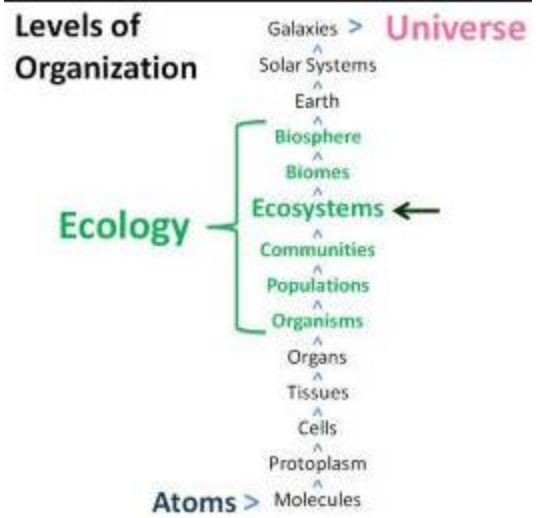
UNIT 9 - ECOLOGY

biosphere
ecosystem, Community, organism,
population, biome

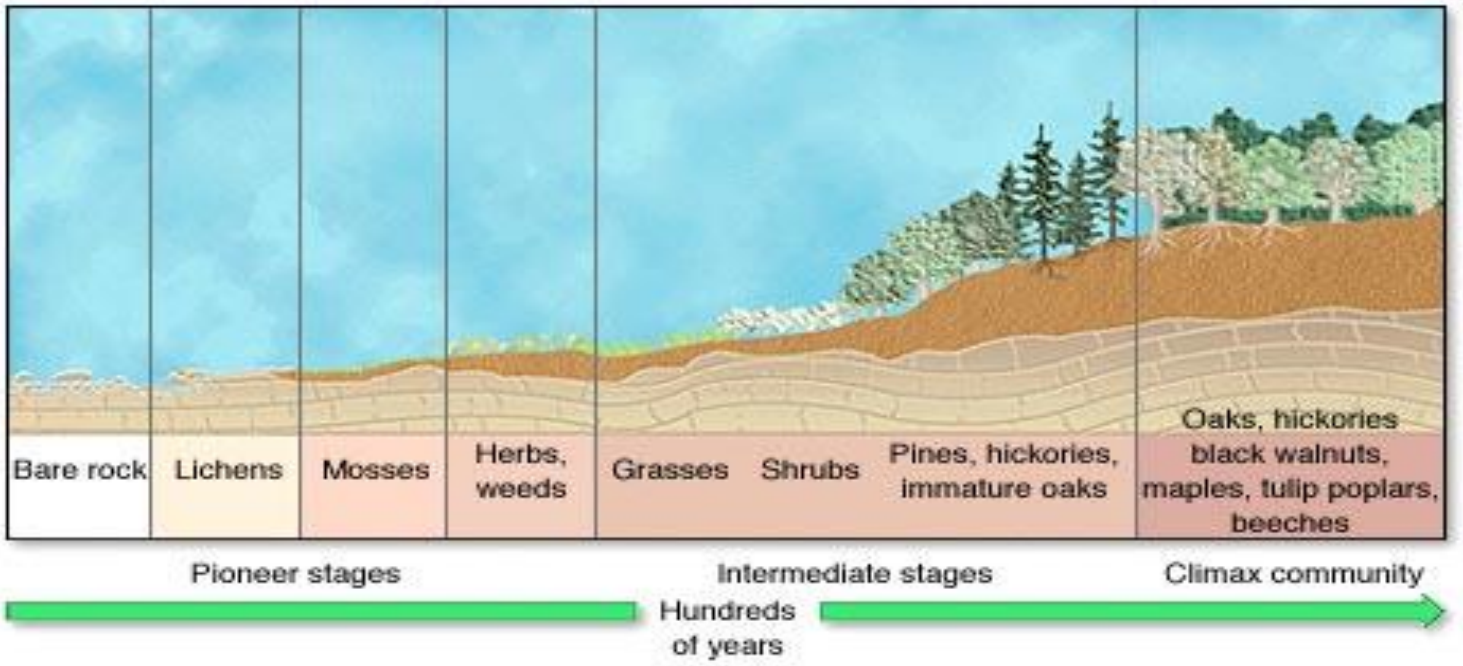
Topic 1 – Ecology Basics
Topic 2 – Population Ecology
Topic 3 – Community Ecology
Topic 4 – Energy Transfer and Nutrient Cycles



TOPIC 1: ECOLOGY BASICS

By the end of this topic, you should be able to…

- Identify and describe the different levels of ecological organization
- List key features of the main biomes (aquatic and terrestrial)
-]



Ecology = the study of the interactions between organisms and the **living** and **nonliving** components of their environment

What is another word for living?

biotic

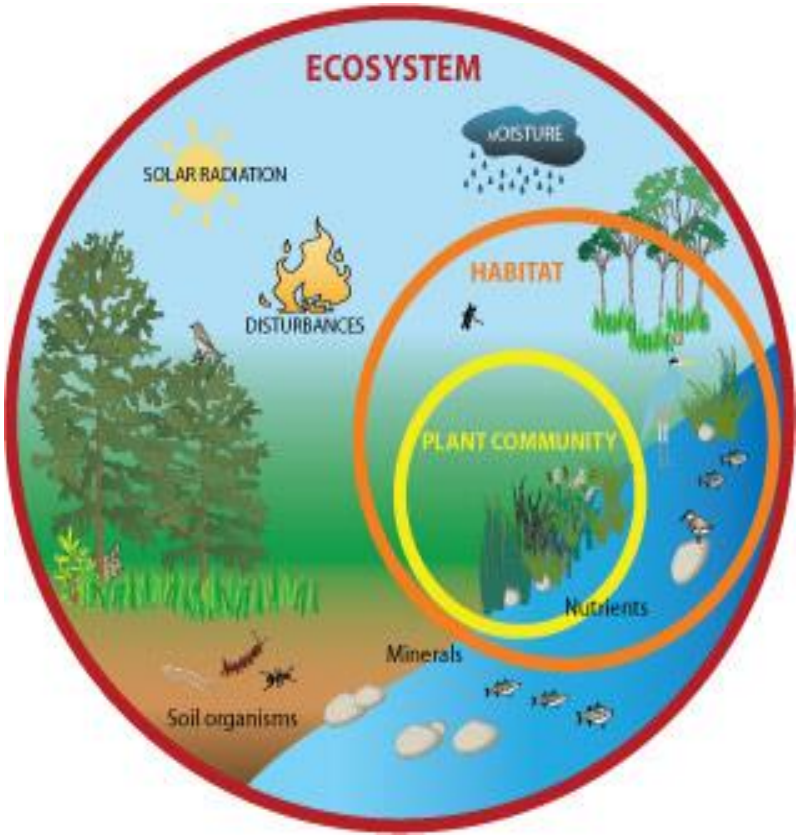
- *examples?*

What is another term for nonliving?

abiotic

- *examples?*

rocks, water, soil, sun,



LEVELS OF ORGANIZATION IN ECOLOGY

Biosphere = the thin volume of earth and its atmosphere that supports life

Biome = major habitat areas, either terrestrial (on land) or aquatic (in water)

Ex: savannah, tundra, ocean

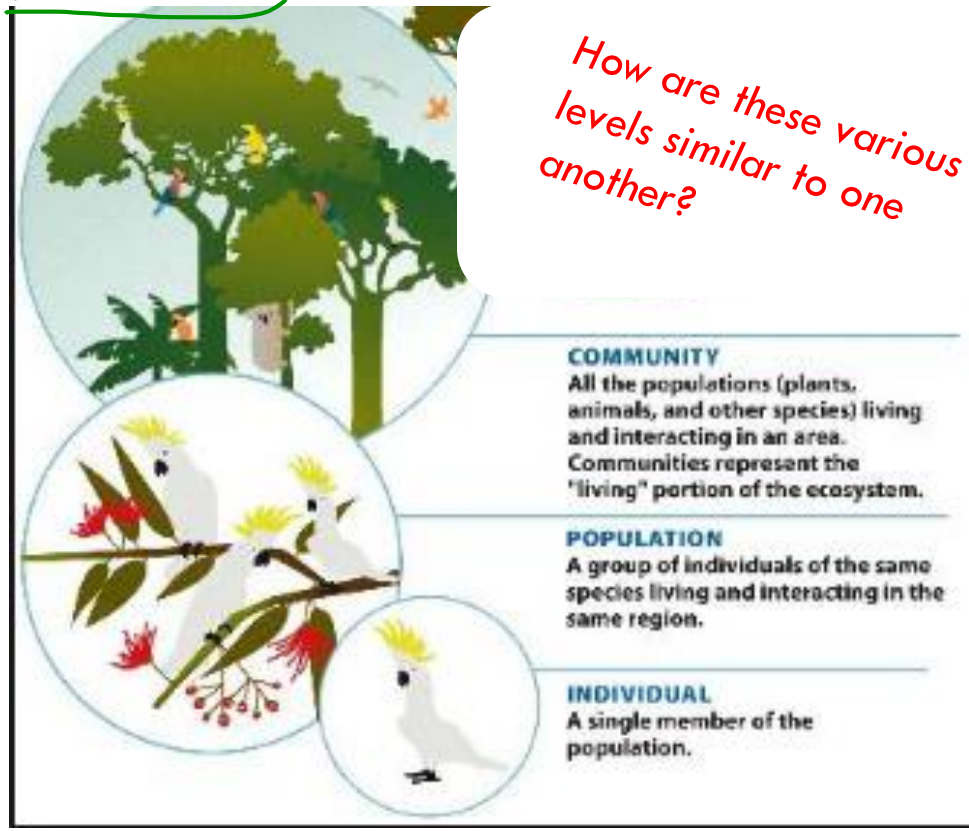
Ecosystems = all the organisms and non-living things in a particular place

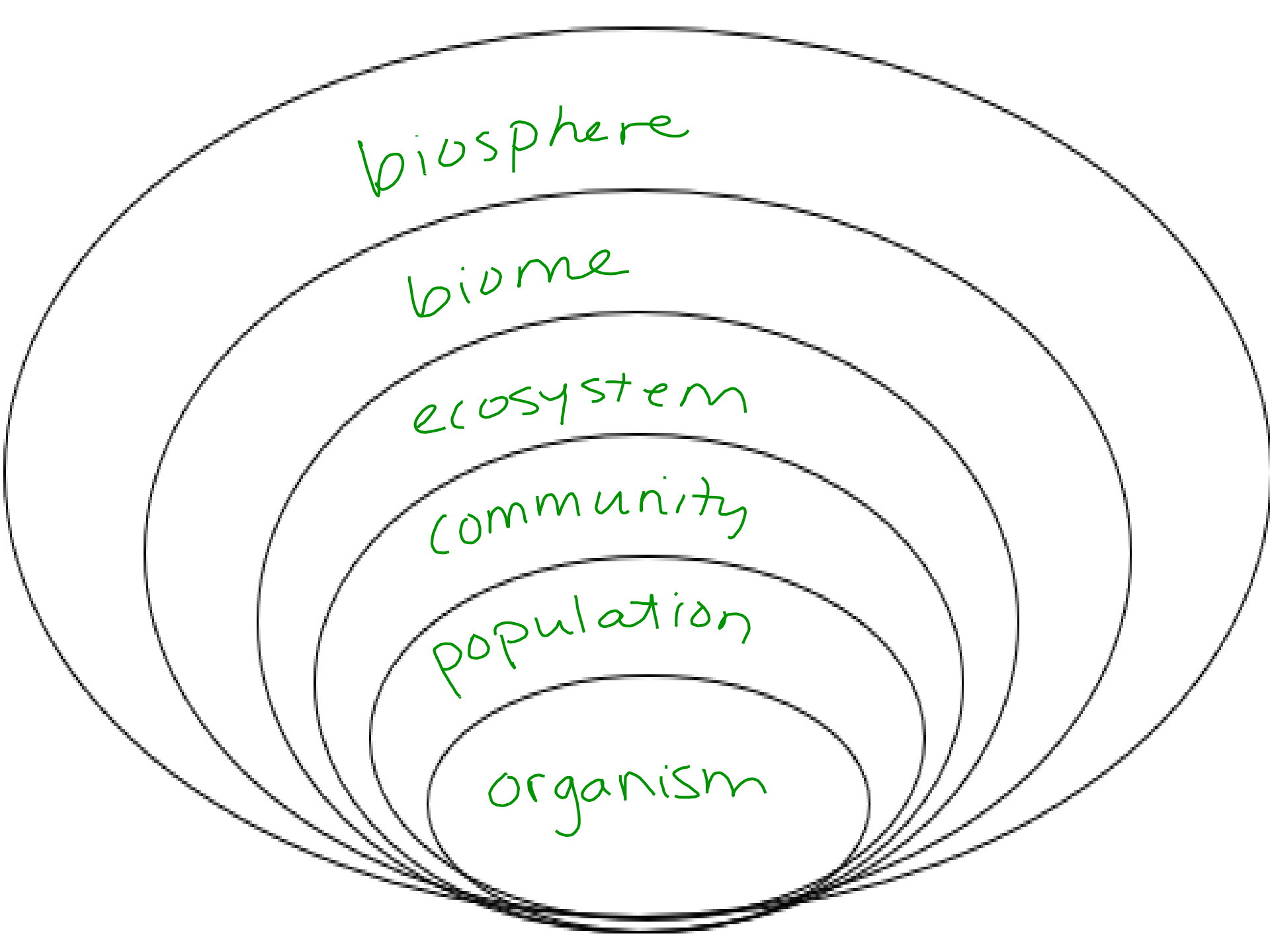
LEVELS OF ORGANIZATION IN ECOLOGY (CTD.)

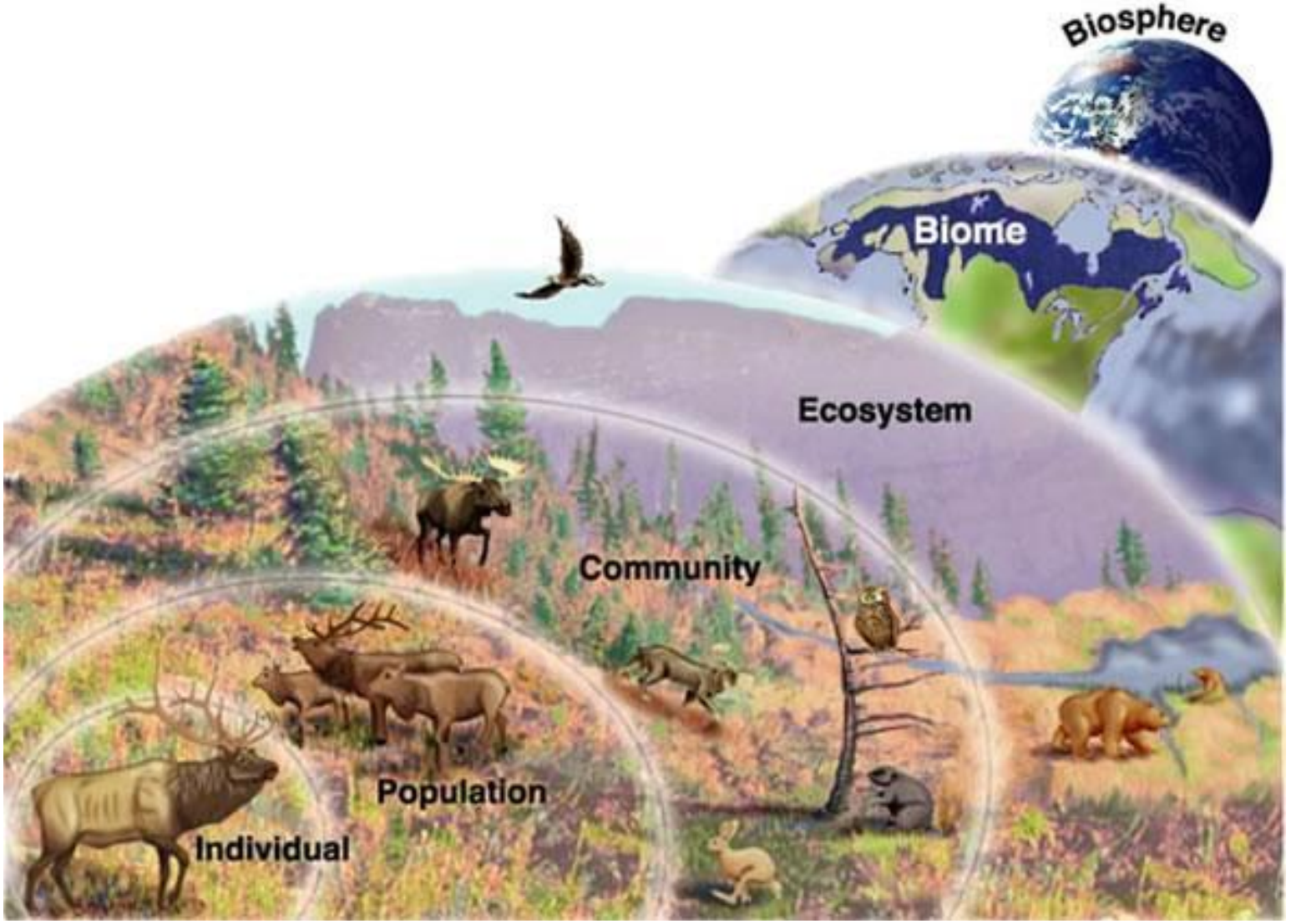
Communities = all the interacting populations in an area (only living things)

Populations = all the members of a single species that live in one place at one time (ex: all the salmon in a stream)

Organisms = An individual living thing




biosphere
biome
ecosystem
community
population
organism


Biosphere
Biome
Ecosystem
Community
Population
Individual

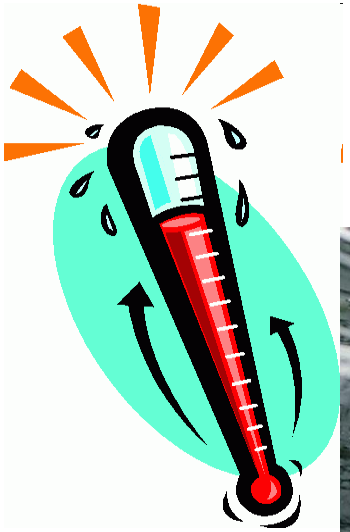
ENVIRONMENTAL FACTORS

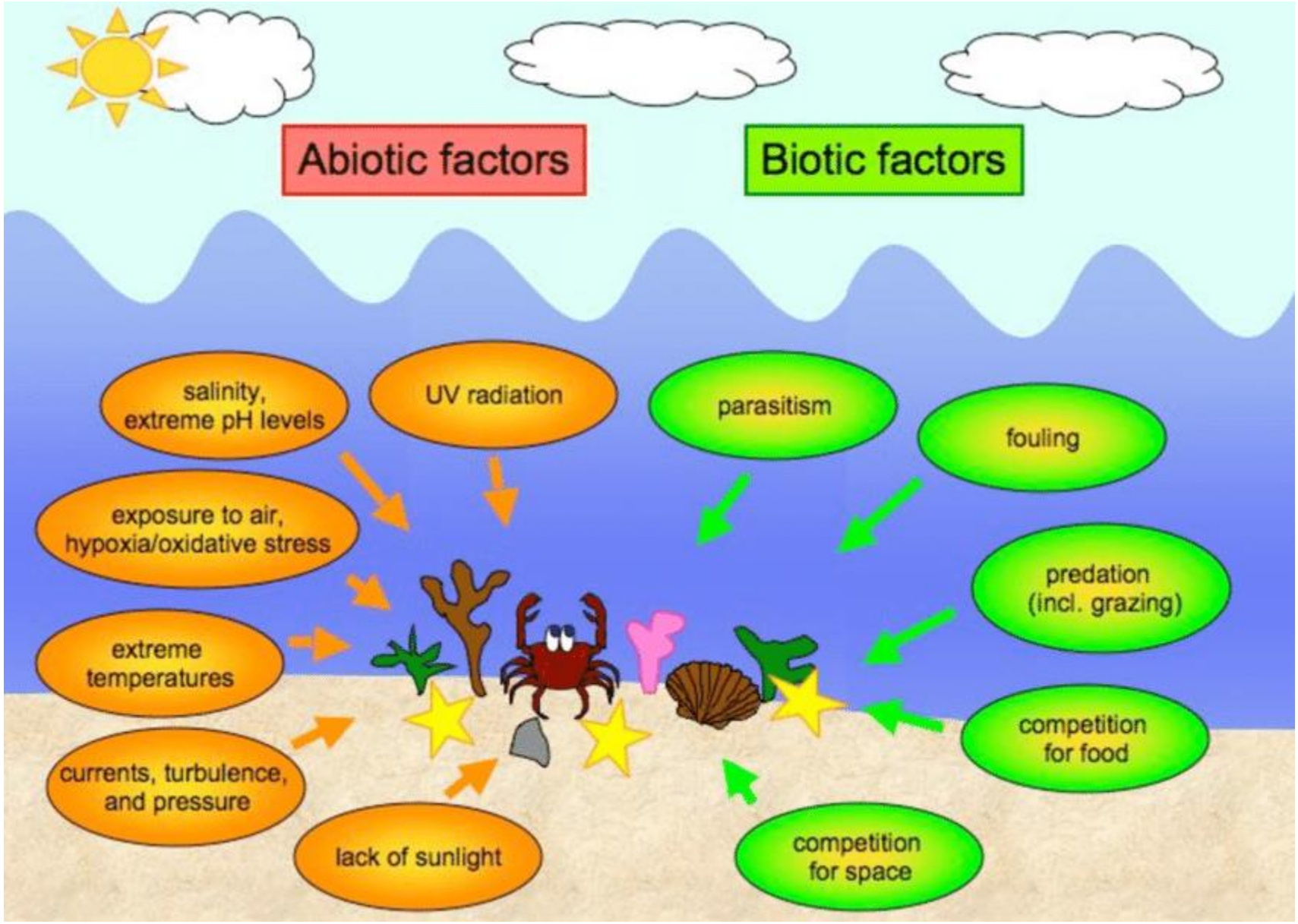
Biotic factors are living and abiotic factors are non-living

Biotic Examples: Predators, disease, parasites

bacteria

Abiotic Examples:
Temperature, humidity, precipitation




Abiotic factors
Biotic factors
salinity, extreme pH levels
UV radiation
parasitism
fouling
exposure to air, hypoxia/oxidative stress
predation (incl. grazing)
extreme temperatures
competition for food
currents, turbulence, and pressure
lack of sunlight
competition for space

NICHE

Niche = the role an organism plays in its environment (includes habitat, ways of obtaining nutrients, etc.)

