2.2 – Guided Notes

Objectives

- Compare an open system with a closed system.
- List the characteristics of Earth's four major spheres.
- Identify the two main sources of energy in the Earth system.
- Identify four processes in which matter and energy cycle on Earth.

Earth-System Science

- Some Earth scientists combine knowledge of several fields of Earth science in order to study Earth as a _____.
- **System -** a set of _____ or interacting components considered to be a distinct physical _____ for the purpose of study
- All systems have _____, and many systems have matter and energy that flow though them.
- Even though each system can be described separately, all systems are _____. A large and complex system, such as the Earth system, operates as a result of the combination of smaller, interrelated systems.
- The operation of the Earth system is a result of interaction between the two most basic components of the universe: _____ and _____.
- _____ is anything that has mass and takes up space.
- _____ is defined as the ability to do work. Energy can be transferred in a variety of forms, including heat, light, vibrations, or electromagnetic waves.
- A system can be described by the way that matter and energy are _____ within the system or to and from other systems.

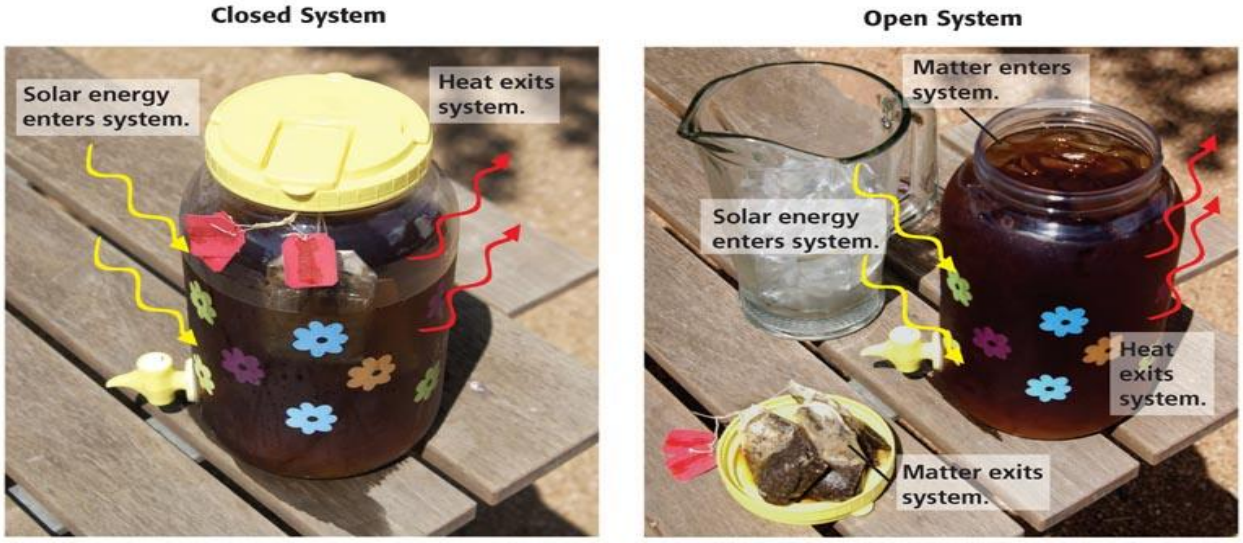
Closed Systems

- A closed system is a system in which _____, but not _____ is exchanged with the surroundings.

Open Systems

- An open system is a system in which both _____ and _____ are exchanged with the surroundings.

The figure below compares open and closed systems.



The Earth System

- Technically, all systems that make up the Earth system are _____.
- However, the Earth system is almost a closed system because matter exchange is _____.
- Energy enters the system in the form of _____ and is released into space as _____.
- Only a small amount of _____ and _____ from space enters the system, and only a fraction of the _____ atoms in the atmosphere escape into space.

Earth's Four Spheres

- Matter on Earth is in _____, _____, and _____ states. The Earth system is composed of four "spheres" that are storehouses of all of the planet's matter.

