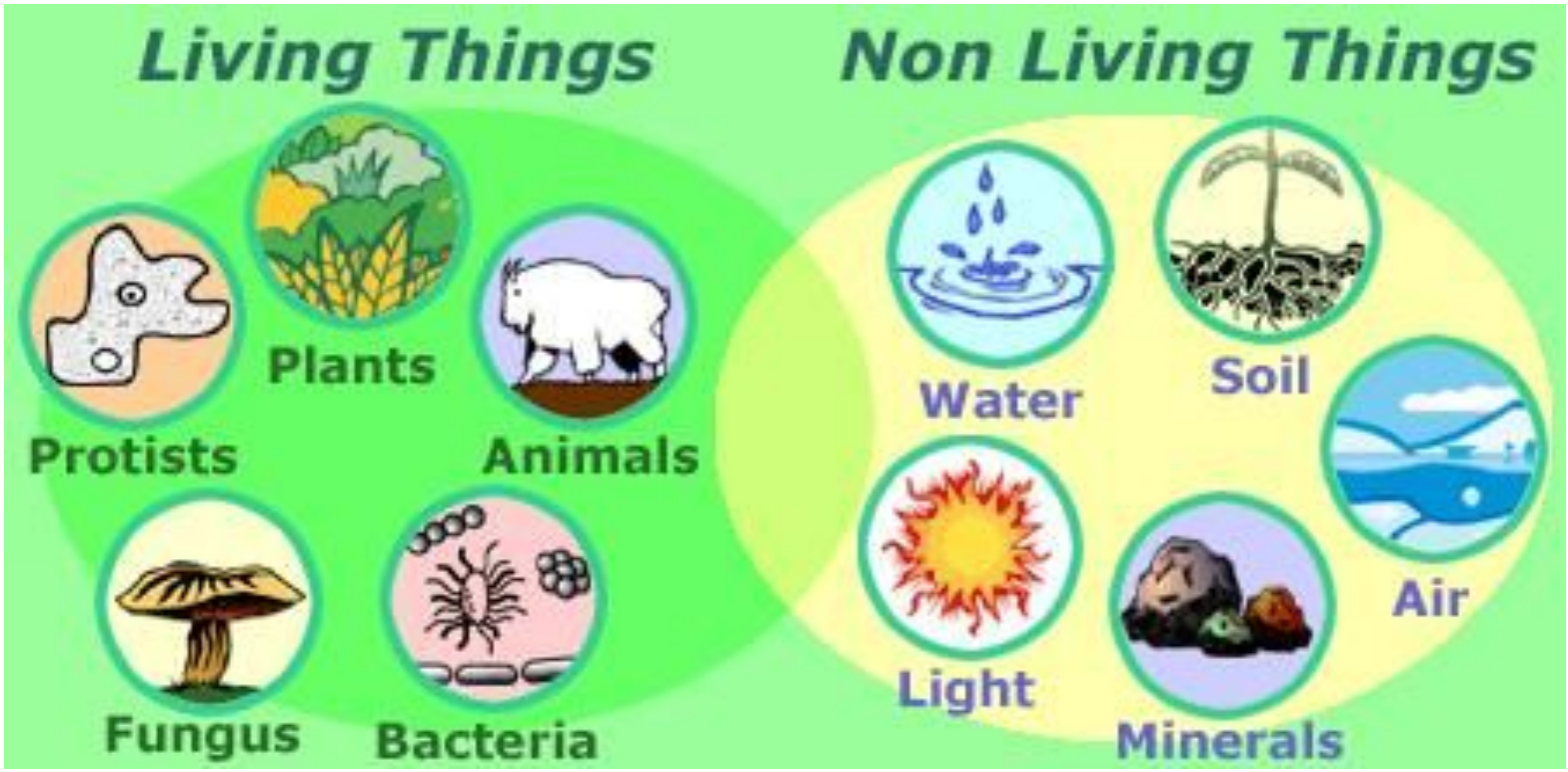
Introduction to Biology

What is Life?

Biology

- Biology is the study of living organisms
  - “Bio” means “life”
  - “-ology” means the study of

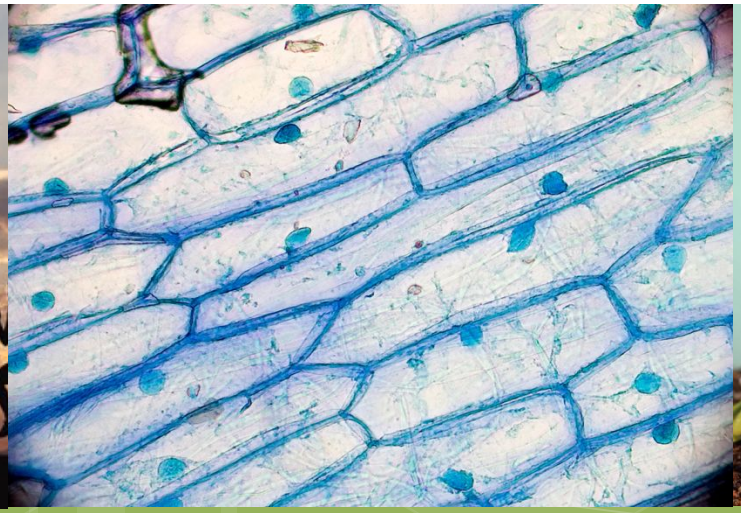
What do you think it means to be living?



The Characteristics of Life

- Living organisms…
  - made of one or more cells
  - Obtain and use energy
  - Grow and develop
  - Reproduce
  - Respond to their environment
  - Adapt to their environment

We are going to look at all of these characteristics this semester!



Bellringer

- What is biology?
- What classifies something as living? Why is, say, a cat considered living while a rock is not?
- What are you hoping to study in this class?

Ecology

The study of ecosystems

WHAT IS AN ECOSYSTEM?

- *Ecosystems* are communities of living organisms in relation to all the nonliving components within them
- *Niche* a role an organism or population plays in an ecosystem
  - species have different adaptations so they do not directly compete for the same resources

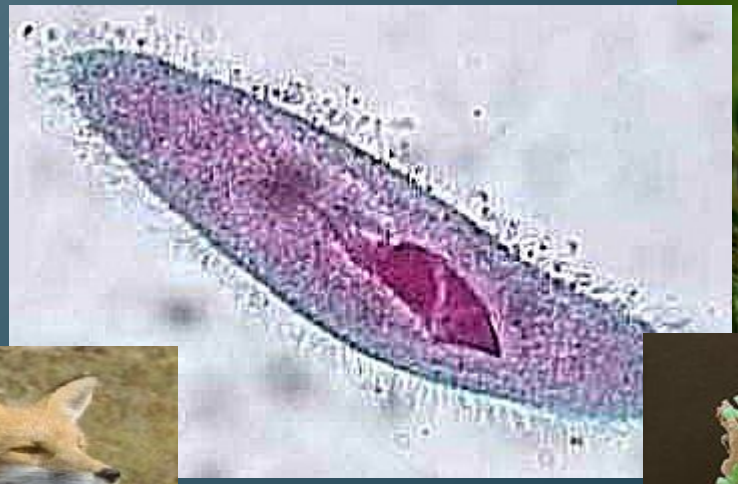
WHAT IS AN ECOSYSTEM?

- *Ecosystems* are communities of living organisms in relation to all the nonliving components within them
- These are called *abiotic* and *biotic* factors

Biotic Factors	Abiotic Factors
Biotic Factors = factors in an ecosystem that are living Examples: -Tree -Rabbit -Frog	Abiotic Factors = factors in a ecosystem that are NON-living Examples: -Sun -Water -Weather -Fire

Biotic Factors = Living things

- Plants
- Animals (YOU)
- Fungi
- Bacteria
- Protists



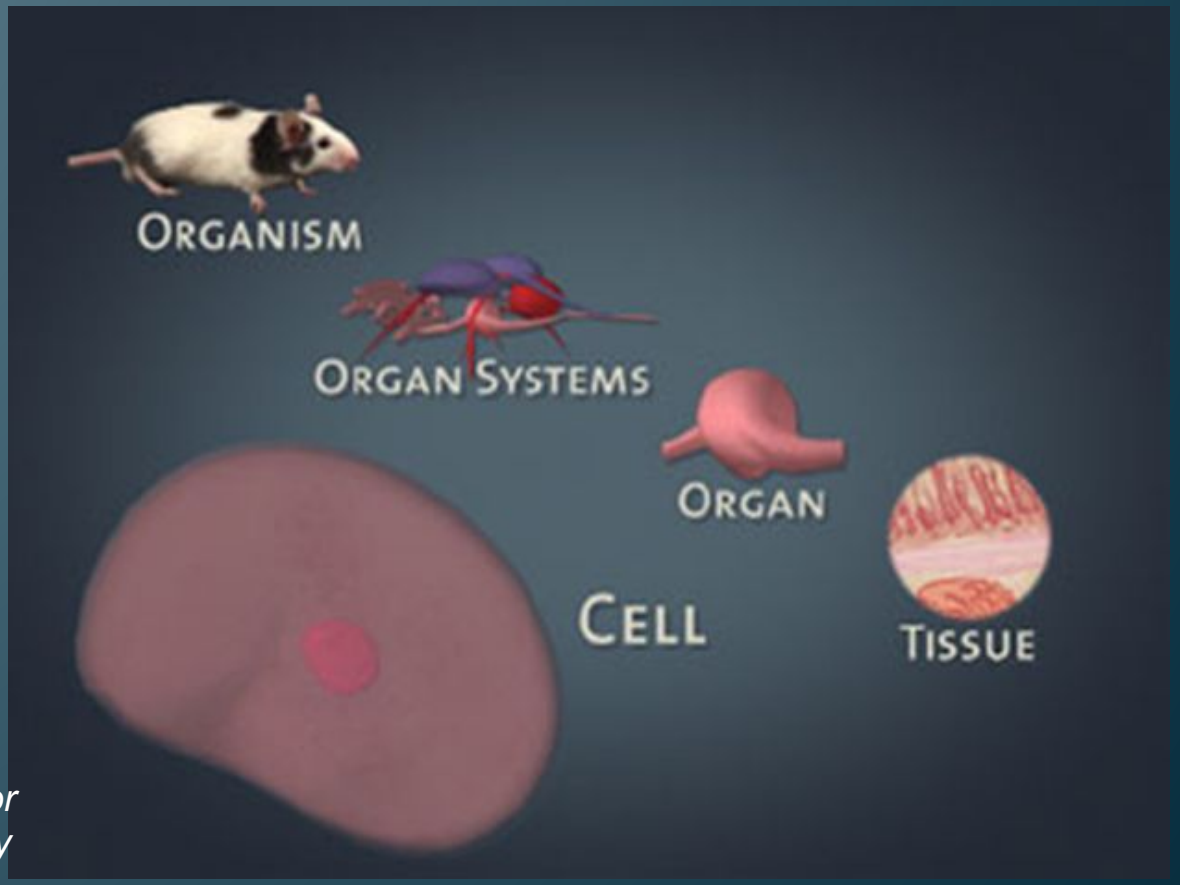
Abiotic Factors = nonliving things

- Soil and rocks
- Weather
- Water/Rain
- Temperature

Levels of Organization….can you remember?