1) Fundamental Niche = the range of conditions and resources a species COULD use/tolerate

- cardinal could live on any tree in forest

what it really uses

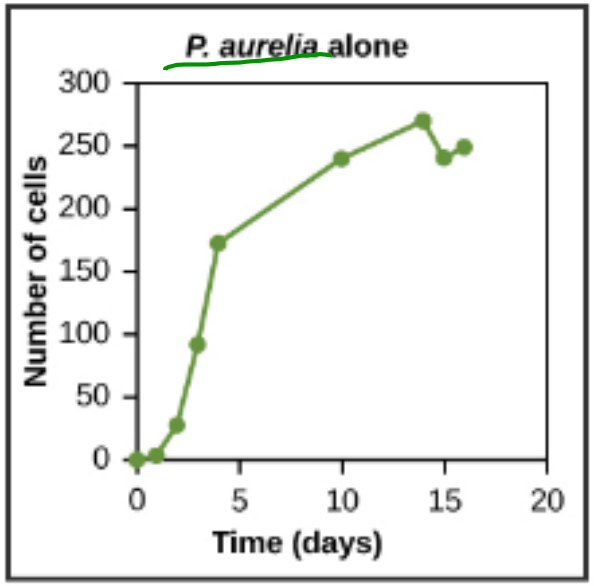
2) Realized Niche = the range of conditions and resources a species actually DOES use/tolerate

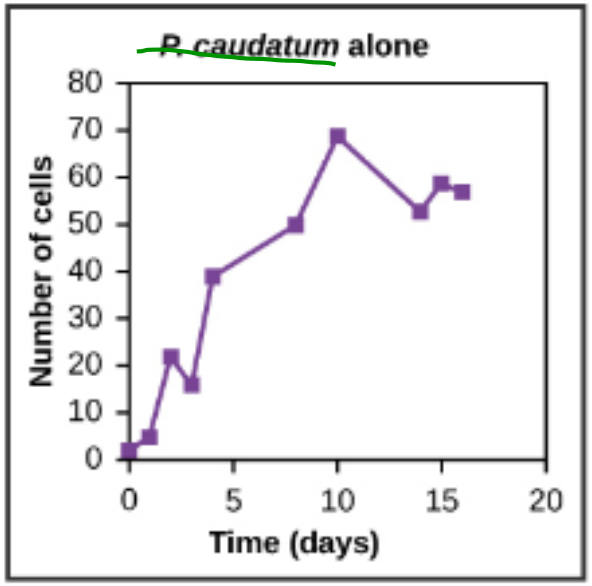
- cardinal actually nest in maple trees

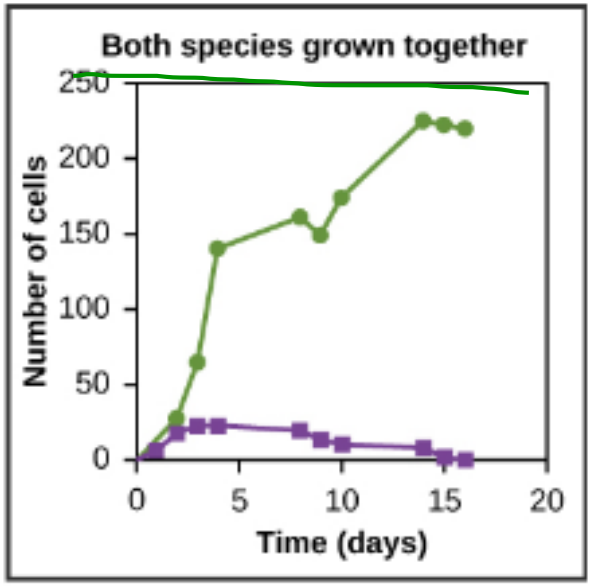
IS A SPECIES' HABITAT THE SAME AS ITS NICHE? (PART OF FUND. V REAL. NICHE)

Tolerance = each organism has an upper and lower limit for survival

- Steelhead trout
- Ideal water temp range = 13 degrees c – 21 degrees c
- Can survive at slightly lower temps
  - Physiological stress = inability to grow & Reproduce





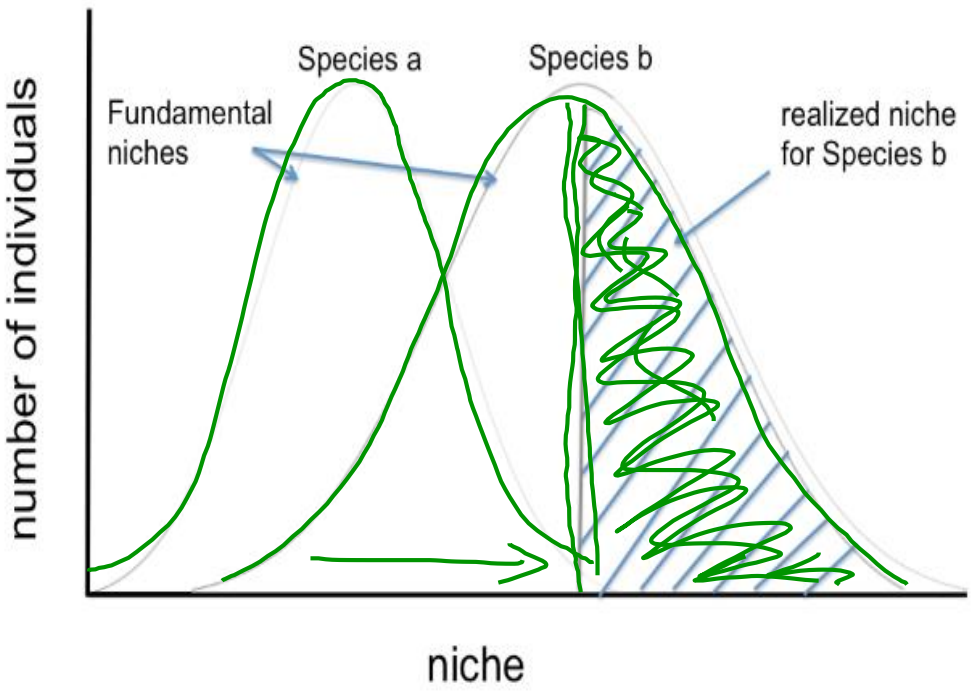


Competitive exclusion principle *- two species can't have exactly the same niche in a habitat and stably coexist*

- *Species with identical niches have identical needs, which means they would compete for precisely the same resources.*

Above: 2 single-celled microorganisms, Paramecium aurelia and Paramecium caudatum

- *Grown individually, both species thrive*
- *Grown in the same test tube (habitat) with a fixed amount of nutrients, both grow more poorly and P. aurelia eventually outcompetes P. caudatum for food, leading to P. caudatum's extinction.*



Based on this graph, is species a or species b the stronger competitor?

IS A SPECIES' HABITAT THE SAME AS ITS NICHE?

A species' habitat (where it lives) is PART of its niche…the fact that a lizard lives in a desert is part of its niche

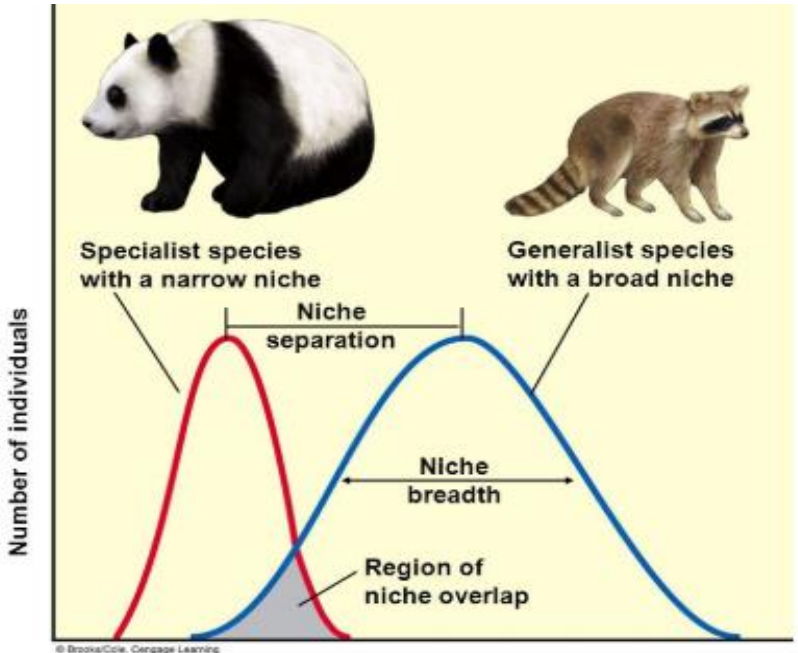
Other parts of its niche:

- -sunning behavior to regulate body temperature
- -methods of catching insects

NICHE

Generalists = species with broad niches (ex: possums and raccoons)

Specialists = species with narrow niches (ex: koala)



Koalas: Australia's Pickiest Eaters

Posted on August 3, 2012 23 Comments

Koalas, one of nature's pickiest eaters, choose to only dine on eucalyptus leaves. (Photo credit: Purestock/Getty Images)

Many people have favorite foods. But the koala takes favorite food to the extreme. These Australian marsupials have evolved to live almost exclusively on eucalyptus leaves. And if that isn't picky enough, recent research suggests that koalas are highly selective as to the species of eucalyptus they prefer and even the individual trees from which they choose to eat. How have these animals become so picky, and how can scientists use this information to aid in koala conservation efforts?

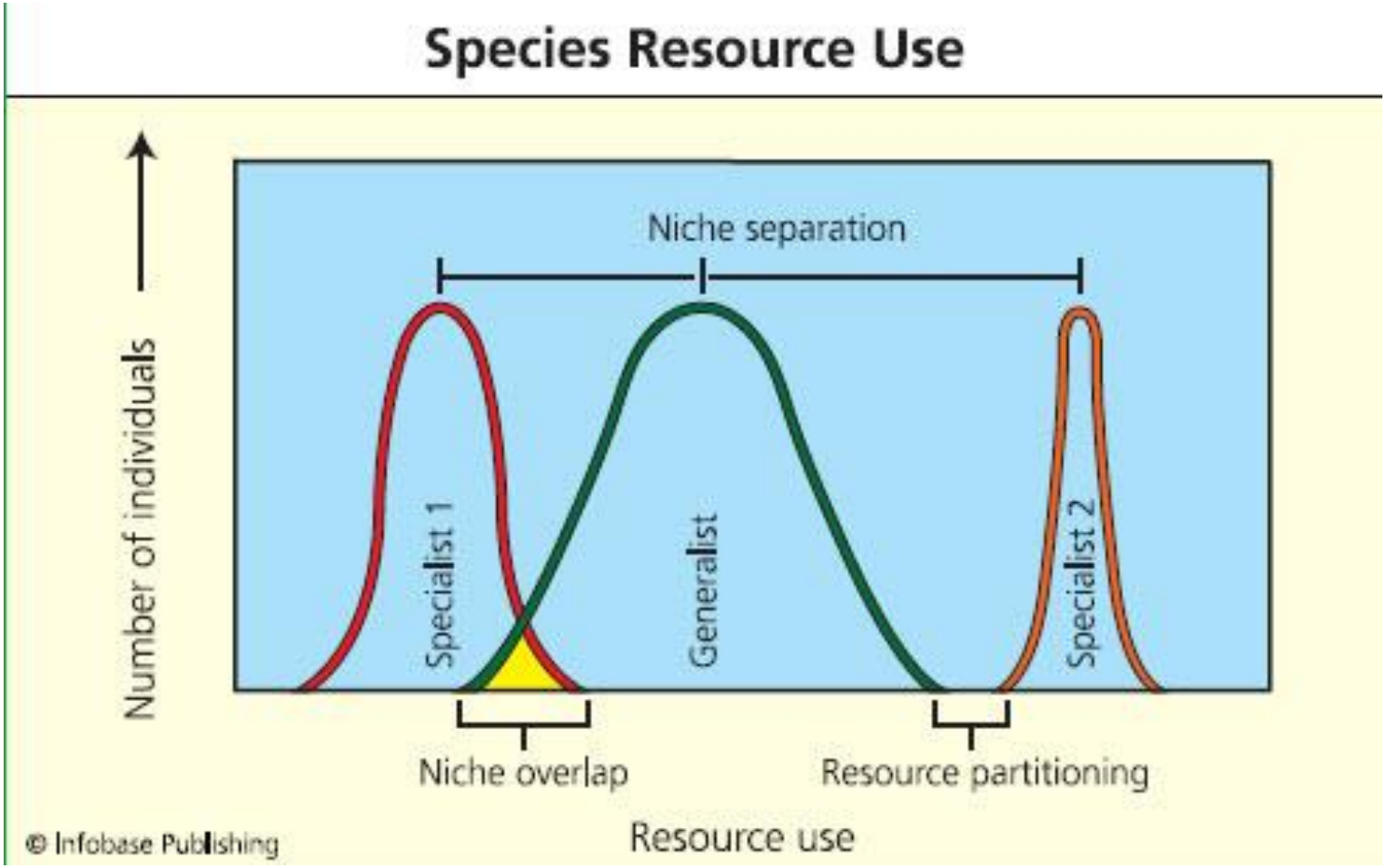
Filling a Niche

In ecological terms, the highly-selective diet of the koala makes them a specialist, that is, a consumer that primarily eats one specific organism or a very small number of organisms. Specialist species are generally sensitive to environmental changes, especially changes that affect the availability of their food source. However, the pickiness of koalas is likely an evolutionary adaptation.

Eucalyptus trees are the dominant trees of Australia. In fact, there are more than 700 species in the genus Eucalyptus, and most are native to Australia. However, the leaves of these trees are actually very low in protein, not easily digested, and contain compounds that are toxic to most species. Therefore, the ability for koalas to specialize in eating eucalyptus leaves has allowed them to fill an ecological niche. Koalas have virtually no competition for their preferred food source.

Koalas spend approximately 18-20 hours each day sleeping, and most of the remaining time is spent eating. They eat about 500 grams of eucalyptus leaves each day. A number of adaptations allow koalas to digest this food efficiently:

- Powerful jaws allow the koala to chew the leaves into a very fine paste.
- The koalas liver is able to deactivate the toxic compounds found in eucalyptus leaves.
- A portion of the koalas large intestine is greatly enlarged to maximize the amount of nutrients extracted.


Species Resource Use
Number of individuals
Niche separation
Specialist 1
Generalist
Specialist 2
Niche overlap
Resource partitioning
Resource use
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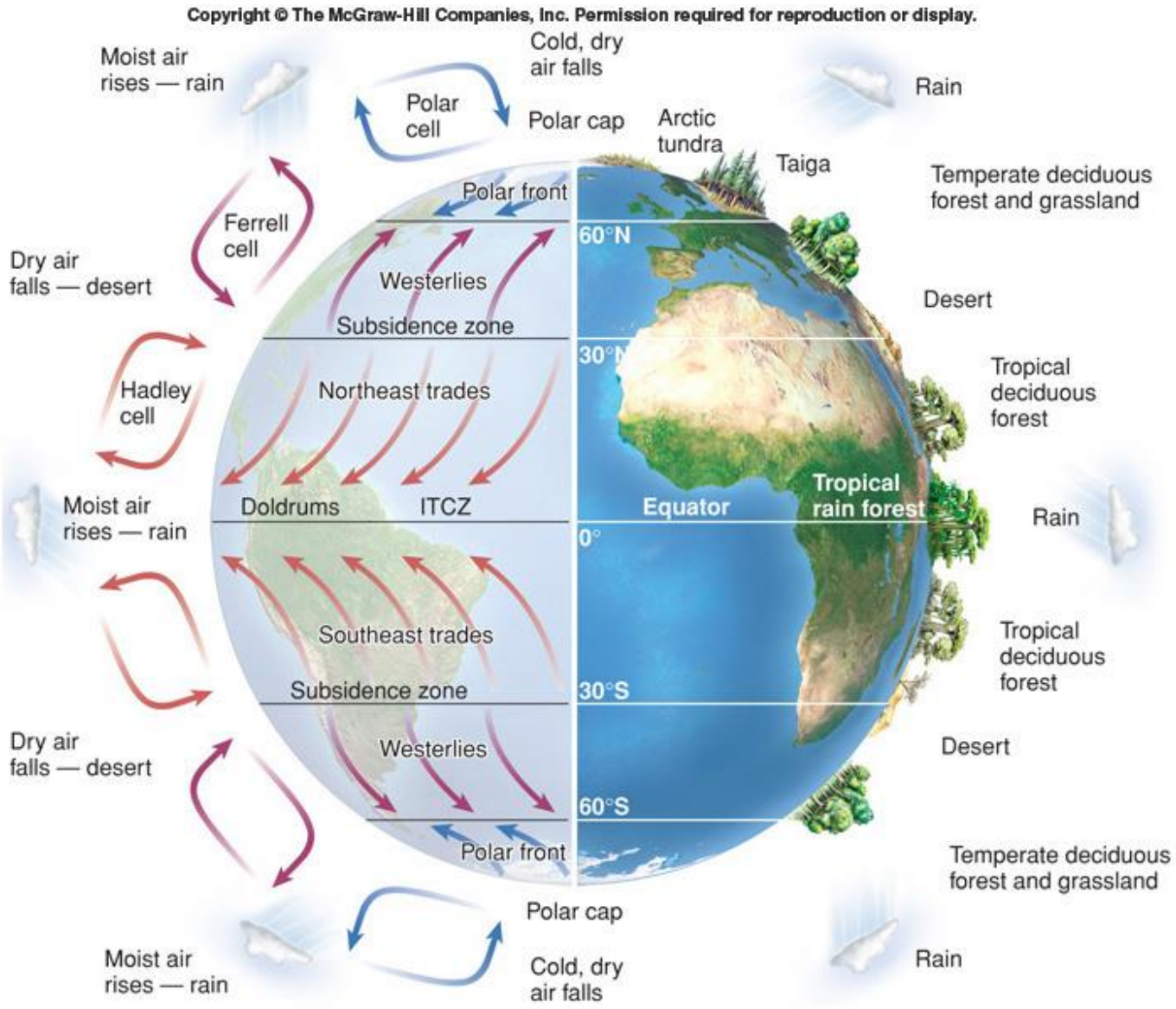
TERRESTRIAL BIOMES



Terrestrial Biomes				
Biome	**Plant Species**	**Animal Species**	**Geographic Location**	**Basics to Remember**
Tropical Rainforest	Tall broad-leaved trees, ferns, etc	Chimpanzees, bats, toucans,	Near equator	Consistently high temperature, rainfall and humidity

Terrestrial Biomes				
Biome	**Plant Species**	**Animal Species**	**Geographic Location**	**Basics to Remember**
Desert	Cacti, Joshua trees,	Lizards, bobcats, desert toads	Every continent except Europe	Widely Varying temperatures, low rainfall

