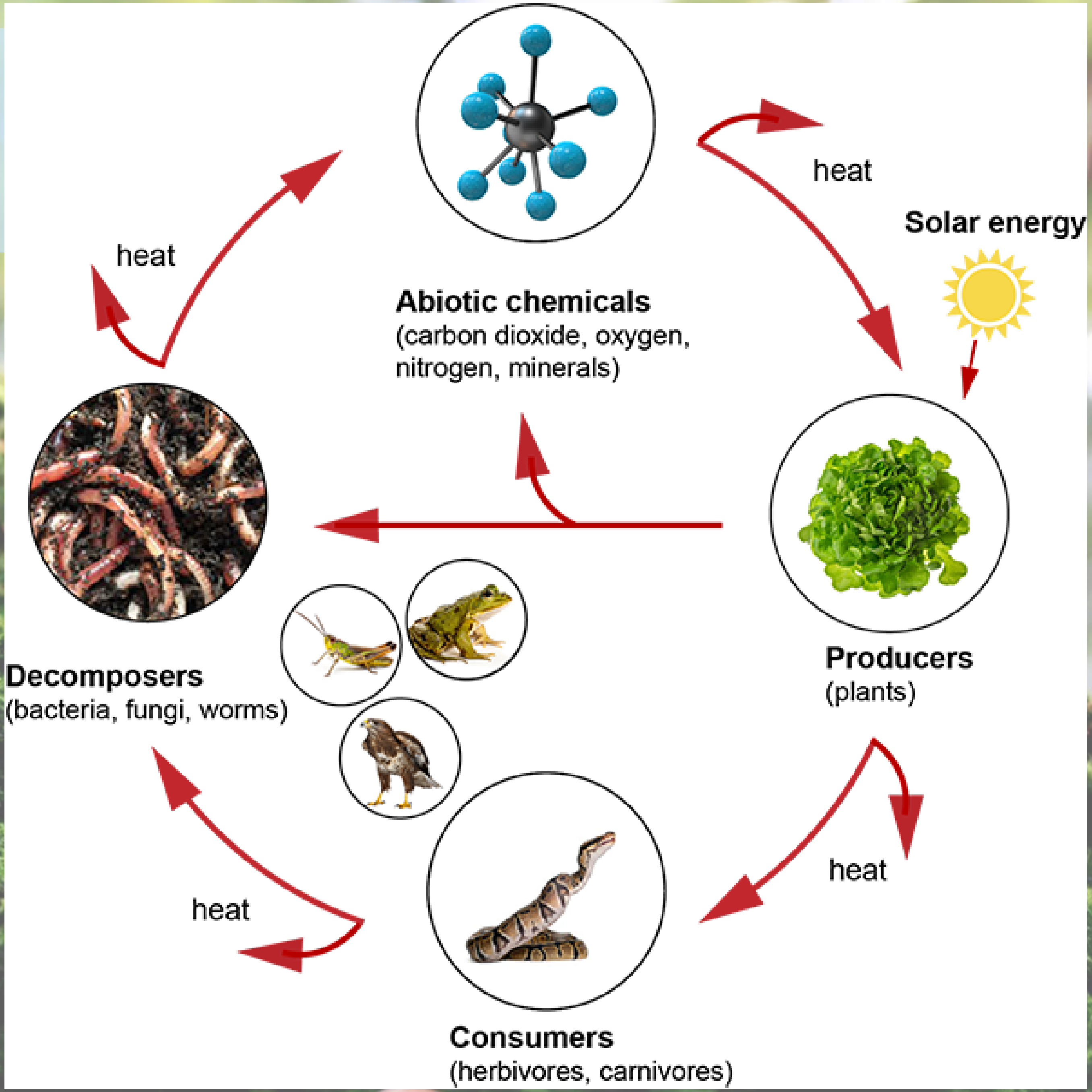
Ecosystems

Energy in an Ecosystem

- The flow of energy and nutrients through ecosystems follows a cycle that is dependent on the structure of food chains and food webs.
- The biosphere exists because certain organisms, called producers (plants), can turn energy from the sun into sugar. Sugars act as the building blocks and energy source to make all living tissue. For this reason, producers are the starting point for all food chains

Energy Flow


heat
Solar energy
Abiotic chemicals
(carbon dioxide, oxygen, nitrogen, minerals)
heat
Decomposers
(bacteria, fungi, worms)
Producers
(plants)
heat
heat
Consumers
(herbivores, carnivores)

Energy

Energy

- The amount of energy in an ecosystem determines its biodiversity and how many organisms it can support.
- If little energy from the sun is available, the number and diversity of species in an ecosystem are limited. Energy is therefore a limiting factor in ecosystems.
- The sun's energy is captured by plants.
- This energy then flows through the ecosystem when animals eat plants or eat other animals.
- Biologists study energy flow by looking at food chains and food webs to determine the limiting factors of an ecosystems and how these factors affect the carrying capacity.

Energy Flow in Food Chains

- A food chain is the simplest way to show what species are eating in an ecosystem.
- The food chain diagram uses arrows to indicate the direction in which energy and matter are transferred from one organism to another.
- For example, in the following three-species food chain, an acorn is eaten by a chipmunk, and the chipmunk, in turn, is eaten by a fox.

