**ECOSYSTEMS    With Scientist Cindy      www.scientistcindy.com**

   **What should you learn?**

* You should be able to…
* define ecology.
* distinguish among the following ecological levels: population, community, ecosystem, landscape, and biosphere.

**What is ecology? -** Ecology is the study of systems that include interactions among organisms and between organisms and their abiotic environment. The word   ECOLOGY means “the study of one’s house.”   **Ernst Haeckel**, a 19th-century scientist, developed the concept of ecology and named the new discipline--    *eco* from the Greek word for    “house” and logy from the Greek word for “study.”   Thus, ecology literally means “the study of one’s house.”

**The environment consists of two parts**
​       1. the biotic (living) environment
                                a. which includes all organisms
​      2.   the  abiotic (nonliving, or physical) surroundings
                                 a.      Space / territory
                                 b.     temperature
                                 c.      sunlight
                                 d.      soil
                                 e.     wind
                                 f.      precipitation

**What Do Ecologists Do?**
*Ecologists study the vast complex web of relationships among living organisms and their physical environment.*

**Ecologists look for answers to the questions:**

* why organisms are distributed the way they are
* why some species are more abundant than others
* how the ecological roles of different organisms in their environment vary
* how the interactions between organisms and their environment help to maintain the overall health of our living world.

 Can You…

* Identify the biotic factors?
* Identify the abiotic factors?
* Predict how the ecosystem would be different at high tide?
* Predict how the ecosystem would be affected after a severe flood?
* Ecology
* Ecology is the broadest field within the biological sciences, because it is linked to every other biological discipline.
* The universality of ecology links subjects that are not traditionally part of biology.
* Geology and earth science  - takes into consideration the physical environment of planet Earth.
* Chemistry - knowledge of chemistry is necessary to understand chemical reactions in the atmosphere, the soil, and living organisms (example – photosynthesis)
* Physics  - the principles of physics reveals the laws of thermodynamics.
* Sociology - Humans are biological organisms, and our activities have a bearing on ecology.
* Economics – economic dependence on industries that harm the environment such as farming, deforestation, power plants, fossil fuels etc.
* Politics have profound ecological implications – control over resources

* Levels of Organization

Ecologists study the levels of biological organization from individual organisms to the biosphere.

* The coral reef community.

This is a great example of a community.

* **What is the source of energy for all (essentially) ecosystems?**
* **The Sun** supports most of Earth's ecosystems.
* Plants create chemical energy from abiotic factors that include solar energy.
* The food energy created by producers is passed on to consumers through the **food chain**.

* **How Energy Flows Through Ecosystems**
* All living things need energy to power the processes of life.
* For example, it takes energy to grow.
* It also takes energy to produce offspring.
* In fact, it takes energy just to stay alive.
* Remember that energy can’t be created or destroyed.
* It can only change form.
* Energy changes form as it moves through ecosystems.

* **The Flow of Energy**
* Most ecosystems get their energy from the Sun.
* Only producers can use sunlight to make usable energy.
* Producers convert the sunlight into chemical energy or food.

* **The Flow of Energy – Food Chain**
* Producers – Make their own energy (food)
* Consumers – Must consume other organisms to gain energy
* In this way, energy flows from one living thing to another.

* **Food Webs**
* An Ecosystem Consists of Biotic and Abiotic Factors

* Processes of an Ecosystem
* Ecosystem processes include…
* The water cycle
* The carbon cycle
* The nitrogen cycle
* The phosphorus cycle
* The sulfur cycle
* ENERGY FLOW

These are necessary processes that must occur
In order for life to exist and persist.

* Processes of an Ecosystem

***Ecosystems have…***

* ***Energy flows***
* ***Material cycles***
* Ecosystems affect other ecosystem nearby
* LANDSCAPE = A region that includes several interacting ecosystems.
* Examples of interactions between different ecosystems in a landscape:

         1) An organism may feed in one ecosystem and build a habitat in a nearby ecosystem.

* Energy Flow
* Energy enters the biological system as light energy, or photons.
* Light energy is transformed into chemical energy by organisms through cellular processes including photosynthesis and respiration.
* Some of this energy is converted to heat energy and can no longer be recycled in the system
* Without the continued input of solar energy, biological systems would quickly shut down. Thus the earth is an ***open system*** with respect to energy.
* Energy Flow
* Photons à Producers ◊ Primary Consumers ◊ Secondary Consumers ◊ Tertiary Consumers ◊ and so on.

