Community Ecology
& Ecosystems
I. Species Interactions and community structure
A biological community consists of all the organisms that inhabit a particular area, an assemblage of populations of different species living together for potential ___________

Structure of communities
- Species __________ – number of species in a given area
- Species Diversity – the variety of species present and their relative abundance

A. Forces that affect community structure, species interactions:
   1) Competition
   2) Consumption
   3) Mutualism

Species Interactions
Results of species interactions:
- species interactions may affect the distribution and abundance of a particular species
- species act as agents of natural selection when they interact
- the outcome of interactions among species is dynamic and conditional

1) Competition
   intraspecific competition
   - occurs between members of ________________
   - intensifies as a population’s density increases and is a major cause of density-dependent growth

_____________ competition occurs between members of different species

Two similar species that compete for the same limiting resources cannot coexist long term. Competitive exclusion principle = when two species compete for the same niche,

___________: the way an organism uses the abiotic and biotic resources in its environment (i.e., an organism’s “profession”), two species cannot occupy the same niche

niche overlap leads to ________________
Semibalanus cannot survive high on rocks - not very tolerant of desiccation
Chthamalus is desiccation tolerant, but cannot compete with Balanus in lower regions of the intertidal

Mechanisms of Coexistence
a. resource partitioning (niche differentiation): competition drives species to become adapted to different niches

Mechanisms of Coexistence
b. character displacement: traits diverge in sympatric populations

2) Consumption
Consumption is a ________ interaction that occurs when one organism eats another.

There are three major types of consumption:
1. ___________ is the consumption of plant tissues by herbivores.
2. ________________ is the consumption of small amounts of tissues from another organism, or host, by a parasite.
3. Predation is the killing and consumption of most or all of another individual (the prey) by a predator.
Offense and Defense
many adaptations for capturing prey and for avoiding being eaten
• speed and agility
• heat sensing organs
• camouflage for ambush

Defensive Adaptations
A. coloration
  1. cryptic coloration:
     example - flounder
  2. aposematic coloration:
     example - poison dart frog
  3. deceptive coloration: prey looks more dangerous than it is
  4. ___________ : harmless species comes to look like a poisonous one, example:
     hornet moth and hoverfly look like wasp beetle; or two toxic species look like each other

B. schooling: safety in numbers
C. weaponry: teeth,

3) Mutualism
-Mutualisms are +/+ interactions that involve a wide variety of organisms and rewards.
examples:
• Cleaner shrimp feed on

B. Species with Large Impacts on community structure
1. dominant species: are numerically abundant or have the highest biomass in a community
2. ___________ species: not necessarily a dominant species, but ecologically significant for the community
   (determining impact of a species is often examined by removal experiments)
   example of keystone species:
   starfish _Pisaster_ feeds on
3. foundation species: species impact not through trophic dynamics, but physical effects on environment
   example of foundation species
II. Ecosystem Ecology:
A. Energy Flow and Cycling of Matter

In the biosphere, energy flow is unidirectional and matter is

ecosystem components:
- primary producers:
- consumers: eat living organisms
  - primary consumers:
  - secondary consumers:
- detritovores: decomposers
- abiotic environment: includes soil, climate, atmosphere, nutrients, etc.

Ecosystem Energy Budgets

**primary productivity**: amount of new biomass from autotrophs added to ecosystem per unit of time

**net primary production** = gross primary production - respiration

net primary production = E or biomass/unit area/unit time (e.g., J/m\(^2\)/y, g/m\(^2\)/y)

**standing crop**: total biomass of autotrophs per unit area (e.g., g/m\(^2\))

**secondary production**: increase in biomass of consumers over time

Net 1° Productivity of Ecosystems

Productivity is limited by sunlight, temperature, water and nutrients

Trophic Levels, Food Chains, and Food Webs

**trophic levels**: steps in energy transfer

**food chain**: connects the trophic levels in a particular ecosystem

food chains embedded in a more complex network of a food web
The Transfer of Energy in a Food Chain:
The Trophic Pyramid

all ecosystems exhibit a pattern - the pyramid of productivity.
productivity is greatest at the lowest trophic level and declines at higher levels.
at each trophic level some energy used in keeping an organism alive.

$\text{trophic efficiency} = \text{percent of production transferred from one trophic level to the next}$,
estimated at ________.

B. Biogeochemical Cycles
A biogeochemical cycle is the path that an element takes as it moves through biotic and abiotic systems of the Earth.

Factors that Control Nutrient Cycling
Most often, decomposition of detritus limits the rate at which nutrients move through an ecosystem.
Decomposition rate influenced by
1. abiotic conditions (such as temperature and moisture)
2. quality of the detritus as a nutrient source

The Hydrologic Cycle

The Carbon Cycle

1 GT = $10^9$ tons = 1 billion tons
______________ are the largest reservoir of carbon (long term storage in oceans and rocks not included in model above)
Time scale of carbon transfer can vary from a few seconds to millions of years
CO₂ and Climate Change

Carbon dioxide is a greenhouse gas (a gas that traps heat radiated from Earth and keeps it from being lost to space). Increases in concentrations of greenhouse gases have the potential to warm Earth’s climate by increasing the atmosphere’s heat-trapping potential.

Humans Are Causing Increases in Atmospheric CO₂

Human activities such as intensive agriculture, deforestation, and the burning of fossil fuels have changed the carbon cycle by adding large amounts of carbon dioxide to the atmosphere.

Impacts of Global Warming

Through perturbation of carbon and hydrologic cycles

Atmosphere: CO₂ buildup
- greenhouse warming
- climate zone shifts (temperature and rainfall)

Hydrosphere: sea level rise
- ocean chemistry changes (e.g., acidification)
- changes in sedimentation
- polar ice melts

Biosphere: ecological instability
- animal and plant migrations
- tropical diseases expand in range
- hyperthermia
- extinction (e.g., coral reefs, polar bears)