Almost all energy in the ecosystem comes originally from the sun.

Food chains show the direction of energy transfer.

Example: Algae → Fish → Heron
A terrestrial food chain

A marine food chain
A Trophic level is a step in the food chain.

What type of organism is always at the 1\textsuperscript{st} trophic level?

- autotroph/producer

What type(s) of organism can be at the 2\textsuperscript{nd} trophic level?

- herbivore or omnivore
Ecological Pyramid

When you compare the biomass (total mass of living things) at each level of a food chain, it forms a pyramid. The greatest mass is always the autotrophs (producers) with decreasing amounts as you move to higher trophic levels.

The pyramid effect of biomass is due to the availability of energy.
Energy Pyramid

1,000,000 J of sunlight

- Primary producers
  - 10,000 J
- Primary consumers
  - 1,000 J
- Secondary consumers
  - 100 J
- Tertiary consumers
  - 10 J
The Law of Conservation of Energy states that energy can not be created or destroyed. Yet the energy pyramid shows that less energy is available as you move up a food chain. What happens to the rest of the energy?

Much of the energy that an organism consumes is used by the organism and given off in the form of heat and some is released in waste.
Why does it take (on average) 16 lbs. of corn or soybeans to produce 1 lb. of beef?

Much of the energy that the cow consumes is given off as heat rather than being stored up as energy in its body.
King mackerel is a fish that tends to be high in mercury, tilapia is a fish that is usually low in mercury contamination. Predict what that indicates about their roles in the food chain.

Fish that are high in mercury contamination tend to be fish at the top of the food chain (king mackerel, shark). Mercury bioaccumulates since it is not broken down and stays in the body.
PASSING POLLUTION ALONG THE FOOD CHAIN

Once pollutants enter an organism's system, they stay in its body while other waste is excreted. This means that contaminants accumulate and are passed along the food chain. By the time an orca eats 10 pounds of salmon, it is ingesting pollutants from 10,000 pounds of microscopic plants and algae.

10,000 lbs. Microscopic plants and algae

1,000 lbs. Small invertebrates

100 lbs. Small fish

10 lbs. Salmon

To gain one pound, an orca might eat...

Mud and water contaminated with PCBs, mercury and other pollution

Source: F-1 reporting
Food Webs

Many heterotrophs feed on more than one type of organism. So most communities have energy flow in a food web, made of interacting food chains.
The Water Cycle

- Water storage in ice and snow
- Precipitation
- Snowmelt runoff to streams
- Infiltration
- Ground-water discharge
- Ground-water storage
- Water storage in oceans
- Water storage in the atmosphere
- Evaporation
- Condensation
- Transpiration
- Surface runoff
- Streamflow
- Spring
- Freshwater storage
The Carbon Cycle

Photosynthesis uses carbon dioxide in order to produce a sugar.

When organisms break down sugar to provide usable energy, in a process called cellular respiration, carbon dioxide is produced. Thus carbon cycles through living things and the environment.

Also, burning of organic matter (wood, fossil fuels) produces carbon dioxide.
CO₂ in atmosphere

Cellular respiration

Photosynthesis

Plants, algae, cyanobacteria

Burning

Wood and fossil fuels

Detritivores (soil microbes and others)

Detritus

Higher-level consumers

Primary consumers
Nitrogen Cycle

Nitrogen is an element that is found in organic molecules (molecules in living things), including DNA and protein.

Nitrogen makes up 78% of the atmosphere. But it is in a form that can not be used by most organisms.
Certain bacteria can convert atmospheric nitrogen into usable nitrogen. This process is called nitrogen fixing. This usable nitrogen in the soil can then be utilized by plants and passed through a food chain.
Nitrogen Fixating Bacteria
nitrogen in the atmosphere

nitrogen in animal proteins

nitrogen in plant proteins

nitrogen in decaying matter and waste

bacteria "fix" nitrogen for use by plants
Many farmers grow cover crops, like fava beans or clover, on their fields to improve the health of the soil.

How do these crops help?

These plants have nodules on their roots where nitrogen fixing bacteria live. This increases the nitrogen content of the soil that plants need.
The original source of energy in ecosystems comes from:

- A) Sunlight
- B) Food
- C) Chemicals in hydrothermal vents
- D) All the above
- E) Both A and C