Earth Systems
Sphere Interactions
Open vs. Closed System

• Open System – a system in which both energy and matter are exchanged with the surroundings.

• Closed System – a system in which energy, but not matter, is exchanged with the surroundings.
Earth as Closed System
Earth as Closed System

• Earth is a system of matter (stuff) and energy (ability to do work)

• Earth is a closed system because matter does not enter or exit the system but energy does.

Sealed Jar vs. Aquarium
Earth’s 4 Spheres

- Matter on Earth is liquid, solid, or gas

- Earth’s 4 spheres “store” matter
  1. Atmosphere
  2. Hydrosphere
  3. Geosphere
  4. Biosphere
Atmosphere

- Gases that surround Earth’s surface
- Provides air we breathe
  (78% Nitrogen, 21% Oxygen, 1% Other)
- Protects from sun’s harmful radiation
- Burns up meteoroids
- Keeps us warm
Hydrosphere

• Earth’s water (except in gaseous form) 
  (97% salt water, 3% Freshwater)

• Oceans, lakes, rivers, glaciers, polar ice sheets, etc.
Geosphere

• Mostly solid part of Earth
• Sometimes referred to as Lithosphere
• Rock and soil on Earth’s surface and on ocean floor
• Solid and molten (liquid) interior
Biosphere

• All forms of life in geosphere, hydrosphere, and atmosphere

• Extends from deepest part of oceans to atmosphere
Earth’s Four Spheres
The names of Earth’s four spheres are derived from ancient Greek. The Greek word for “ball” is *spharia*, from which the word *sphere* is derived. The Greek roots are:

- **Atmos** = vapor
- **Hydro** = water
- **Geo** = Earth
- **Bios** = Life
Interactions of Four Spheres

• Earth itself is a closed system

• Four spheres are open systems
  – Matter and energy are constantly exchanged between the spheres via
    • Chemical reactions, radioactive decay, radiation (light and heat), growth and decay of organisms

• Matter and energy move between spheres in order to complete certain cycles in Earth’s system
  – Energy, water, nitrogen, carbon, phosphorous, and rock cycles
Interactions of Four Spheres

• Spheres are closely connected
  – Birds (biosphere) fly through air (atmosphere)
  – Water (hydrosphere) flows through soil (geosphere)
  – Dogs (biosphere) drink water (hydrosphere)
  – Other examples?
Energy Cycle

Energy from the Sun is taken up by the plants, which absorb that energy in their chloroplasts.

Energy used in chloroplasts to create ordered, energy-rich sugar molecules.

Plants can reuse these products with the input of energy from the Sun.

In the process, they convert the highly ordered sugars into carbon dioxide and water, a disorganized form.

Sugars available to plants to use for their own purposes.

Sugars also available to the animals for food.

Animals use the sugars to produce their own "energy currency" through the mitochondria.

ATP: The energy source for animal life processes.
Water Cycle

[Diagram showing the water cycle: condensation, precipitation, evapotranspiration, runoff]
Nitrogen Cycle
Carbon Cycle
Rock Cycle

- Sedimentary rock
  - Erosion, deposition, and cementation
  - Melting and cooling
- Metamorphic rock
  - Changing temperature and pressure
- Igneous rock
  - Changing temperature and pressure