* Only 10% of the energy is transferred to the next level.
* BIOSPHERE
* The Biosphere includes all organisms, populations, communities, ecosystems, and landscapes on Earth, as well as the Earth’s physical environment: the atmosphere, hydrosphere, and lithosphere

* Raven, Peter H.; Hassenzahl, David M.; Hager, Mary Catherine; Gift, Nancy Y.. Environment, 9th Edition (Page 42). Wiley. Kindle Edition.
* The Biosphere includes …
* **The atmosphere**= gaseous envelope surrounding Earth
* **The hydrosphere**= Earth’s supply of water (liquid and frozen, fresh and salty, groundwater and surface water.)
* **The lithosphere**= the soil and rock of Earth’s crust.
* Energy
* Energy is the capacity or ability to do work.
* In organisms, biological processes that require energy include
* growing
* moving
* reproducing
* maintaining life processes
* repairing damaged tissues
* Energy exists in several forms:
* Chemical - Chemical energy is energy stored in the bonds of molecules; energy is released when chemical bonds are broken.
* Radiant – All forms of electromagnetic waves – solar (ultraviolet radiation, visible light, and infrared radiation), radio waves, gamma waves, microwaves, and X-rays
* Thermal - Thermal energy is heat that flows from an object with a higher temperature (the heat source) to an object with a lower temperature (the heat sink). Heat refers to the kinetic energy of the subatomic particles within the matter itself.
* Mechanical - Mechanical energy is energy involved in the movement of matter.
* Nuclear - Some of the matter contained in atomic nuclei can be converted into nuclear energy. Subatomic particles that make up the nucleus of an atom
* Electrical - Electrical energy is energy that flows as charged particles. Electrons are transferred from one metal ion to the next in a copper wire, for example.
* Kinetic – In physics, the kinetic energy of an object is the energy that it possesses due to its motion.
* Potential – energy “stored” or the ability to do work.
* The Electromagnetic Spectrum

* (a) Closed system. Energy is not exchanged between a closed system and its surroundings. A thermos bottle is an approximation of a closed system. Closed systems are rare in nature.

* Raven, Peter H.; Hassenzahl, David M.; Hager, Mary Catherine; Gift, Nancy Y.. Environment, 9th Edition (Page 44). Wiley. Kindle Edition.

* (a) Closed system. Energy is not exchanged between a closed system and its surroundings. A thermos bottle is an approximation of a closed system. Closed systems are rare in nature.

* (b) Open system. Energy is exchanged between an open system and its surroundings. Earth is an open system because it receives energy from the sun, and this energy eventually escapes Earth as it dissipates into space.
* **Thermodynamics**
* **Thermodynamics** is the branch of science concerned with heat and temperature and their relation to energy and work.
* **Thermodynamics**

**THE FIRST LAW OF THERMODYNAMICS**

* **According to the first law of thermodynamics, an organism may absorb energy from its surroundings, or it may give up some energy into its surroundings, but the total energy content of the organism and its surroundings is always the same. As far as we know, the energy present in the universe at its formation, approximately 15–20 billion years ago, equals the amount of energy present in the universe today.**

* **Raven, Peter H.; Hassenzahl, David M.; Hager, Mary Catherine; Gift, Nancy Y.. Environment, 9th Edition (Page 45). Wiley. Kindle Edition.**and work.
* **Thermodynamics**
* **THE SECOND LAW OF THERMODYNAMICS**
* **As each energy transformation occurs, some energy is changed to heat that is released into the cooler surroundings. No other organism can ever reuse this energy for biological work; it is “lost” from the biological point of view.**

* **Raven, Peter H.; Hassenzahl, David M.; Hager, Mary Catherine; Gift, Nancy Y.. Environment, 9th Edition (Page 45). Wiley. Kindle Edition.**and work.
* **Thermodynamics**
* **THE SECOND LAW OF THERMODYNAMICS**
* **Entropy – systems go from order à disorder**
* **As each energy transformation occurs, some energy is changed to heat that is released into the cooler surroundings. No other organism can ever reuse this energy for biological work; it is “lost” from the biological point of view.**

* **Raven, Peter H.; Hassenzahl, David M.; Hager, Mary Catherine; Gift, Nancy Y.. Environment, 9th Edition (Page 45). Wiley. Kindle Edition.**and work.
* Photosynthesis and Cellular Respiration
* **Figure 3.8 from text: Raven, Peter H.; Hassenzahl, David M.; Hager, Mary Catherine; Gift, Nancy Y.. Environment, 9th Edition (Page 45). Wiley. Kindle Edition.**

* Photosynthesis

6 CO2 + 12 H2O + radiant energy → C6 H12 O6 + 6 H2O + 6 O2

English translation =
6 Carbon-Dioxide molecules + 12 Water molecules
are used (react) in photosynthesis to produce
1 Glucose molecule, 6 Water molecules and 6 Oxygen molecules

* Aerobic Cellular Respiration

C6 H12 O6 + 6 H2O + 6 O2 à 6 CO2 + 12H2O + energy

English translation =

1 Glucose molecule, 6 Water molecules and 6 Oxygen molecules are used (react) in aerobic cellular respiration to produce 6 Carbon-Dioxide molecules + 12 Water molecules + energy

* Photosynthesis VS. Aerobic Cellular Respiration

PHOTOSYNTHESIS REACTION:
6 CO2 + 12 H2O + radiant energy → C6 H12 O6 + 6 H2O + 6 O2

AEROBIC CELLULAR RESPIRATION REACTION:
C6 H12 O6 + 6 H2O + 6 O2 à 6 CO2 + 12H2O + energy

Do you see any similarities?

