Ecosystem

1

- An ecosystem is a self-supporting unit. There are 4 processes that continually take place.
  1. Energy Production
  2. Energy Transfers
  3. Decomposition
  4. Recycling

Energy

2

- Capacity or ability to do work
- Flows through ecosystems
- 1st Law of Thermodynamics:
  - Energy cannot be created or destroyed
  - Energy can be changed from one form to another

1. Energy Production

3

- The source of energy for ecosystems is the sun.
- Sunlight is captured by green plants during photosynthesis.

2. Energy Transfers

4

- Energy from plants is then transferred to the herbivores (plant-eating animals) and omnivores (plant and animal-eating animals) that eat them.
- The energy is transferred again to the carnivores (animals that eat other animals).

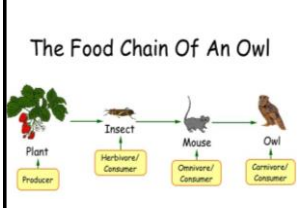
2. Energy Transfers

5

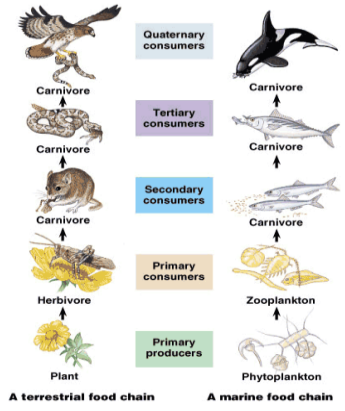
- Energy transfers can be shown through the use of:
  - Food chains: show the flow of energy in an ecosystem.
  - Food webs: represent interconnected food chains.
  - Energy pyramids: show the changes in available energy from one trophic level to another.

Food Chains

6



- Because green plants convert the sun's energy into chemical energy, they are called producers.
- Animals that eat producers are primary consumers.
- Animals that eat primary consumers are secondary consumers, and so on.



Food Chains

8

- We need to think of ecosystems as being made up of several feeding levels, called trophic levels.
- Producers make up the first trophic level, primary consumers the second, secondary consumers the third, and so on.

Food Webs

9

- Most organisms are part of many food chains.
- Arrows in a food web represent the flow of energy and nutrients.
- Following the arrows leads to the top consumers.

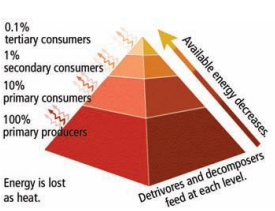
Second Law of Thermodynamics

10

- When energy is changed from one form to another, some is degraded into heat, a less usable form of energy that goes into the environment.
- Meaning….Most of the energy that enters each trophic level is used by the organism just to stay alive, escapes as heat, and a small amount is passed as waste.

Energy Pyramids

11

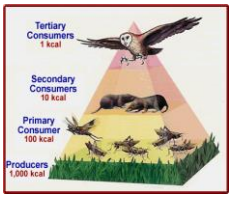


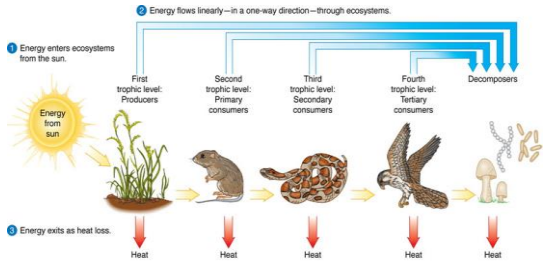
- This leaves only a very small percentage (~10%) to be stored as body tissues and it is this energy that gets passed on to the next trophic level.
- An energy pyramid is a way to show how energy moves through a food chain.

Energy Pyramids

12

- The trophic level of an organism identifies its position in the pyramid.
- The producers are on the bottom with the most energy.
- As you move up you will find less energy…which means there will be a smaller number of organisms and a smaller overall biomass (total mass of all living things in a given area).





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3. Decomposition

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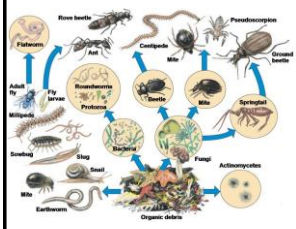
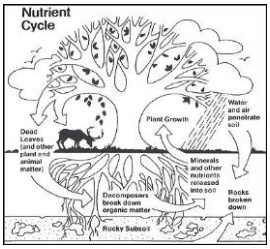


- When biotic things die, their bodies get consumed by scavengers (such as ravens, ants) and detritivores (such as earthworms, beetles, crabs that feed on dead things).
- Eventually all biotic things will be decomposed (broken down) by microorganisms and fungi.

3. Decomposition

15

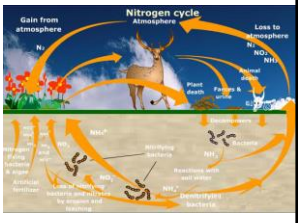
- Once decomposed, the chemicals from biotic things are returned to the soil and used again by plants.
- This creates a cycling of important nutrients in ecosystems – called nutrient or biogeochemical cycles.



