Symbiosis, Nutrient Cycles, and Populations

Matthew Williams • Biology • May 8, 2026

Symbiosis, Nutrient Cycles, and Populations

This page brings together three parts of ecology: relationships among organisms, recycling of nutrients, and changes in population size.

Relationships Among Organisms

Organisms interact in many ways. Three important relationships are mutualism, parasitism, and commensalism.

Relationship	Species 1	Species 2	Example
Mutualism	benefits	benefits	Rhizobium and legume
Parasitism	benefits	harmed	tick and dog
Commensalism	benefits	unaffected	orchid and tree

Mutualism

Mutualism is a relationship in which both organisms benefit.

Examples include Rhizobium bacteria in legume root nodules, termites and Trichonympha, and clownfish with sea anemones. In each case, both organisms gain something from the relationship.

Parasitism

Parasitism is a relationship in which one organism benefits and the other is harmed.

The parasite benefits. The host is harmed.

Examples include ticks feeding on mammals, tapeworms living in the intestine, Plasmodium causing malaria, and dodder growing on another plant.

Commensalism

Commensalism is a relationship in which one organism benefits and the other is neither helped nor harmed.

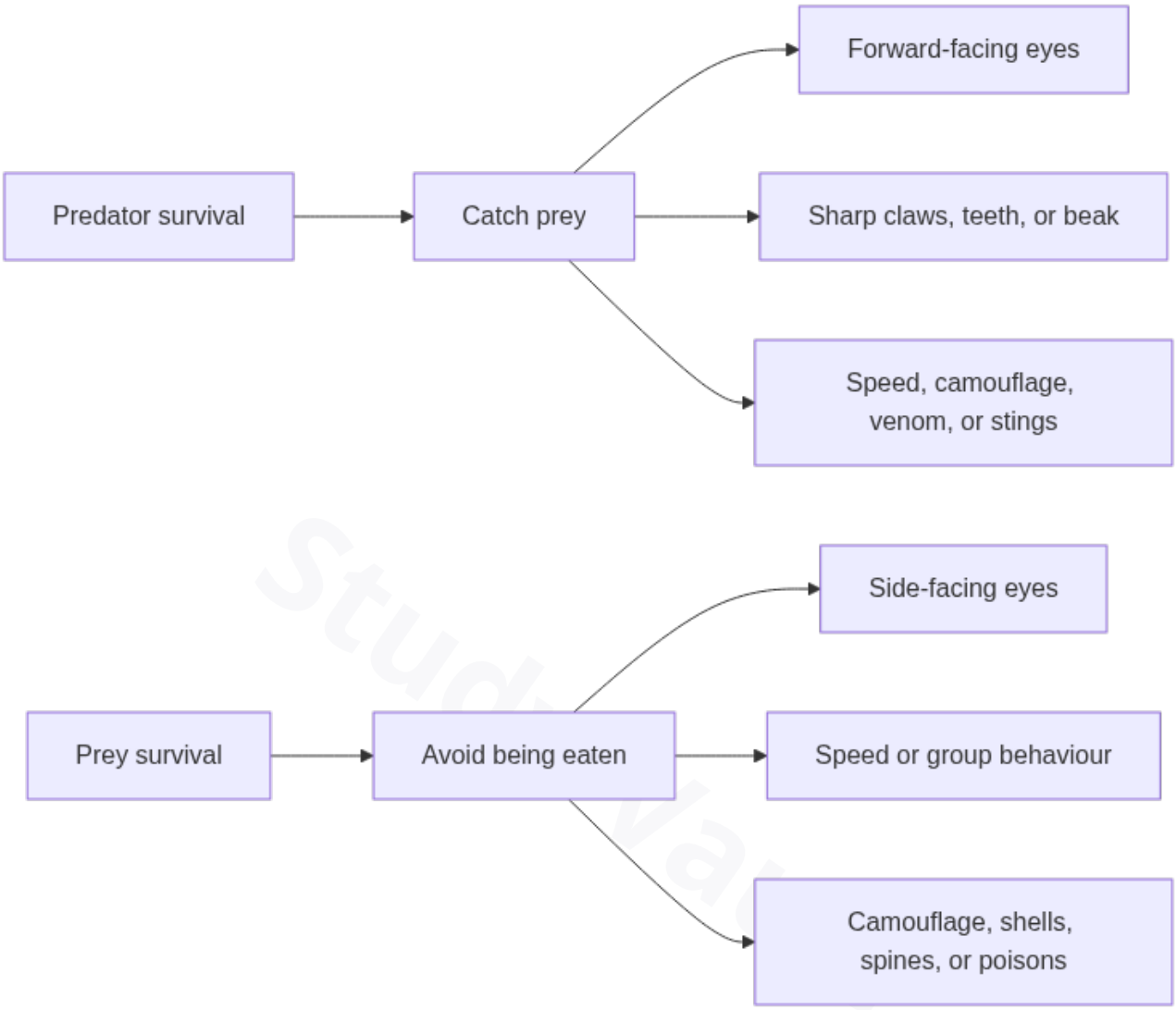
Orchids growing on trees show commensalism: the orchid gains support and better access to light, while the tree is not harmed.

Adaptations in Feeding Relationships

Predators and prey often have features that help them survive.

Predators may have sharp claws, sharp teeth or beaks, forward-facing eyes for judging distance, speed, camouflage, venom, or stings. Prey may have camouflage, side-facing eyes for a wider field of view, speed, group behaviour, poisons, shells, spines, or other protective structures.