1. Atom
2. Molecule
3. Cell
4. Tissue
5. Organ
6. Organ system
7. Organism
8. Population
9. Community
10. Ecosystem
11. Biome
12. Biosphere

focus for Ecology

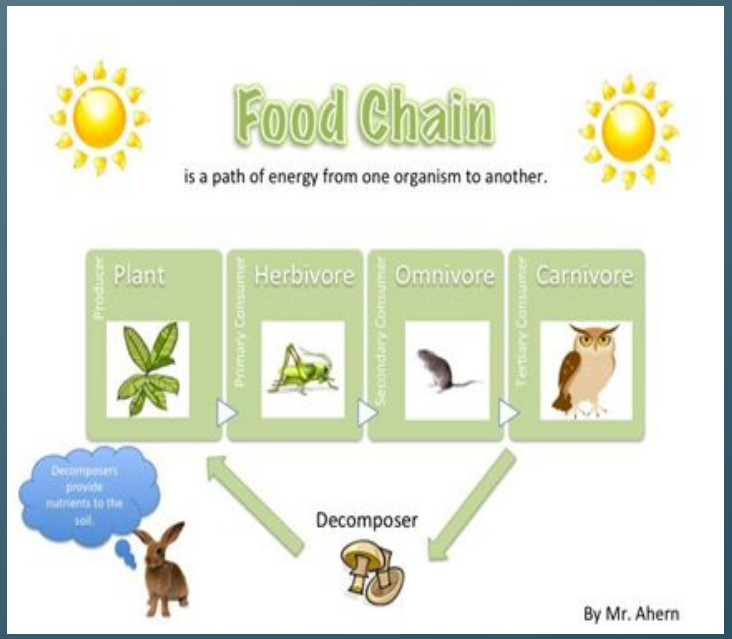


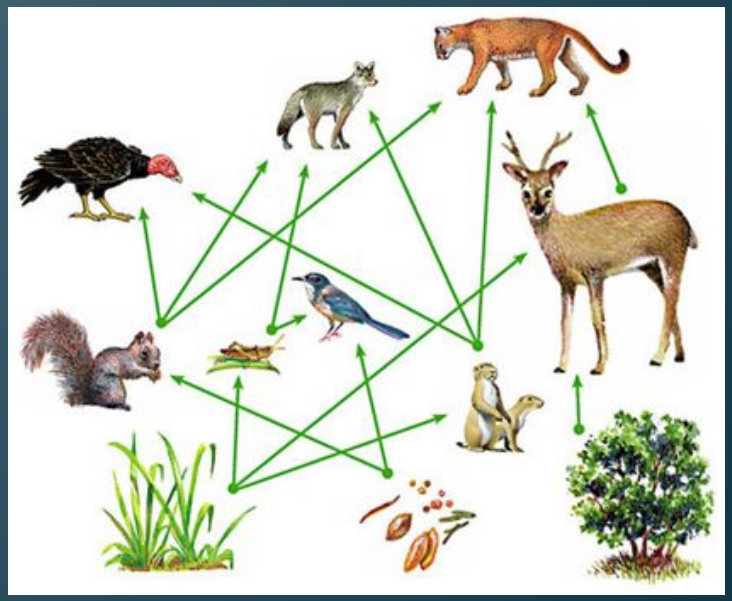
6 Levels of Ecology focus on organism to biome

1. Organism = one individual
2. Population = 2+ of the *same* organism
3. Community = All types of living organisms in an area
4. Ecosystem = All living organisms AND nonliving factors in an area
5. Biome = group of similar ecosystems
6. Biosphere = all areas on Earth where life exists

FOOD CHAINS and FOOD WEBS

- *Food Chain*
  - One pathway of energy flow
- *Food Web* - All possible pathways of energy flow

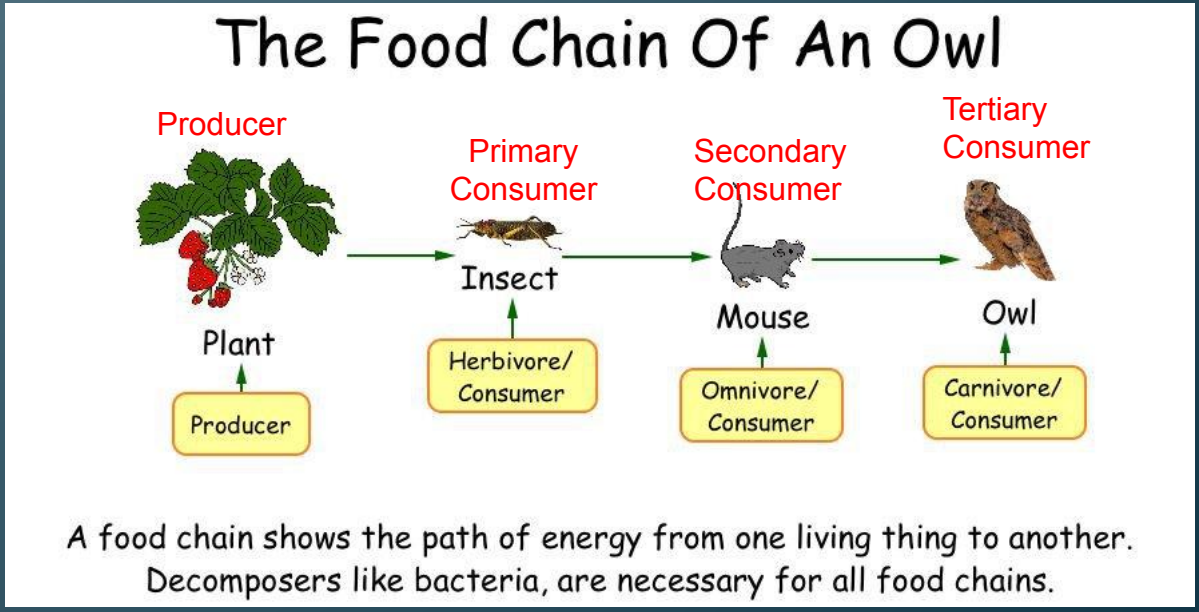




Arrows always point in the direction of the energy flow.

PARTS OF THE FOOD CHAIN

- *Autotrophs*-make their own food using CO_2 to make glucose (sugar)→ producers
- *Heterotrophs*-have to eat other organisms to gain energy → consumers
- *Decomposers*-break down dead, organic matter



All living things must have energy in order to maintain homeostasis.

Where does ALL energy originate?

The food chain and food web show how energy originating in the sun travels through each organism.

Energy flow is a “one way” street

Energy Flow

Energy from the sun is called Radiant Energy

Plants use photosynthesis to convert radiant energy into chemical energy.

Think about it....

What is the difference between radiant energy and thermal energy?

Think about it....

What is the difference between radiant energy and thermal energy?

Radiant energy - light energy

Thermal energy - heat energy

Think about it....

Is the sun part of the food chain?

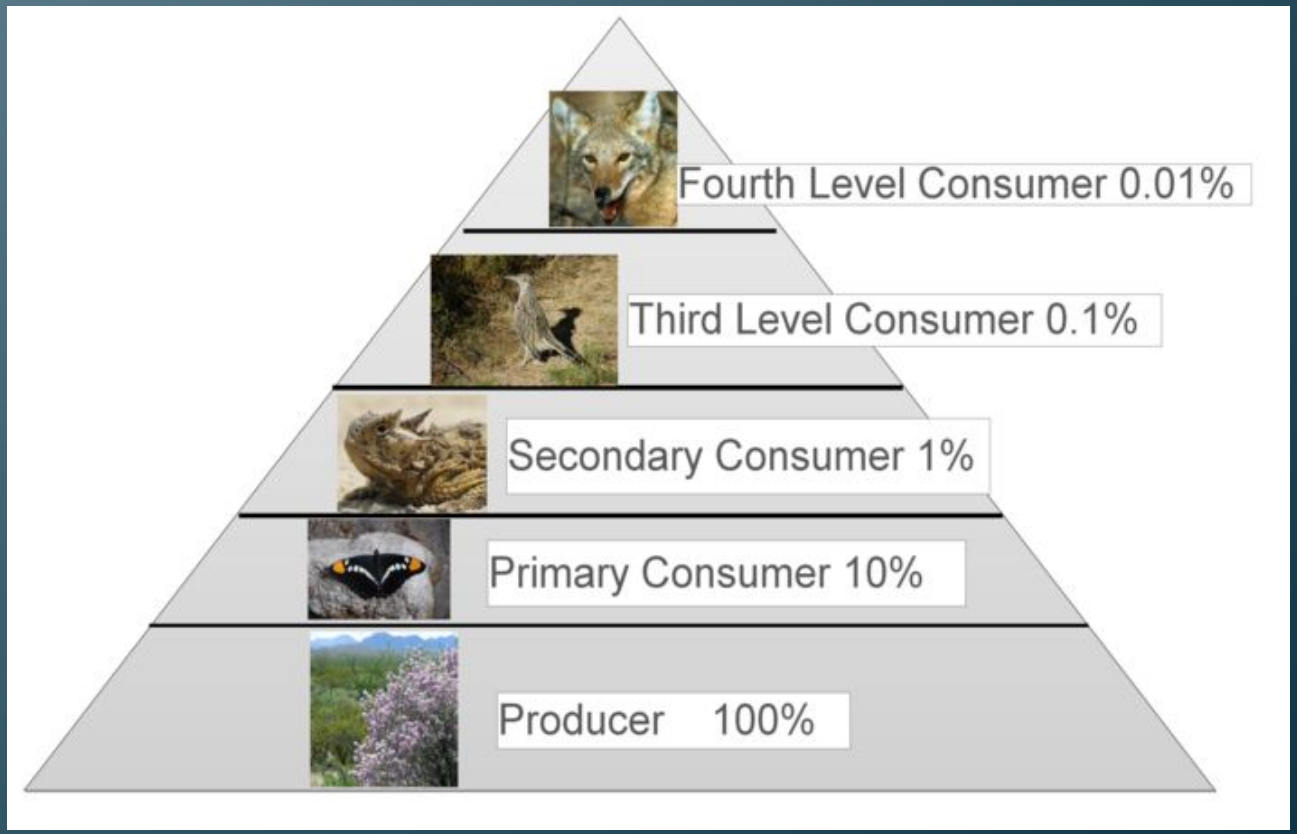
Think about it....

Is the sun part of the food chain?

Not a LIVING part - BUT it is the source of all of the energy in the food chain

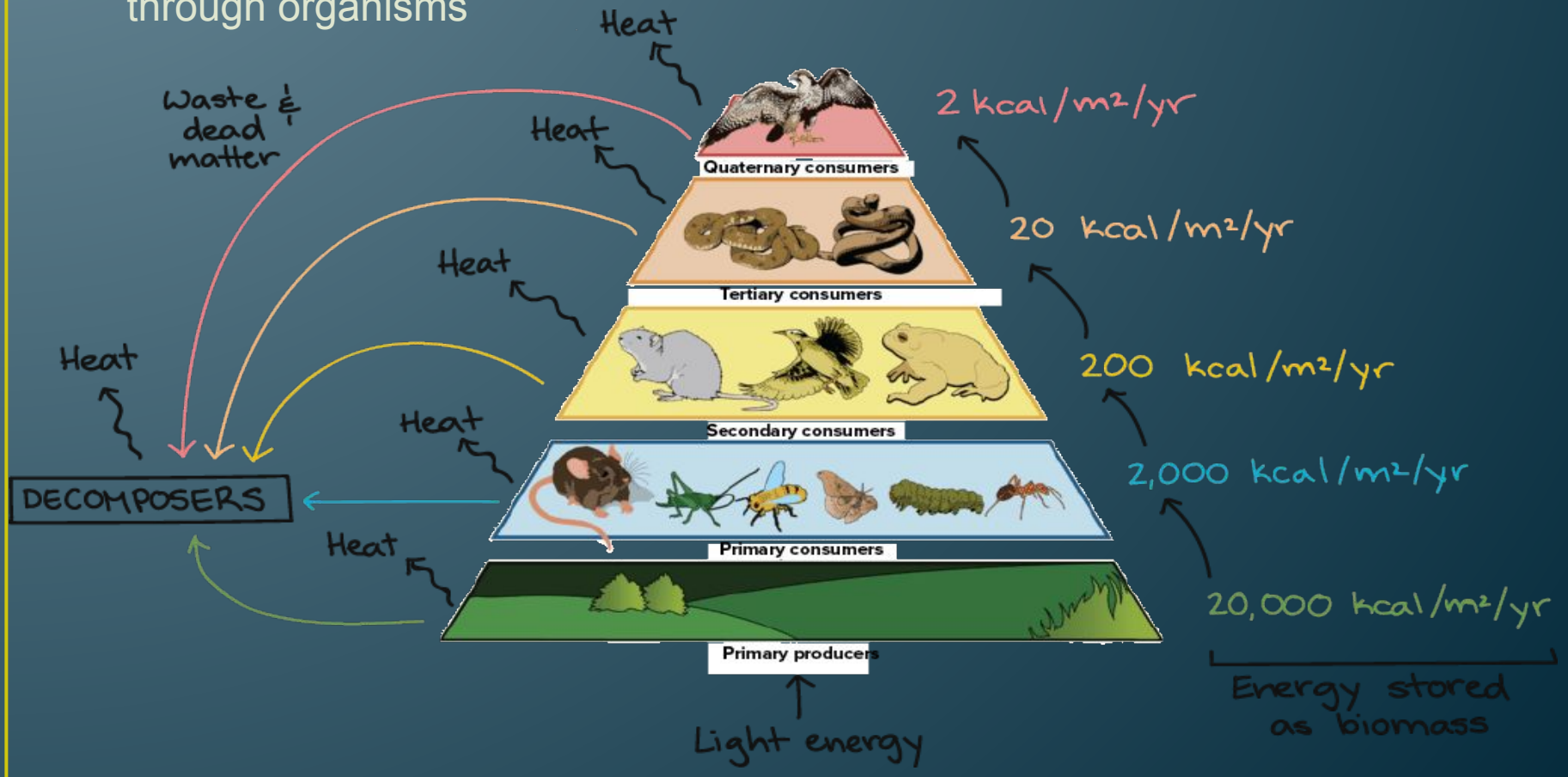
ENERGY PYRAMID

Ecological pyramid (aka energy pyramid): a graphical representation showing the flow of energy at each trophic level in an ecosystem.



