



3-2 Energy Flow



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3-2 Energy Flow ➡ Producers

 **Where does the energy for life processes come from?**


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3-2 Energy Flow ➡ Producers

Producers

Without a constant input of energy, living systems cannot function.

 **Sunlight is the main energy source for life on Earth.**

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3-2 Energy Flow → Producers

Only plants, some algae, and certain bacteria can capture energy from sunlight or chemicals and use that energy to produce food.

These organisms are called **autotrophs**.



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3-2 Energy Flow → Producers

Autotrophs use energy from the environment to fuel the assembly of simple inorganic compounds into complex organic molecules.

These organic molecules combine and recombine to produce living tissue.

Because they make their own food, autotrophs are called **producers**.



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3-2 Energy Flow → Producers

Energy From the Sun

The best-known autotrophs harness solar energy through a process known as photosynthesis.

During **photosynthesis**, these autotrophs use light energy to convert carbon dioxide and water into oxygen and energy-rich carbohydrates.

Carbon dioxide + water → oxygen + carbohydrates



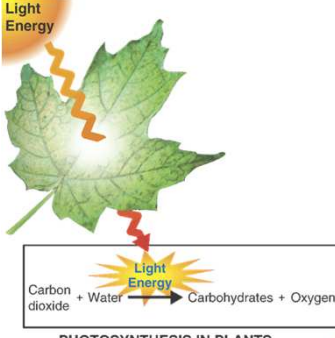
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3-2 Energy Flow → Producers

Photosynthesis is responsible for adding oxygen to—and removing carbon dioxide from—Earth's atmosphere.



Light Energy

Carbon dioxide + Water + Light Energy → Carbohydrates + Oxygen

PHOTOSYNTHESIS IN PLANTS

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3-2 Energy Flow → Producers

Plants are the main autotrophs on land.

Algae are the main autotrophs in freshwater ecosystems and in the upper layers of the ocean.

Photosynthetic bacteria are important in certain wet ecosystems such as tidal flats and salt marshes.

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3-2 Energy Flow → Producers

Life Without Light

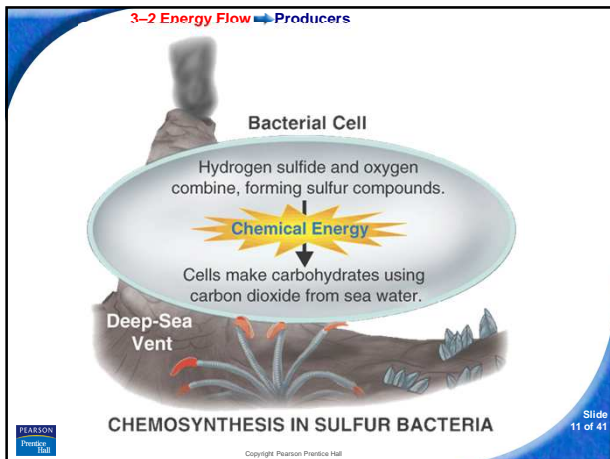
Some autotrophs can produce food in the absence of light.

When organisms use chemical energy to produce carbohydrates, the process is called **chemosynthesis**.

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Chemosynthesis is performed by several types of bacteria.

These bacteria represent a large proportion of living autotrophs.

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Some chemosynthetic bacteria live in very remote places on Earth, such as volcanic vents on the deep-ocean floor and hot springs.

Others live in more common places, such as tidal marshes along the coast.

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3-2 Energy Flow → Consumers

Consumers

Many organisms cannot harness energy directly from the physical environment.

Organisms that rely on other organisms for their energy and food supply are called **heterotrophs**.

Heterotrophs are also called **consumers**.

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3-2 Energy Flow → Consumers

There are many different types of heterotrophs.


- **Herbivores** eat plants.
- **Carnivores** eat animals.
- **Omnivores** eat both plants and animals.
- **Detritivores** feed on plant and animal remains and other dead matter.
- **Decomposers**, like bacteria and fungi, break down organic matter.

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3-2 Energy Flow → Feeding Relationships

 **How does energy flow through living systems?**

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3-2 Energy Flow ➡ Feeding Relationships

Feeding Relationships


The relationships between producers and consumers connect organisms into feeding networks based on who eats whom.

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3-2 Energy Flow ➡ Feeding Relationships

 Energy flows through an ecosystem in **one direction**, from the sun or inorganic compounds to autotrophs (producers) and then to various heterotrophs (consumers).

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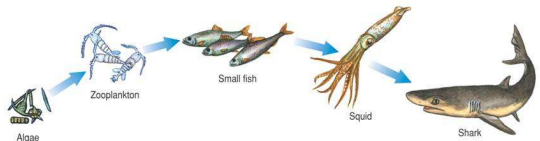
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3-2 Energy Flow ➡ Feeding Relationships

Food Chains

A **food chain** is a series of steps in which organisms transfer energy by eating and being eaten.