A hawk has forward-facing eyes, which helps it judge distance accurately when catching prey.



Predator and prey adaptations

Nutrient Cycles

Nutrients are reused in ecosystems. This cycling helps maintain balance.

The main cycles for this section are:

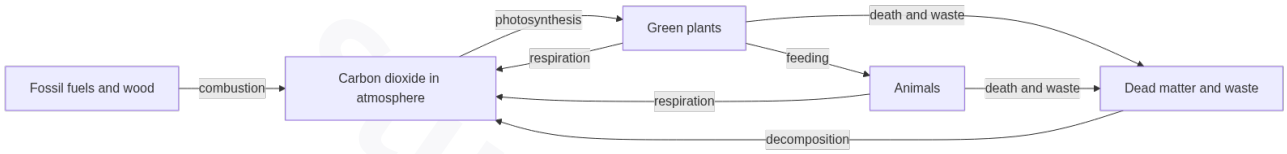
- carbon cycle
- water cycle
- nitrogen cycle

Carbon Cycle

Carbon moves between the atmosphere, organisms, dead matter, oceans, and fossil fuels.

Key processes:

- photosynthesis removes carbon dioxide from the air
- feeding transfers carbon compounds through food chains
- respiration releases carbon dioxide
- decomposition releases carbon compounds from dead matter and waste
- combustion releases carbon dioxide when wood and fossil fuels burn



Carbon cycle

Water Cycle

The water cycle moves water between the atmosphere, land, and living organisms.

Key processes:

- evaporation from seas, rivers, lakes, and soil
- transpiration from plant leaves
- condensation to form clouds
- precipitation as rain
- runoff into rivers and seas
- infiltration into soil

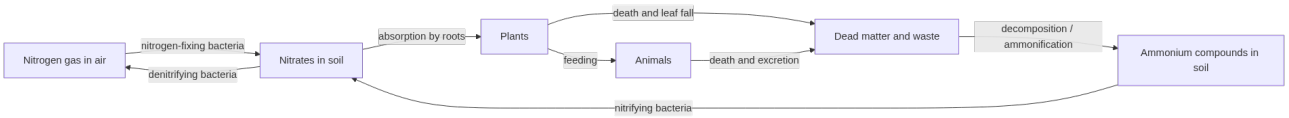
Nitrogen Cycle

Nitrogen is needed to make proteins and DNA. Most organisms cannot use nitrogen gas directly, so bacteria are essential.

Main stages:

- nitrogen fixation changes nitrogen gas into compounds plants can use
- plants absorb nitrates from the soil
- animals obtain nitrogen by feeding on plants or other animals

- decomposition returns nitrogen compounds to the soil
- denitrifying bacteria return nitrogen gas to the atmosphere



Nitrogen cycle

Decomposers link feeding relationships to nutrient cycles by returning minerals to the soil so producers can keep growing.

Population Growth

A population is affected mainly by birth rate, death rate, immigration, and emigration.

Population size increases when birth rate or immigration increases, or when death rate or emigration decreases. Population size decreases when death rate or emigration increases, or when birth rate or immigration decreases.

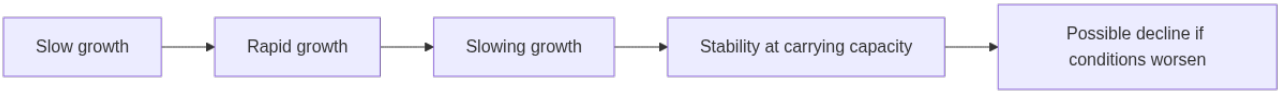
Carrying Capacity

Carrying capacity is the maximum population size that an environment can support over time.

As a population grows, limiting factors become stronger.

Examples:

- food becomes scarce
- waste builds up
- disease spreads more easily
- competition increases
- predators may increase
- pests may spread
- invasive species may compete with native organisms
- natural disasters may suddenly reduce population size



Population growth phases

If a population graph levels off, it has likely reached carrying capacity. The population is no longer growing rapidly because limiting factors are controlling it.

Human Population Growth

Humans are affected by the same basic limits as other organisms, but technology allows humans to reduce some limiting factors.

Humans have increased food supply through agriculture, reduced disease through medicine and sanitation, and created more living space through building and land clearing.

However, human population growth still increases pressure on:

- land
- water
- food supplies
- energy resources
- waste disposal systems
- natural habitats

Population questions may use graphs. For example, a population may fall sharply after a hurricane, drought, disease outbreak, pest invasion, or introduction of a new predator.

Core idea

Organisms interact with each other, nutrients cycle through ecosystems, and population size changes when birth, death, movement, and limiting factors change.

PRACTICE — SYMBIOSIS, CYCLES, AND POPULATIONS

Mutualism
A relationship where both organisms benefit.

Parasitism
A relationship where one organism benefits and the host is harmed.

Commensalism
A relationship where one organism benefits and the other is not helped or harmed.

Carbon cycle
The cycling of carbon through photosynthesis, feeding, respiration, decomposition, and combustion.

Nitrogen cycle
The cycling of nitrogen through bacteria, soil nitrates, plants, animals, decomposition, and return to the atmosphere.

Carrying capacity
The maximum population size an environment can support over time.

Limiting factor
Any biotic or abiotic factor that restricts population growth or survival.