The Energy Pyramid

- Transfer of energy
- 10% Rule
- Only 10% of the energy transfers from one organism to the next, the rest is lost to respiration, digestion, etc.
- Food Chains and Food Webs show how energy originating in the sun travels through organisms



Bellringer

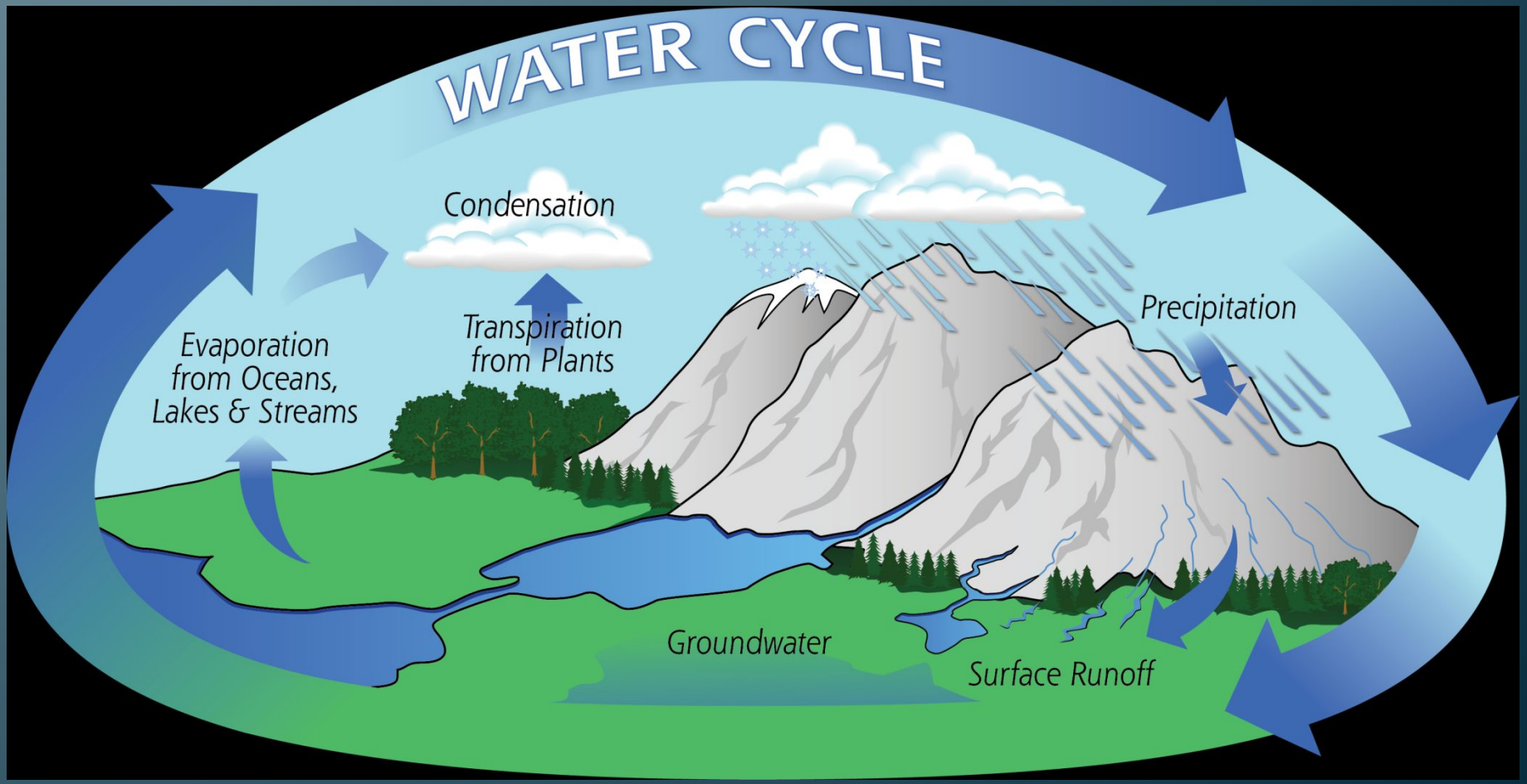
1. What is the difference between autotrophs and heterotrophs? What role do autotrophs play in the nutrient cycles?
2. What types of environmental concerns are associated with the burning of fossil fuels? Hypothesize some methods to reduce these concerns.

NUTRIENT CYCLES

THE FLOW OF ENERGY

- Nutrients are recirculated through organisms and their surrounding environments
- Energy cycles within ecosystems include:
  - Water Cycle
  - Nitrogen Cycle
  - Carbon Cycle

THE WATER CYCLE

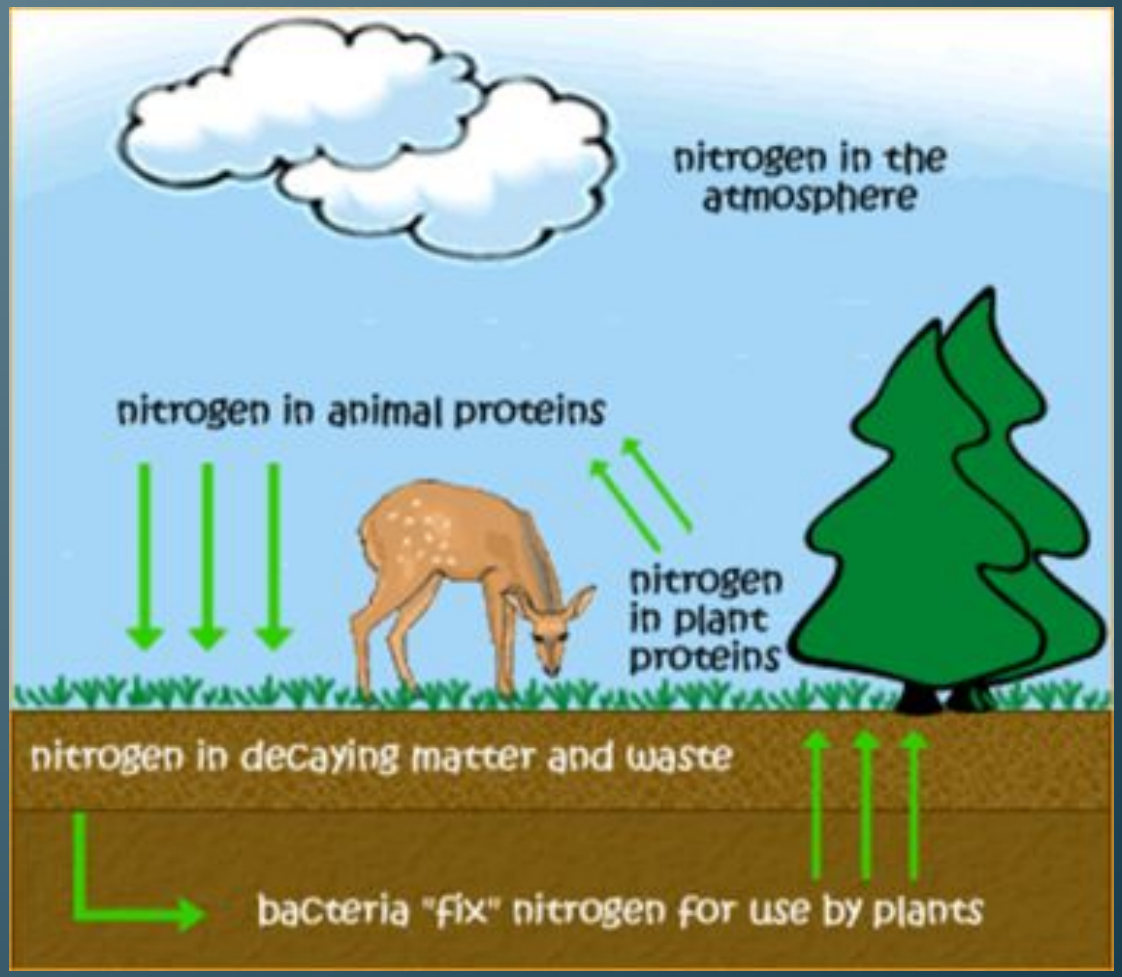


THE NITROGEN CYCLE

- Nitrogen cycles through the environment in various chemical forms
  - All organisms require nitrogen to live and grow
  - 78% of nitrogen is in the atmosphere
  - it must be converted to a usable form!
- *Nitrogen Fixing Bacteria* - Microorganisms that convert nitrogen from the atmosphere into fixed nitrogen in the soil (usable form) for other plants to use

Nitrogen Fixing Bacteria

THE NITROGEN CYCLE



We add nitrogen to the soil in the form of fertilizer, what happens to the natural cycle?

What happens to the natural cycle when we add nitrogen in the form of fertilizer?

What happens to the natural cycle when we add nitrogen in the form of fertilizer?

throws off the natural cycle because there is too much nitrogen

WHY IS THE NITROGEN CYCLE SO IMPORTANT TO LIFE?