Energy Flow in Food Chains

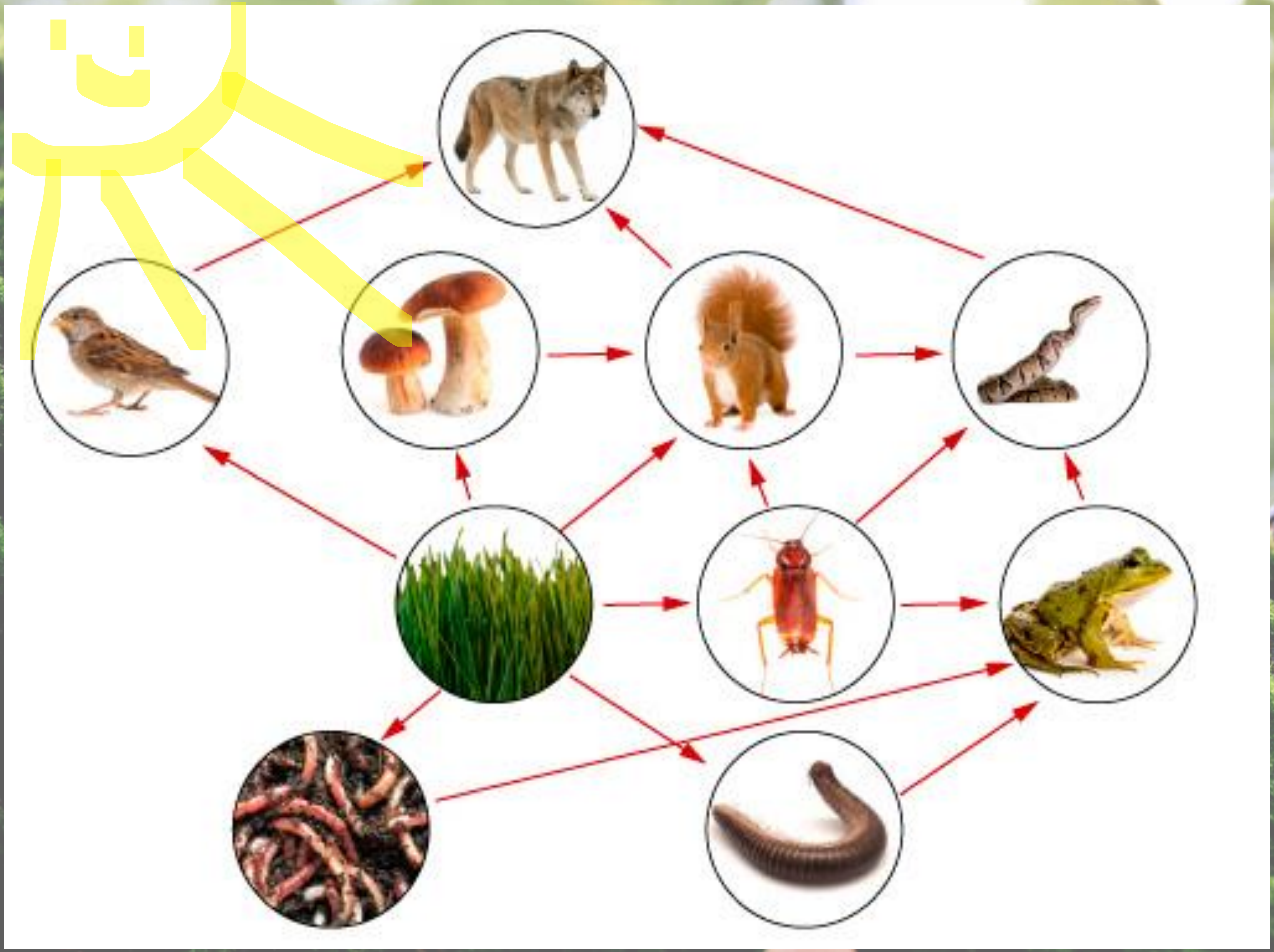
- In the food chain shown in the image, the energy in the acorn is passed on to the chipmunk.
- The chipmunk then uses it to grow, move, and reproduce. When the chipmunk is eaten by the fox, the original energy from the acorn is passed to the fox.
- You will notice that energy in a food chain flows in one direction only – the acorn can’t eat the fox!

Food Webs

- Most species eat more than one type of food item. For example, a hawk may eat mice, birds, squirrels, and even snakes.
- A frog might eat worms and insects. This means that several food chains are often combined into food webs.
- Food webs show the complexity of how organisms exist in an ecosystem.

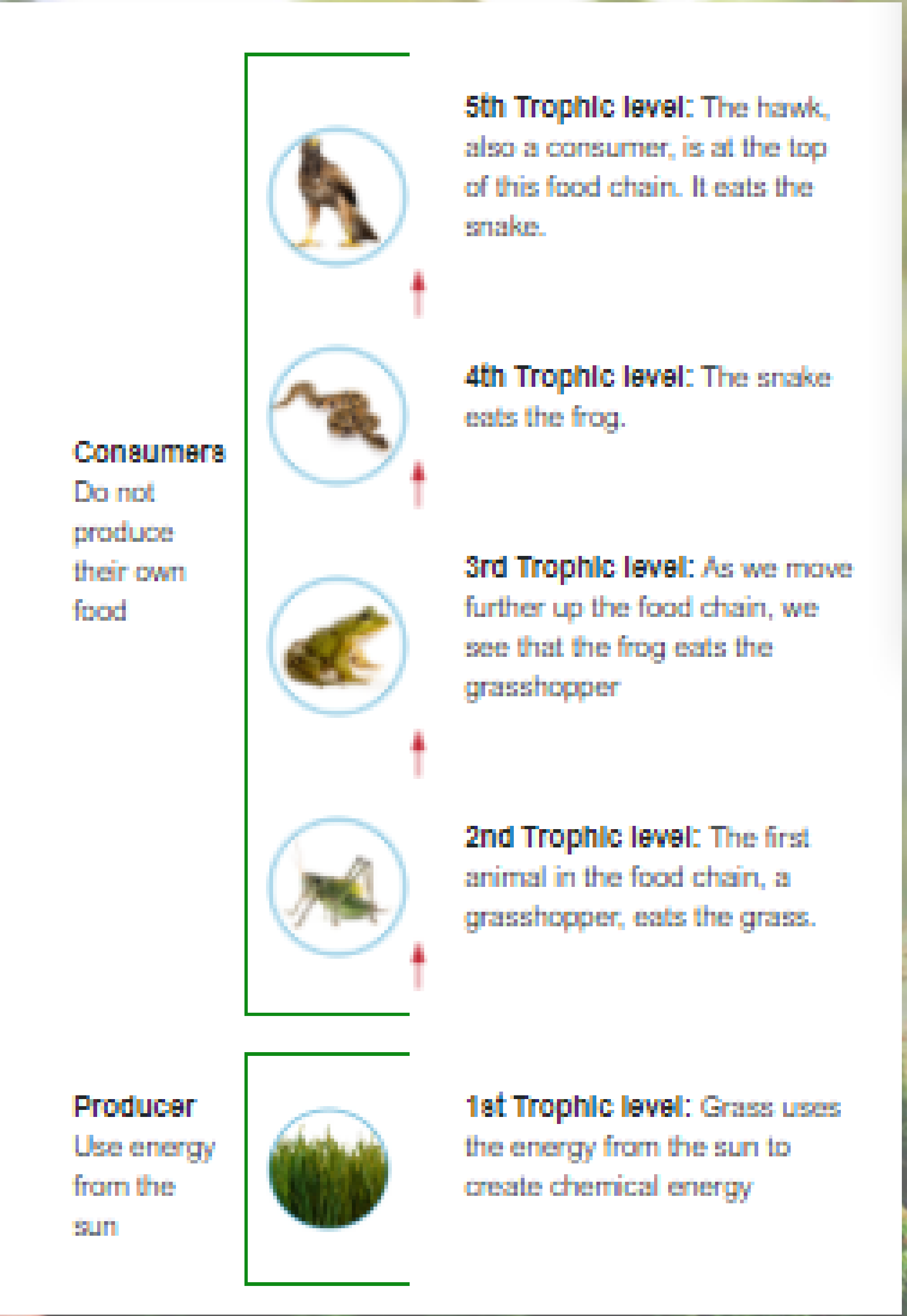
Food Webs

- A food web highlights how important certain species are to an ecosystem.
- For example, if the squirrel were removed from the sample food web here, this would affect all of the organisms that the squirrel is connected to, including the wolf, snake, mushroom, insect, and plant.
- Food chains and food webs are great visual depictions of the feeding relationships in ecosystems, but they do not tell us a lot about the energy transferred from the producers to the highest level of consumer.
- For that, we need to understand trophic levels.

