

Energy Transformations

Cellular Respiration and Photosynthesis

99% of all life on this planet derives its energy from the sun, either directly or indirectly. (1% or less derives energy from chemical energy in rocks etc. "chemotrophic")

How does sunlight energy become trapped in a plant? PHOTOSYNTHESIS. The process of photosynthesis, requires a molecule known as chlorophyll, that will be contained in chloroplasts in plants, or can be free in simpler organisms such as bacteria and phytoplankton. Chlorophyll is green!

Word Equation:

carbon + water + sunlight → glucose + oxygen
dioxide

Chemical Equation:

$\text{CO}_2 + \text{H}_2\text{O} + \text{sunlight} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$

Balanced Chemical Equation:

$6\text{CO}_2 + 6\text{H}_2\text{O} + \text{sunlight} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$

Plants:

- consume carbon dioxide (from our atmosphere)
- need water
- produce oxygen (our oxygen on planet earth was made from photosynthesis)
- produce **GLUCOSE** which contains trapped energy and glucose can be used to make other molecules

Glucose contains trapped solar energy.

How is the energy release from glucose?

CELLULAR RESPIRATION. All cells, plants or animals perform cellular respiration. This can occur with or without mitochondria. Cellular respiration produces useable energy.

Word Equation:

glucose + oxygen → carbon dioxide + water + useable energy

Chemical Equation:

$C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O + \text{useable energy}$

Balanced Chemical Equation:

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$

Plants are called producers because they can make energy. All other organisms that eat plants or eat organisms that eat plants are consumers. In this way an chain of energy that starts plants feeds all life.

Trophic Levels / Energy Pyramids

Producer (Plants etc.)	1 st Trophic Level
Primary Consumer - Herbivore	2 nd Trophic Level
Secondary Consumer - Carnivore	3 rd Trophic Level
Tertiary Consumer	4 th Trophic Level
Quaternary Consumer	5 th Trophic Level
etc	etc

The first row in this table is the only row where energy comes directly from the sun.
(Trophic level is how many levels you are away from the sun)

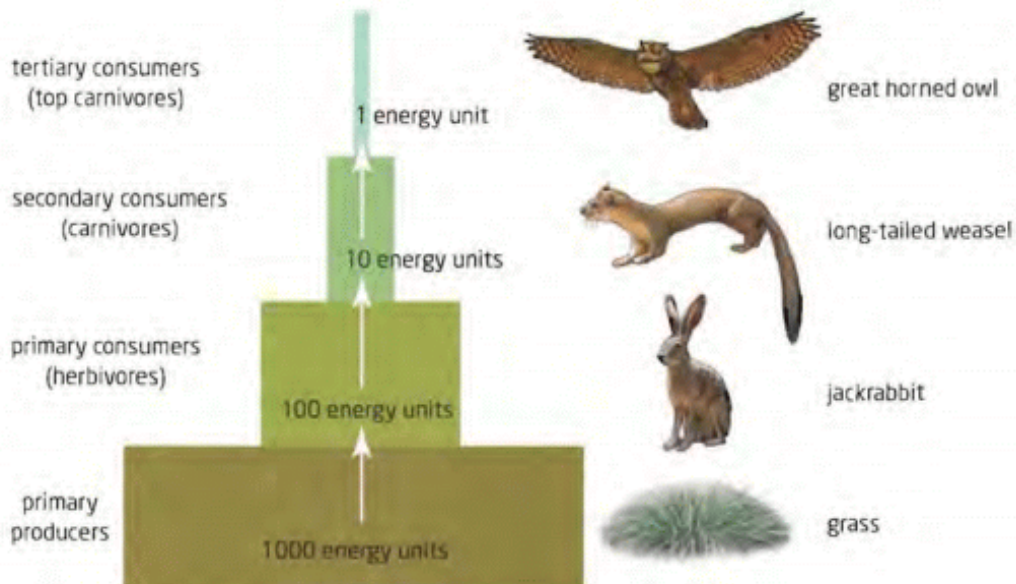
eg Grass → Cow → Human (Carnivore at the 3rd Trophic Level - Secondary Consumer)

eg Seaweed → Small Fish → Seal → Shark → Human (5th Trophic Level)

General Energy Consideration: every trophic level is only able to access at most 10% of the energy from the previous level. The other 90% is lost as heat, digestion processes, failure to absorb all nutrients and the act of gathering the food in the first place. This means every trophic level loses 90% of the “solar” energy trapped in the plant.

sun → plant → herbivore → carnivore
100% 10% 1% 0.1%

Energy (Food) Pyramid: a way of looking at how energy is distributed as you go up the trophic levels, the higher the trophic level the further up the pyramid.



Pyramids can also be created for:

- biomass: always decrease in size as you go up the pyramid
- numbers: gives the number of organisms at each trophic level, does not always decrease as you go up the pyramid (takes many worms to eat a dead wolf)