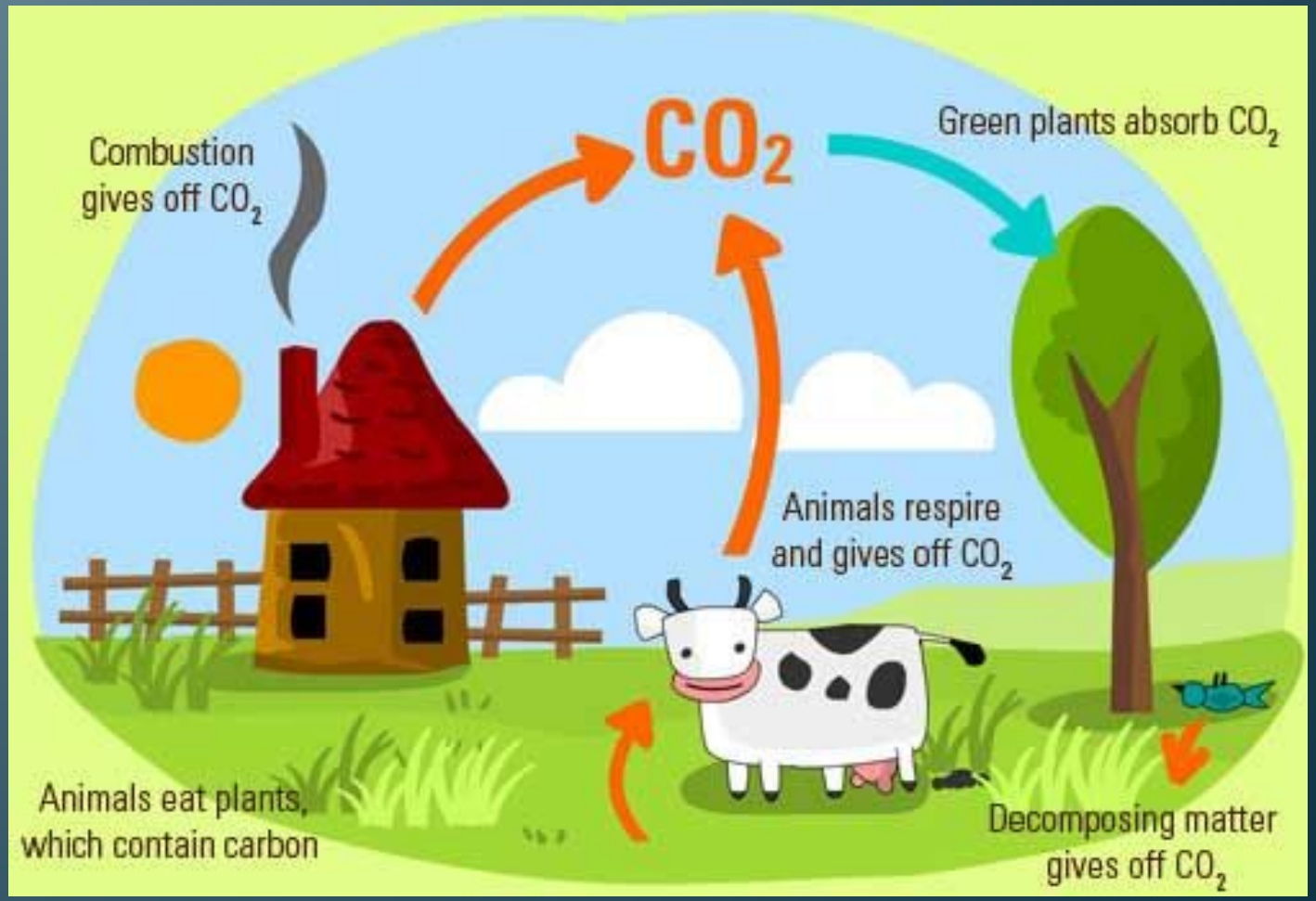
WHY IS THE NITROGEN CYCLE SO IMPORTANT TO LIFE?

- Not only is the nitrogen cycle important for the producers - but that is the beginning of all things that we consume
- It also is used in making Chlorophyll, found in plants - required for the absorption of light
- it is also an important part of Cellular Processes, such as Amino Acids, Proteins and our DNA

THE CARBON CYCLE

- Carbon circulates through the atmosphere and organisms
- Plants take in carbon dioxide (CO_2) through photosynthesis and release oxygen; animals inhale oxygen and exhale CO_2 through respiration

THE CARBON CYCLE



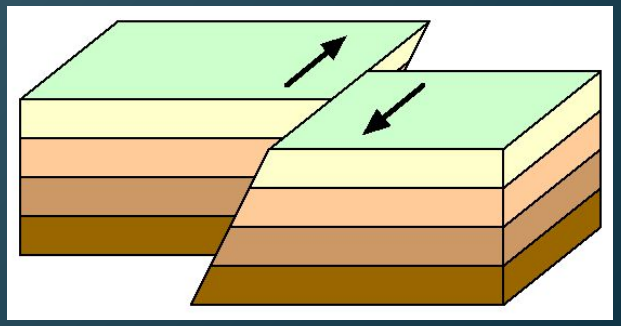
FACTORS THAT INFLUENCE CLIMATE and CARBON LEVELS

HUMAN PROCESSES

- *Global climate change (human influenced increase in the greenhouse effect!)*
- *Humans release CO_2 through a number of factors, including the burning of fossil fuels*

NATURAL PROCESSES

- Volcanic Eruption-volcanoes naturally emit CO_2 when eruptions occur
- Geological processes-faults, wells, vents, land shifts



GLOBAL CLIMATE CHANGE

- Carbon is a naturally occurring part of our atmosphere - *it is supposed to be there!*
- *The Greenhouse Effect - a* naturally occurring effect that keeps our Earth warm; we need it to survive!
- *Global Warming* - human activities (like burning fossil fuels and deforestation) are increasing CO_2 levels

Think about it...

How is global warming related to the greenhouse effect, and what impact might this have on the carbon cycle?

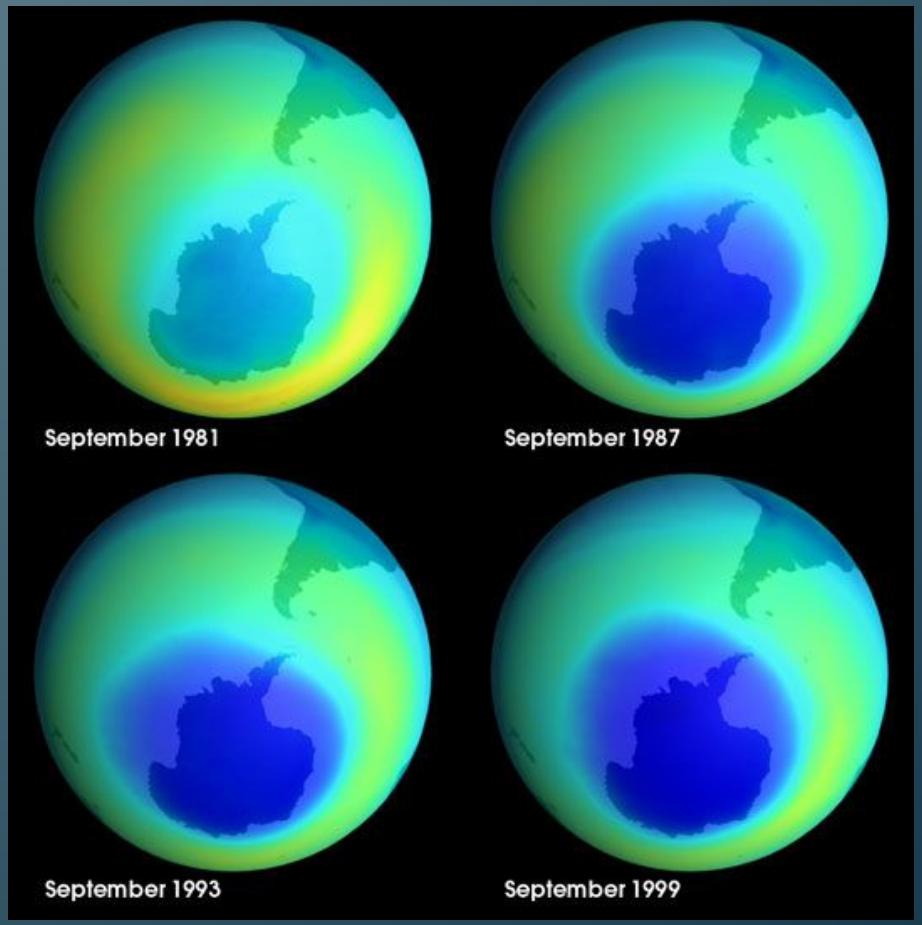
Think about it...

How is global warming related to the greenhouse effect, and what impact might this have on the carbon cycle?

- without greenhouse gases the Earth would be ice, these gases keep our planet livable
- Greenhouse Effect - trapping heat energy
- Global Warming - releasing burned coal, oil, gas from vehicles & factories add more CO_2 into the air and it is making the Earth warmer

Think about it...

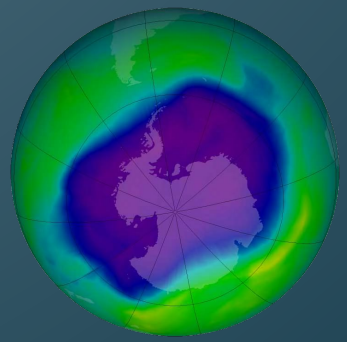
How does the destruction of the ozone layer relate to global climate change?



Think about it...

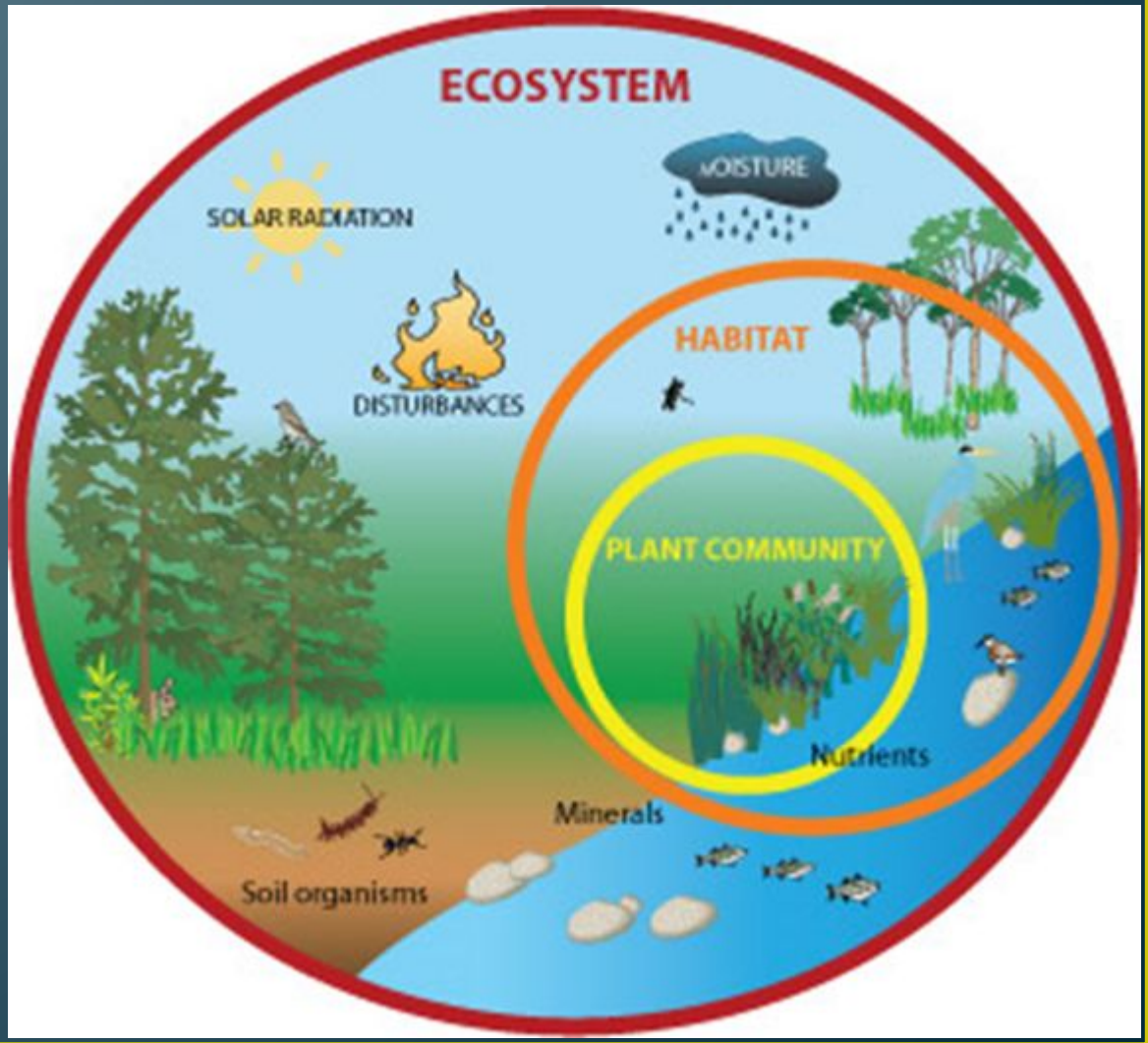
How does the destruction of the ozone layer relate to global climate change?

- Pollutants released by humans alter the ozone layer, especially CFC's
- Ozone Layer - absorbs ultraviolet radiation



Organism Interactions in Ecosystems

- Predator/Prey
- Competition
- Symbiosis



Species Relationships

Predator - the organism that hunts and kills another organism

Prey - the organism that is hunted and killed by another organism

Ex. The lion (predator) hunts the gazelle (prey).