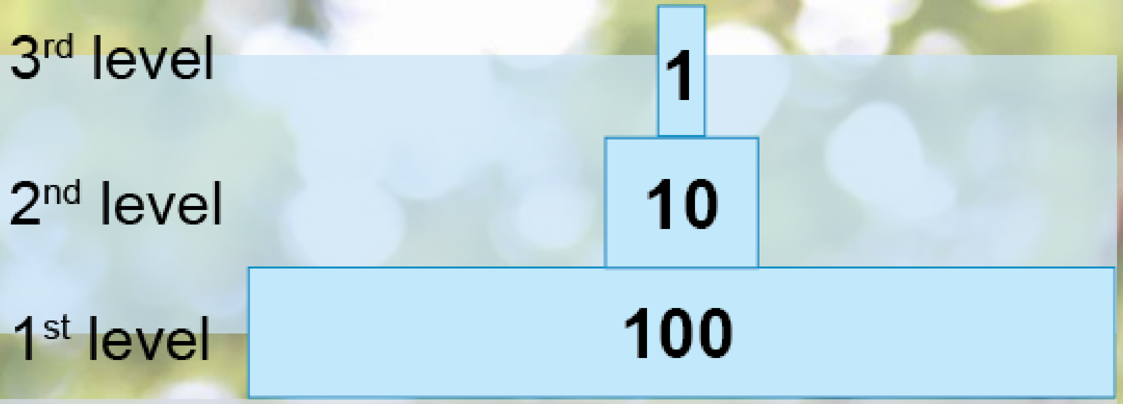


Transfer of Energy

- A trophic level refers to the position of a species in a food chain.
- Trophic levels are arranged in a hierarchy from the bottom upwards. For example, here is a five-species food chain.



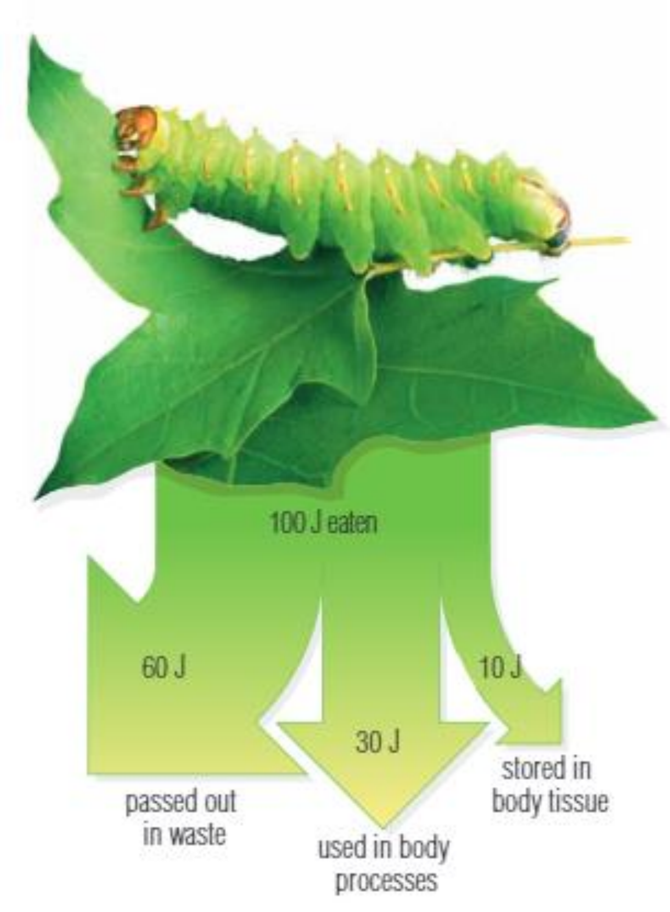
Pyramids



- Energy transfer follows a pattern in all food chains and webs.
- The amount of energy available to a higher trophic level is always much less than the total energy in the level below it.
- When you plot the amount of energy available at every trophic level as a horizontal bar, you get a pyramid with a wide base and a narrow top.
- In general, about 10% of the energy in a given trophic level is transferred to the level immediately above it.

Energy Use

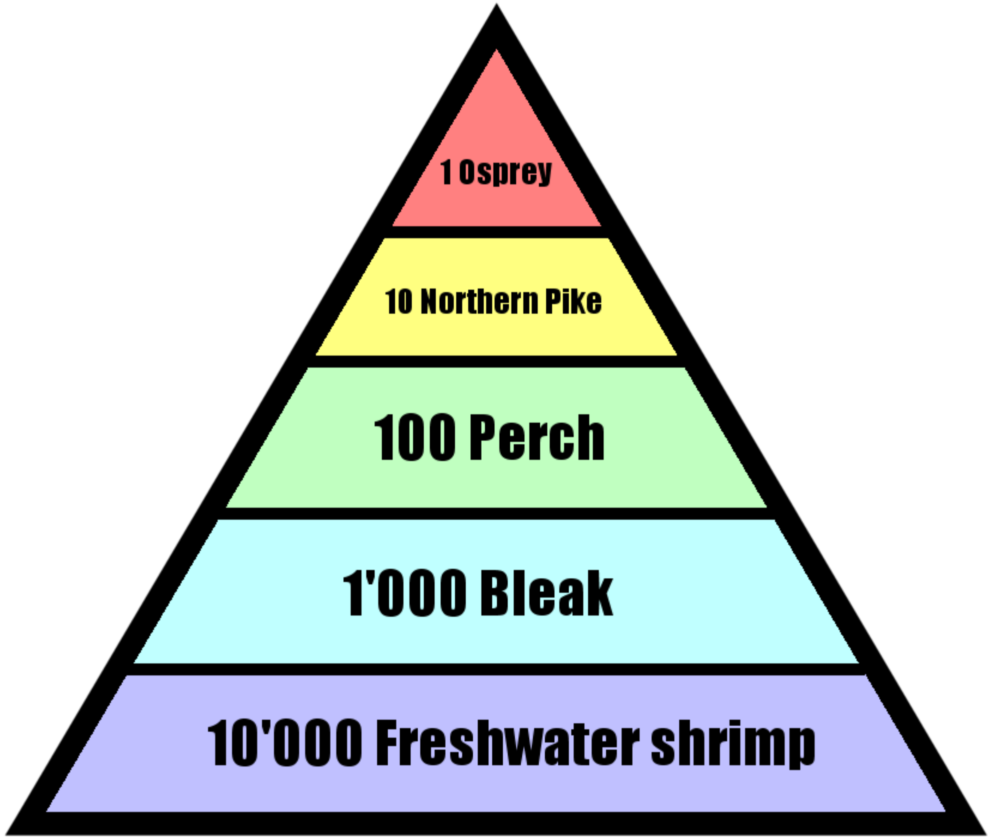
- The reason the amount of energy acquired decreases as you go up the pyramid is that the consumers use a lot of energy simply for survival.
- For example, plants use some of the energy they capture from sunlight to maintain their cells and to develop (including structures such as thorns, which are not eaten by consumers).
- The consumers that eat the plants also use some of that initial energy to maintain their cells and make structures, such as teeth, which are not digested by the predators that feed on them