The Atmosphere

- **atmosphere** a mixture of _____ that surrounds a planet or moon
- The atmosphere provides the air you breathe and shields Earth from the sun's harmful _____.

The Hydrosphere

- **hydrosphere** the portion of Earth that is _____
- Water covers ____% of Earth's surface.
- Water in the hydrosphere occurs in the form of oceans, lakes, rivers, streams, glaciers and ice sheets, and groundwater.

The Geosphere

- **geosphere** the mostly solid, _____ part of Earth; extends from the center of the _____ to the surface of the _____
- The geosphere includes all of the rock and _____ on the surface of the continents and on the ocean floor.
- The geosphere also includes the solid and molten _____ of Earth.

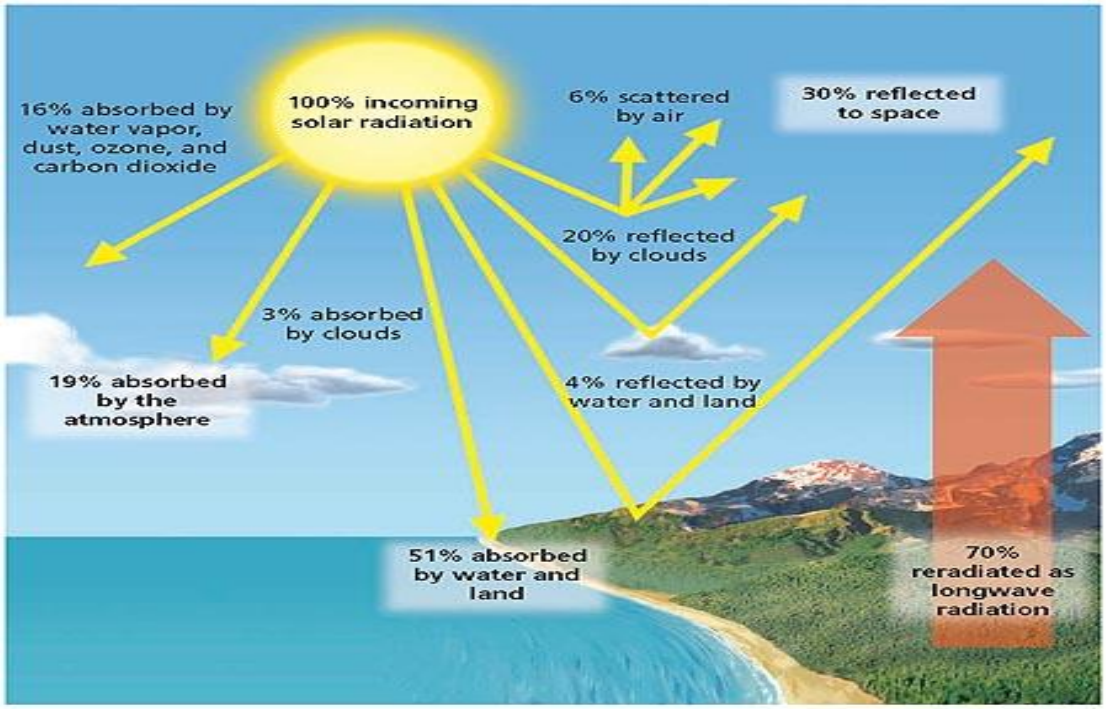
The Biosphere

- **biosphere** the part of Earth where _____ exists; includes all of the living organisms on Earth
- The biosphere is composed of all of the forms of life in the geosphere, in the hydrosphere, and in the atmosphere, as well as any _____ matter that has not decomposed.
- The biosphere extends from the deepest parts of the ocean to the _____ a few kilometers above Earth's surface.