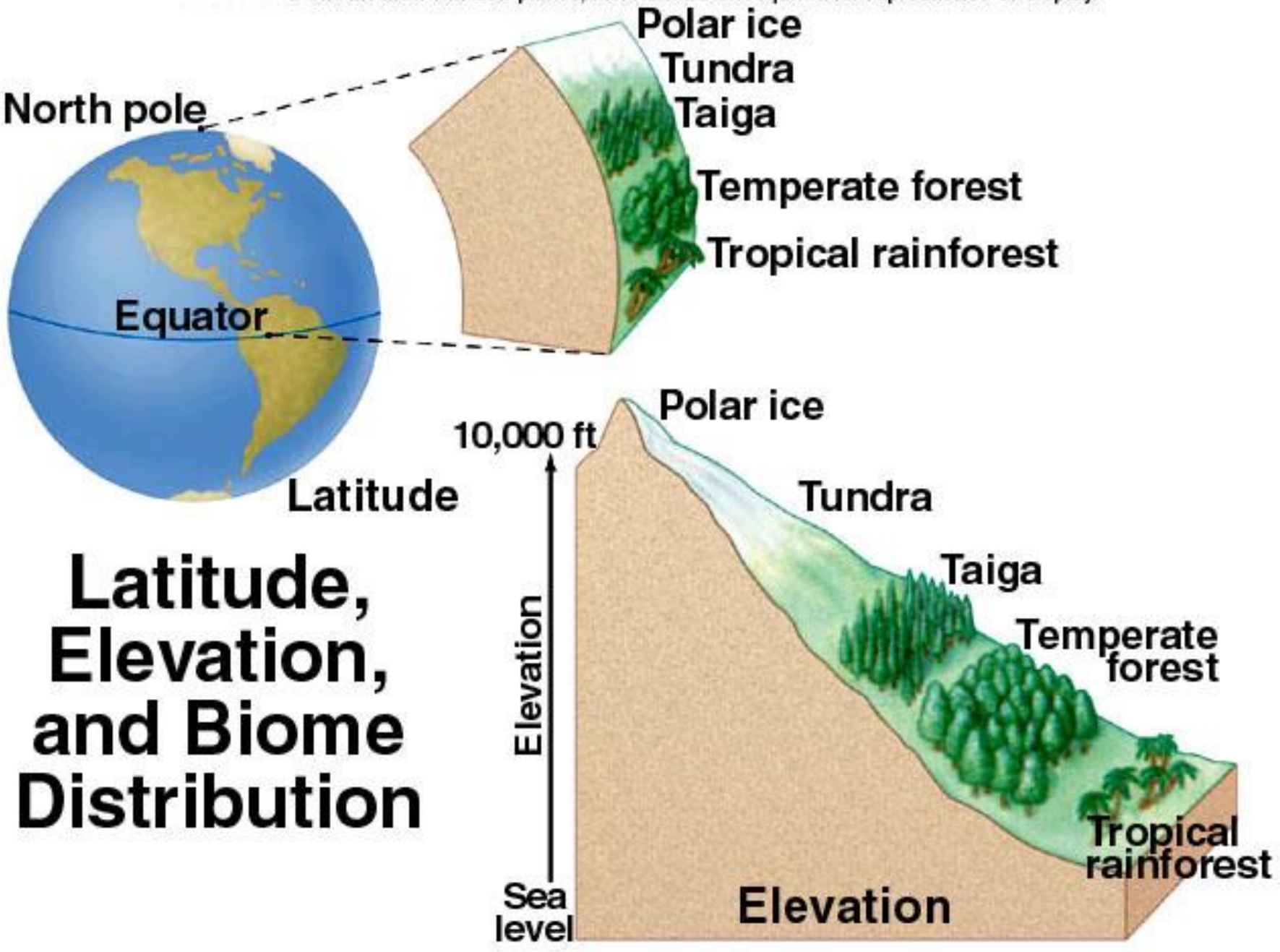
Terrestrial Biomes				
Biome	**Plant Species**	**Animal Species**	**Geographic Location**	**Basics to Remember**
Boreal Forest (AKA Taiga)	Spruce and fir trees, small shrubs	moose, beavers, mountain lions	South of arctic circle	Summers = short and moist ; winters = long, cold, and dry ; contains mostly coniferous trees (don't lose leaves)

Terrestrial Biomes				
Biome	**Plant Species**	**Animal Species**	**Geographic Location**	**Basics to Remember**
Temperate Forest Deciduous	Oak, beech, and maple trees	Squirrels, deer, black bears	South of the boreal forests	Well-defined seasons (spring, summer, fall, winter) ; mostly deciduous trees (lose leaves in fall)

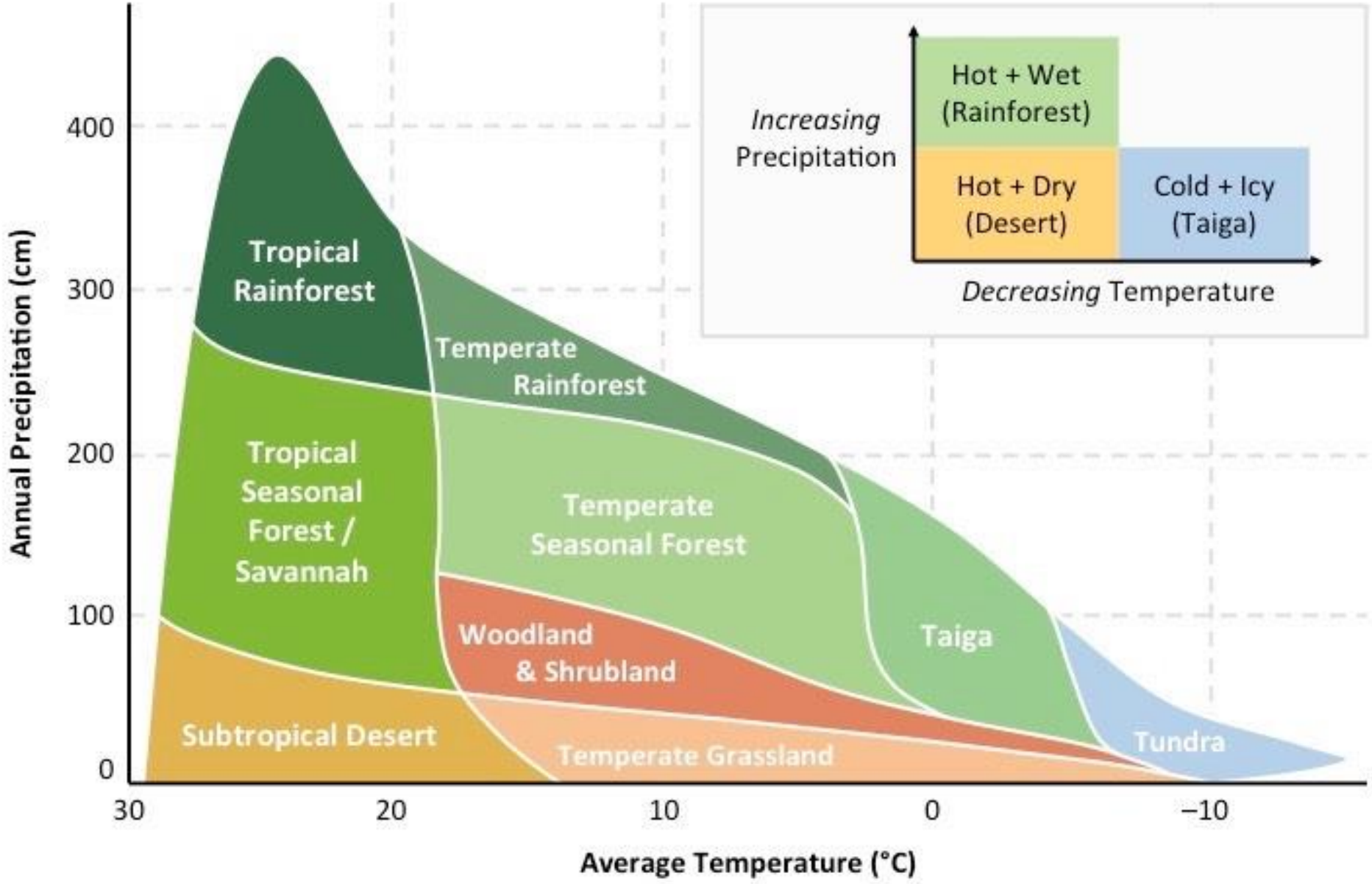
Terrestrial Biomes				
Biome	**Plant Species**	**Animal Species**	**Geographic Location**	**Basics to Remember**
Savannah (Grassland Type 1)	Grasses and scattered trees	Lions, elephants,zebras	Africa, South America, and Australia	Summers = hot and rainy, winters = cool and dry

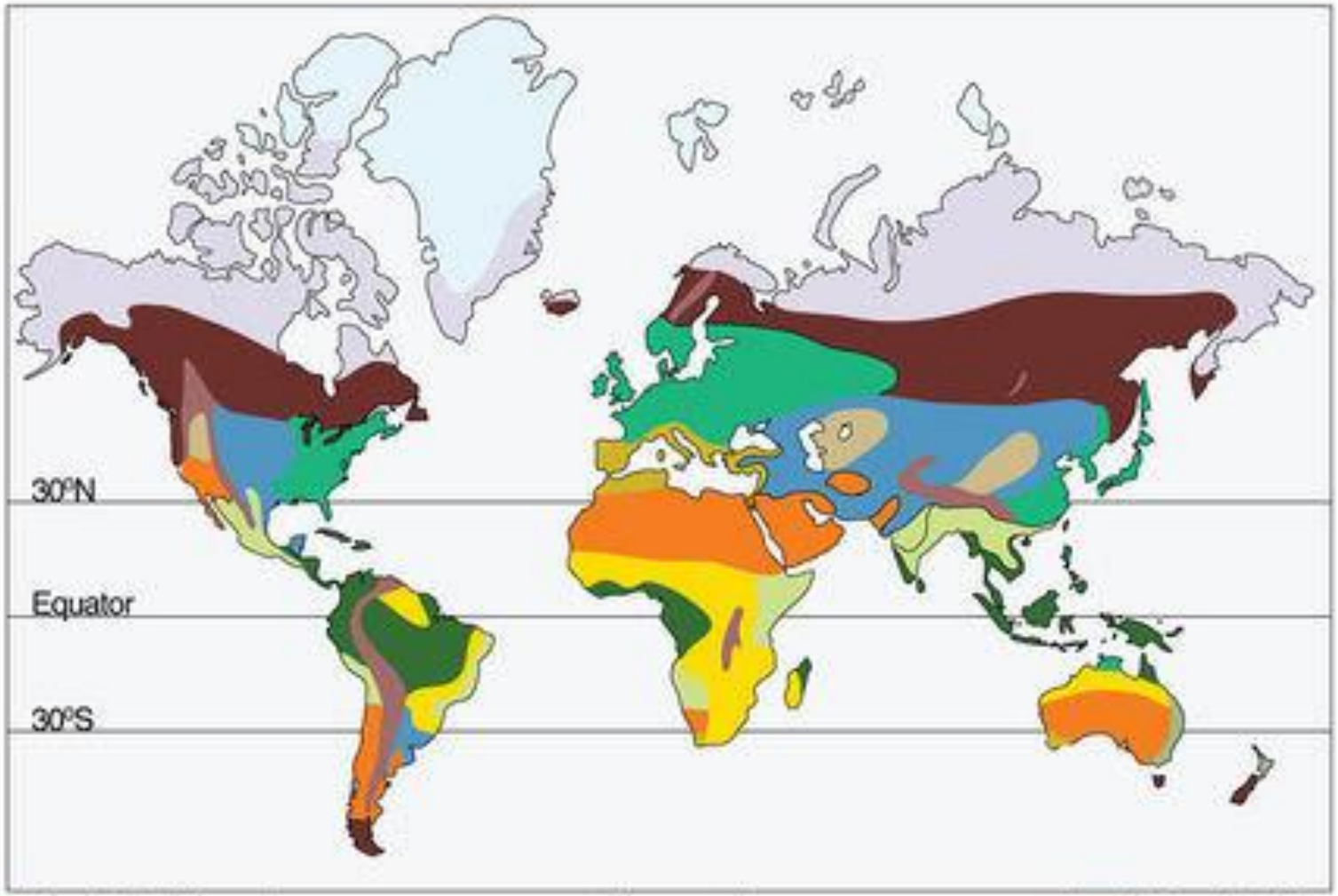
Terrestrial Biomes				
Biome	**Plant Species**	**Animal Species**	**Geographic Location**	**Basics to Remember**
Temperate Grassland (Grassland Type 2)	Grasses and herbs	bison, horses, mice	All continents except Europe	moderate rainfall and temperature, fires possible

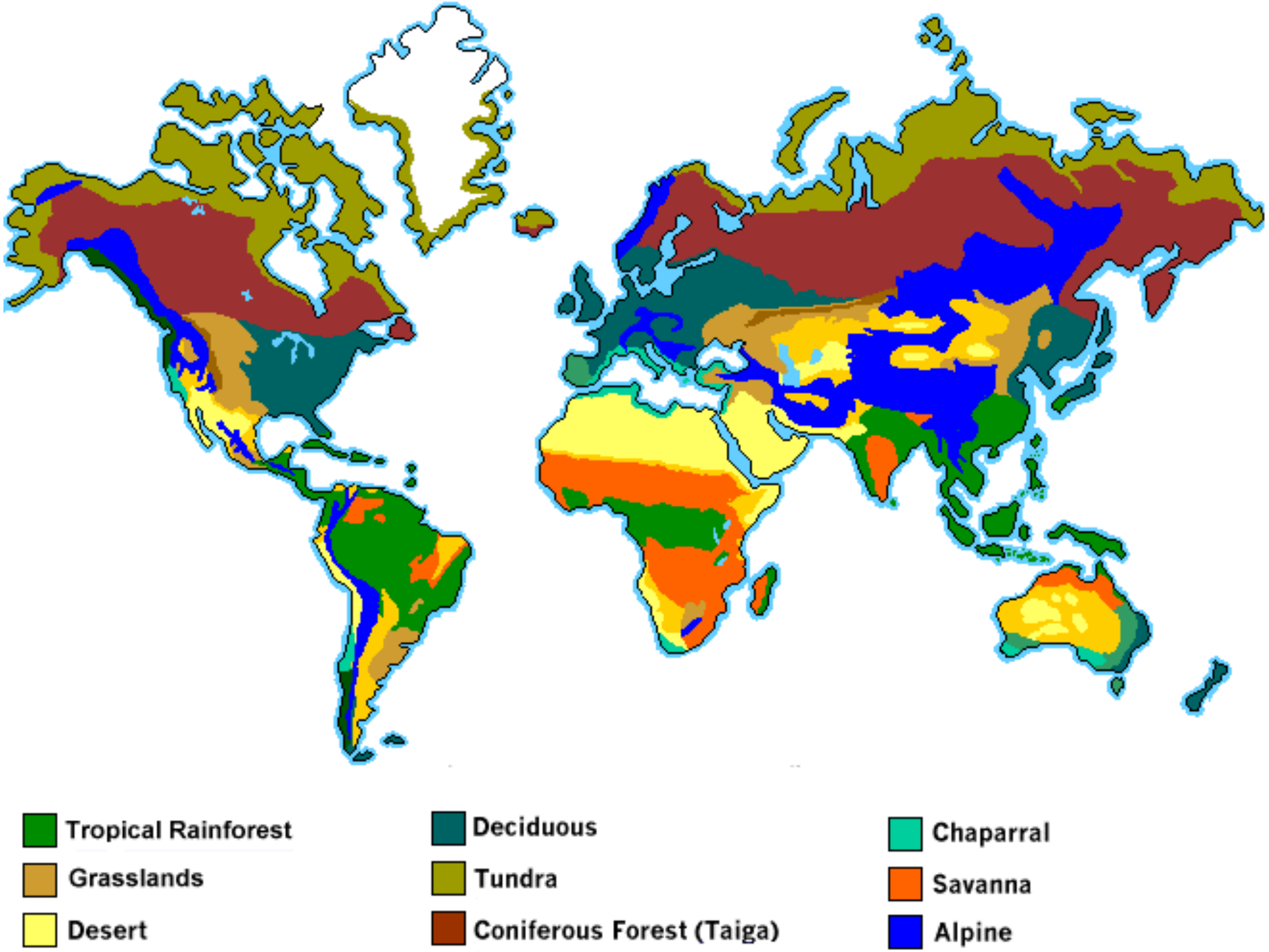
Terrestrial Biomes				
Biome	**Plant Species**	**Animal Species**	**Geographic Location**	**Basics to Remember**
Tundra	Short grasses, shrubs	Caribou, polar bears, salmon,	Arctic Circle	Constant layer of frost (permafrost), cold and dark much of the year



Latitude, Elevation, and Biome Distribution

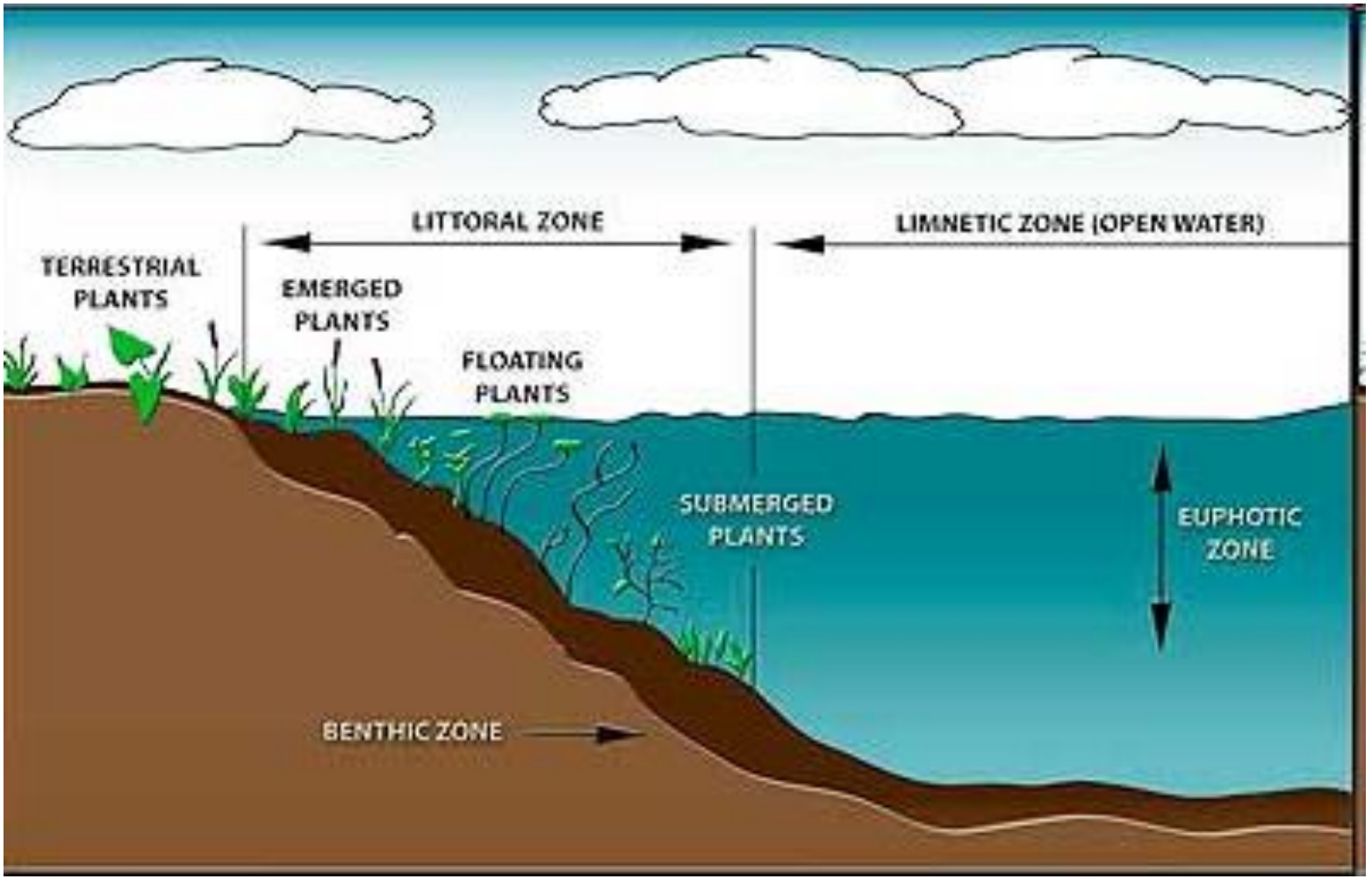

Annual Precipitation (cm)
400
300
200
100
0
30
20
10
0
−10
Average Temperature (°C)
Tropical Rainforest
Temperate Rainforest
Tropical Seasonal Forest / Savannah
Temperate Seasonal Forest
Woodland & Shrubland
Taiga
Subtropical Desert
Temperate Grassland
Tundra
Increasing Precipitation
Hot + Wet (Rainforest)
Hot + Dry (Desert)
Cold + Icy (Taiga)
Decreasing Temperature


30°N
Equator
30°S
Tropical rainforest
Tropical dry forest
Temperate rainforest
Temperate decidious forest
Chaparral
Temperate desert
Temperate grassland
Savanna
Tropical desert
Polar ice cap
Boreal rainforest
Arctic Tundra
Alpine Tundra


Tropical Rainforest
Grasslands
Desert
Deciduous
Tundra
Coniferous Forest (Taiga)
Chaparral
Savanna
Alpine

AQUATIC BIOMES

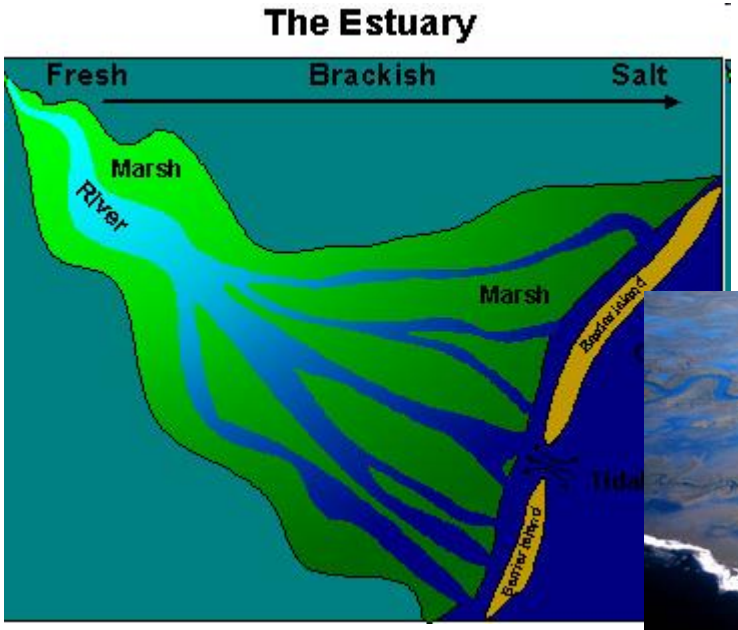
Aquatic Biomes				
Biome	**Marine**	**Freshwater**	**Key Organisms**	**Basics to Remember**
Lakes/Ponds		X	Algae, frogs, fish,	Body of standing water Zones based on water depth (littoral, limnetic, and profundal)