Competition - two organisms compete over a common resource (food, territory, etc)


BASICS OF SYMBIOSIS

Not all interactions among organisms involve eating each other…

- ***Symbiosis*** **- organisms *living* together**
- **3 Types of symbiotic relationships**
  - **Mutualism**
  - **Commensalism**
  - **Parasitism**

Mutualism

- ***Mutualism*** **- benefits both organisms in relationship**

Bee and a flower
clownfish and anemone

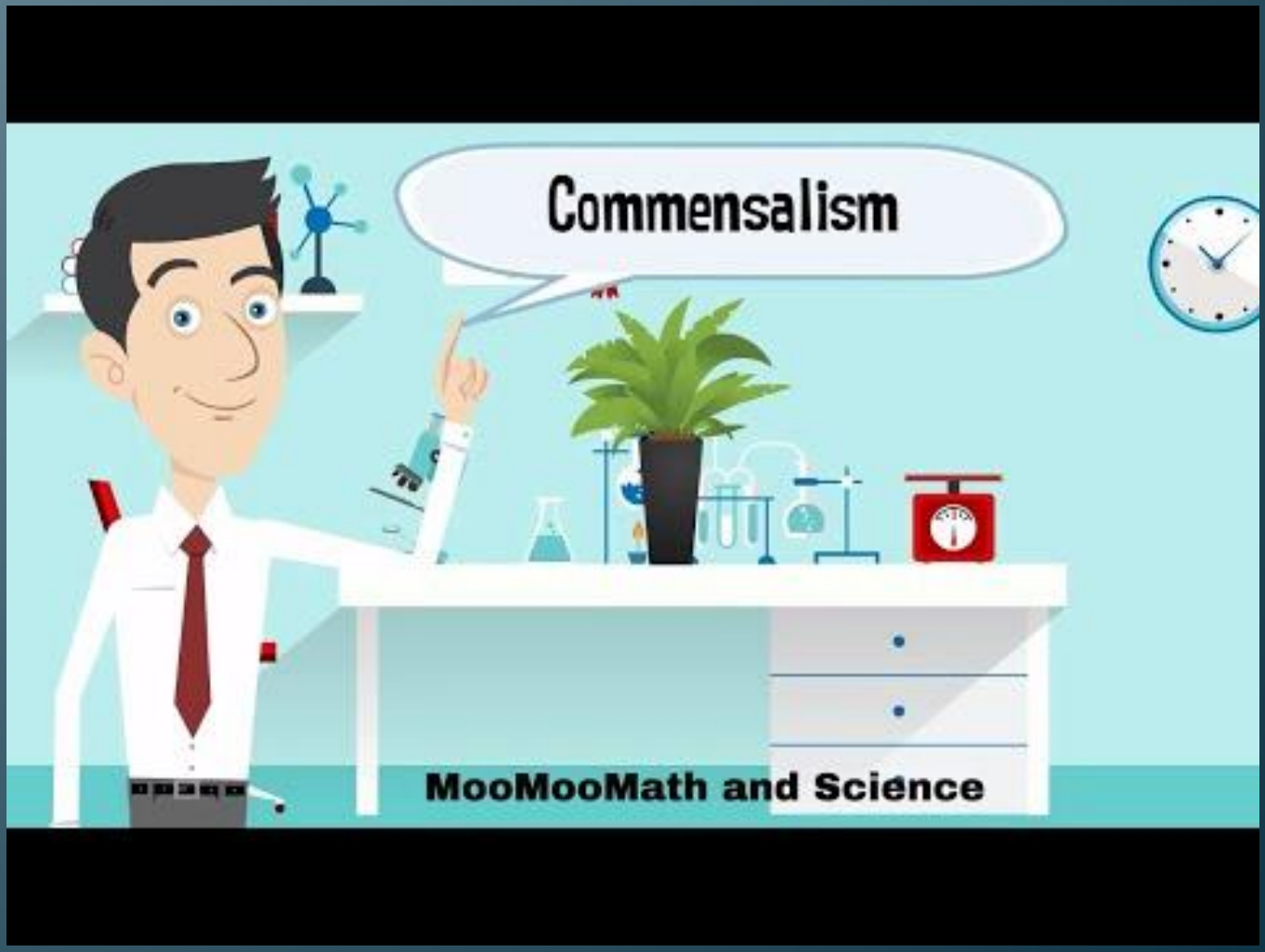
Mutualism

Commensalism

- ***Commensalism*** **= one organism benefits and the other is unaffected**

Whale and barnacles
Ungulate and Egret

Commensalism



Parasitism

- ***Parasitism*** **- one organism benefits and the other is harmed**
  - **PARASITES (like viruses) don't *immediately* kill host… use it first – sometimes kill it later!**

Guinea Worm (nematode) and fish
Tick and host
Mosquito and host
Hookworm and host

Parasitism

ORGANISM INTERACTIONS

- Communication within society using pheromones-bees, ants, and wasps!
  - Ex. Ants use pheromones to determine family members, to summon for attack/defense, and even to warn other ants when they are squashed
  - Ex. Bees use pheromones to communicate and maintain organization in their colony

ORGANISM INTERACTIONS

- *Courtship Dances* - animals sometimes have rituals (may be a dance, vocalization, or display of beauty/power) in order to select a reproductive partner

ORGANISM INTERACTIONS

- *Territorial Defense*-animals may defend their territory against other organisms, in or outside of their species
  - Ex. Male fighting fish will build a nest and maintain that territory during breeding season, acting particularly defensive against other males

Organism SURVIVAL AND REPRODUCTIVE SUCCESS

SURVIVAL AND REPRODUCTIVE SUCCESS

- *Adaptation* - Any trait an organism acquires over time that helps it survive in its environment
- Can be structural, behavioral, or reproductive
  - *Structural* - Physical features an organism has that help it survive
  - *Behavioral* - Something an organism does to help it survive
  - *Reproductive* - An organism chooses the “correct mate” to reproduce and raise offspring



ADAPTATIONS

- *Transport and Excretion* - Organisms maintain balance; move nutrients into cells and waste out
- In plants: Vascular and nonvascular

Vascular Plants	Nonvascular Plants
Vascular tissue contains special cells for transport of water and nutrients	Lack of roots and stems means plants must take water directly through their cells
	

ADAPTATIONS

- *Respiration*-organisms take in and release gases (we will discuss more later)
- *Nutrition*-feeding adaptations that allow organisms to get nutrition

Autotrophic	Heterotrophic
Organisms that gain energy through making their own food (ex. Plants)	Organisms that gain energy through eating their food (ex. Us!!)
	

ADAPTATIONS

- Reproduction, Growth, and Development-Organisms have adaptations to distribute their population

Sexual	Asexual
Reproduction involving sex (needs a male and female)	Reproduction without sex (can be 1 organism)

Example: Seeds have a hard protective coating that allows them to survive some harsh conditions; some are small/prickly to allow transport

BEHAVIORAL ADAPTATIONS

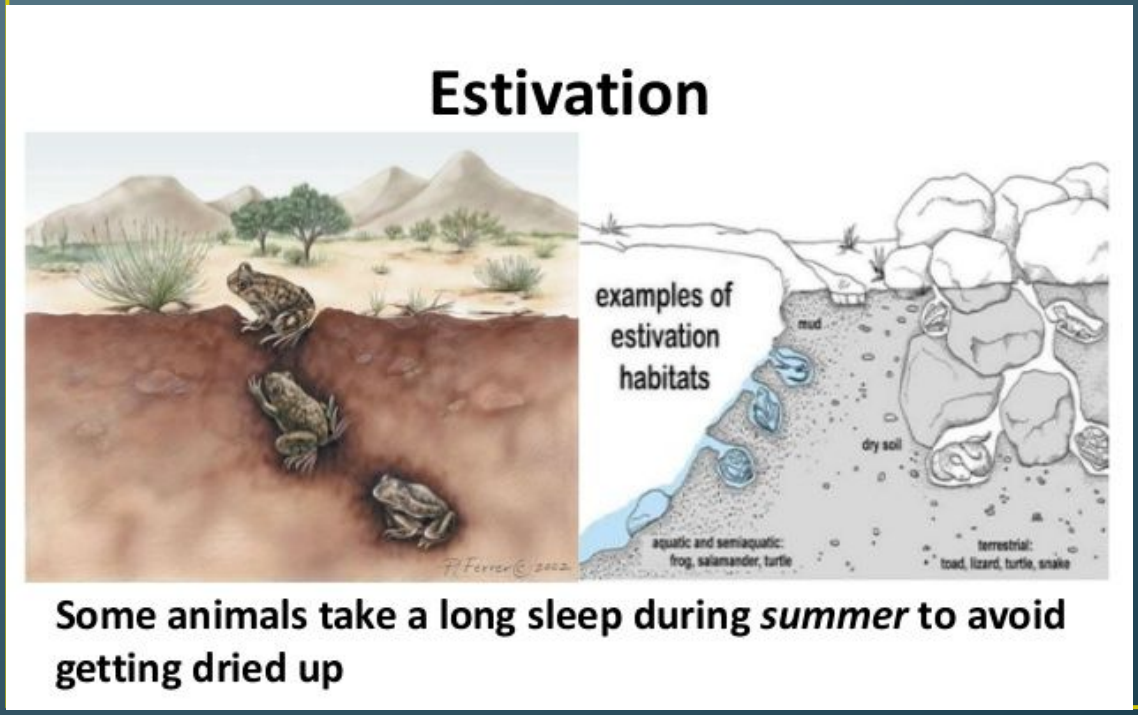
- Behavioral adaptations can be innate or learned
  - *Innate* - “hardwired;” you are born knowing how to do this
  - *Learned* - learned behavior either by interacting with the world or being taught!

INNATE BEHAVIORS

- *Suckling*-Babies are born knowing how to suckle; adaptation allows them to be nourished
- *Taxes/Taxis*-movement of an organism in response to a stimulus (ex. Light or food)
- *Migration*-seasonal movement of animals in response to resource availability

BEHAVIORS

- *Estivation* - dormancy during the warm season, some insects, amphibians and reptiles
- *Hibernation* - dormancy during the cold season

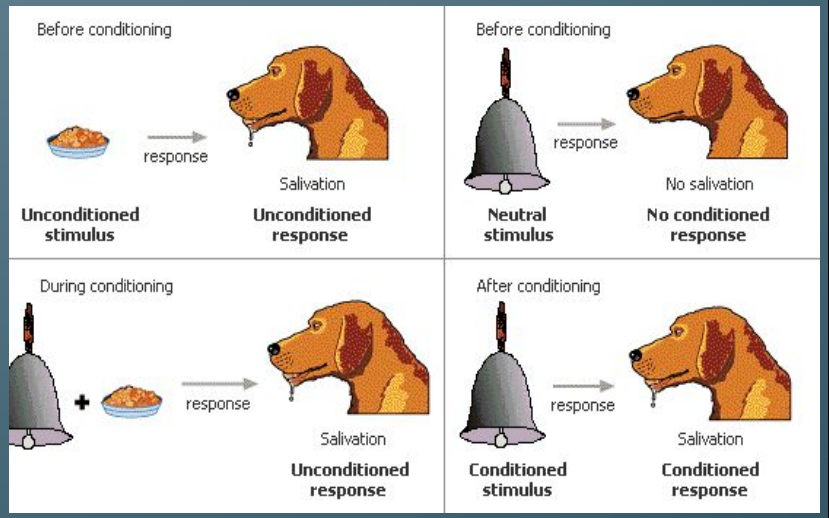


LEARNED BEHAVIORS

- *Habituation*-an animal stops responding to a stimulus after too much exposure
- *Imprinting*-Baby recognizes something as parent/object of trust

LEARNED BEHAVIORS

- *Classical conditioning*-Learning a new behavior through association (ex. Pavlov's dog)