4. Recycling

16

- Because earth is a closed system, nutrients are recycled - meaning nutrients are never added or lost, simply used over and over again.
- The major biogeochemical cycles include:
  - Carbon
  - Nitrogen
  - Phosphorus



Carbon Cycle

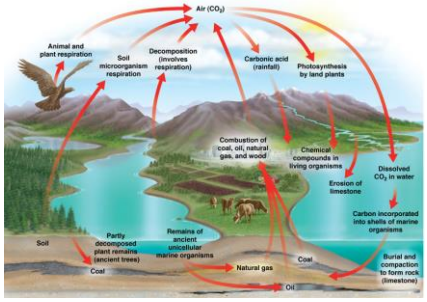
- Essential component for life
- Gas (CO_2) in atmosphere
- Several forms in ocean
- Can take a long time—think fossil fuels

Photosynthesis

CO_2 ⇉ Sugar ⇉ CO_2

Cellular respiration

Carbon Cycle



Nitrogen Cycle

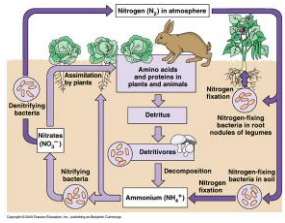
19

- Earth's atmosphere is 78% N_2 (nitrogen gas) but most organisms cannot use this nitrogen directly.
- Plants can use NO_3^- (nitrate) and NH_4^+ (ammonium).
- Nitrogen becomes usable when is "fixed" – pulled from the air and bonded with other elements to make new compounds. This process is called nitrogen fixation.

Nitrogen Cycle

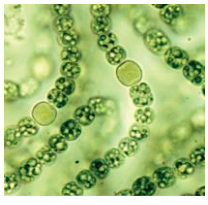
20

- 1. Nitrogen moves from the atmosphere to the soil or water through nitrogen fixation.
  - Lightning changes N_2 → NO_3^-.
  - Rain washes nitrate into soil.
  - Bacteria in soil (*rhizobium*) & cyanobacteria in water change N_2 → NH_4^+.



Nitrogen Fixation

- Specialized bacteria
- Split atmospheric nitrogen and combine it with hydrogen



Nitrogen Cycle

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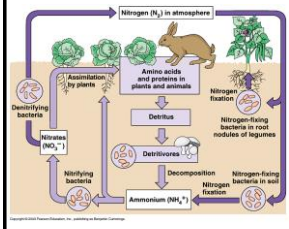


2. Nitrogen moves from the soil and water to plants and animals.
   - Animals get the nitrogen they need by eating plants or other animals that contain nitrogen.

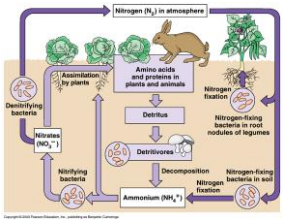
3. Nitrogen moves from plants and animals back to the soil and water.
   - When organisms die, their bodies decompose bringing the nitrogen into soil or water.

Nitrogen Cycle

23

4. Nitrogen moves from the soil and water to the atmosphere.
   - Certain bacteria can convert nitrogen from the soil (NH_4^+) to nitrates. This process is called nitrification.

NH_4^+ → NO_2^- → NO_3^-

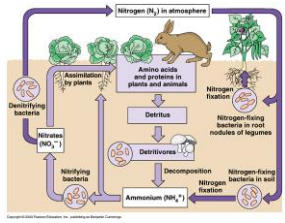


Nitrogen Cycle

24

- Following nitrification, bacteria and volcanic eruptions change the soil nitrates into N_2 through a process called denitrification.
- Nitrogen gas is then released to the atmosphere.

NO_3^- → N_2

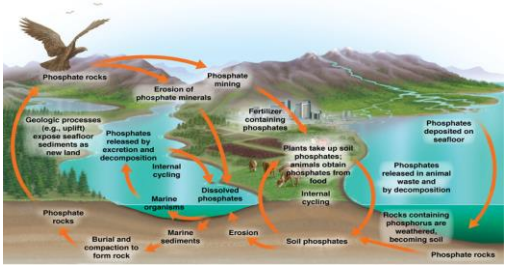


Phosphorus Cycle

- No atmospheric component
- Phosphates used in DNA and ATP (chemical energy)
- Phosphates move through the food chain

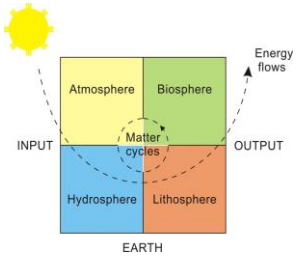
Land ➡ Organism ➡ Organism ➡ Land

Phosphorus Cycle



Conclusion

27



- In ecosystems, both energy and matter constantly circulate.
- Energy flows through ecosystems while matter cycles.