Earth's Energy Budget

- The _____ of energy between Earth's spheres can be thought of as parts of an *energy budget*.
- The first law of _____ states that energy is transferred between systems, but it cannot be created or destroyed.
- The second law of thermodynamics states that when energy transfer occurs, matter becomes less _____ with time. Thus, the universe's energy is spread out more uniformly over time.
- The constant exchange of matter and energy between Earth's spheres happens through _____ reactions, radioactive _____, the radiation of energy, and the growth and decay of _____.

The figure below shows Earth's energy budget.



Internal Sources of Energy

- When Earth formed about 4.6 billion years ago, its interior was heated by _____ decay and _____ contraction.
- The decay of radioactive atoms still generates enough _____ to keep Earth's interior hot. Earth' interior also retains much of the energy from the planet's formation.
- By the process of _____, the heat in Earth's interior is transferred through the layers of Earth and is released at Earth's surface.

External Energy Sources

- Earth's most important external energy source is the _____.
- Solar _____ warms Earth's atmosphere and surface. This heating causes the movement of air masses, which generates _____ and ocean _____. Many chemical reactions on Earth also require _____ energy.
- Another important external source of energy is _____ energy from the moon and sun. This energy helps generate _____ that cause currents and drive the mixing of ocean water.

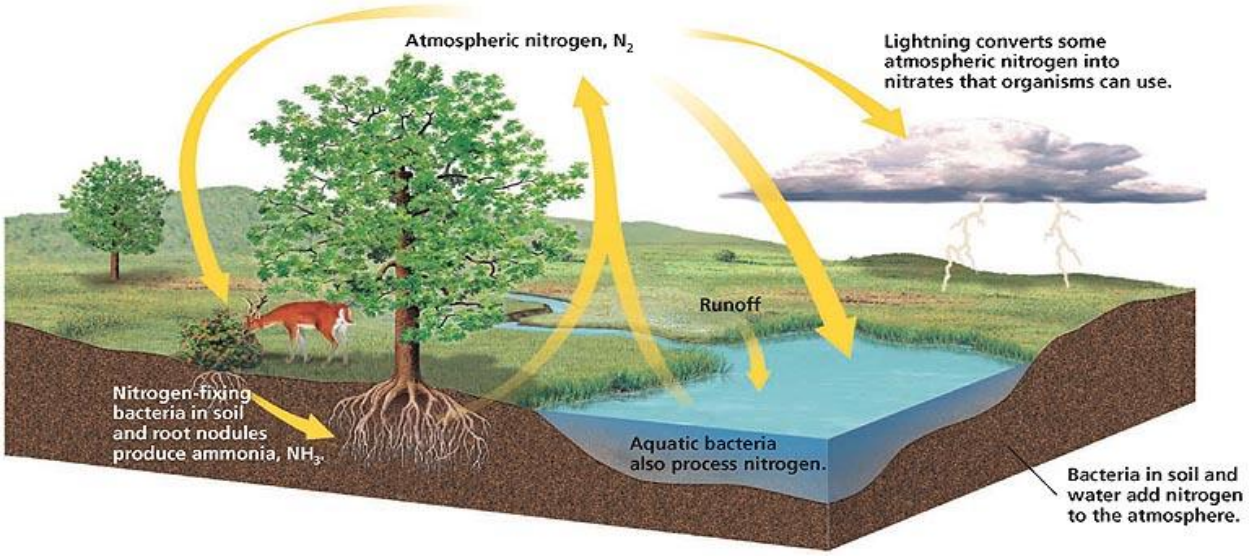
Cycles in the Earth System

- A _____ is a group of processes in which matter and energy repeatedly move through a series of reservoirs.
- A _____ is a place where matter or energy is stored.
- Many elements on Earth cycle between reservoirs. These cycles rely on _____ sources to drive them.
- The length of time that energy or matter spends in a reservoir can vary from a few hours to several million years.

The Nitrogen Cycle

- In the nitrogen cycle, nitrogen moves from the _____ to _____, from _____ to _____ and _____, and back to air again.
- Nitrogen is removed from air mainly by the action of nitrogen-fixing _____ in the soil.
- The nitrogen enters plants, which are eaten by animals. The nitrogen is returned to the soil by _____ and by animal _____.
- _____ processes that occur in the soil release the nitrogen back into the air.