LEARNED BEHAVIORS

- Video Examples from Modern TV Show: Big Bang Theory

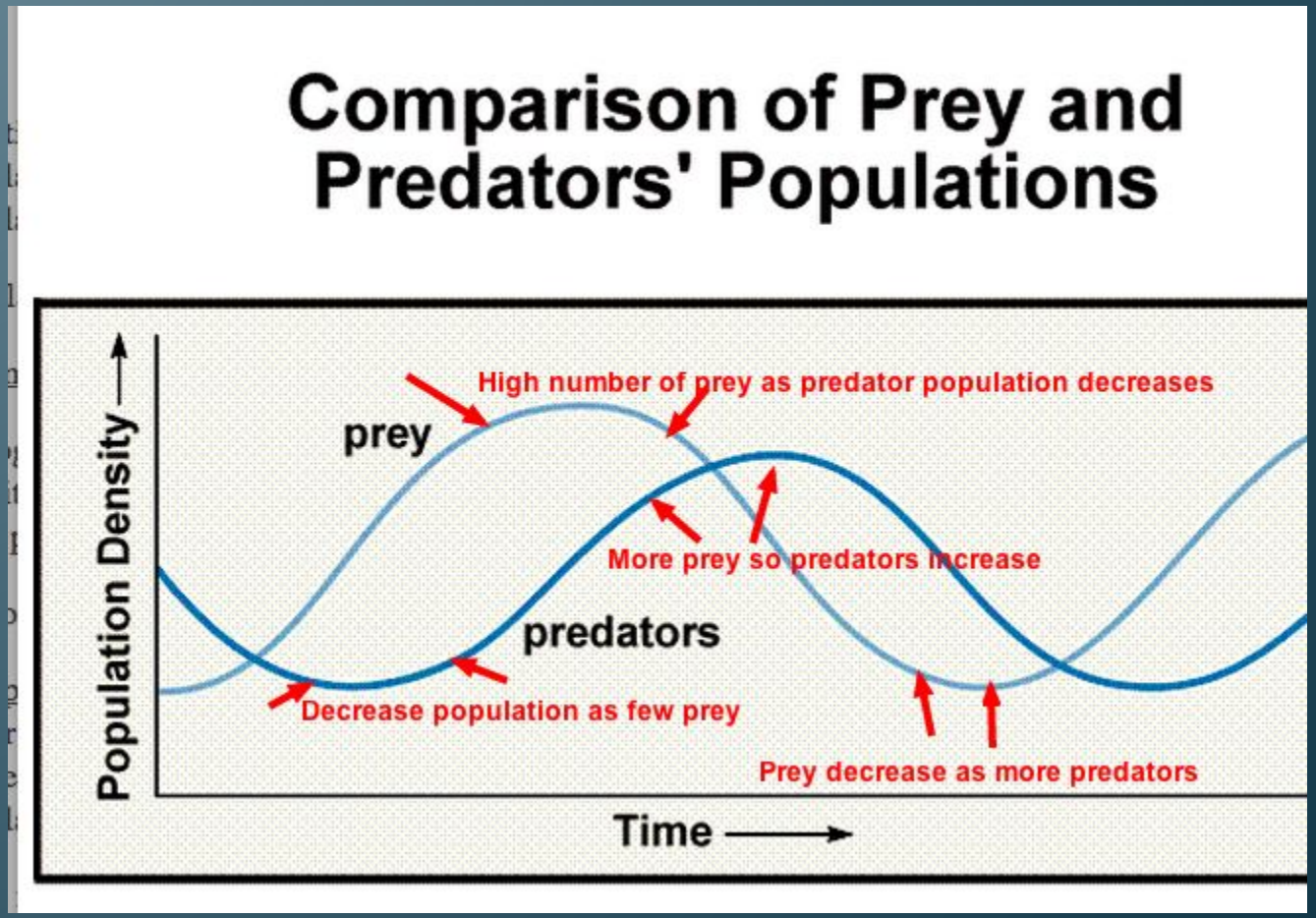
LEARNED BEHAVIORS

- *Trial and Error* - Animal associates behaviors with the consequences they produce

Work with a partner…..obtain an organism...answer the following in google slides, 4 slides ***minimum***

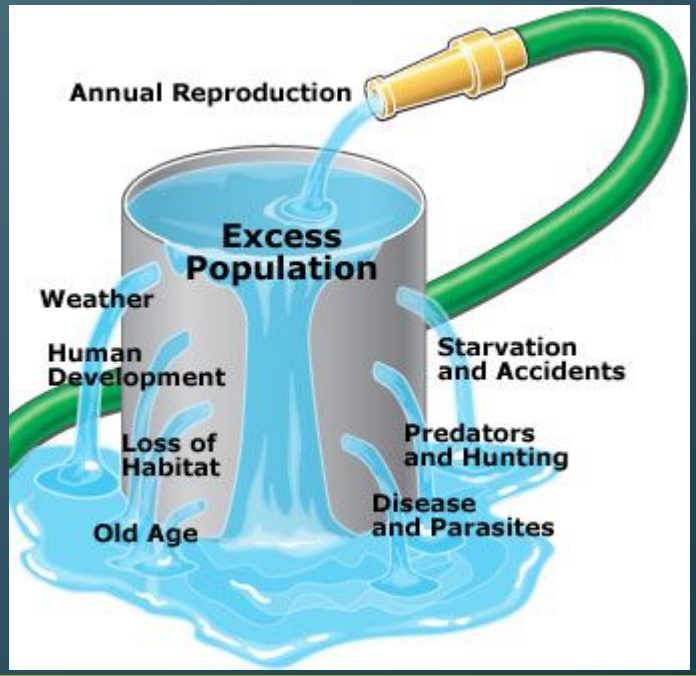
- Slide 1 - Title slide/group members names/image of your organism
- Slide 2 - What does your organism have to survive? *physical characteristics, be specific (elaborate)*
- Slide 3 - What traits does your organism have to survive? *the different innate/learned behaviors/adaptations, special features*
- Slide 4 - How does your organism reproduce to survive? *(sexual or asexual, how do they choose a mate, is that mate for life, what is their gestation period, how many offspring are born, how long do they stay with their young, which organism is responsible for them etc)*

GRAPHING RELATIONSHIPS

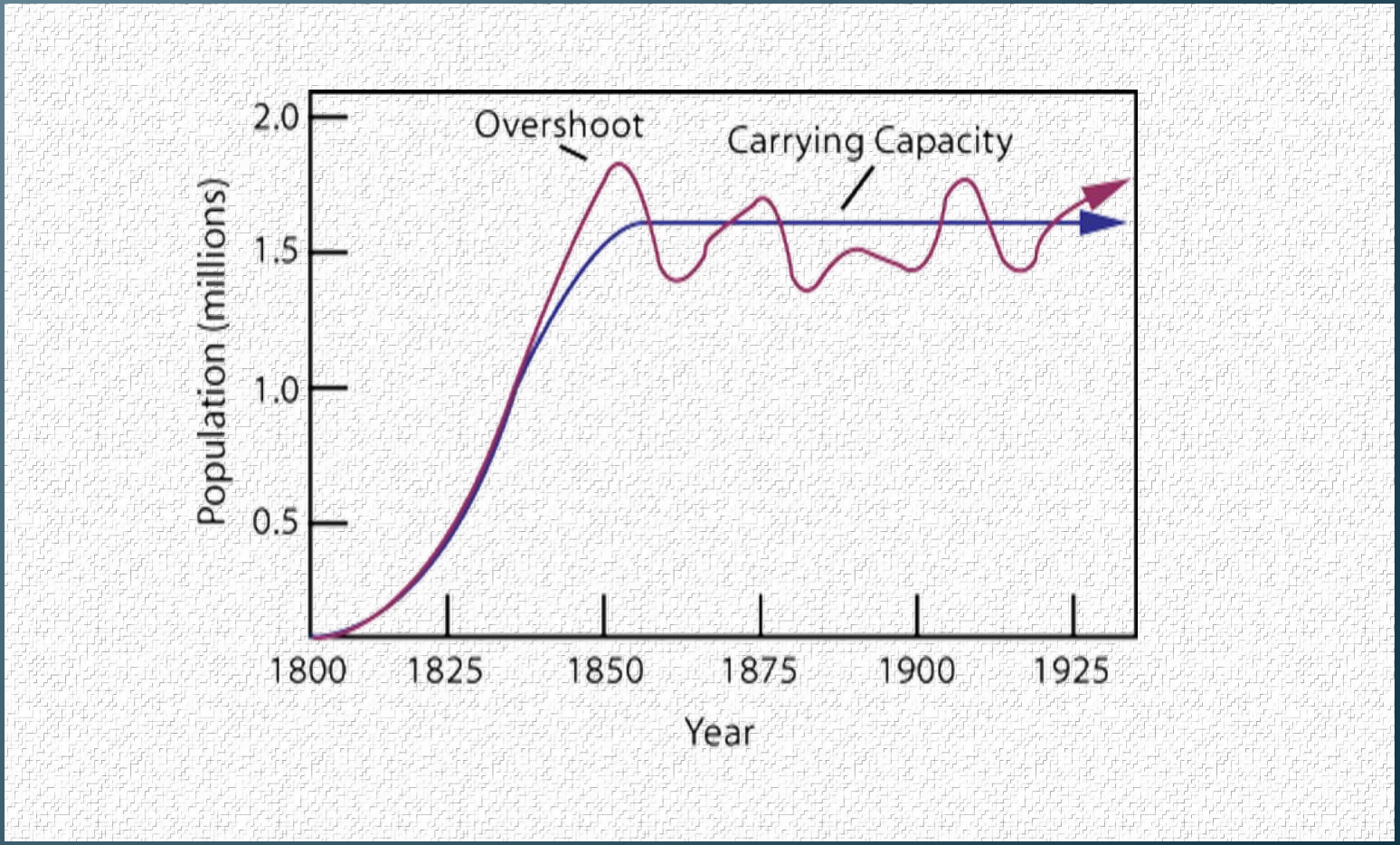


GRAPHING RELATIONSHIPS

- *Carrying capacity* - the maximum population size an ecosystem can hold
  - Based on limiting factors like food, climate, water, territory
- Predator/Prey relations can help maintain stability

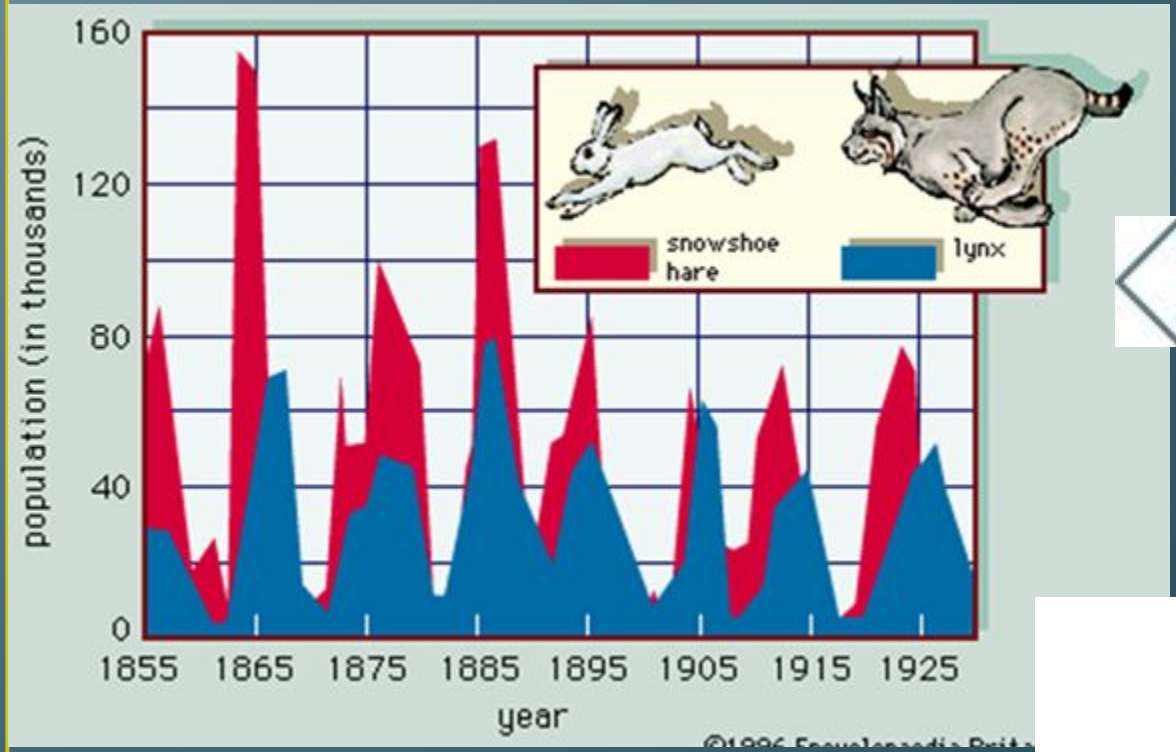


PREDATOR/PREY RELATIONSHIPS



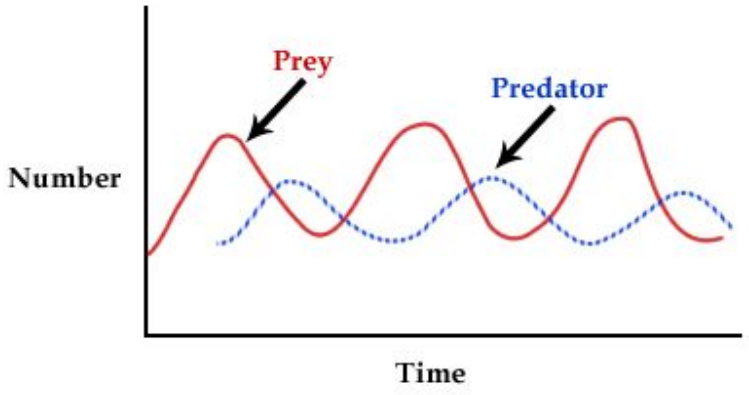
What is happening in this graph?