Types of Pyramids

Pyramid of Numbers

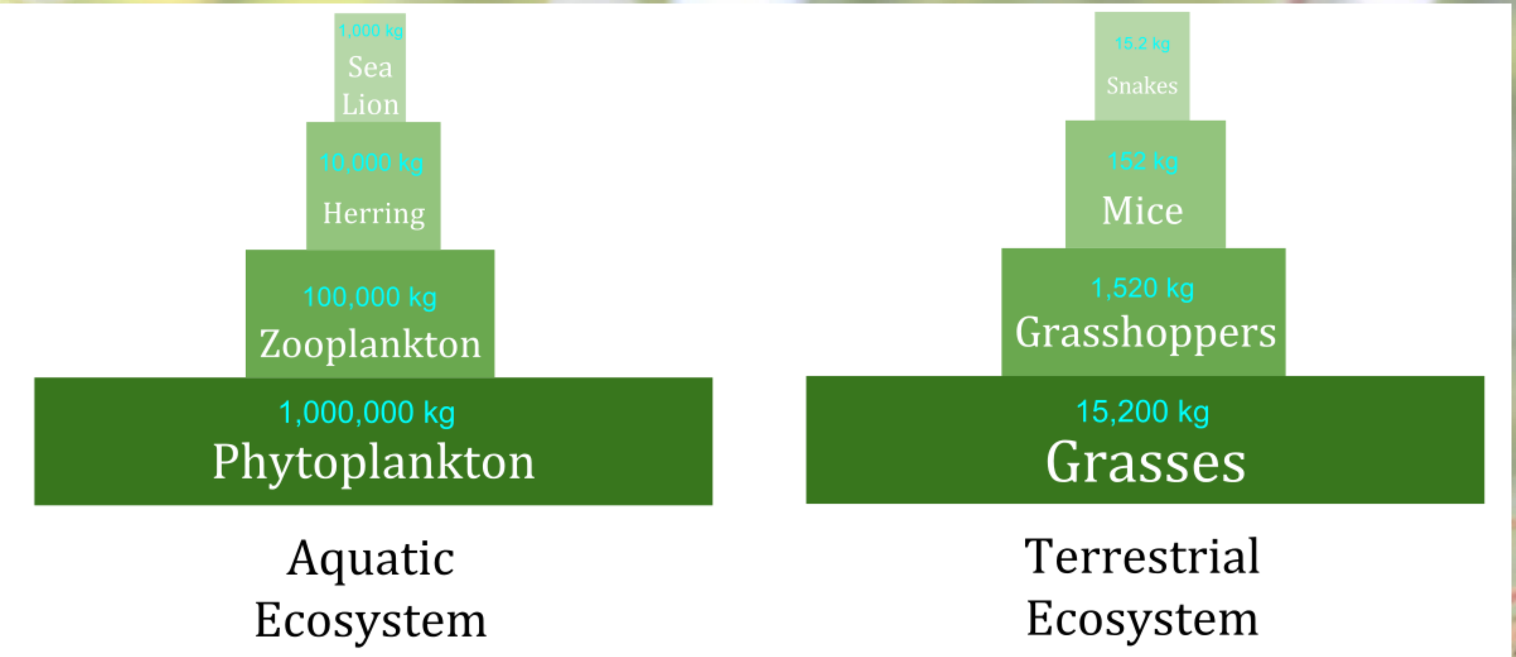
- Count the individual organisms in each trophic level. Lower levels have more energy and usually more organisms.



Types of Pyramids

Pyramid of Biomass

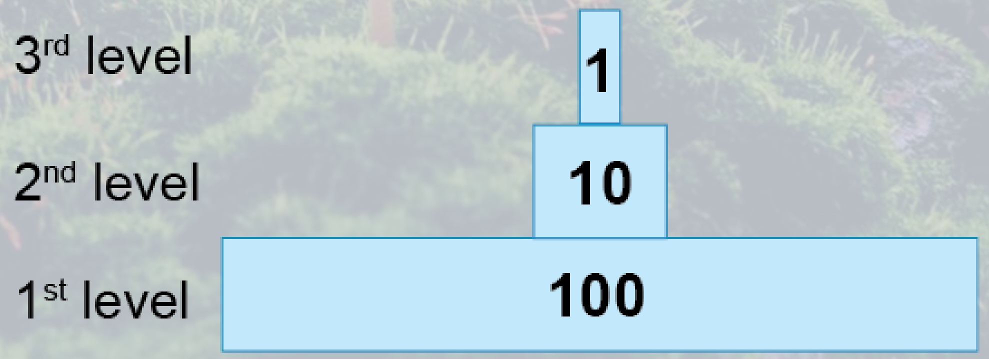
- How much of an organism is in the environment (it is a dry mass). There are generally less numbers of larger animals as you move up the trophic levels.



