dioxide is released:

1. Burning in cellular respiration, which includes decomposition.

2. Burning of fossil fuels or wood.

EPA water cycle

Objectives:

Discuss the nitrogen, phosphorus and sulfur cycles and human impact on each.

Warm Up;

How have humans impacted the carbon cycle?

NITROGEN CYCLE

Nitrogen cycle animation

1. **Nitrogen Fixation**: converts gaseous nitrogen (N_2) into ammonia (NH_3). Certain bacterial species, both aerobic and anaerobic, carry out this conversion.

2. **Nitrification**: only certain bacteria, the nitrifying bacteria, can use NH_3 as an energy source. The reaction occurs in two steps:

1. ***Nitrosomonas*** bacteria convert ammonia (NH_3) to nitrite (NO_2^-)

2. ***Nitrobacter*** bacteria convert nitrite (NO_2-) to nitrate (NO_3^-)

3. Denitrification**: bacteria that can respire anaerobically will convert nitrate (NO_3^-) to nitrite (NO_2^-). Note that nitrate is now serving as an electron acceptor. Some anaerobic respirers can also use nitrite (NO_2^-), converting it further into nitrous oxide (NO), nitrogen dioxide (N_2O), and ultimately nitrogen gas (N_2).** . Therefore plants compete with denitrifying bacteria for nitrates.

4.Assimilation: ammonia can be directly assimilated into organic compounds inside cells, producing amino groups (-NH_2).

5.Excretion: during excretion, fermentation, and other catabolic processes, excess amino groups (-NH_2) are released, ultimately producing ammonia (NH_3).

6. Assimilatory Nitrate Reduction: since nitrate (NO_3^-) is far more common than ammonia, many organisms can only acquire nitrogen in the form of nitrate. They must reduce nitrate to form the amino groups needed for metabolism. This process, which superficially resembles nitrate reduction by anaerobic respiration, is entirely different.

This nitrate is absorbed by plants and then reduced to NH_4+, which is used by the producer to make amino acids for proteins.Ammonia, ammonium & nitrate fertilizers are added to soil.

NITROGEN IS RETURNED TO THE ATMOSPHERE -Denitrifying bacteria break down nitrates into N_2 and N_2O_2 (nitrous oxide – a greenhouse gas), which are gasses.

HUMANS: By using synthetic fertilizers, cultivating nitrogen-fixing crops & burning fossil fuels, we now convert more nitrogen to ammonia & nitrates than all natural land processes combines.

Nitrogen released into the atmosphere reacts with water to form Nitric acid which is one form of acid precipitation.

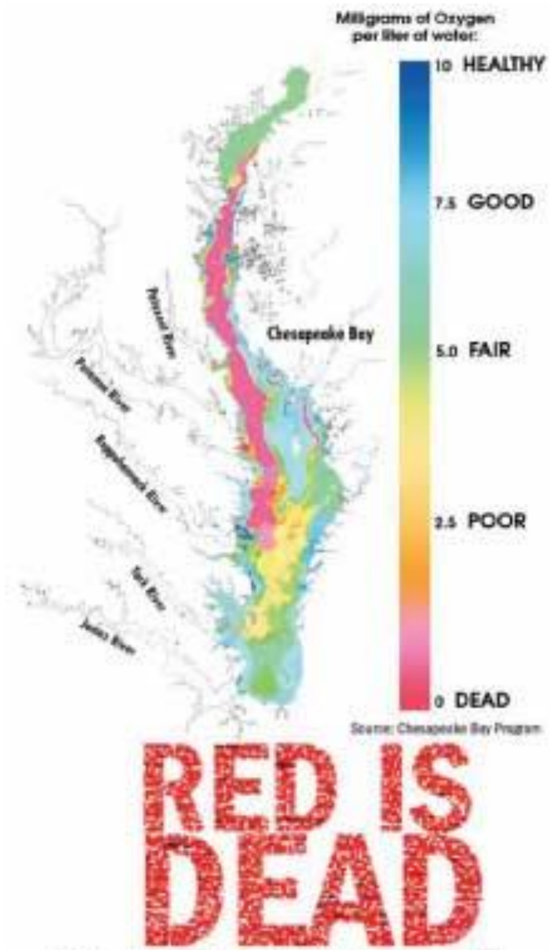
Nitrogen washing into water fertilizes the water causing eutrophication (dead zones).

Eutrophication:

A. Fertilizer washes into water.

B. Algae blooms occur.

C. Decay of dying algae uses up oxygen creating dead zone.



In August 2005, 41 percent of the Bay's main stem had too little oxygen to support a healthy ecosystem.

PHOSPHORUS CYCLE

Phosphorus released from rocks by leaching and is dissolved in water. (Used in nucleic acids & energy rich compounds like ADP and ATP.)

Phosphorus is returned to rocks & minerals by decomposition. Phosphorus has no atmospheric form. It is washed out into the oceans where it remains for millennia.

HUMANS:

Excess phosphates cause explosive algae & photosynthetic bacteria growths.

SULFUR

Sulfur in rocks & minerals (Pyrite & gypsum) is released into air & water by weathering, emissions from deep seafloor vents & volcanic eruptions.

Sulfur in living things (part of proteins) is released by decomposition. Sulfur is present in many forms:

Hydrogen sulfide (H_2S), Sulfate ion (SO_4^{-2}), sulfur (S).

Dimethylsulfide (DMS), produced by single-celled ocean creatures in warm water, is converted to SO2 and then to SO4, which act as cloud droplets and therefore cools the surface. This is a negative feedback mechanism; warmer water greater production of DMS cooling.

HUMANS

Total yearly anthropogenic sulfur emissions rival those of natural processes.

Sulfuric acid produced when fossil fuels (mainly coal) are burned causes acid rain.