Predator/Prey Relationships

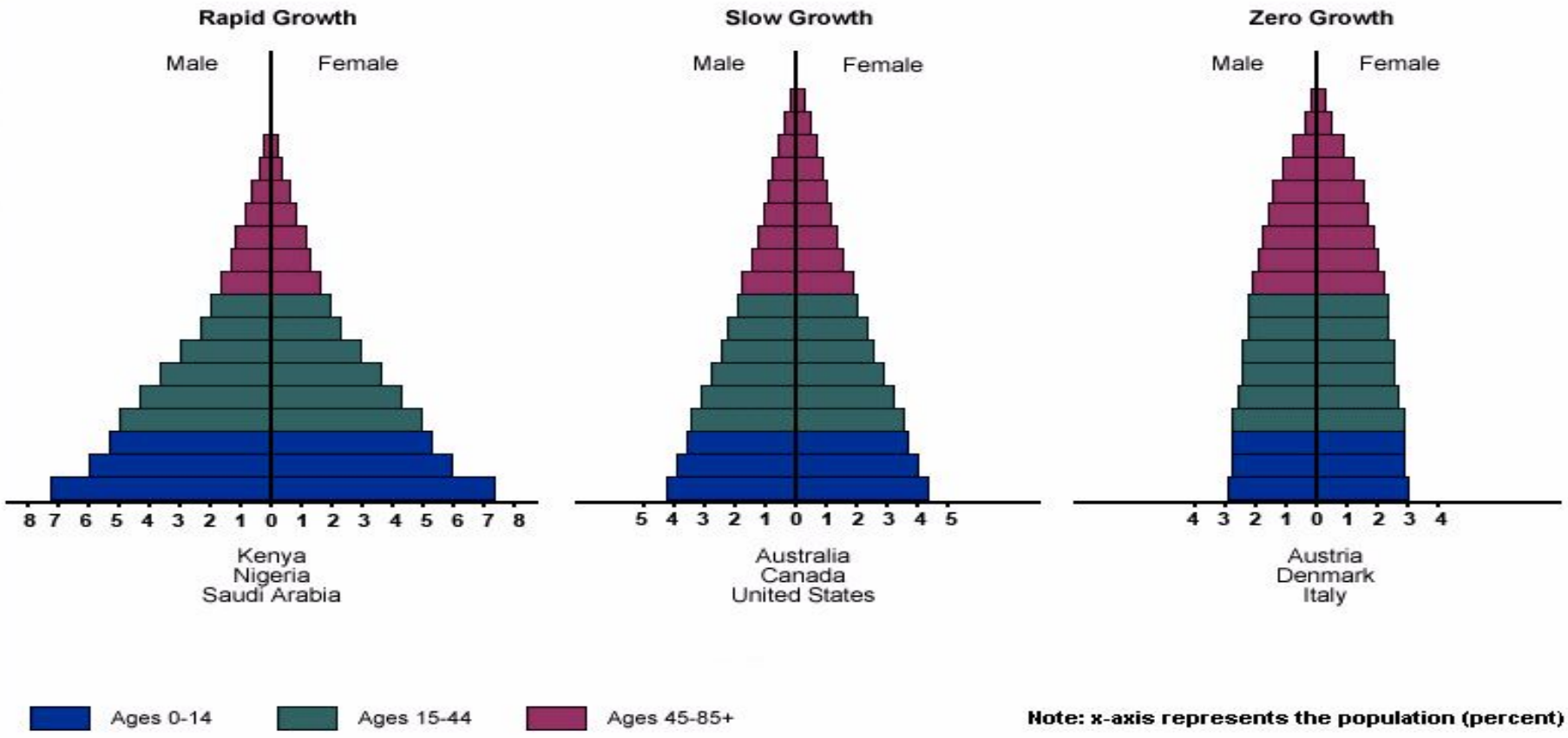


What happens to prey populations as predator population increases?

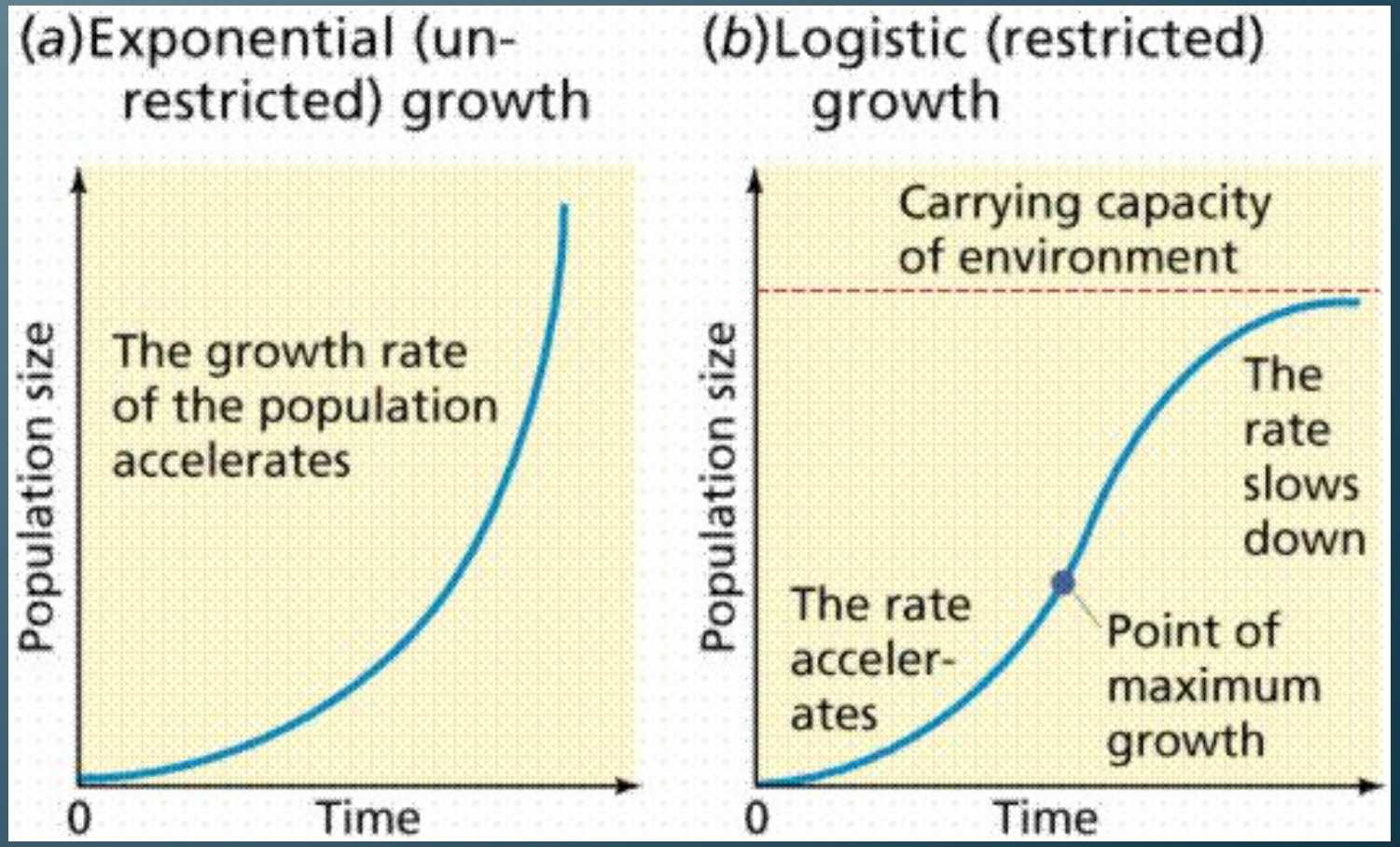
How about when they decrease?