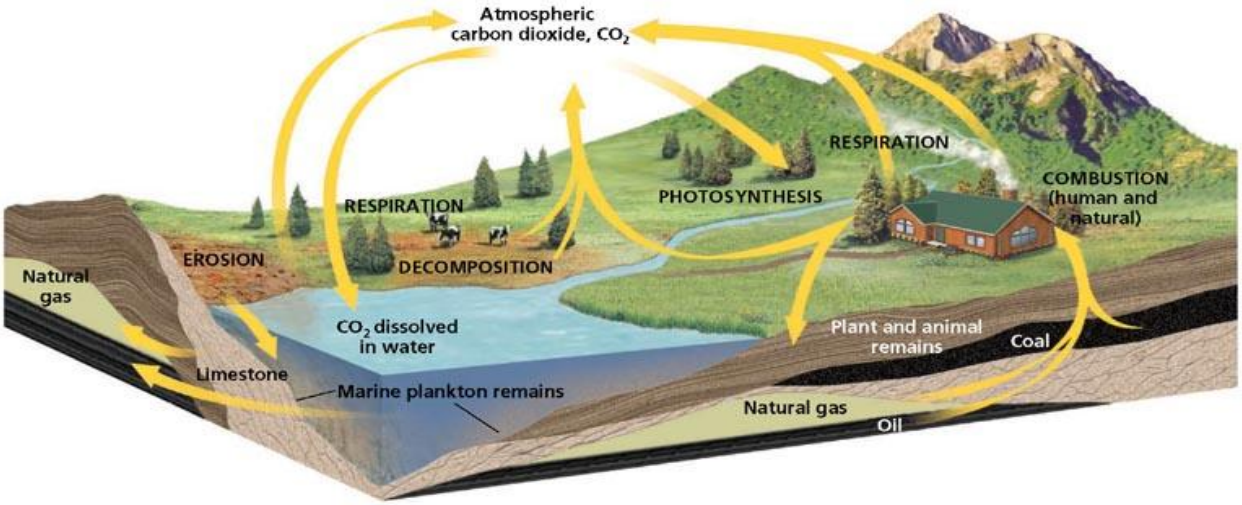
The figure below illustrates the nitrogen cycle.



The Carbon Cycle

- Carbon moves through all _____ spheres through the carbon cycle.
- In the short-term carbon cycle, _____ convert carbon dioxide, CO_2, from the atmosphere into _____. When organisms' bodies break down the carbohydrates and release some of the carbon back into the air as CO_2 or through their organic wastes as CO_2 or methane, CH_4.
- In the long-term carbon cycle, carbon is stored in the geosphere in a type of rock called a _____.

The figure below illustrates the carbon cycle.



The Phosphorus Cycle

- During the phosphorus cycle, phosphorus moves through every sphere except the _____.
- Phosphorus enters soil and water when _____ breaks down, when phosphorus in rock dissolves in water, or when organisms excrete phosphorus in their waste.
- Plants absorb phosphorus through their _____ and incorporate the phosphorus into their tissues.
- Animals absorb the phosphorus when they eat the _____. When the animals die, the phosphorus returns to the environment through _____.

The Water Cycle

- The movement of water from the _____ to Earth's _____ and back to the _____ is called the water cycle.
- In the water cycle, water changes from liquid water to water _____ through the energy transfers involved in _____ and _____. During these processes, water absorbs heat and changes into a gaseous state.
- When the water loses energy, it condenses to form water _____, such as those that form clouds and fall to Earth's surface as _____.

Humans and the Earth System

- All natural cycles can be altered by _____ activities.
- The carbon cycle is affected when humans use _____ fuels.
- The nitrogen and phosphorus cycles are affected by _____.
- Humans must be careful to moderate their _____ on natural systems.