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3-2 Energy Flow ➡ Feeding Relationships

In some marine food chains, the producers are microscopic algae and the top carnivore is four steps removed from the producer.

```

    graph LR
      Algae --> Zooplankton
      Zooplankton --> SmallFish[Small Fish]
      SmallFish --> Squid
      Squid --> Shark
  
```

Algae Zooplankton Small Fish Squid Shark

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3-2 Energy Flow ➡ Feeding Relationships

Food Webs

Ecologists describe a feeding relationship in an ecosystem that forms a network of complex interactions as a **food web**.

A food web **links all the food chains** in an ecosystem together.

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3-2 Energy Flow ➡ Feeding Relationships

This food web shows some of the feeding relationships in a salt-marsh community.

```

    graph TD
      Producers[Producers: Algae, Marsh grass, Salt-marsh grass] --> Herbivores[Herbivores: Marsh grasshopper, Marsh wren, Salt-marsh sparrow, Marsh hawk]
      Herbivores --> FirstLevelCarnivores[First-level Carnivores: Marsh hawk, Marsh sparrow, Marsh wren]
      FirstLevelCarnivores --> TopLevelCarnivores[Top-level Carnivores: Osprey]
      Decomposers[Decomposers: Bacteria, Fungi] --> Producers
  
```

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3-2 Energy Flow ➡ Feeding Relationships

Trophic Levels

Each step in a food chain or food web is called a **trophic level**.

Producers make up the **first** trophic level.

Consumers make up the second, third, or higher trophic levels.


Each consumer depends on the trophic level below it for energy.

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3-2 Energy Flow ➡ Ecological Pyramids


 **How efficient is the transfer of energy among organisms in an ecosystem?**

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3-2 Energy Flow ➡ Ecological Pyramids

 **Only about 10 percent of the energy available within one trophic level is transferred to organisms at the next trophic level.**

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3-2 Energy Flow ➡ Ecological Pyramids

Ecological Pyramids

The amount of energy or matter in an ecosystem can be represented by an ecological pyramid.

An **ecological pyramid** is a diagram that shows the relative amounts of energy or matter contained within each trophic level in a food chain or food web.

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3-2 Energy Flow ➡ Ecological Pyramids

Ecologists recognize three different types of ecological pyramids:

- energy pyramids
- biomass pyramids
- pyramids of numbers

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3-2 Energy Flow ➡ Ecological Pyramids

Energy Pyramid:

Shows the relative amount of energy available at each trophic level.

Only part of the energy that is stored in one trophic level is passed on to the next level.

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3-2 Energy Flow ➡ Ecological Pyramids

Biomass Pyramid

The total amount of living tissue within a given trophic level is called **biomass**.

Biomass is usually expressed in terms of grams of organic matter per unit area. (gm/unit area)

A biomass pyramid represents the amount of potential food available for each trophic level in an ecosystem.

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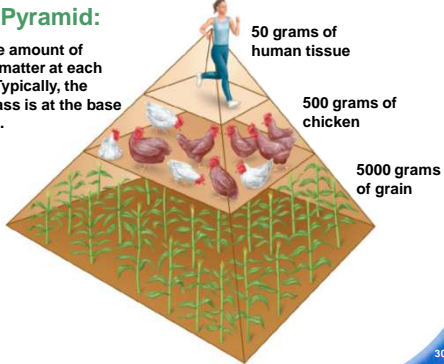
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3-2 Energy Flow ➡ Ecological Pyramids

Biomass Pyramid:

Represents the amount of living organic matter at each trophic level. Typically, the greatest biomass is at the base of the pyramid.



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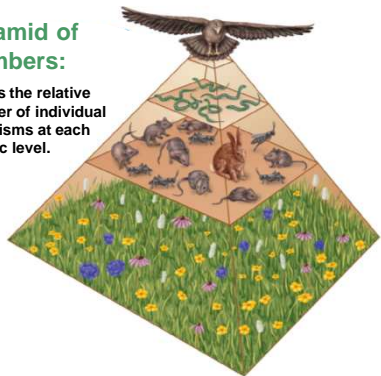
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3-2 Energy Flow ➡ Ecological Pyramids

Pyramid of Numbers:

Shows the relative number of individual organisms at each trophic level.



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3-2 Energy Flow → Ecological Pyramids

For some ecosystems, the shape of the pyramid of numbers is the same as that of the energy and biomass pyramids.

However, in ecosystems where there are fewer producers than there are consumers, such as a forest ecosystem, the pyramid of numbers would not resemble a typical pyramid at all.