Types of Pyramids

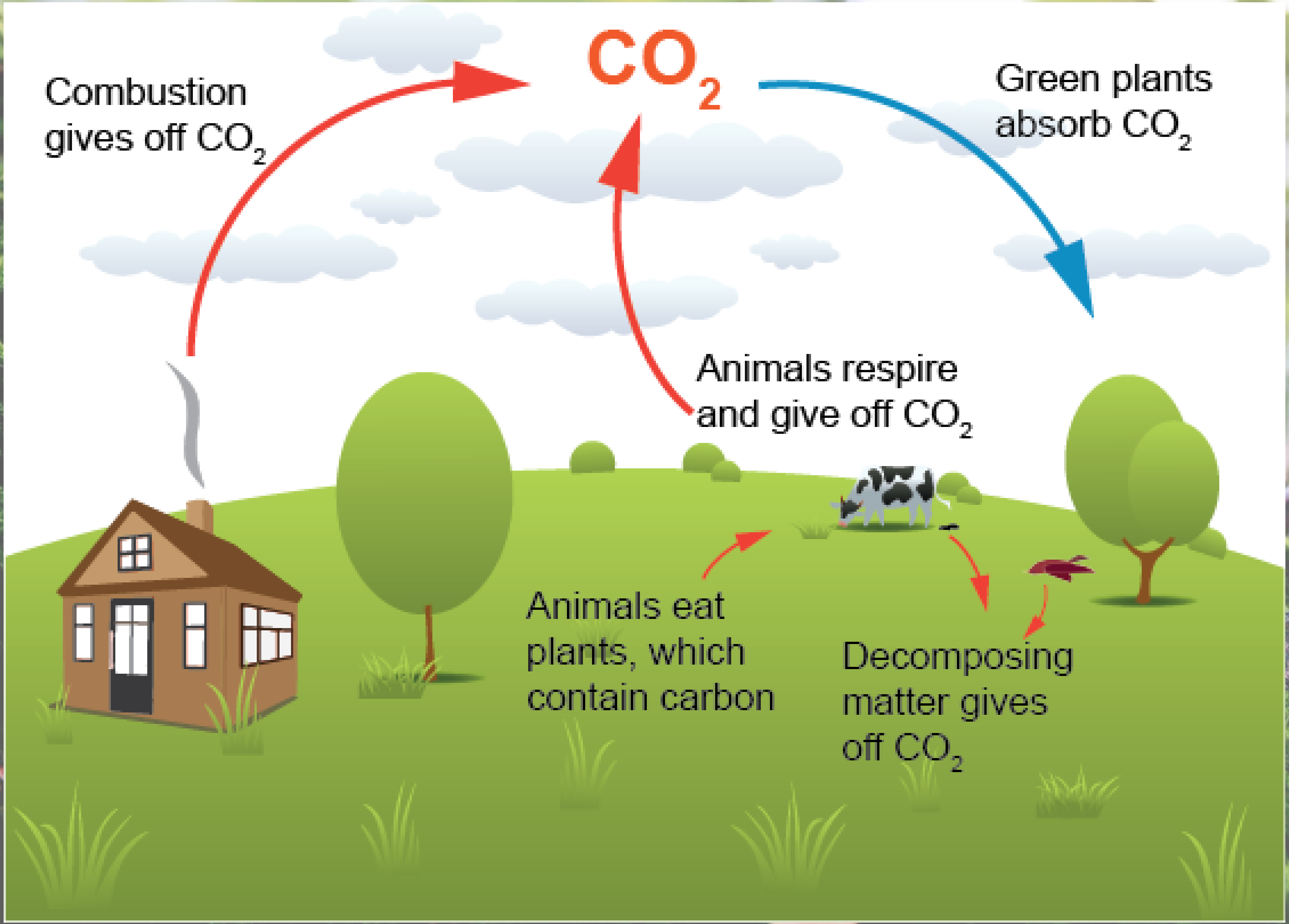
Pyramid of Energy Flow

- Measures the total chemical energy that flows through each trophic level. There are no inverted energy flow pyramids since energy is lost as you move up trophic levels. There are usually no more than 4 levels in one pyramid since the amount of energy is insufficient to sustain life as it gets up in levels.



Nutrients

- A nutrient is a chemical that an organism needs to live and grow.
- Some examples of nutrients required for life are nitrogen, carbon, and phosphorus.
- Animals get their nutrients by eating plants and other animals, and plants absorb their nutrients from the soil and water.
- Just like energy, nutrients can also limit the number of species and their population sizes in an ecosystem.


CO_2
Combustion gives off CO_2
Green plants absorb CO_2
Animals respire and give off CO_2
Animals eat plants, which contain carbon
Decomposing matter gives off CO_2

Nutrients

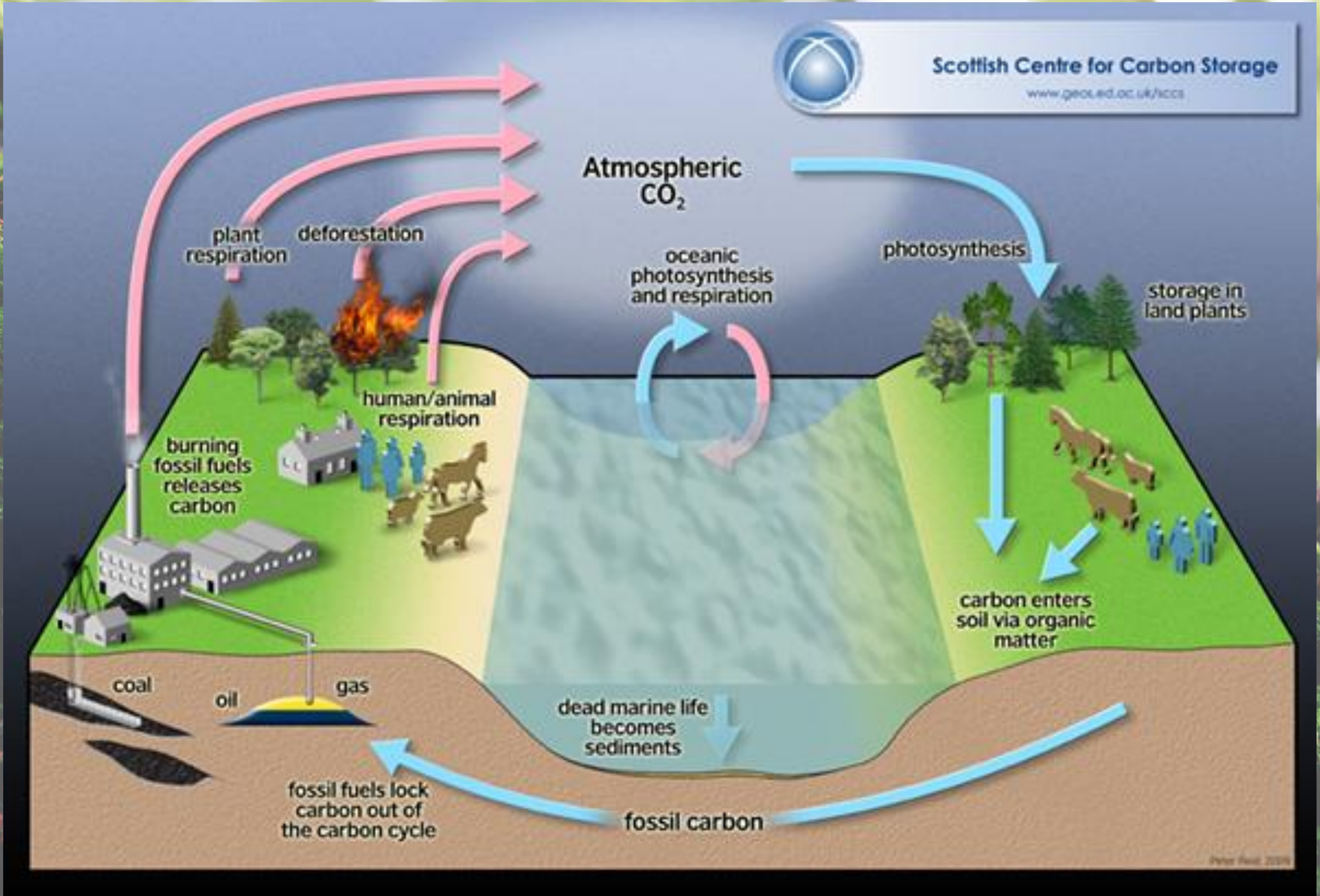
- Movement of nutrients through the ecosystem is called cycling.
- Since the Earth is a closed ecosystem (no nutrients are moved in or out of the system), nutrients must be recycled or they would not be available for us to use.
- Decomposers help with this cycling by breaking up "dead" organisms or wastes into smaller pieces that can be used by primary producers.
- Nutrients cycle through the system by means of;
- □ biotic □ ingest organisms
- □ abiotic □ in air and water

Carbon

- The element carbon is the basis of almost all the molecules that make up living things.
- This makes it one of the most important nutrients.
- Like nitrogen and phosphorus, carbon needs to be combined with oxygen for it to be in a form that organisms can use.
- The simplest carbon molecule that contains oxygen is carbon dioxide (CO_2).
- Carbon is one of the most common elements on Earth. It is found in rocks, the seabed, and in all living things. It is also found in the atmosphere as CO_2 gas.