LITTORAL ZONE
LIMNETIC ZONE (OPEN WATER)
TERRESTRIAL PLANTS
EMERGED PLANTS
FLOATING PLANTS
SUBMERGED PLANTS
EUPHOTIC ZONE
BENTHIC ZONE

Aquatic Biomes				
Biome	**Marine**	**Freshwater**	**Key Organisms**	**Basics to Remember**
Rivers/streams		X	Strong reeds/plants, insect larvae, fish	Moving water, flows from source to mouth

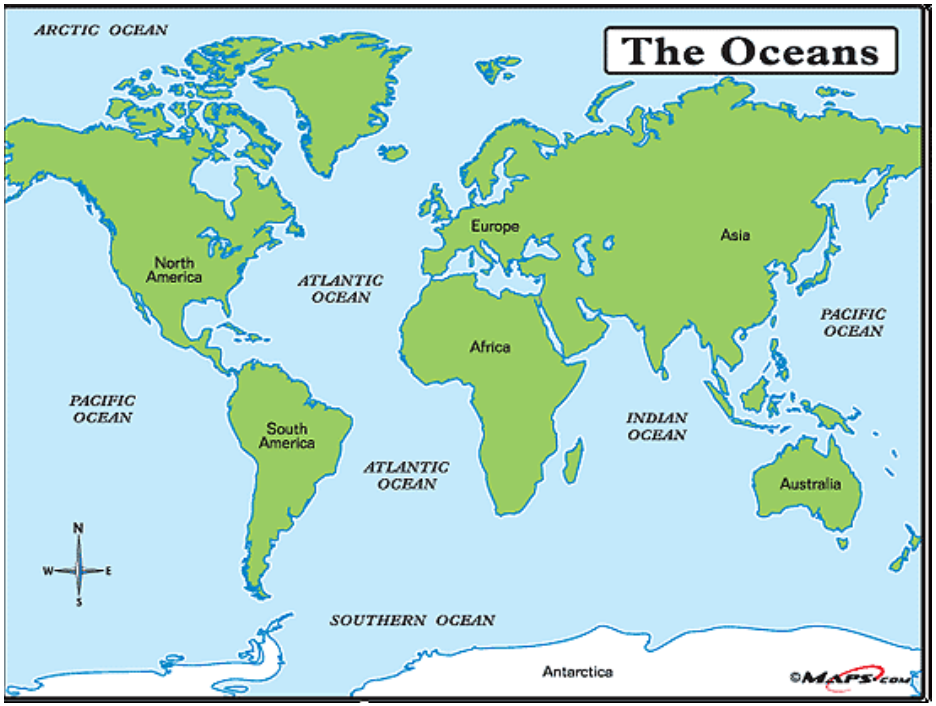
Aquatic Biomes				
Biome	**Marine**	**Freshwater**	**Key Organisms**	**Basics to Remember**
Wetland not	Mixture of salt and freshwater by ocean		pond lilies, cattails, mangroves, willows, amphibians, ducks, raccoons, shrimp, shellfish	Types: marshes, swamps, bogs Moist and humid

Aquatic Biomes				
Biome	**Marine**	**Freshwater**	**Key Organisms**	**Basics to Remember**
Estuary *by ocean	Mixture of salt and freshwater		Algae, seaweeds, marsh grasses, worms, crabs, geese	One of the most diverse ecosystems Forms where fresh water from a stream or river merges with salt water from the ocean



Aquatic Biomes				
Biome	**Marine**	**Freshwater**	**Key Organisms**	**Basics to Remember**
Coral Reefs	X		Coral, algae, sea slugs, octopi, sea stars, fishes	Very diverse Found in warm, shallow marine waters

Aquatic Biomes				
Biome	**Marine**	**Freshwater**	**Key Organisms**	**Basics to Remember**
Oceans	X		Depth depends on sunlight requirements Seaweeds, plankton, fish, jellyfish, whales	Zones based on water depth = photic, aphotic, benthic



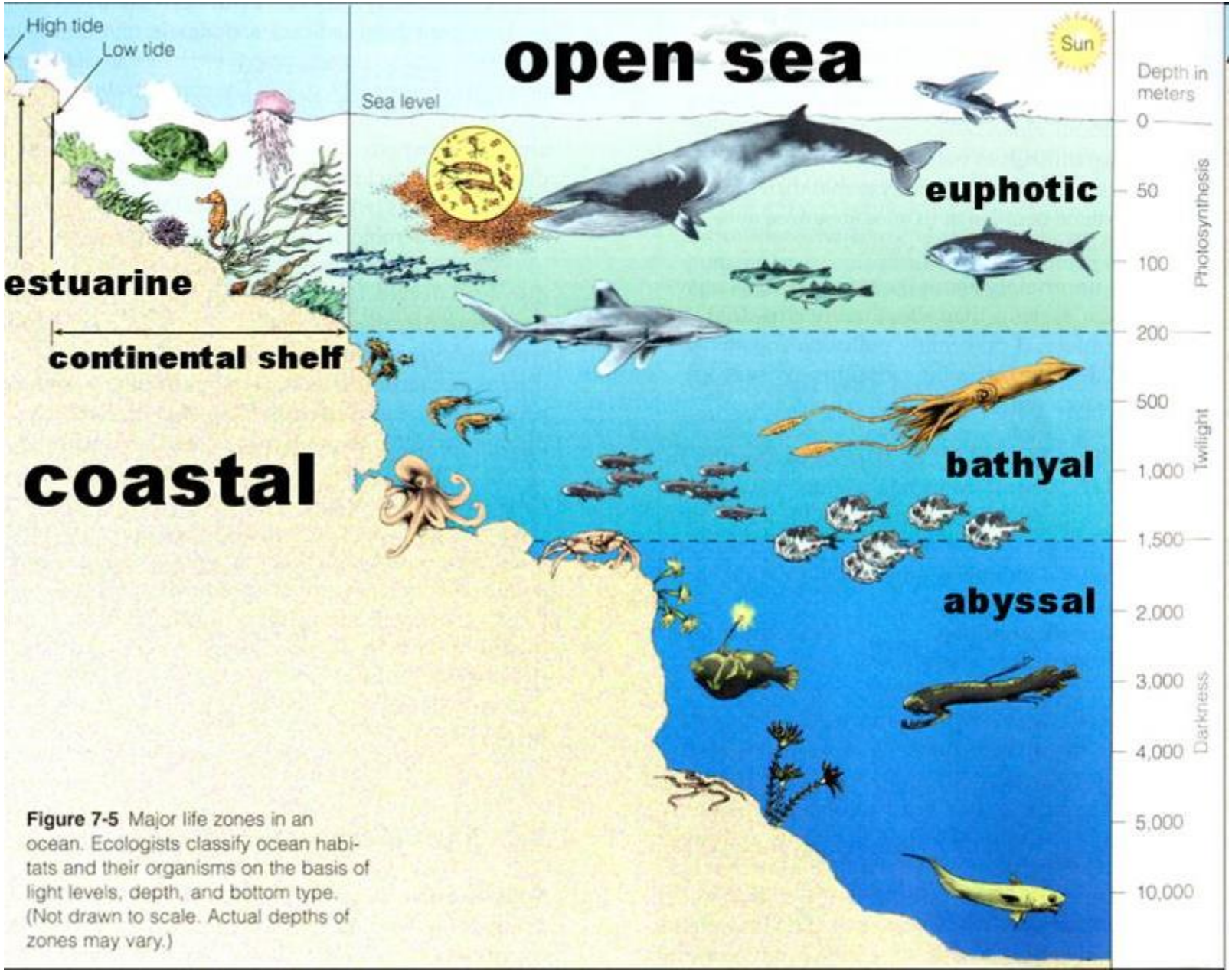
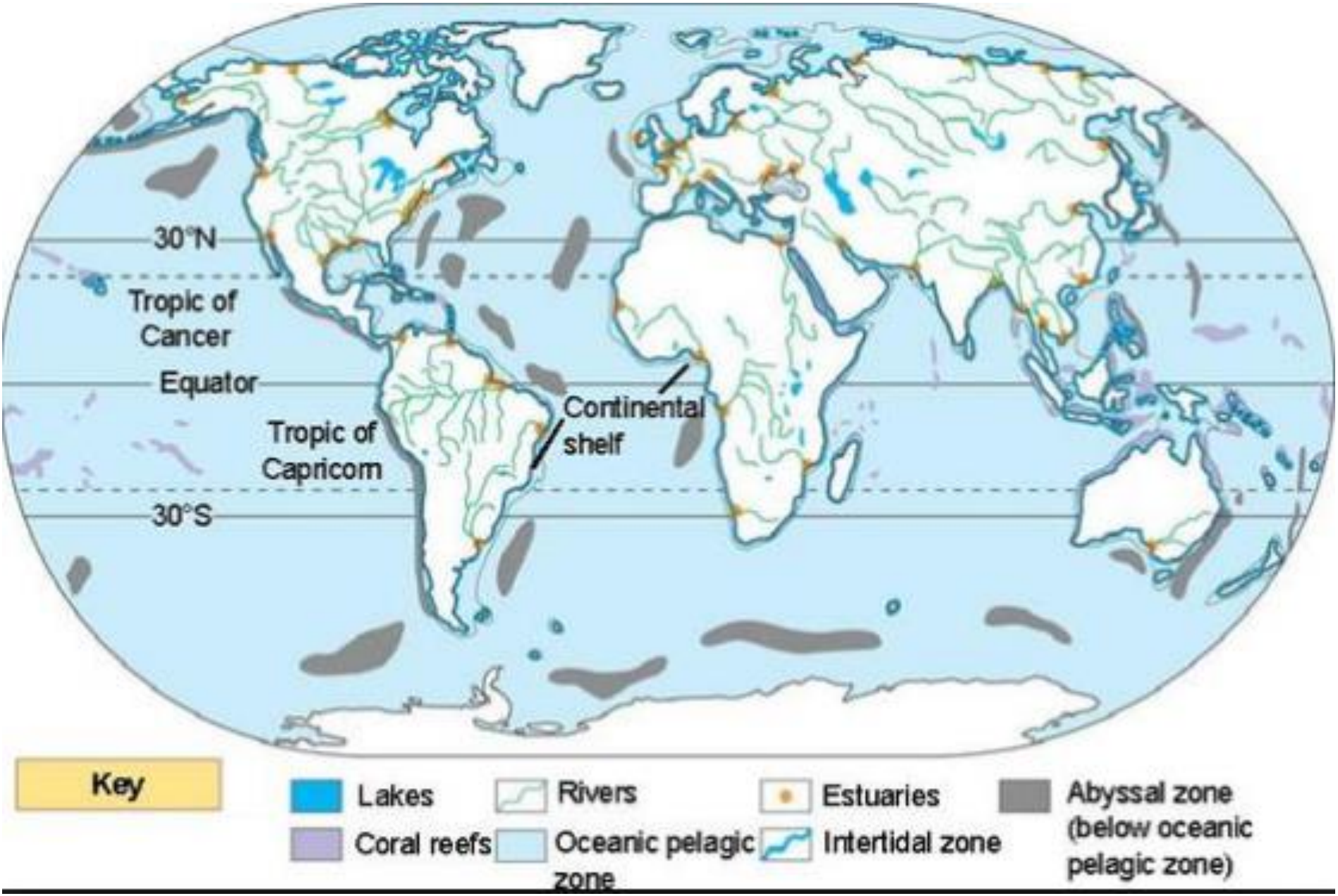


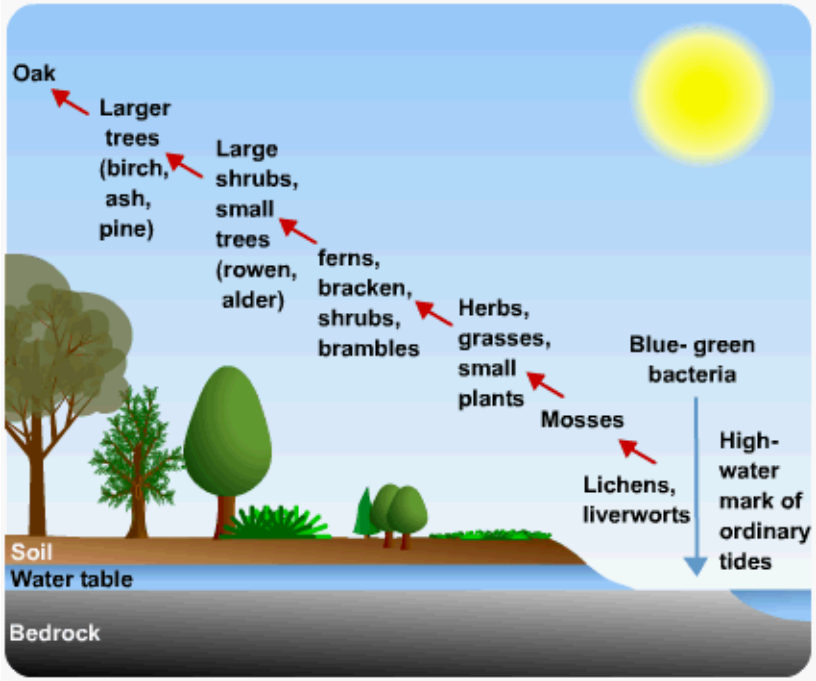
Figure 7-5 Major life zones in an ocean. Ecologists classify ocean habitats and their organisms on the basis of light levels, depth, and bottom type. (Not drawn to scale. Actual depths of zones may vary.)


30°N
Tropic of Cancer
Equator
Tropic of Capricorn
30°S
Continental shelf
Key
Lakes
Rivers
Estuaries
Abyssal zone (below oceanic pelagic zone)
Coral reefs
Oceanic pelagic zone
Intertidal zone

Ecological Succession = a series of changes in an ecosystem in which new populations of organisms gradually replace existing ones

Succession that begins in an area where there is no existing community is called primary succession

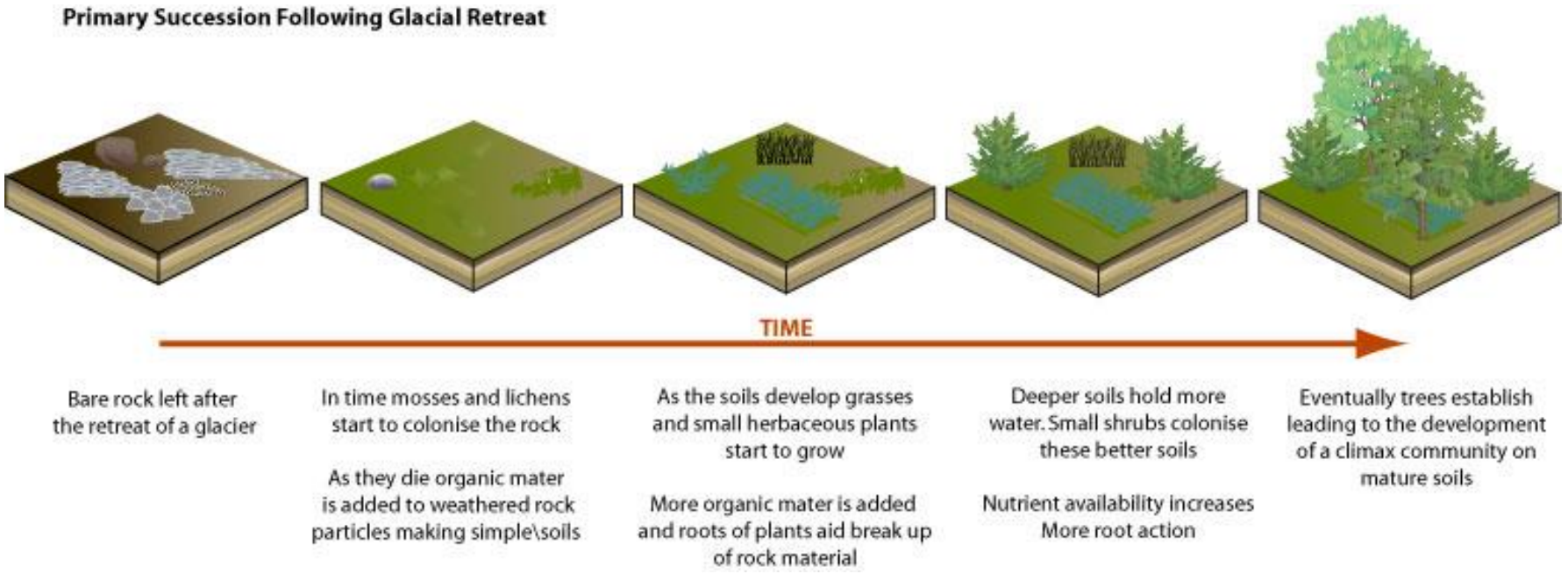
Examples of primary succession = bare rock, sand dune, or island formed by volcanic eruption



PRIMARY SUCCESSION

The first organisms to occupy an area going through primary succession are a pioneer species

Characteristics of a pioneer species= small, fast growing, and reproduce quickly



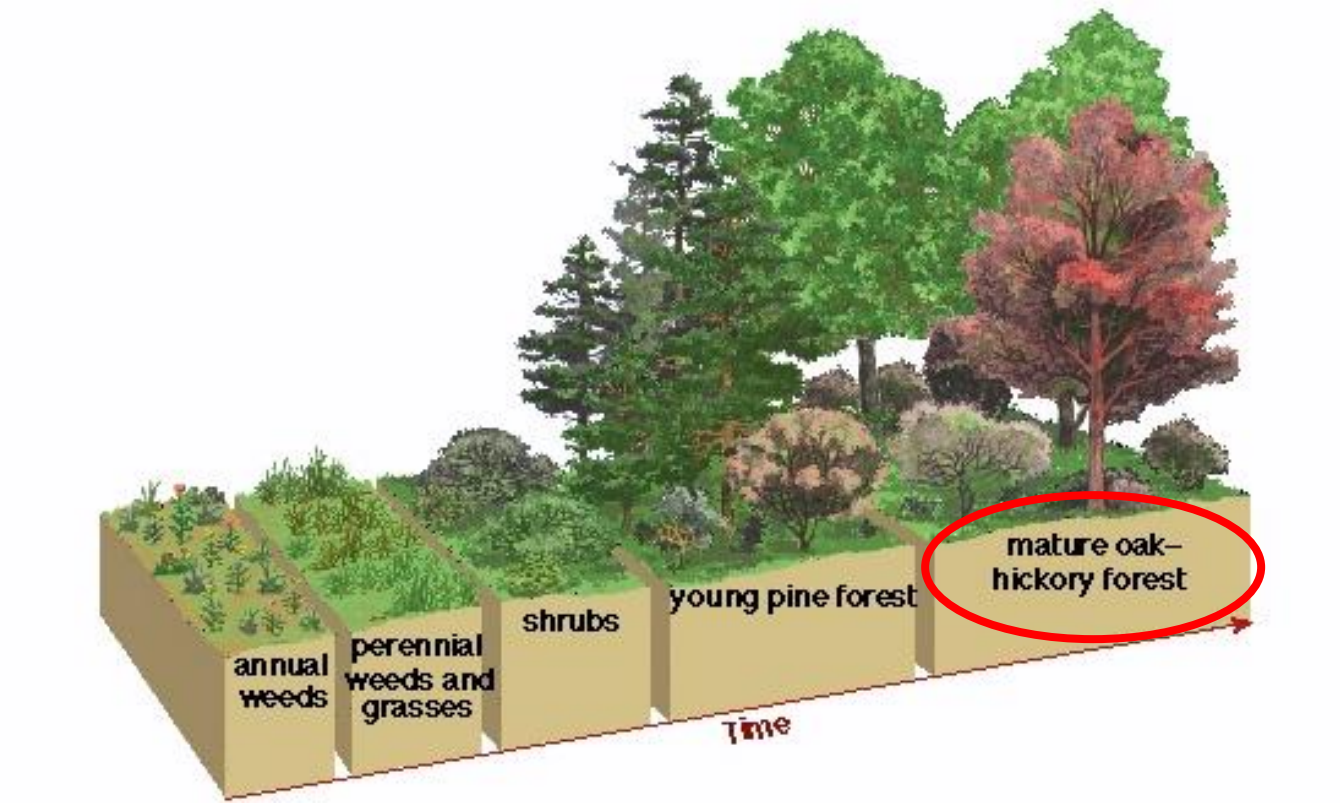
Over time, physical and chemical changes impact areas, leading to a difference in species that live here too (the species no longer fit for the changing environment die out)

SECONDARY SUCCESSION

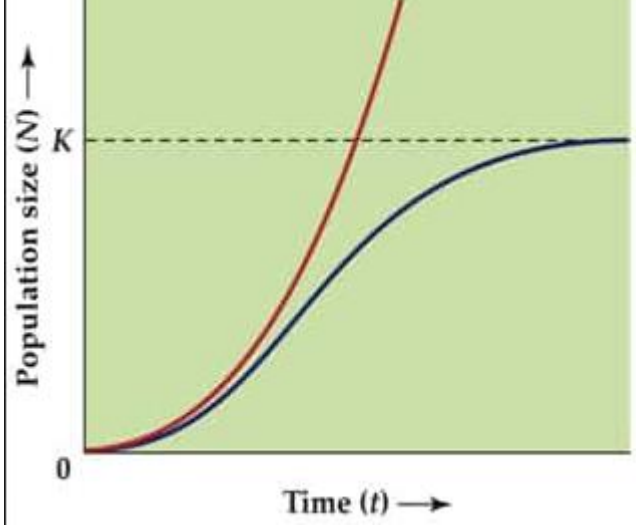
Succession that has occurred in an area where an existing community has been partially destroyed is called secondary succession

Example of secondary succession: new plant growth after a forest fire

Eventually succession slows down and a stable community is established. This is called a climax community