* What are CALORIES?
* A  calorie is the amount of energy (joules) required to raise the temperature of 1 mL of water by 1 degree Celsius.
* What we call calories is actually kilocalories.
* Biologists generally express energy in units of work ( kilojoules, kJ) or units of heat (kilocalories, kcal).
* **1** mL of **water** = **1** GRAM in weight

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* **OPEN SYSTEM**
* Energy enters the biological system as light energy, or photons, is transformed into chemical energy in organic molecules by cellular processes including photosynthesis and respiration, and ultimately is converted to heat energy.
* **OPEN SYSTEM**
* This energy is dissipated, meaning it is lost to the system as heat; once it is lost it cannot be recycled.
* Without the continued input of solar energy, biological systems would quickly shut down.
* Thus the earth is an ***open system*** with respect to energy.
* CLOSED SYSTEM
* Elements such as carbon, nitrogen, or phosphorus enter living organisms in a variety of ways.
* Plants obtain elements from the surrounding atmosphere, water, or soils.
* Animals may also obtain elements directly from the physical environment, but usually they obtain these mainly as a consequence of consuming other organisms.
* These materials are transformed biochemically within the bodies of organisms, but sooner or later, due to excretion or decomposition, they are returned to an inorganic state.
* Often bacteria complete this process, through the process called decomposition or mineralization.
* **CLOSED SYSTEM**
* During decomposition these materials are not destroyed or lost, so the earth is a ***closed system*** with respect to elements (with the exception of a meteorite entering the system now and then). The elements are cycled endlessly between their biotic and abiotic states within ecosystems. Those elements whose supply tends to limit biological activity are called***nutrients***.
* Transformation of Energy in an Ecosystem
* The transformations of energy in an ecosystem begin first with the input of energy from the sun.
* Energy from the sun is captured by the process of photosynthesis.
* Carbon dioxide is combined with hydrogen (derived from the splitting of water molecules) to produce carbohydrates (CHO).
* Energy is stored in the high energy bonds of adenosine triphosphate, or ATP.
* Transformation of Energy in an Ecosystem
* ATP = Adenosine Triphosphate
* Carbohydrates (sugars)
* Carbohydrates store energy in their H-C (hydrocarbon) bonds.
* Breaking thee bonds releases energy.
* Ecological Pyramid – Energy Pyramid

* Ecological Pyramid – Energy Pyramid
* Energy from the sun is transferred through the ecosystem by passing through various trophic levels. Roughly 10% of the energy is transferred from one trophic level to the next, thus preventing a large number of trophic levels. There must be higher amounts of biomass at the bottom of the pyramid to support the energy and biomass requirements of the higher trophic levels.

* What is a TROPHIC LEVEL?
* A TROPHIC LEVEL is “each of several hierarchical levels in an ecosystem, comprising organisms that share the same function in the food chain and the same nutritional relationship to the primary sources of energy.”

* Extreme cheapskates https://www.youtube.com/watch?v=11c4LRomkSo

* The girl who silence the world for 5 minutes  https://www.youtube.com/watch?v=xXiWi8LnZ7I

* **Symbiosis** (from Greek συμβίωσις "living together", from σύν "together" and βίωσις "living")[2] is a close and often long-term interaction between two different biological species. In 1877 Albert Bernhard Frank used the word *symbiosis* (which previously had been used to depict people living together in community) to describe the mutualistic relationship in lichens.[3] In 1879, the German mycologist Heinrich Anton de Bary defined it as "the living together of unlike organisms."[4][5]
* ENDO SYMBIOSIS
* symbiosis in which one of the symbiotic organisms lives inside the other.
* **Symbiogenesis**, or **endosymbiotic theory**
* is an evolutionary theory that explains the origin of eukaryotic cells from prokaryotes.
* Mitochondria in animal cells and chloroplasts in plant cells are thought to have originated from a primitive prokaryotic cell engulfing another prokaryotic to form the first eukaryotic cell.
* **Symbiogenesis**, or **endosymbiotic theory**
* possibly other organelles representing formerly free-living bacteria (prokaryotes) were taken inside another cell as an endosymbiont around 1.5 billion years ago.
* **Ectosymbiosis**
* **Ectosymbiosis** is symbiosis in which the symbiont lives on the body surface of the host, including internal surfaces such as the lining of the digestive tube and the ducts of glands.