Carbon

- Carbon is naturally released from rocks, and it combines with oxygen in the atmosphere to make carbon dioxide.
- Plants absorb carbon dioxide from the air, converting it into molecules of sugar.
- Sugar is then used as an energy source for organisms and also as a chemical building block for all the other molecules in cells.
- When organisms die, some of their carbon is buried in the soil and at the bottom of the oceans.
- Over millions of years, this carbon gets converted back into rock or into oil, natural gas, and coal.
- This process is called the carbon cycle.


Scottish Centre for Carbon Storage
www.geos.ed.ac.uk/sccs
Atmospheric CO_2
plant respiration
deforestation
oceanic photosynthesis and respiration
photosynthesis
storage in land plants
human/animal respiration
burning fossil fuels releases carbon
carbon enters soil via organic matter
coal
oil
gas
dead marine life becomes sediments
fossil fuels lock carbon out of the carbon cycle
fossil carbon

How humans affect the carbon cycle

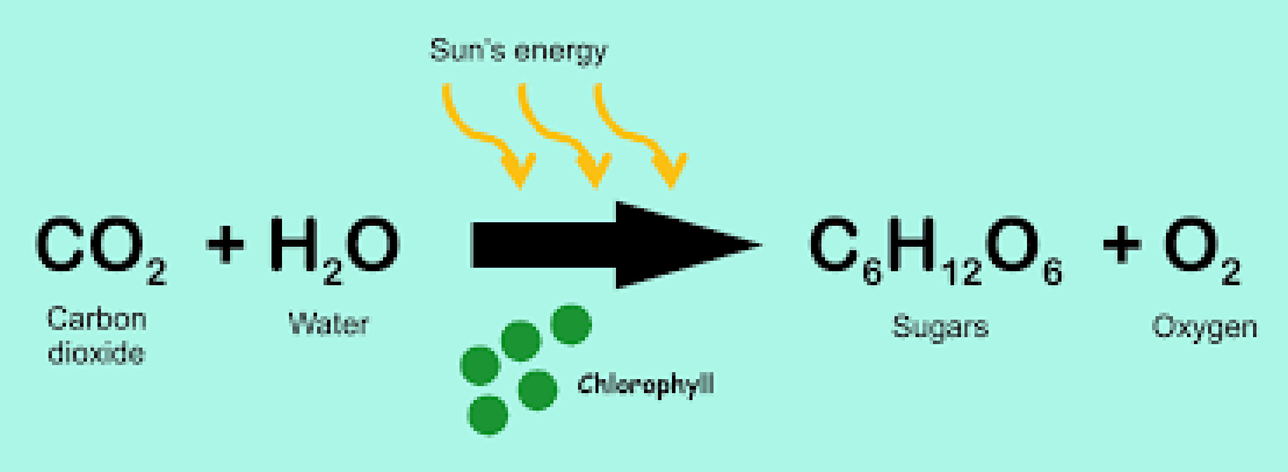
- Concentrations of atmospheric carbon dioxide have been rising over the last century, mostly as a result of human activities.
- Carbon is stored in fossil fuels which are buried deep underground, and humans have been burning these for energy. The carbon stored in these fossil fuels would normally not be released into the atmosphere, but when it is, the plants on Earth cannot absorb the carbon dioxide as quickly as we produce it. As a result, the levels in the atmosphere are at a record high.