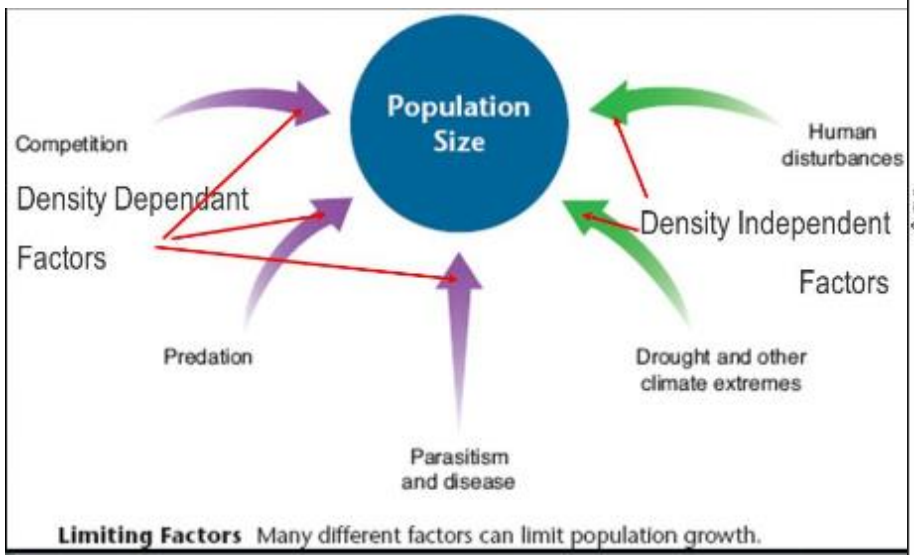


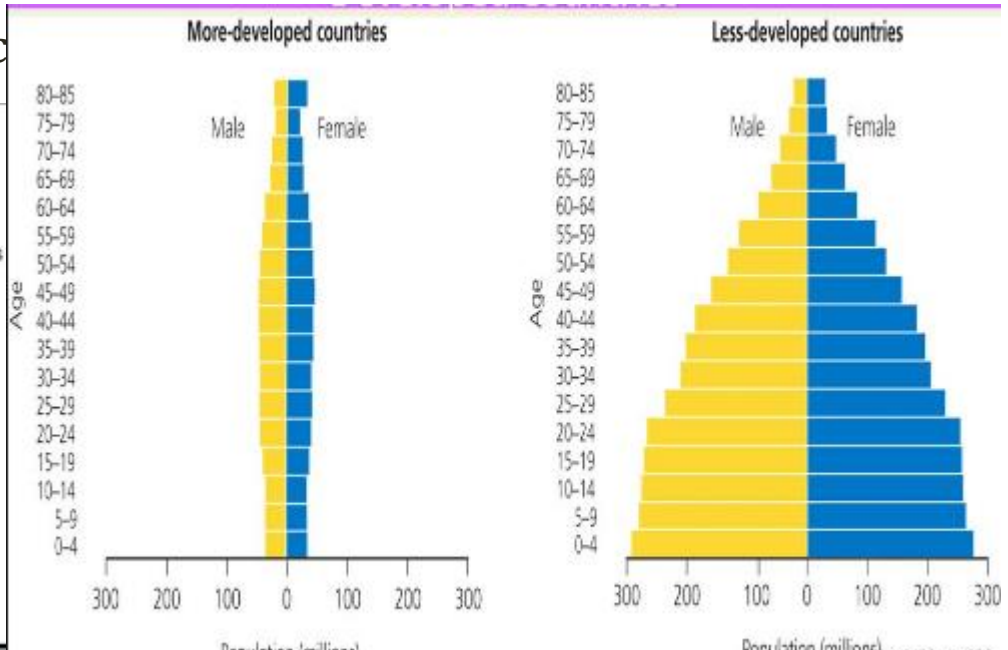
TOPIC 2: POPULATION ECOLOGY

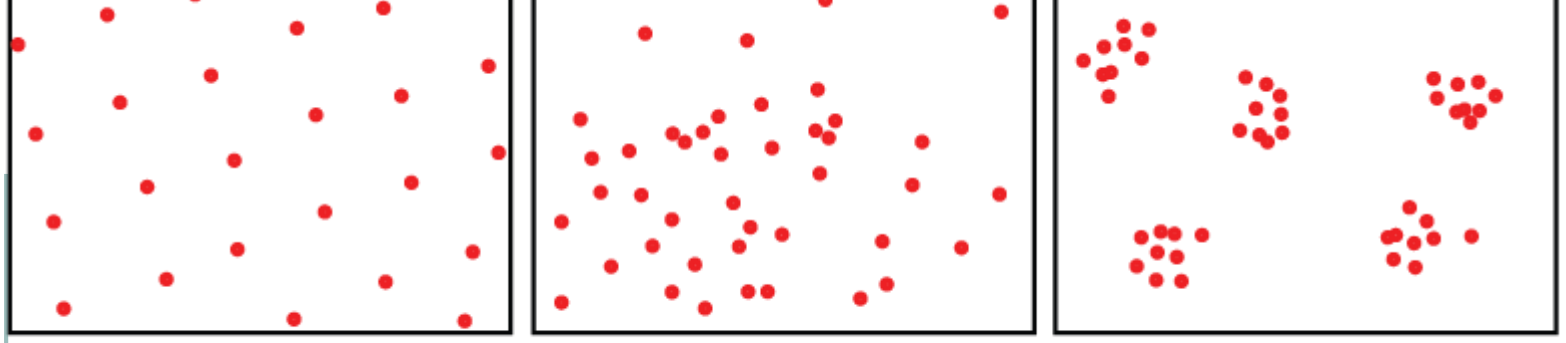


By the end of this topic, you should be able to…

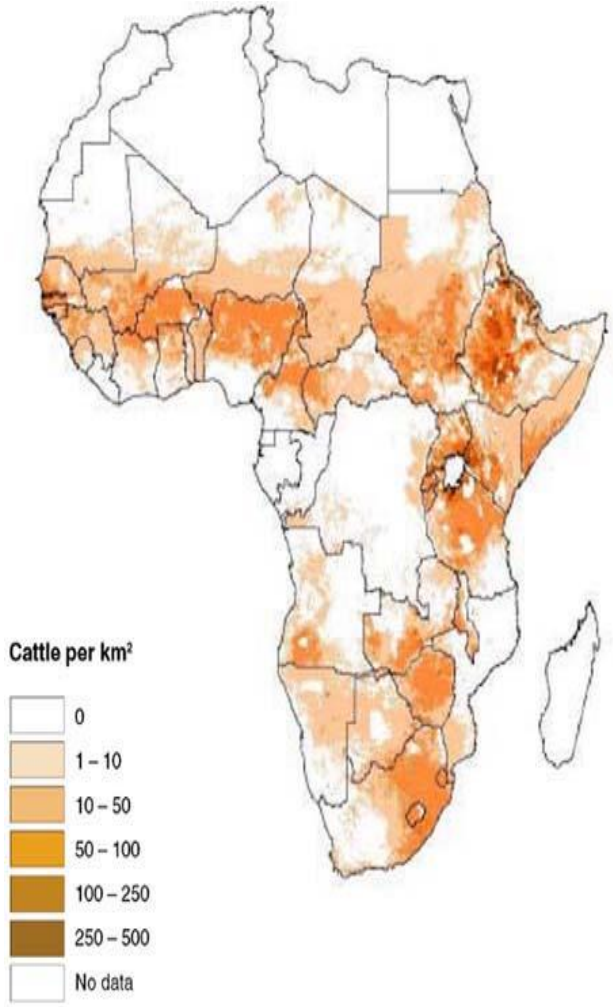
- Compare and contrast exponential and logistic growth
- Compare and contrast density dependent and density independent limiting factors
- Analyze and interpret age struc





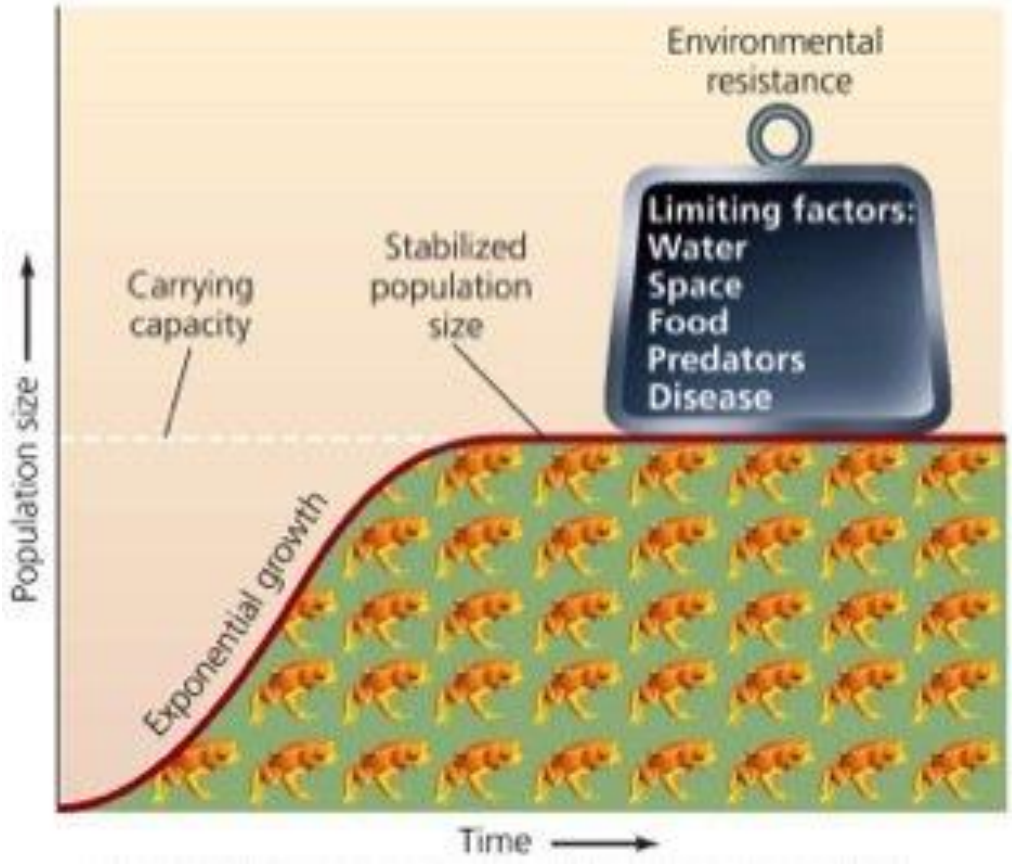


Population = a group of organisms of the same species that live in a particular area



Population Growth = (increasing the density of a population) usually cannot continue forever. When a population can no longer grow it has reached its carrying capacity.

Things that affect population growth can be either biotic (living) or abiotic (non-living), and can depend on how big the population already is

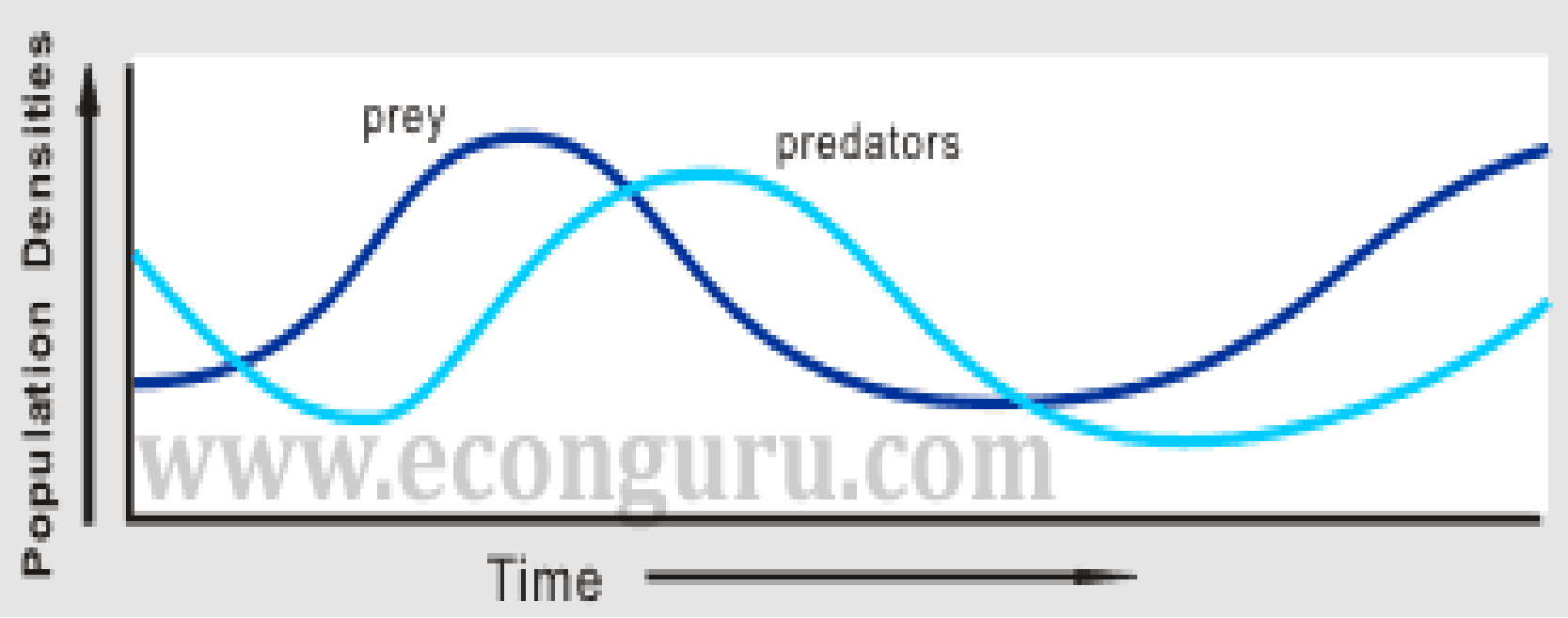


Limiting Factors = components of the environment that limit the growth of a population

Types of Limiting Factors

1) Density Dependent = limits the size of a population when the population reaches a certain density (number of organism per area)

Examples: disease/parasitism, predation, competition



Types of Limiting Factors

2) Density Independent = limits the size of a population no matter what the density is

Examples: natural disasters (tornadoes, hurricanes, forest fires etc.)

Study the table below. Gypsy moth caterpillars can destroy trees by eating too many leaves and making them susceptible to disease or drought. Which student has correctly identified the density-dependent and density-independent limiting factors associated with an invasion of gypsy moth caterpillars?

Forest Ecosystem Factors

Student	Population of Gypsy Moth Caterpillars	Disease	Drought
1	density-independent	density-dependent	density-dependent
2	density-dependent	density-independent	density-independent
3	density-independent	density-independent	density-dependent
4	density-dependent	density-dependent	density-independent

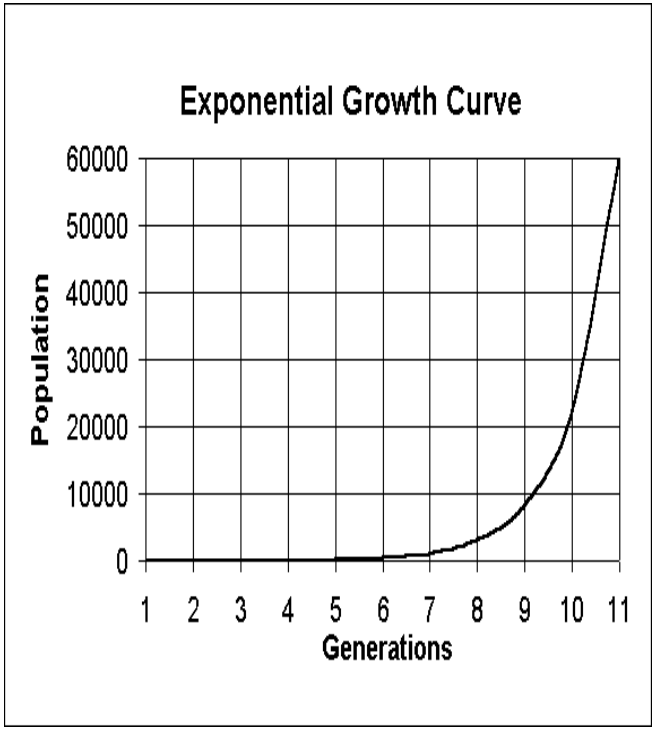
TYPES OF POPULATION GROWTH

1) **Exponential Growth =** population increases quickly in size (can only happen for short periods of time when there are no limiting factors)

We call the graph pictured to the right a J-curve

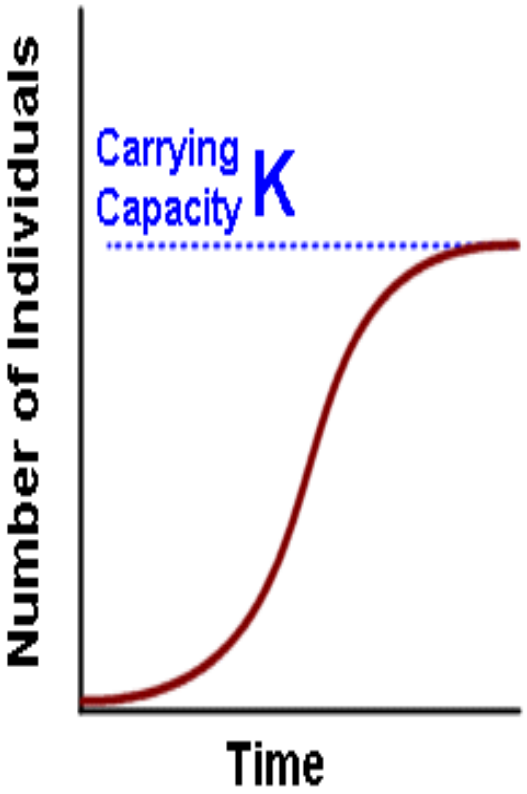
sketch this on your graph in any color of your choosing

Example in Nature: rapid bacteria growth in a new host (body)



TYPES OF POPULATION GROWTH

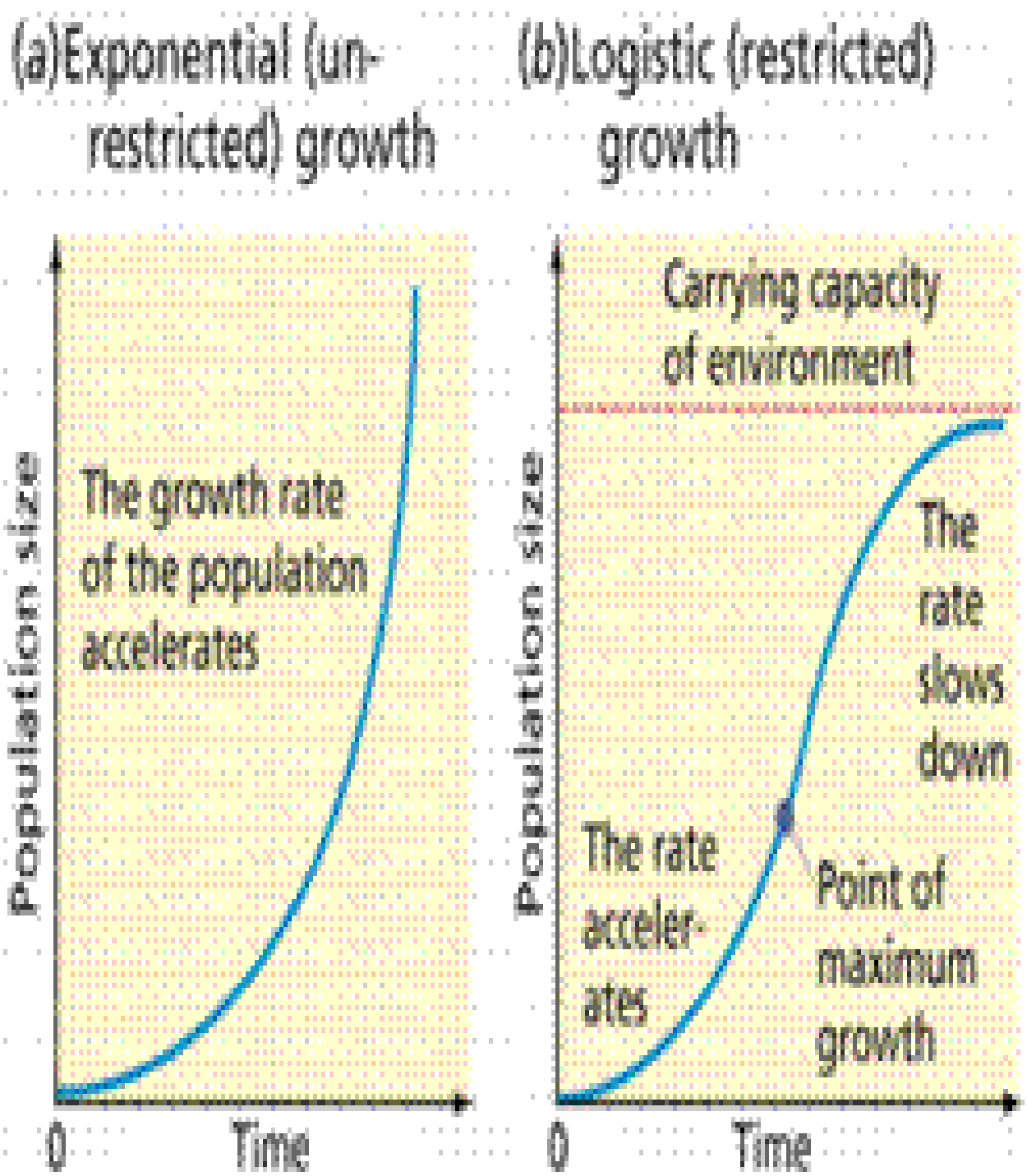
2) **Logistic Growth** = population grows quickly for some time and then stops growing once it reaches its carrying capacity, the total number of individuals the environment can support