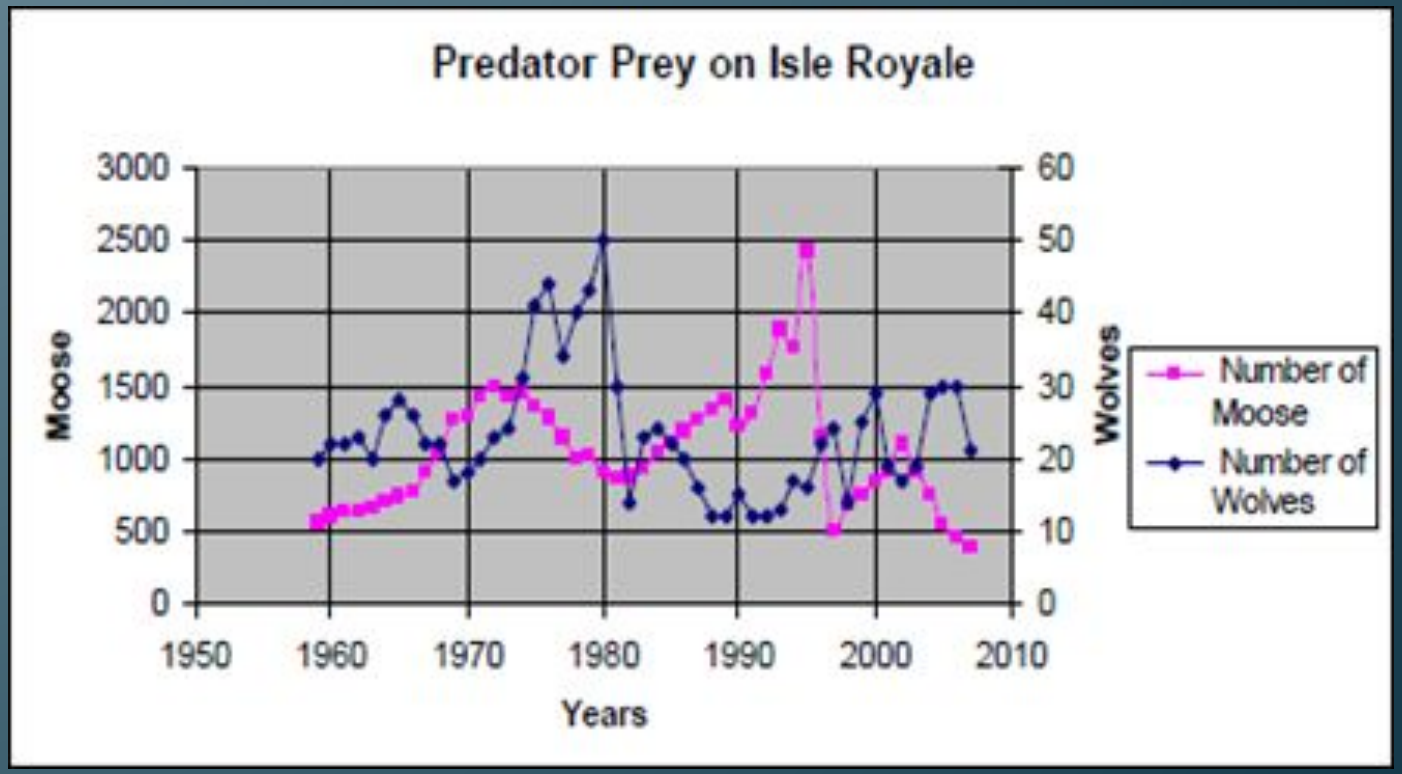
POPULATION GRAPHS



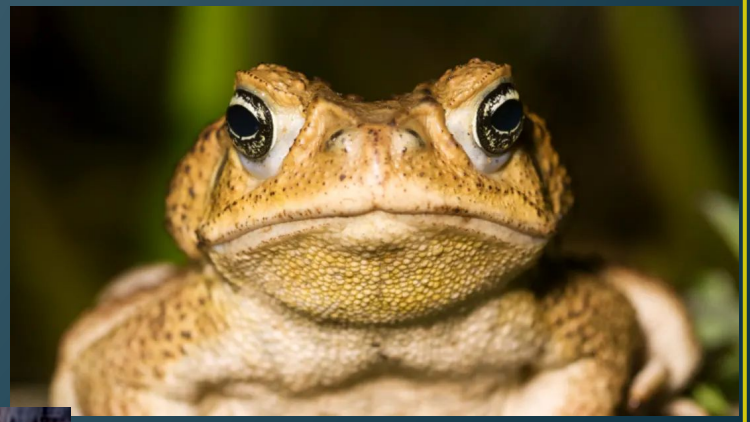
POPULATION GRAPHS



Graph #3


Predator Prey on Isle Royale
Moose
Wolves
3000
2500
2000
1500
1000
500
0
60
50
40
30
20
10
0
1950
1960
1970
1980
1990
2000
2010
Years
Number of Moose
Number of Wolves

HUMAN IMPACT

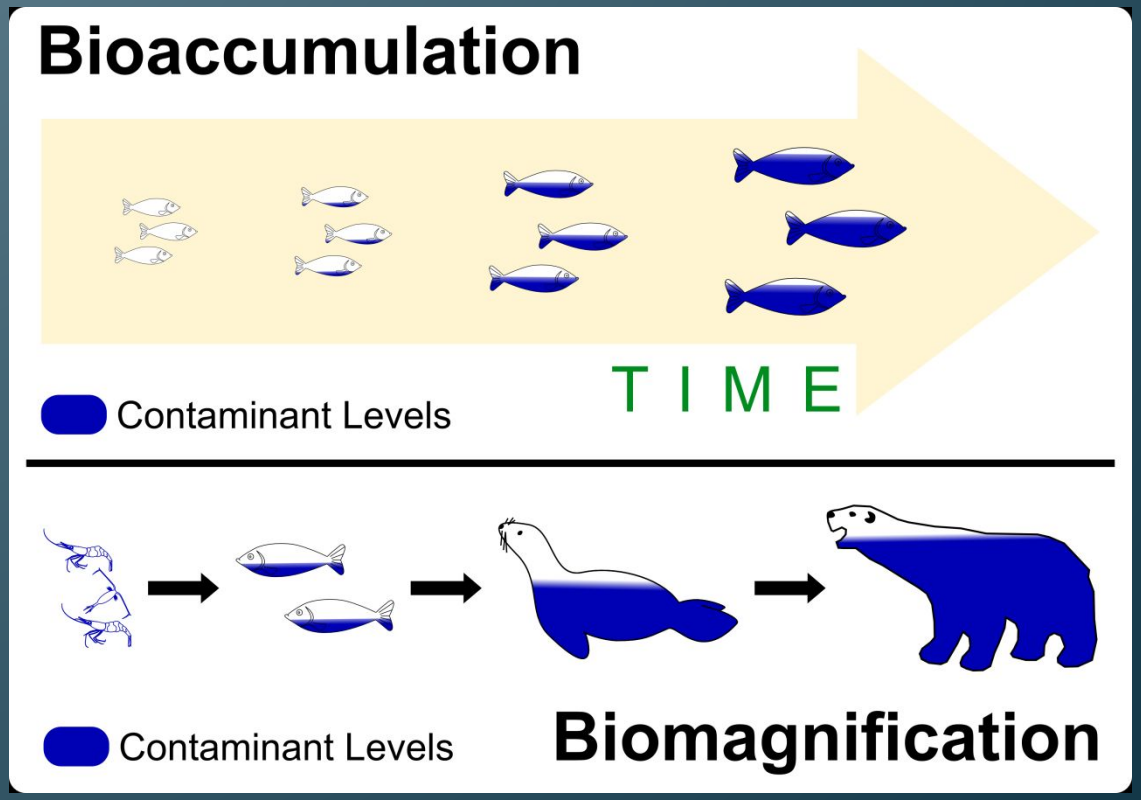


HUMAN IMPACT

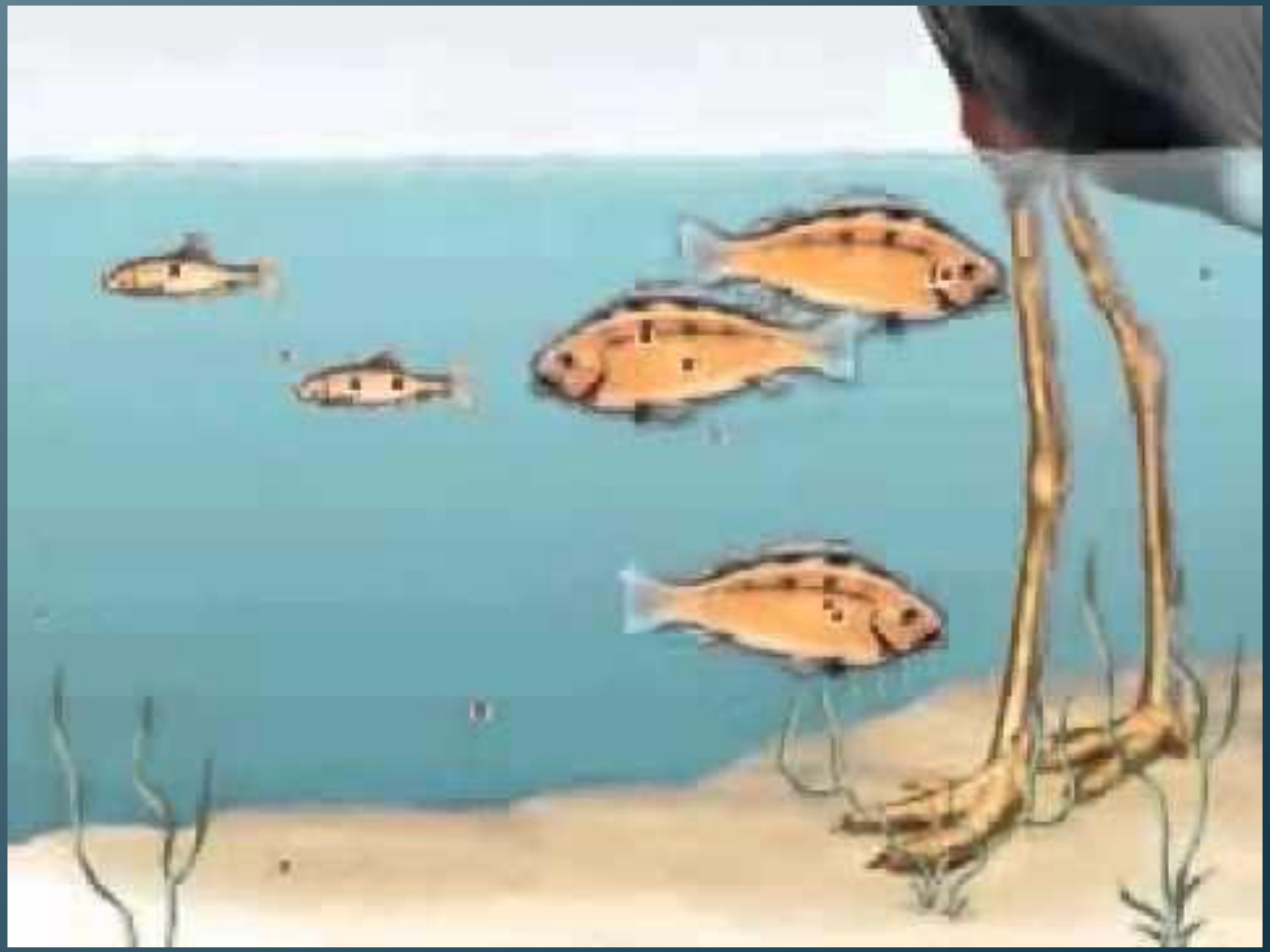
- Humans have a large impact on ecosystems
  - Population growth has led to destruction of habitats
  - We use resources (trees, oil, coal, etc.)
  - More humans = more waste
  - *Deforestation* - human removal of trees; increased CO_2 leading to global warming
  - Pesticide Use

HUMAN IMPACT

- *Bioaccumulation* - as pollutants move through a food chain, they tend to concentrate as they move from one level to the next



Bioaccumulation



Bioaccumulation

In 1972 the Environmental Protection Agency banned the use of DDT, (Dichlorodiphenyltrichlorethane) which was used as a insecticide and had adverse effects on the bird population.

The Brown Pelican, was added to the endangered species list, because of DDT.

The Brown Pelican eggs were unable to mature and hatch because of the DDT. It cause the eggs to be to soft.

Threatened → Endangered → Extinct

Threatened Species - still abundant in nature but declining rapidly, likely to become endangered soon

Endangered Species - so few individuals that the species could be gone all together

Extinct - No living members of the species still exist

FACTORS THAT IMPACT NC ECOSYSTEMS

- *Invasive species* - not a natural part of the ecosystem
  - Invasive species have no natural predators
  - Reproduce out of control!
  - Ex. The Kudzu Vine

Invasive species

FACTORS THAT IMPACT NC ECOSYSTEMS

- *Acid rain effects* - pollution can react with the atmosphere to produce acid rain; can affect many areas - destroy plant life
- *Beach erosion*
- *Urban development* in Piedmont - leads to habitat destruction
- *Waste lagoons* on hog farms-hog waste contaminates streams and drinking water

NC ECOSYSTEMS: Examining the Impact

Factor	Environmental Impact	Potential Solution
Invasive Species		
Beach Erosion		
Oil Use		
Agricultural Methods		

Essential Questions

UNDERSTAND AND BE ABLE TO EXPLAIN THE FOLLOWING CONCEPTS

1. How does carbon cycle through the atmosphere? What role to autotrophs and heterotrophs play in the cycle?
2. What human and natural influences can affect the level of carbon in the atmosphere?
3. How does nitrogen cycle through ecosystems? Explain the importance of nitrogen fixing bacteria.
4. Where does energy originate and how does is move through organism trophic levels? Explain the 10% rule in relation to the energy pyramid.
5. How do adaptations (such as transport and excretion, respiration, nutrition, and reproductive) aid organisms in survival success?
6. What is symbiosis? What three relationships fall under this category?
7. Explain the purpose of organism interactions, such as competition, communication, territorial defense, and courtship dances.
8. Explain the relationship between predators and their prey. What happens to the prey population when there is an abundance of predators? A lack of predators? Be able to analyze a predator/prey graph.
9. What is the difference between logistic and exponential growth?
10. Define carrying capacity. What are limiting factors? Be able to label and analyze the graphs.
11. How are ecosystem population affected by factors such as birth and death rates and disease?
12. How do factors, such as acid rain, deforestation, invasive species, and bioaccumulation, affect the ecosystems of North Carolina?
13. What steps can we as individuals and communities take to advocate conservation?