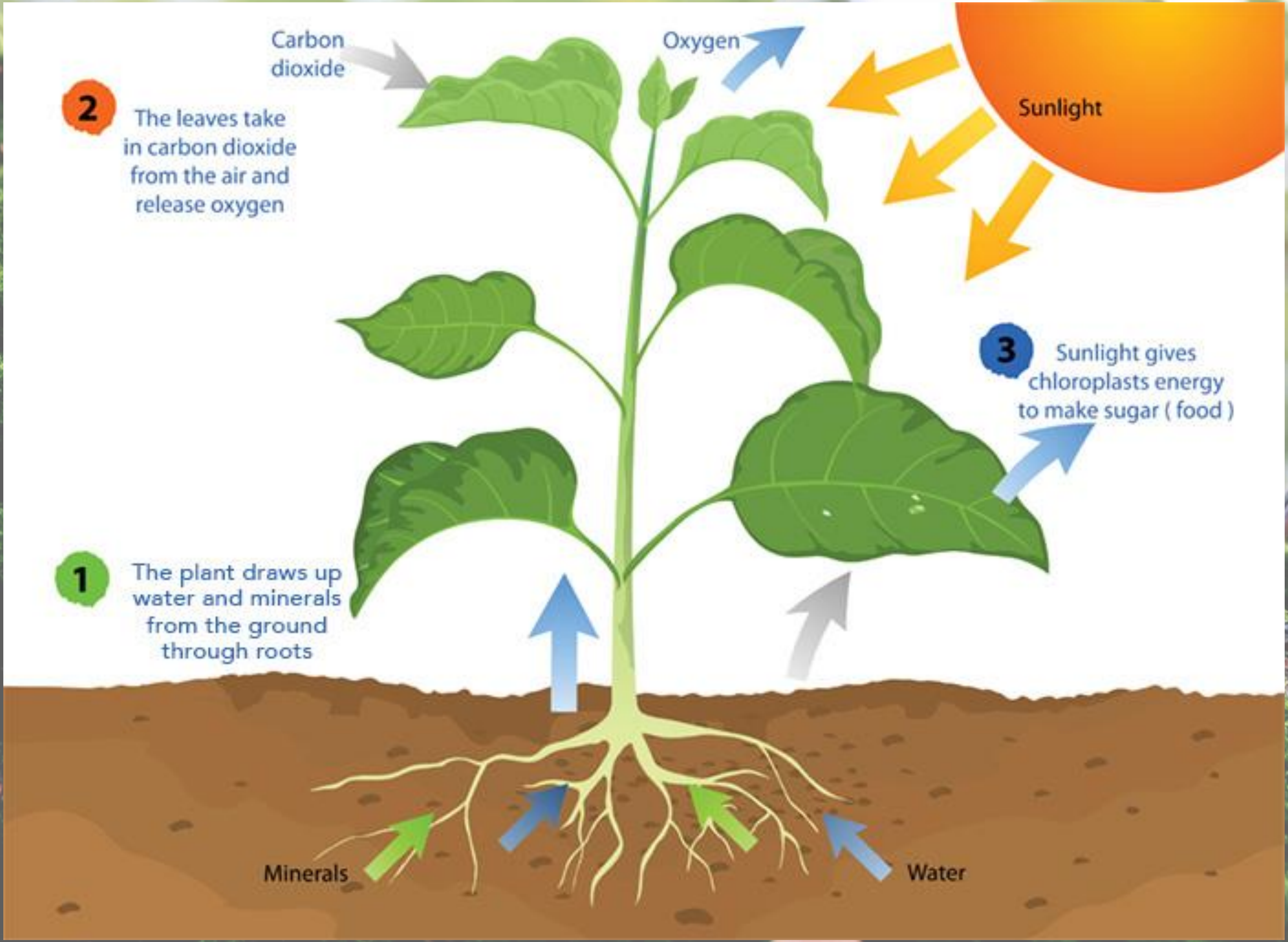
How humans affect the carbon cycle

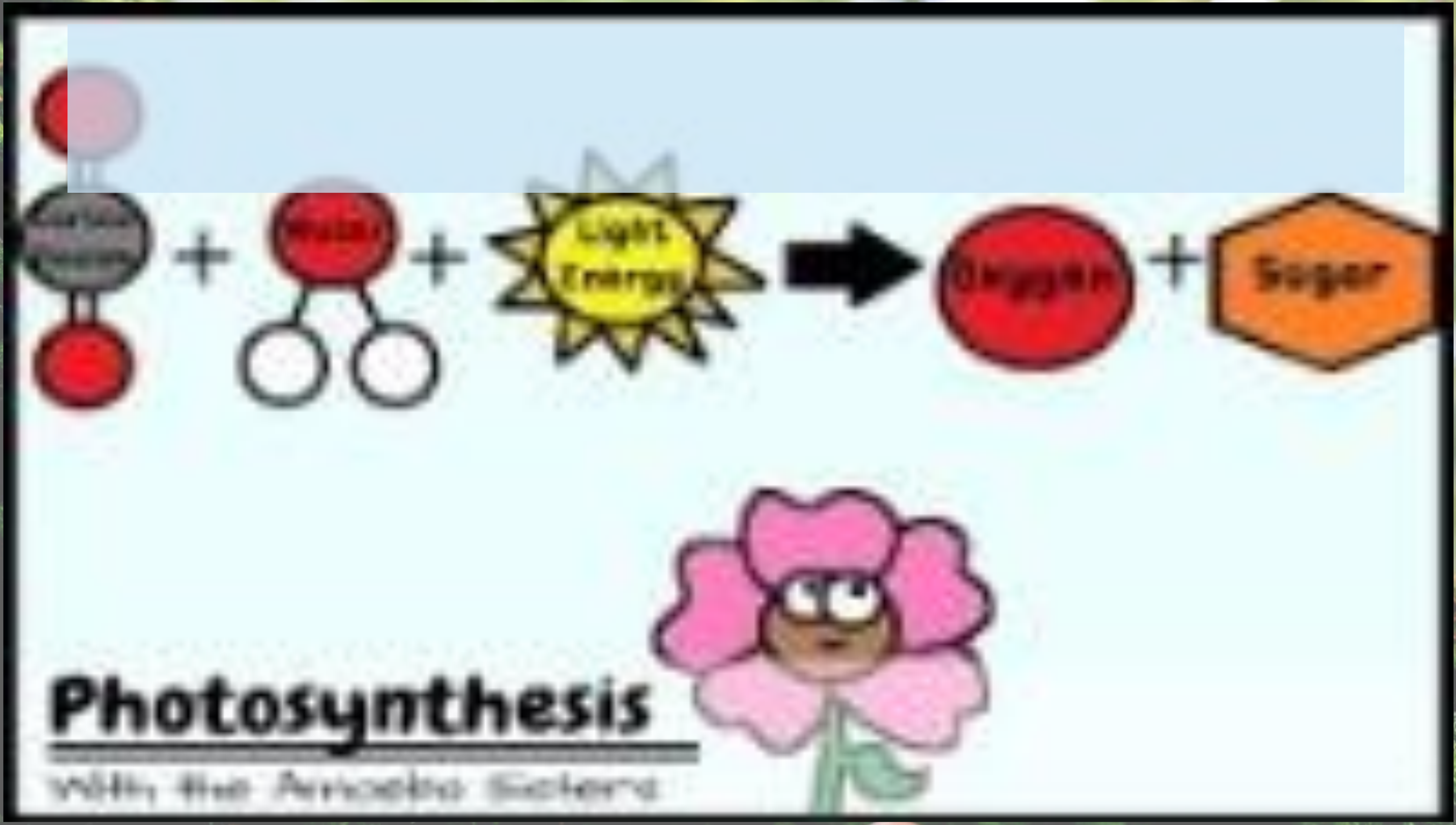
- Carbon dioxide is called a greenhouse gas because it traps the sun's heat in the atmosphere, much like a greenhouse. High levels of carbon dioxide are causing the Earth's climate to heat up. This has potentially devastating consequences on many ecosystems, especially the ones near the poles.

Photosynthesis

- Plants take the sun's energy and use a chemical process called photosynthesis to convert it into a form that cells can use.
- The overall chemical reaction of photosynthesis can be summarized like this:




Carbon dioxide
Oxygen
Sunlight
2
The leaves take in carbon dioxide from the air and release oxygen
3
Sunlight gives chloroplasts energy to make sugar (food)
1
The plant draws up water and minerals from the ground through roots
Minerals
Water


Photosynthesis

Respiration

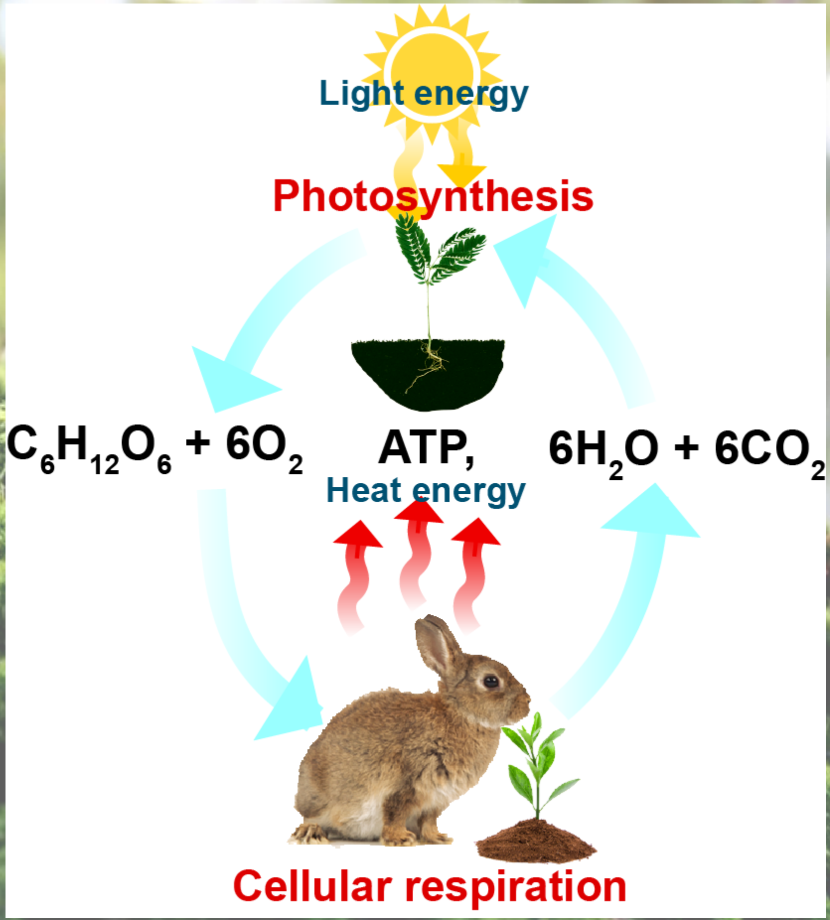
- All organisms need energy to move around, grow, and reproduce. You just saw that plants produce glucose through photosynthesis, but how do they convert glucose into energy that can be used by living cells?
- Glucose needs to be broken down to produce easily accessible energy, called ATP. You can think of ATP as little batteries that zip around a cell, providing short-term energy wherever it is needed.
- To get the adenosine triphosphate (ATP), glucose is broken down through the process of cellular respiration.