We call the graph pictured to the right an S-curve

sketch this on your graph in any color of your choosing, as long as it is different than your J-curve

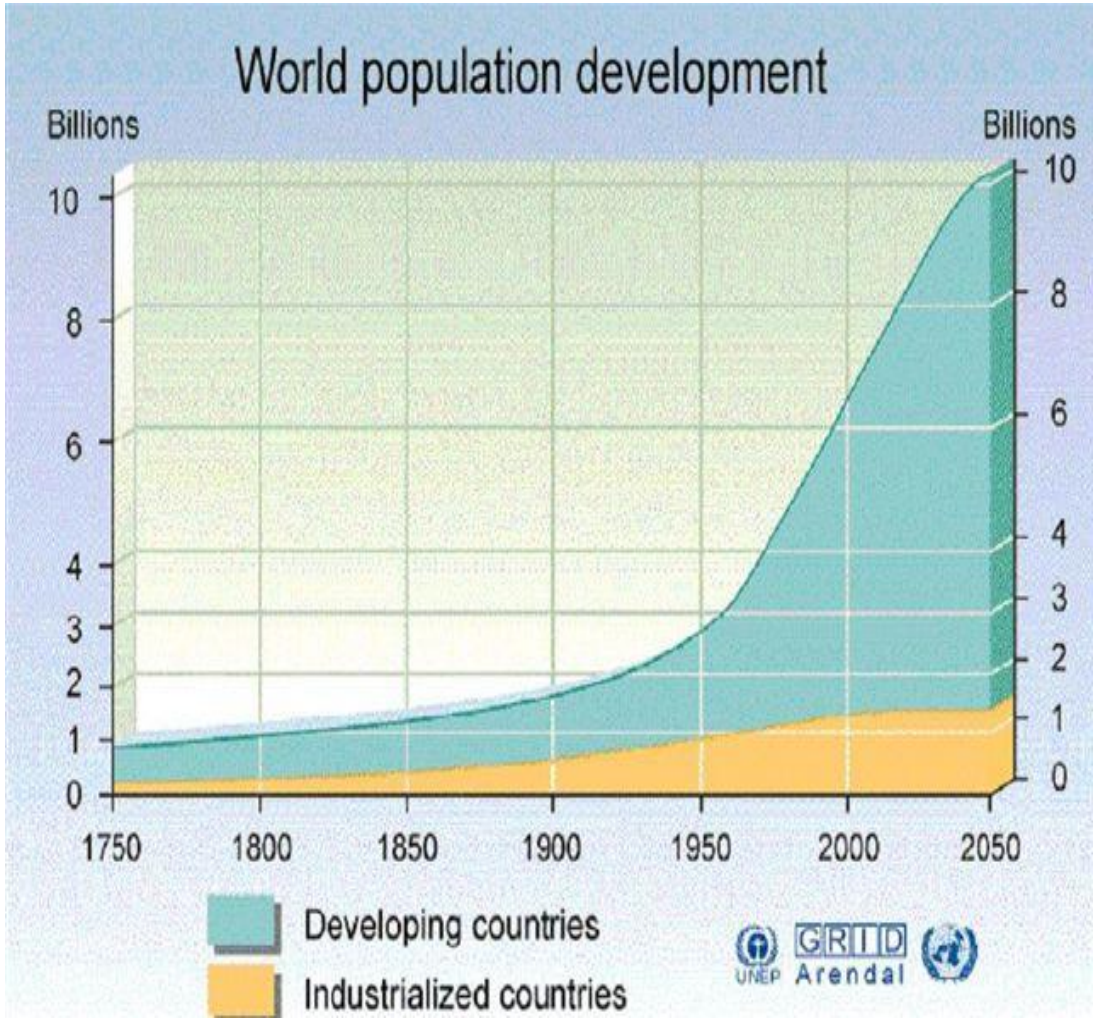
Example in Nature: grizzly bear population (limited by territory size)


(a)Exponential (un-restricted) growth
(b)Logistic (restricted) growth
Population size
The growth rate of the population accelerates
0
Time
Carrying capacity of environment
Population size
The rate slows down
The rate acceler-ates
Point of maximum growth
0
Time

HUMAN POPULATION GROWTH

Useful Measurements = birth rate*, death rate (AKA mortality rate), life expectancy, age structure

*aka natality rate

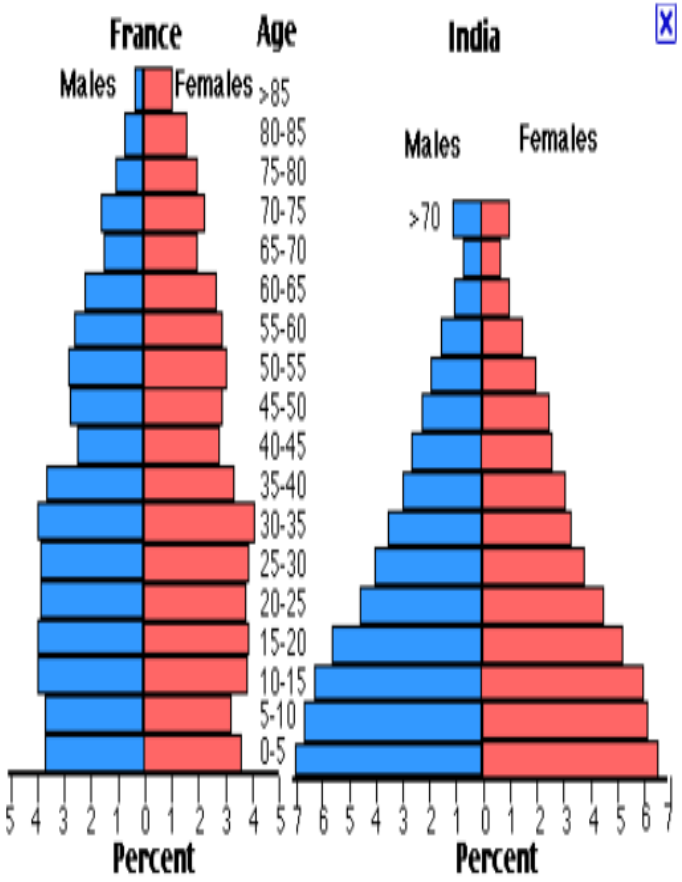


AGE STRUCTURE PYRAMIDS

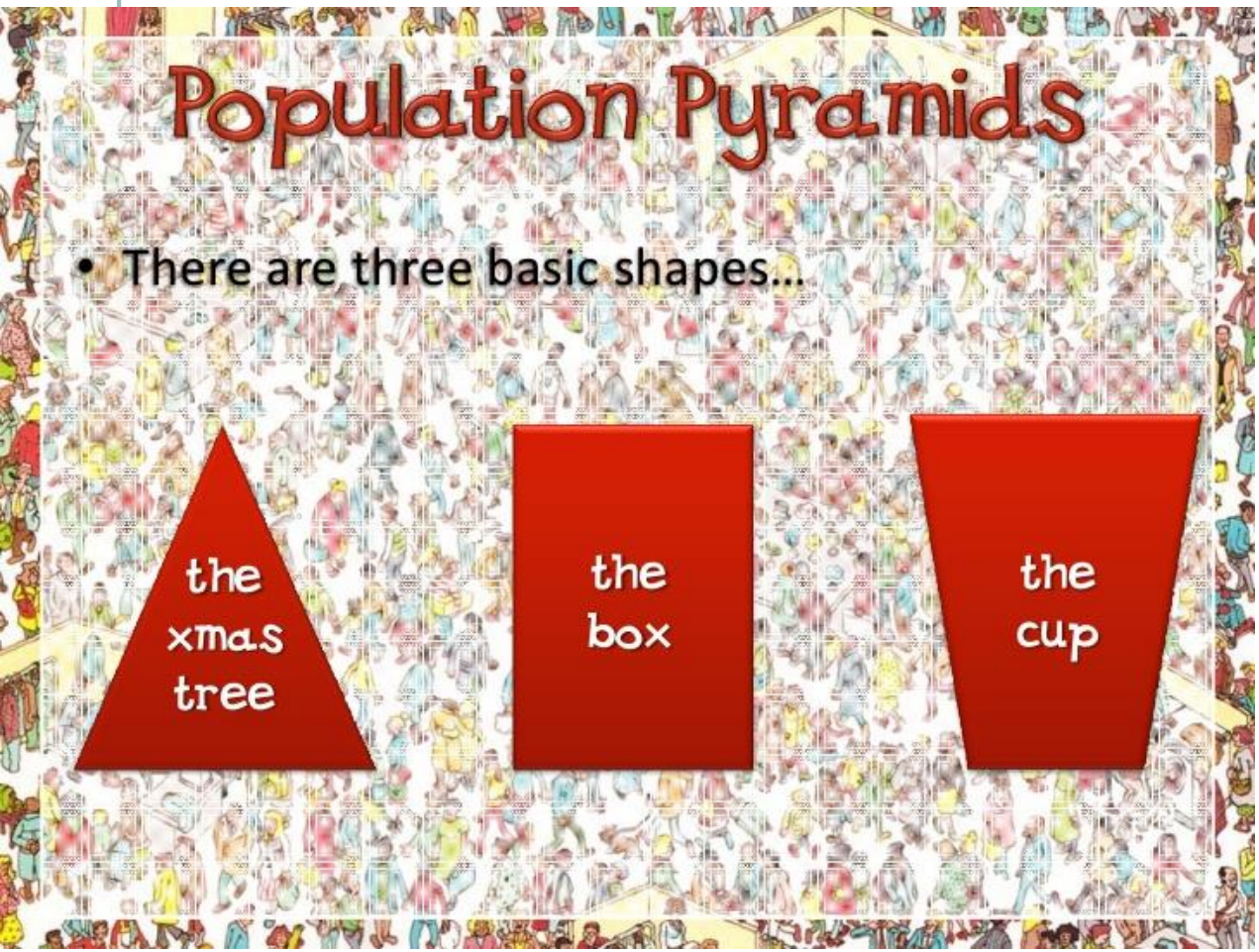
What is different about these two pyramids?

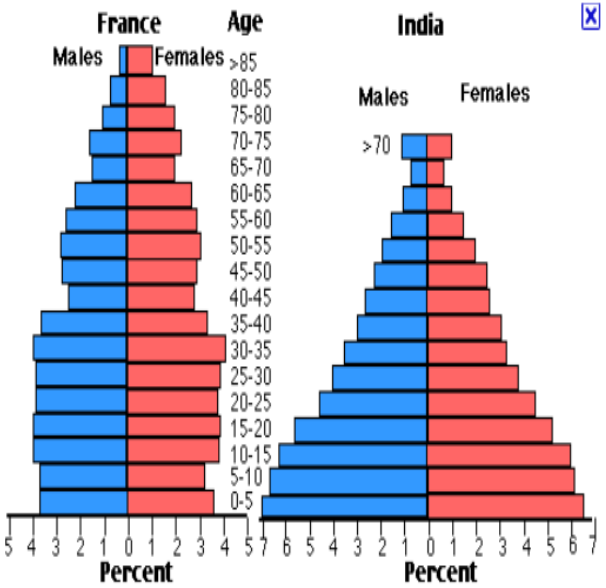
Which country/population seems to be growing more?

List several reasons why a **developed country** like France might have a different age structure than a **developing country** like India.



TYPES OF PYRAMIDS





TYPES OF PYRAMIDS

What it Means...

the christmas tree
(developing nation)

- growth rates are slow
- high birth rate
- short life expectancy

Like?
Namibia
Bangladesh

the box
(developed nation; slow growth)

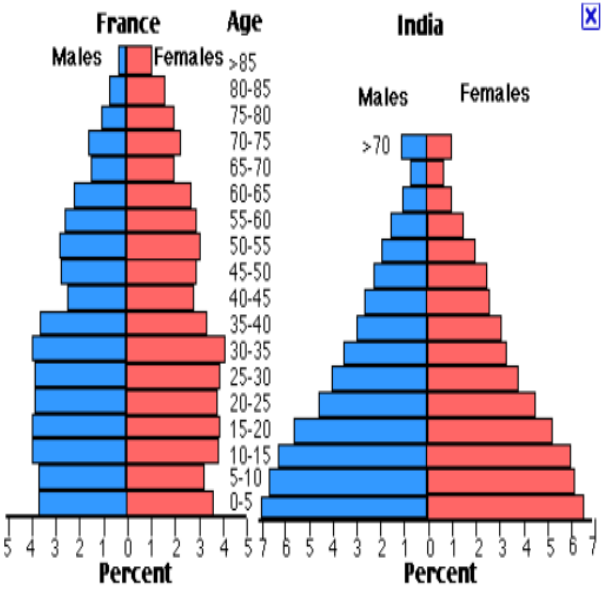
- low infant mortality
- slow population growth
- long life expectancy

Like?
Sweden
USA

the cup
(developed nation; negative growth)

- low birth rate
- shrinking population
- long life expectancy

Like?
Italy
Japan



The **growth rate** is determined by: birth, death, immigration, and emigration

Immigration = the movement of organisms into a population

Emigration = the movement of organisms out of a population

LIMITING FACTORS FOR HUMAN POPULATIONS

What are some **density-dependent** factors that could affect human population growth?

What are some **density-independent** factors that could affect human population growth?

TOPIC 3: COMMUNITY RELATIONSHIPS

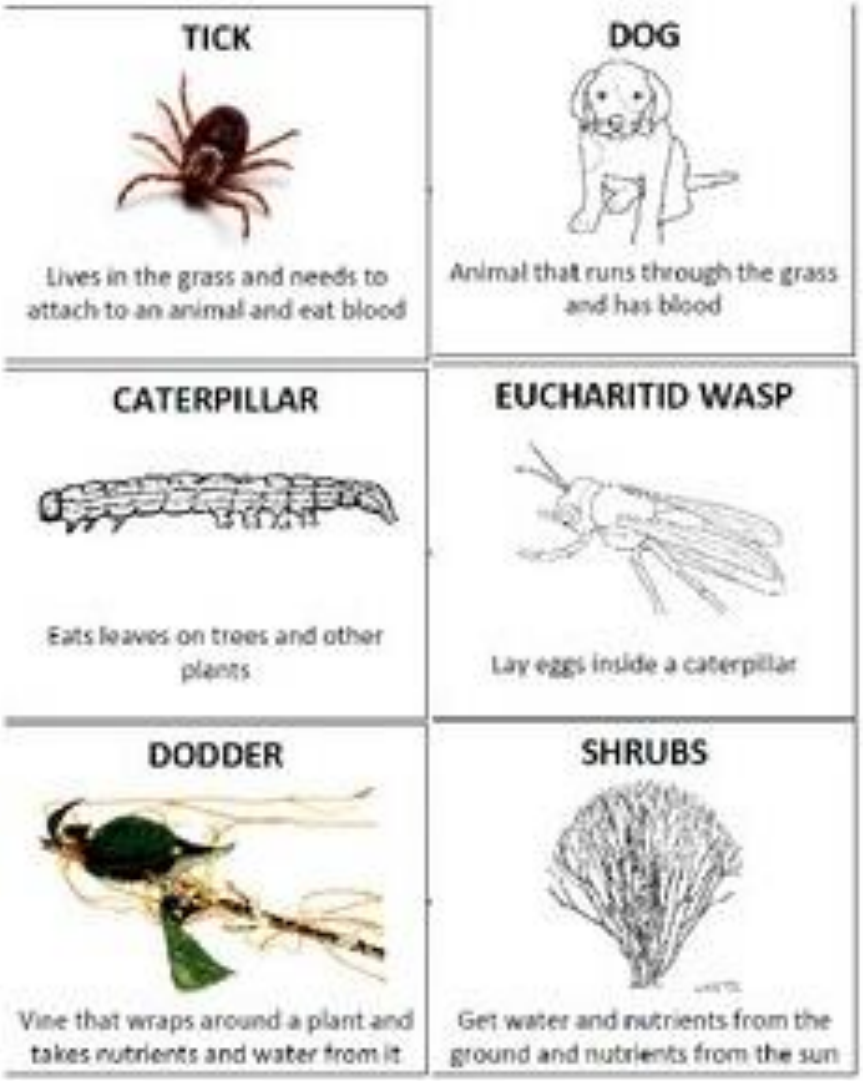
By the end of this topic, you should be able to…

- Compare and contrast the different types of symbiotic relationships within communities

Symbiosis = close relationships between members of different species

Types of Symbioses

1) Predation
2) Parasitism
3) Competition
4) Mutualism
5) Commensalism



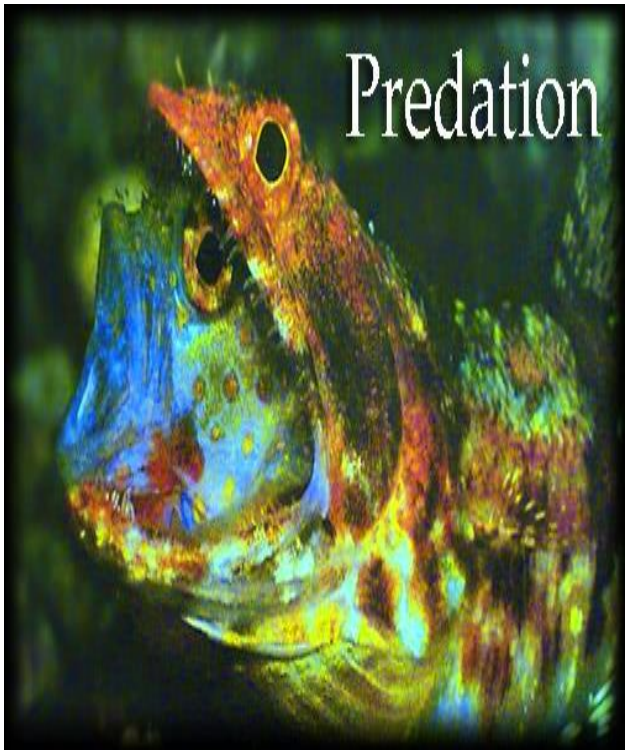
PREDATION

One organism kills another organism for food (the 2nd organism dies)

+ / -

Ex: Lizardfish and

gobey



PREDATION

- Predators evolve adaptations to capture prey and vice versa
- **Predator Adaptations:** spider webs ; tiger stripes
- **Prey Adaptations:** mimicry, plant toxins

PREDATOR EXAMPLES

Lady Bugs

Preying Mantis

Venus Fly Trap

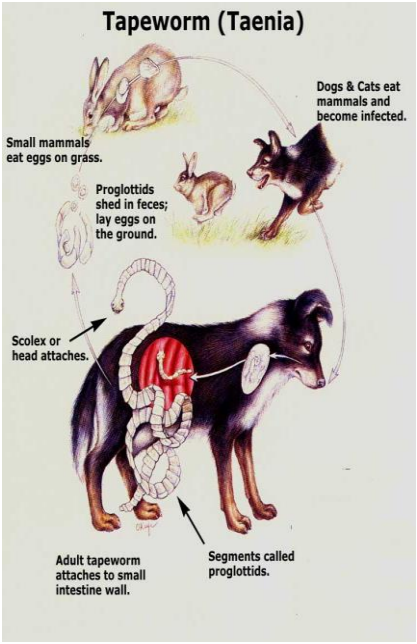
PARASITISM

One organism benefits and the other organism is harmed (the 2nd organism DOES NOT die!)

\+ / -

Ex: tick (ectoparasite)

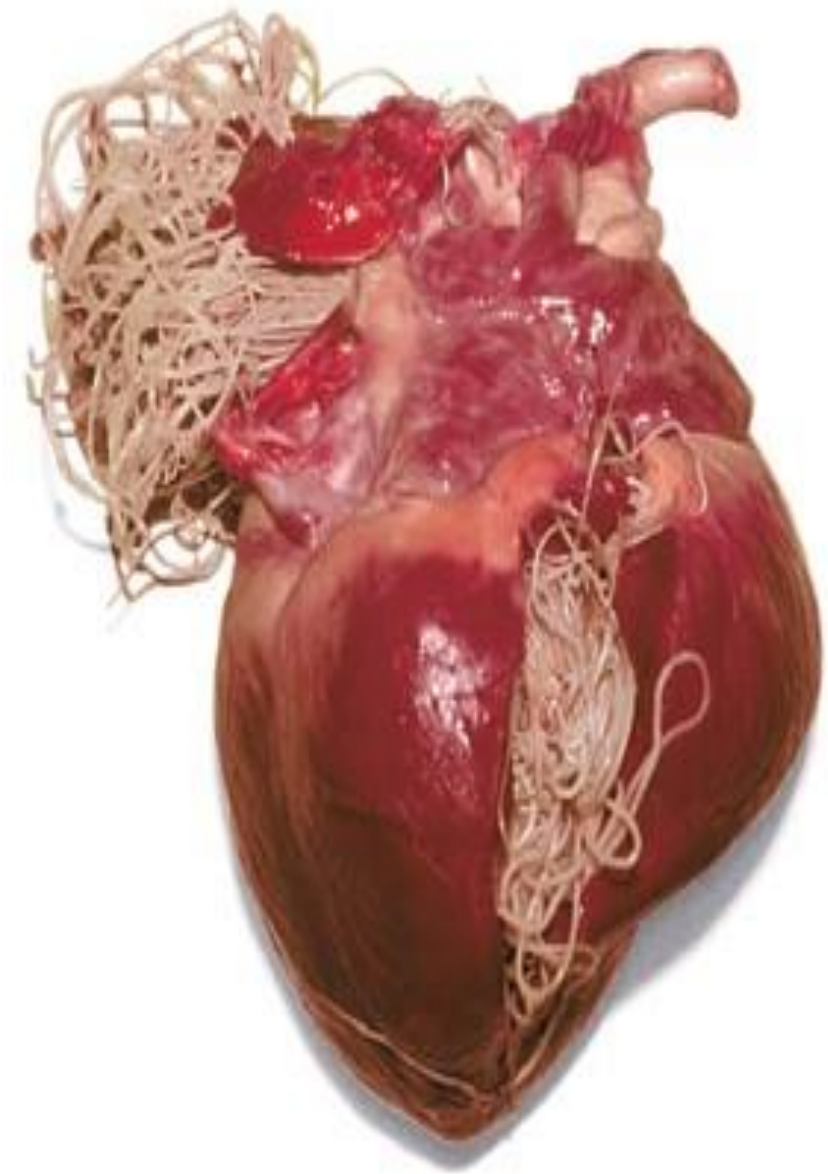
tapeworm (endoparasite)



PARASITISM: HEART WORM

If host dies:

The parasite must quickly find another host or it will die as well.



BROOD PARASITISM

Brown-headed cowbirds demonstrate brood parasitism because they rely on other bird species to:

- build their nests
- incubate their eggs
- Baby cowbirds push the host's eggs or young from the nest
- Lower population of songbirds

COMPETITION

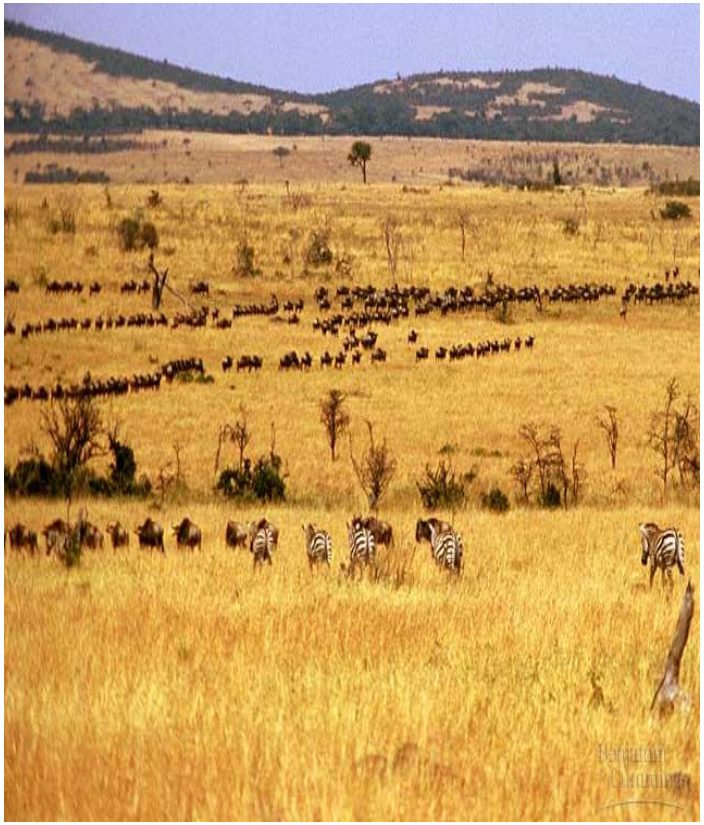
Both organisms are harmed by the interaction when they try to use the same resources

- / -

Ex: Animals compete

for water during a

drought



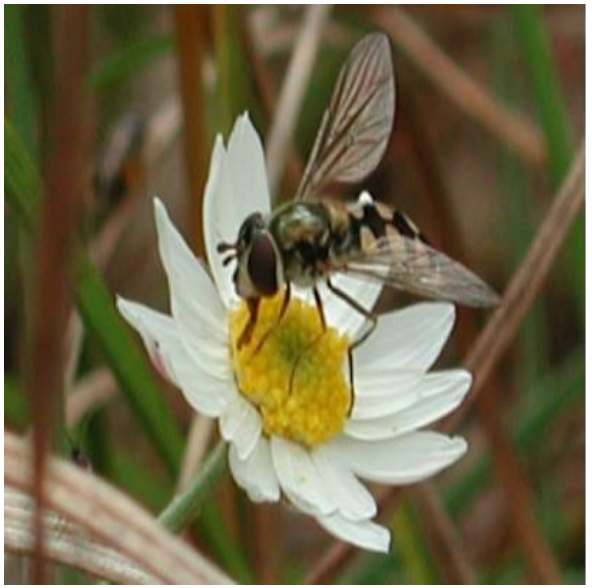
MUTUALISM

Both organisms benefit from each other

+ / +

Ex: Insects and
flowering plants

E Coli's NASTY Mutualism with Humans:



Example: Lichens = mutualism between fungi and algae

- Algae provide food for the fungi
- Fungi provide a habitat for the algae

Cleaner Fish & Ocean Sunfish

COMMENSALISM

One organism benefits and the other is neutral (not helped or harmed)

+ / 0

Ex: clownfish and sea anenome

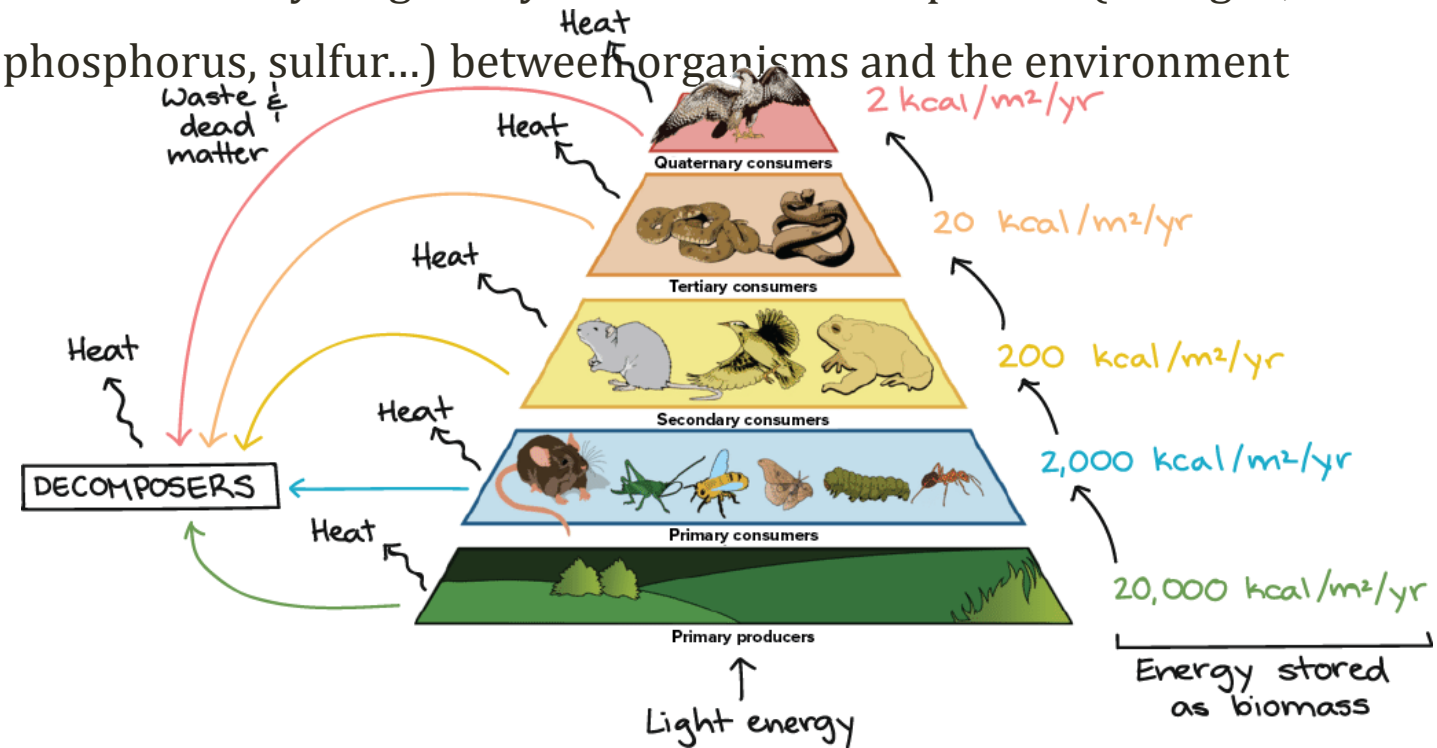
COMMENSALISM

Barnacles

TOPIC 4: NUTRIENT CYCLES AND FOOD WEBS

By the end of this topic, you should be able to…

- Describe energy (E) transfers (food chains, food webs) that occur within an ecosystem
- Describe the cycling of key elements and compounds (nitrogen, carbon, water, phosphorus, sulfur…) between organisms and the environment



The ultimate source of all energy on earth is the sun

Role of Organisms in Energy Transfer:

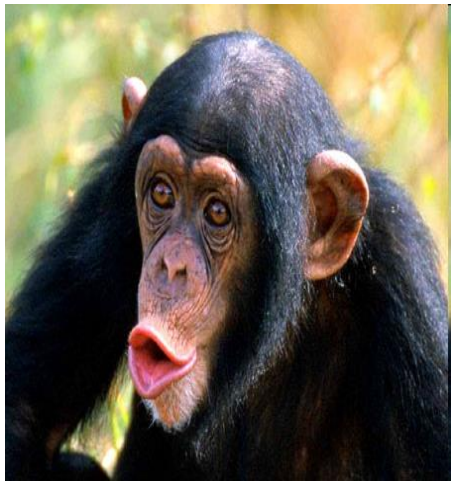
1) **Producers**: capture energy from the sun and use it to make simple energy-rich molecules (ex: glucose). Another name for a producer is an autotroph

Ex: plants, blue-green bacteria

2) **Consumers** = cannot make their own food, must obtain nutrients by eating other organisms. Another name for a consumer is a heterotroph

Ex: Animal, amoeba

Three Types: carnivores (meat only), omnivores (meat and plants), and herbivores (plants only)



3) **Decomposers** = cannot make their own food, break down dead organic matter as a food source; help recycle nutrients throughout the ecosystem

Ex: Fungi

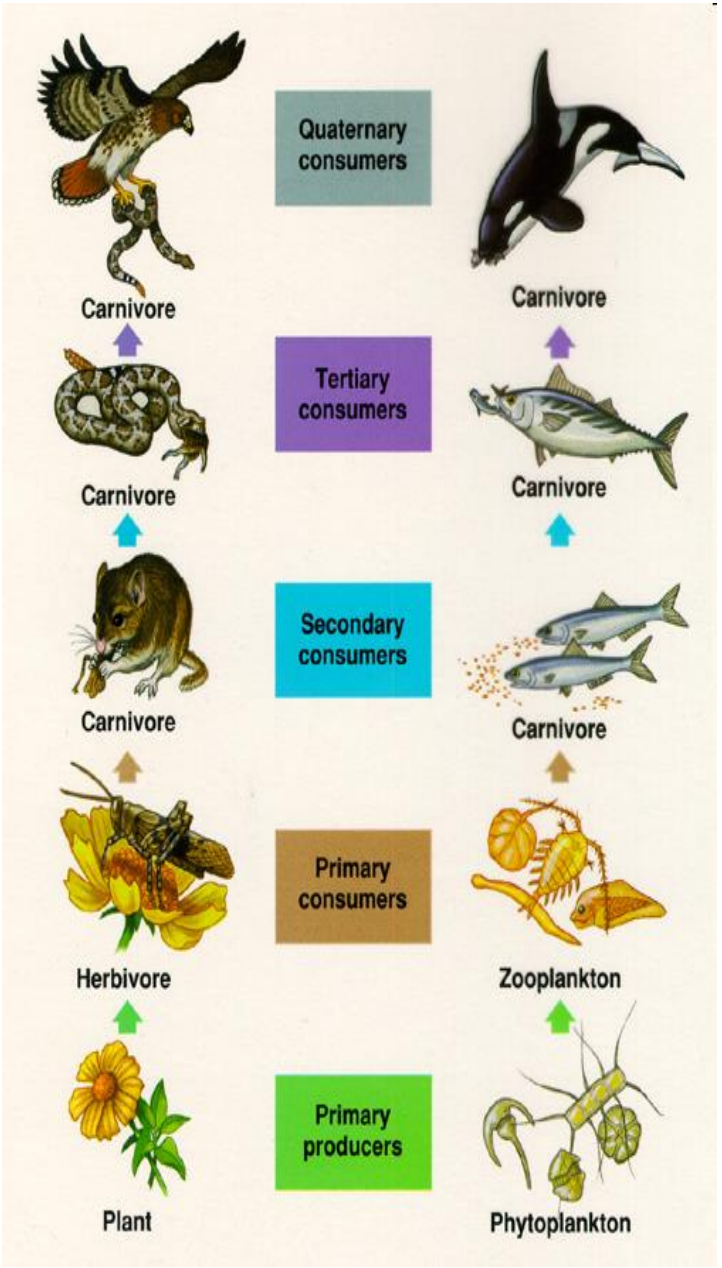
There are different “trophic levels” that represent the different levels of energy transfer.

organism that eats a producer:

primary consumer

organism that eats a primary consumer:

secondary consumer



ALGAE → ZOOPLANKTON → MACKEREL → SQUID → SHARK

Food chains show linear relationships among organisms whereas food webs show many different pathways of energy transfer and species' relationships.

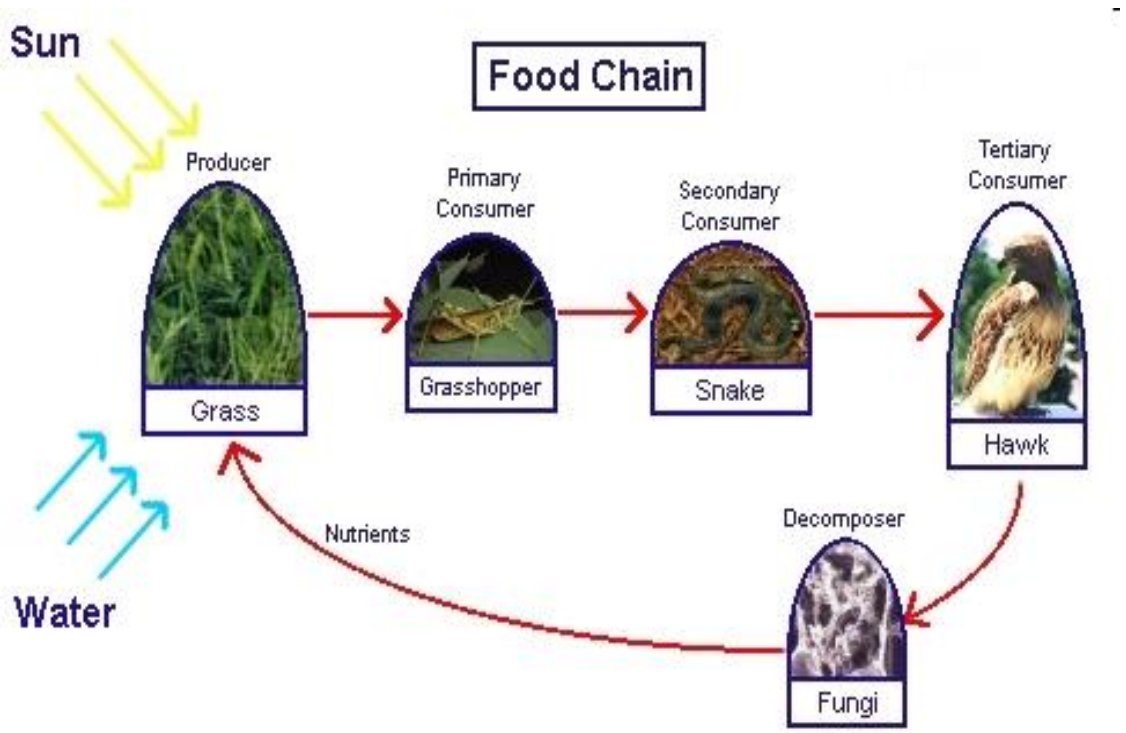
How many trophic levels are in the food chain shown above? _____

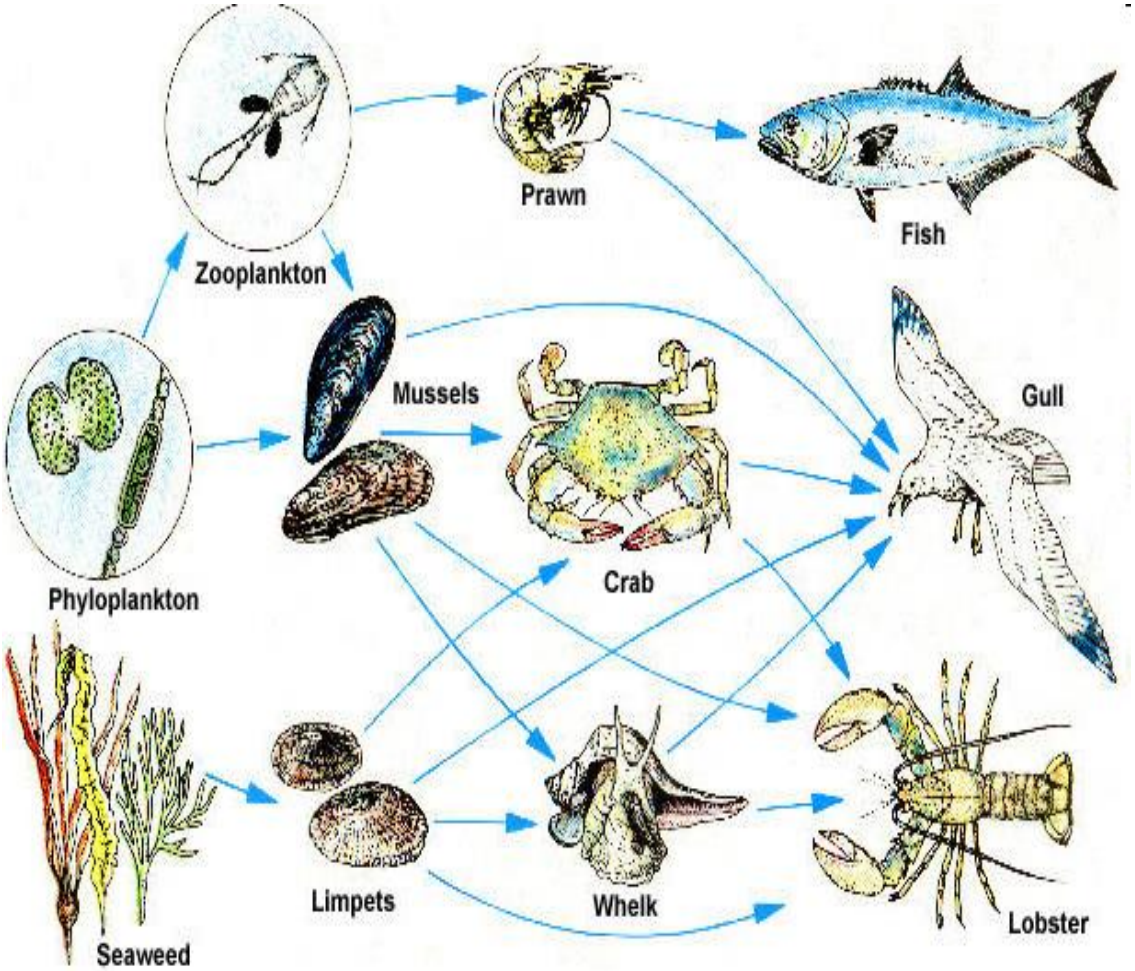
Identify the trophic level of each organism

Organism	Trophic Level
Algae	
Zooplankton	
Mackerel	
Squid	
Shark	

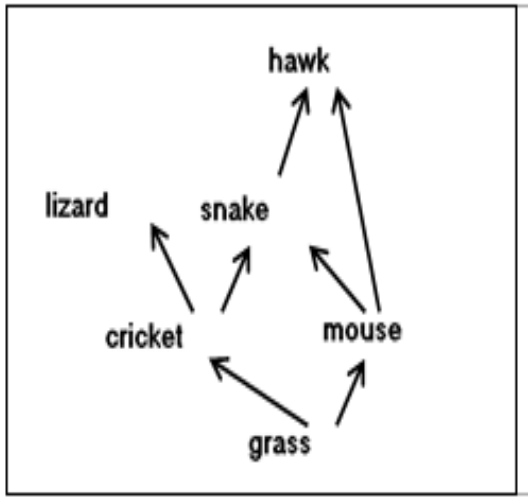
FOOD CHAINS VS. FOOD WEBS

Which is a better method for showing the energy-transfer relationships in an ecosystem and why?




Zooplankton
Prawn
Fish
Phyloplankton
Mussels
Crab
Gull
Seaweed
Limpets
Whelk
Lobster

FOOD WEB PRACTICE



A) Which organism is a producer?

B) Which organisms are primary consumers?

C) Which organism is both a secondary and tertiary consumer?

D) What does the snake eat?

E) Which organism would be *most* affected by the extinction of the cricket?