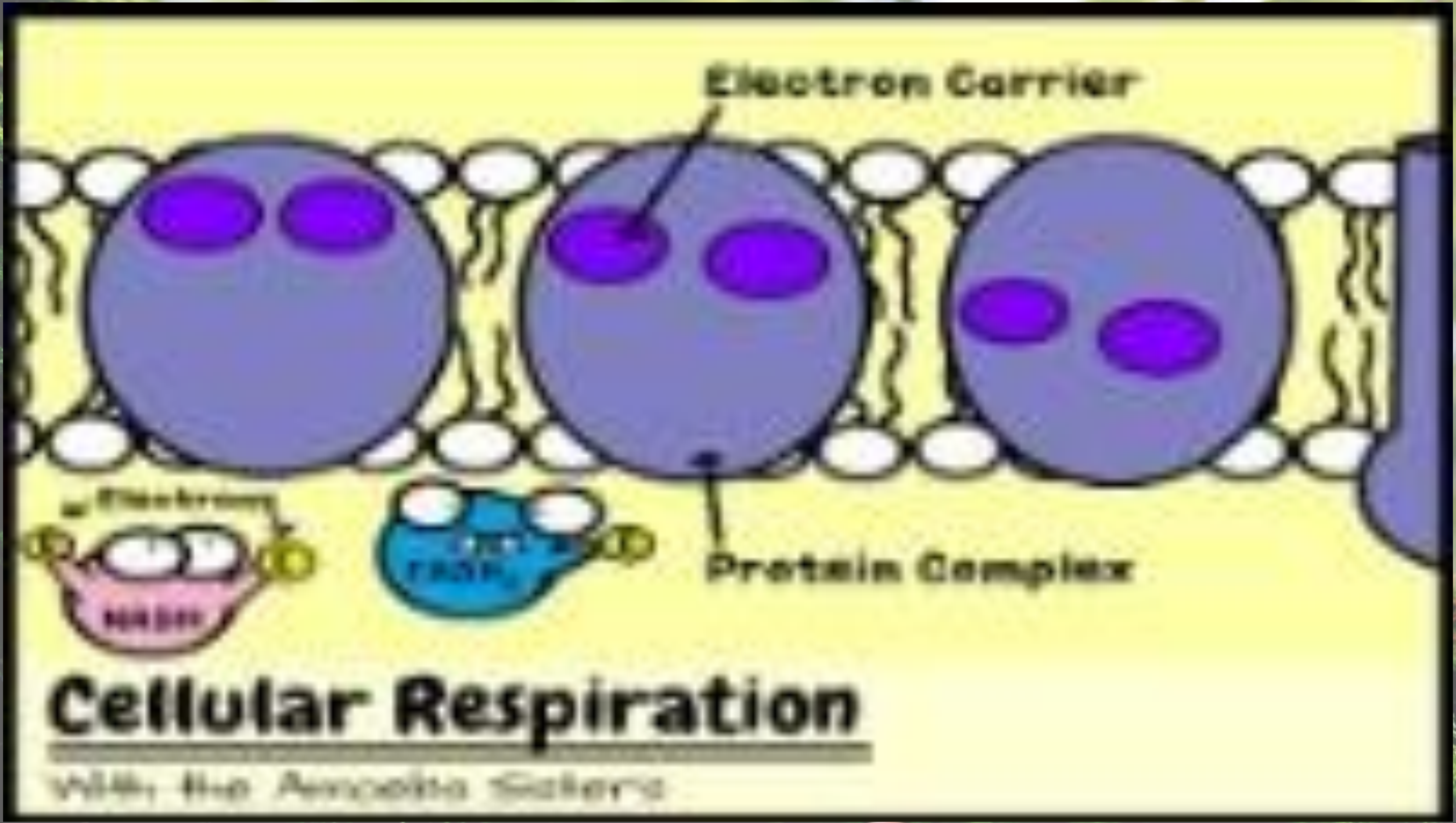
Respiration

- Cellular respiration, like photosynthesis, is a chemical reaction. During cellular respiration, glucose is combined with oxygen to produce carbon dioxide and water. This reaction produces many units of ATP, the cell’s usable energy. The ATP is then free to travel throughout the cell, supplying energy when needed.
- The respiration reaction can be summarized as foll
- Glucose + oxygen → carbon dioxide + water + ATP (i.e., energy)ows:

Photosynthesis and Cellular Respiration

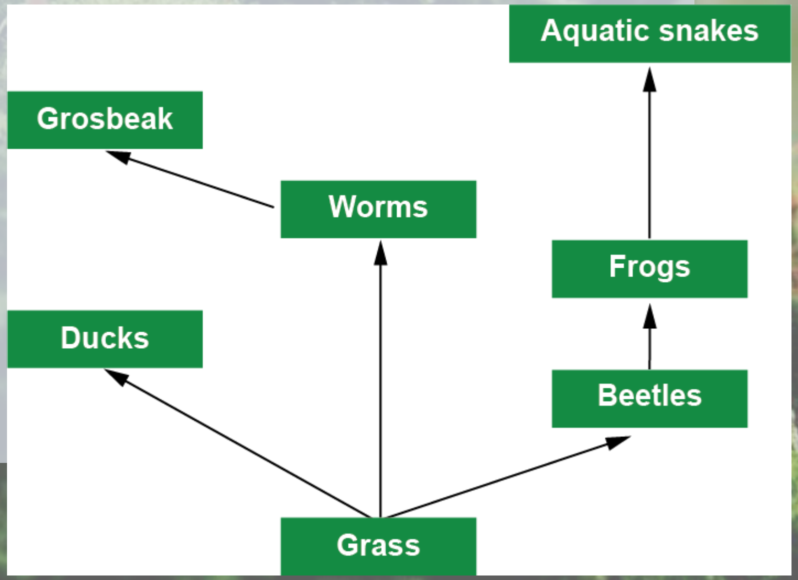
- These processes are complimentary.
- The following cycle shows how the two systems are complementary.
- Chloroplasts are the specific structures in plant cells that trap energy from the sun and perform photosynthesis.
- Mitochondria are the specific structures in cells that break down glucose molecules to produce energy.




Electron Carrier
Protein Complex
Cellular Respiration

Post 2: Food Web

- Show the energy flow within your ecosystem by creating a food web which includes 6-10 species. Draw your food web online and insert into your blog. If you are using a pen and paper, then take a picture of it to insert into your blog post.
- Identify one species in the first, second, and third trophic level to show energy transfer. Write the three species in your blog.
- See the following diagram as an example.



Food Webs, Trophic Interactions and Cycles Assignment