EFFICIENCY OF ENERGY TRANSFER

The total mass of organic matter (living stuff) at each trophic level is called the biomass

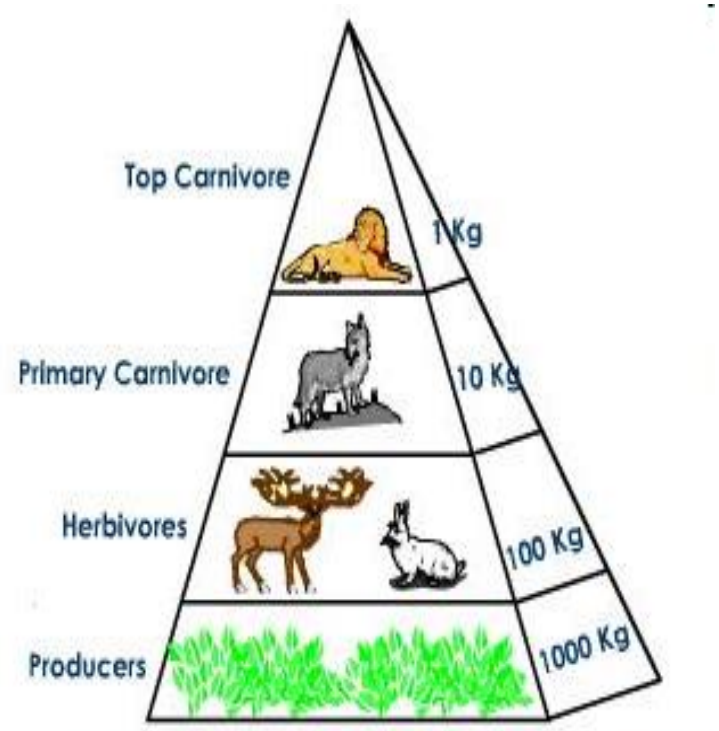
Only 10% of the energy/biomass from one level can be transferred to the next level.

Why is this? – not all energy-containing material can be eaten or digested

Ex: bird beaks, cellulose in plants, teeth

BIOMASS VS. ENERGY PYRAMIDS

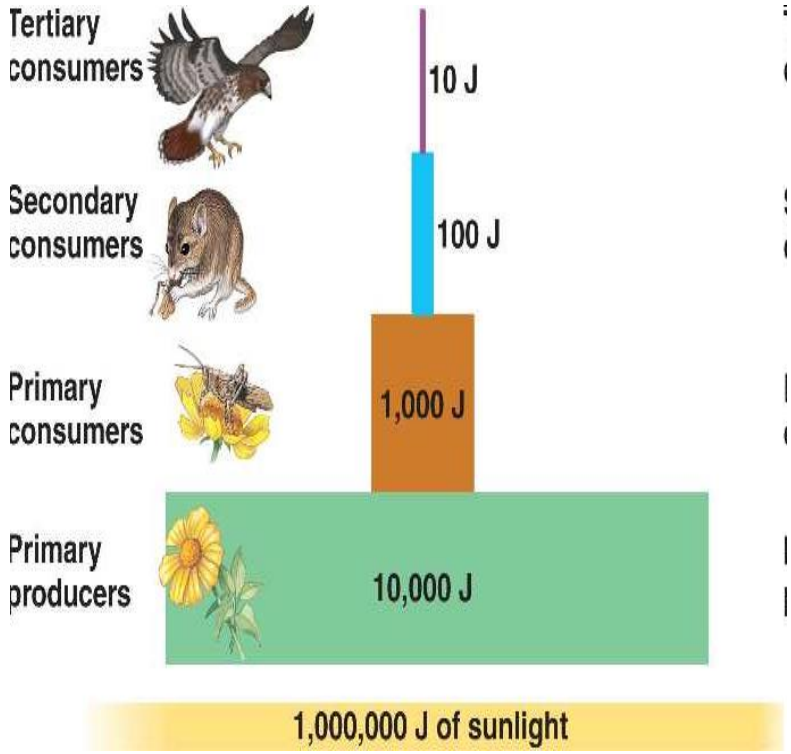
Below is a basic **biomass** pyramid



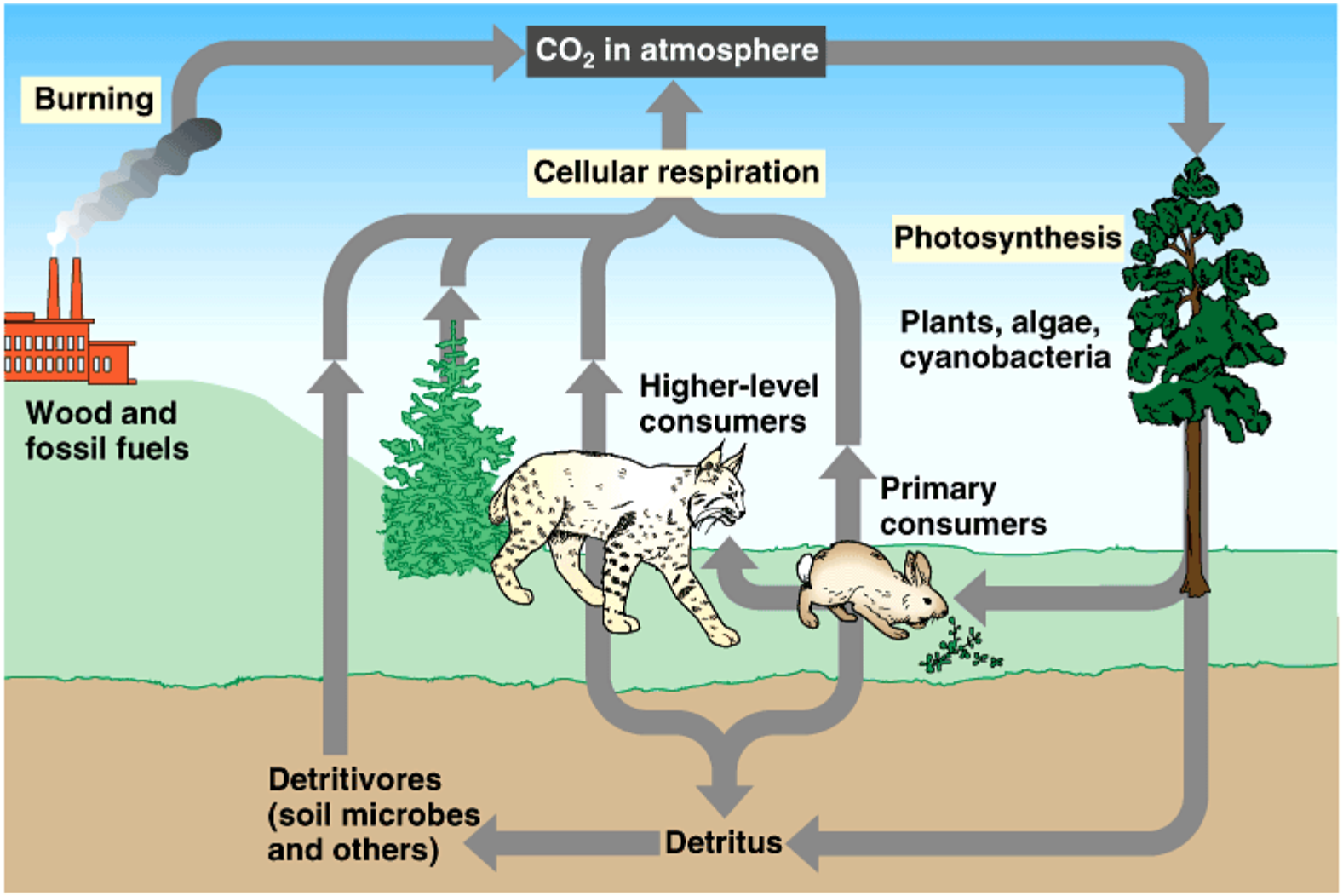
Upright Pyramid of biomass in a Terrestrial Ecosystem

BIOMASS VS. ENERGY PYRAMIDS

Below is a basic **energy** pyramid



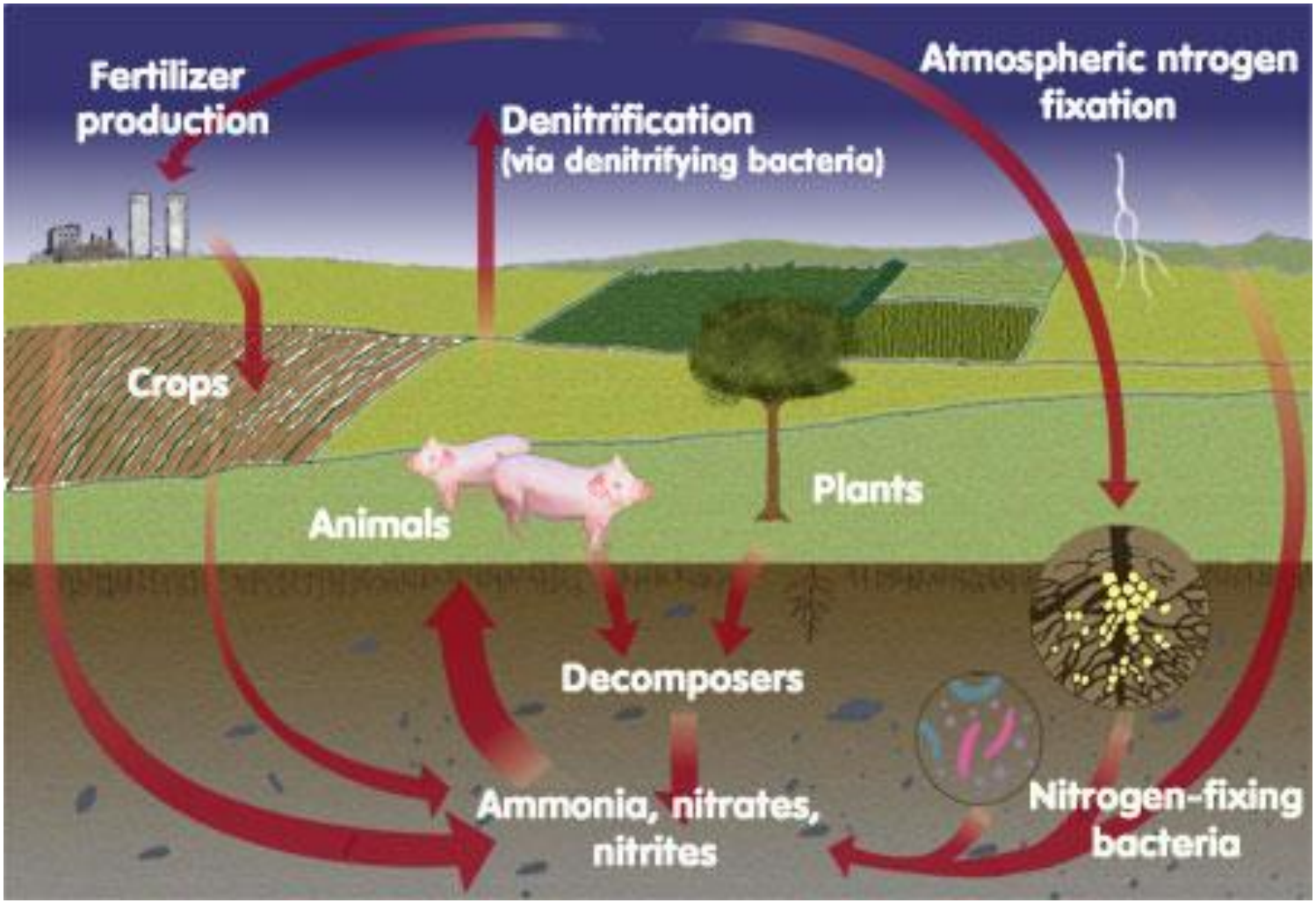
CARBON CYCLE



MAIN PROCESSES

Term	***Definition***
Photosynthesis	The process by which plants convert carbon dioxide and water into sugars and release oxygen back into the air
Respiration	Organisms recycle carbon dioxide and release it back into the air
Decomposition	Decomposers (ex: fungi) break down dead material and release the carbon stored in these organisms back into the soil
Fossil Fuels	Organic matter that is buried underground which is converted into peat, coal, oil or gas deposits
Combustion	The burning of fossil fuels, adds CO2 (carbon dioxide) to the atmosphere

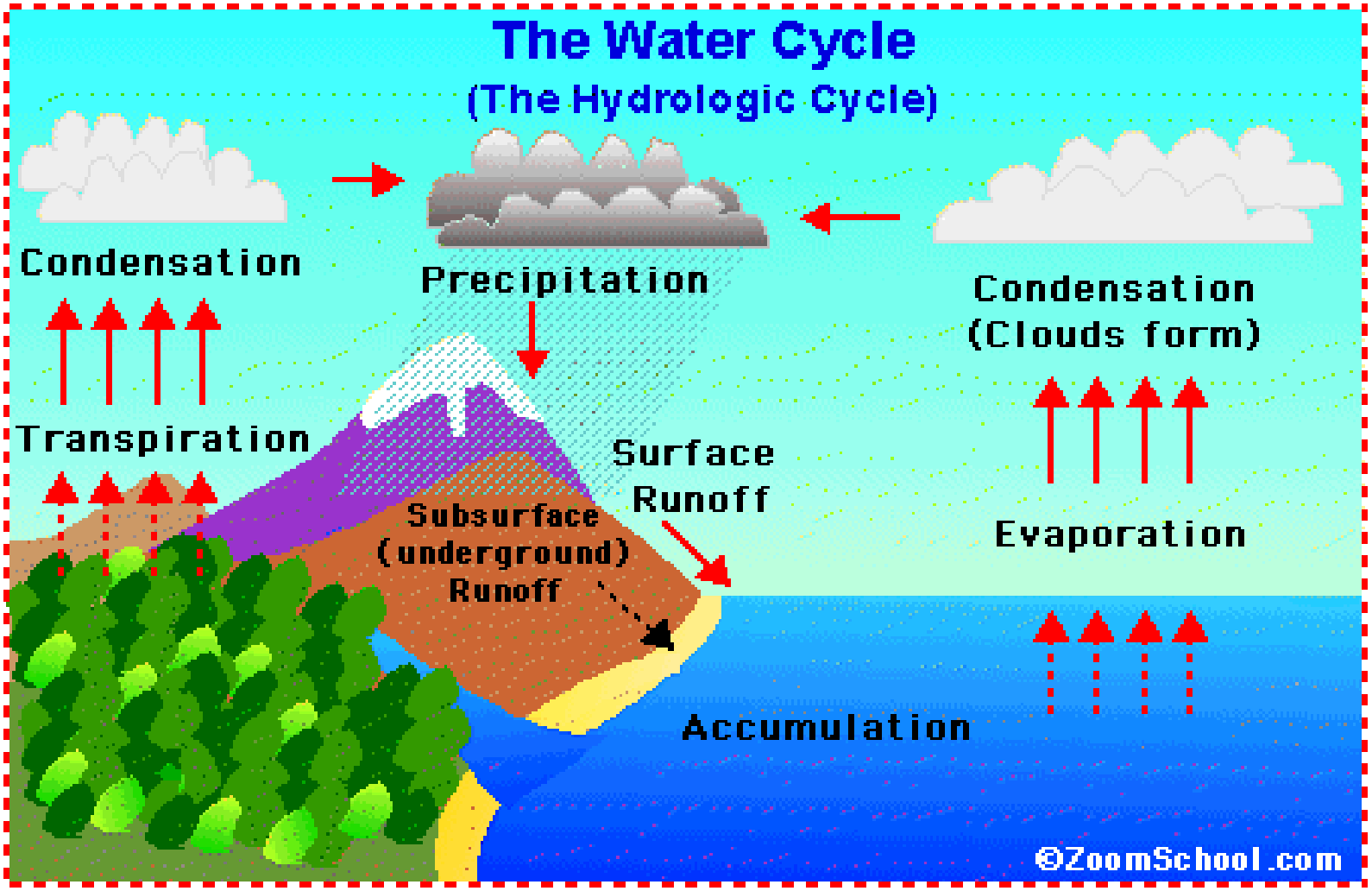
NITROGEN CYCLE



MAIN PROCESSES

Term	*Definition*
N_2	Nitrogen gas that is found in the atmosphere; not useable nitrogen for plants and animals
NH_3	Ammonia; Found in the waste products of living organisms
NO_3	Nitrate; Humans add this to the nitrogen cycle through plant fertilizers
NO_2	Nitrite; Found in the waste products of living organisms
Bacterial Nitrogen Fixation	Nitrogen fixing bacteria capture and convert nitrogen gas into ammonia
Legumes	Plants that contain nitrogen-fixing bacteria in their roots
Atmospheric Nitrogen Fixation	Lightning bolts convert nitrogen gas into nitrates
Denitrification	Soil bacteria convert nitrates into nitrogen gas
Decomposers	Convert the nitrogen in dead organisms into ammonia

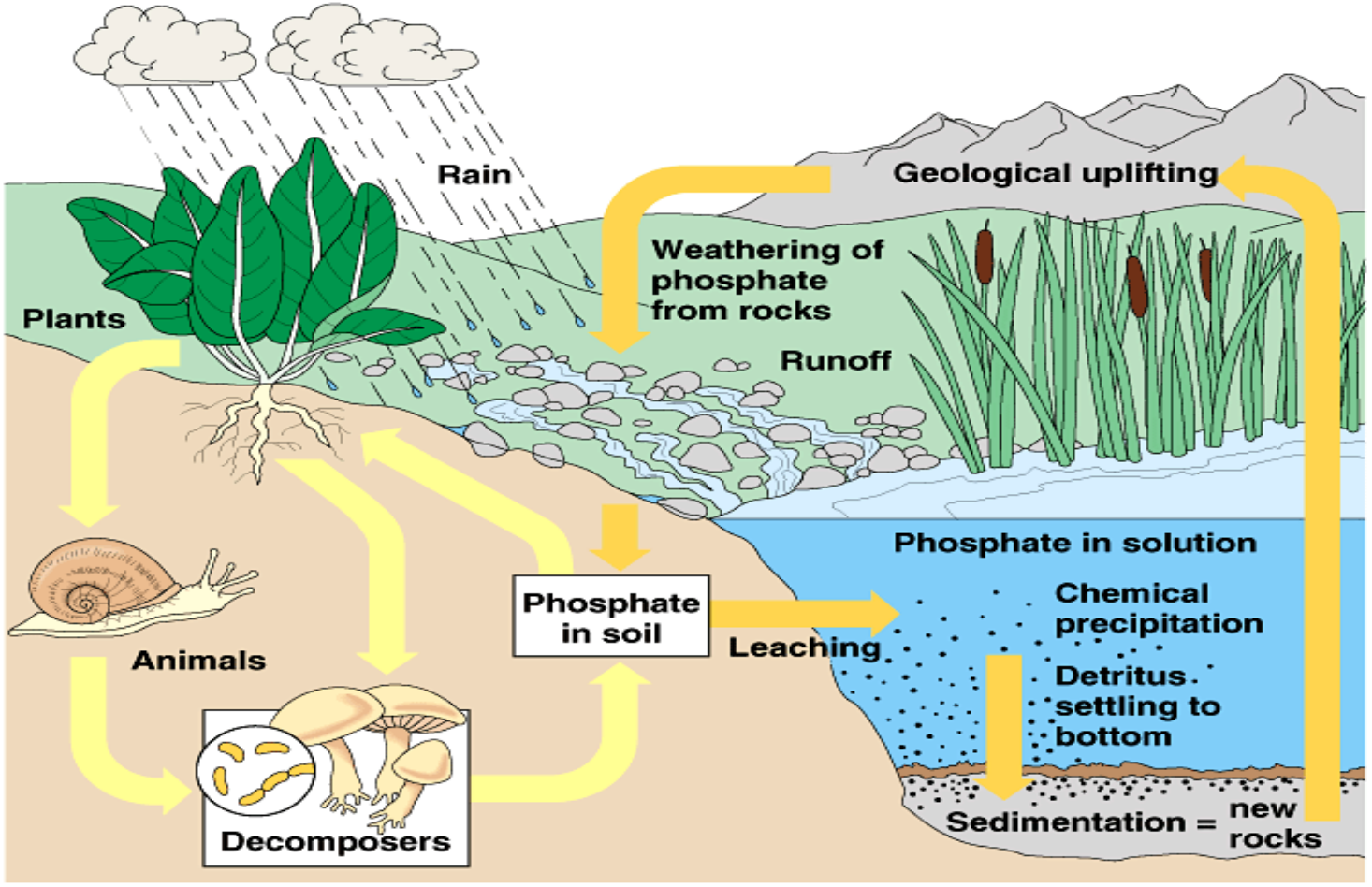
WATER CYCLE


The Water Cycle
(The Hydrologic Cycle)
Condensation
Precipitation
Condensation
(Clouds form)
Transpiration
Surface
Runoff
Subsurface
(underground)
Runoff
Evaporation
Accumulation
©ZoomSchool.com

MAIN PROCESSES

Term	***Definition***
Condensation	Water vapor in the atmosphere changes into liquid water
Precipitation	Condensed water returns to earth in the form of rain, sleet, snow, or hail
Evaporation	Liquid water from lakes, ponds, etc. changes into atmospheric water vapor
Transpiration	Water evaporates from the leaves of a plant
Percolation	Seepage of precipitation into the soil to form groundwater
Groundwater	Water that falls on land and soaks into the ground
Runoff	Leftover precipitation that cannot percolate into the soil and instead drains into a body of water

PHOSPHORUS CYCLE



MAIN PROCESSES

Term	***Definition***
Soil phosphate	PO_4, the form of phosphorus that is present in the soil
Producers	Plants that absorb phosphates from the soil
Consumers	Animals that eat producers and obtain phosphates
Decomposition	When decomposers (ex: fungi) break down dead/decaying organisms and return phosphorus to soil in the form of phosphates
Weathering	When rocks are eroded, which releases phosphate into the soil
Sedimentation	Formation of rocks that contain phosphorus