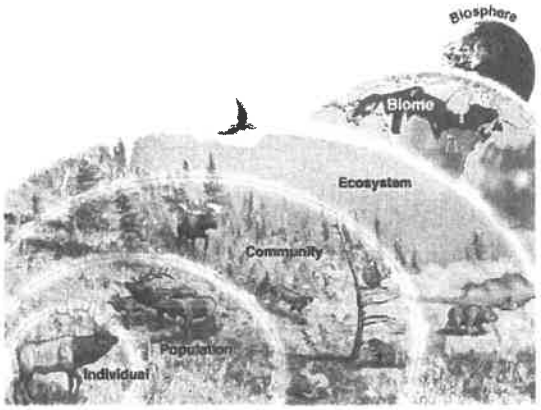
CLIMATE &

ECOSYSTEM DYMAMICS

INTRODUCTION TO ECOSYSTEMS

Ecology is...

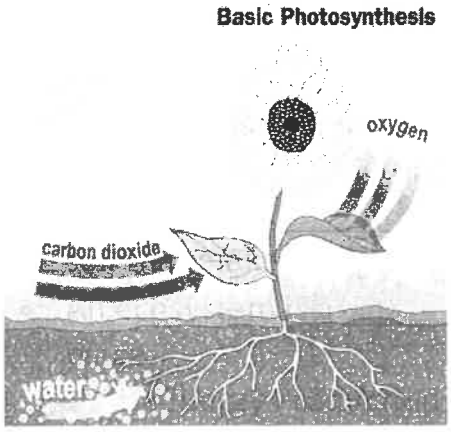
- the study of _____ among organisms with each other and with their _____



Ecosystem

- An _____ is made up of one or more communities living together in a specific area.
- Within a community, living things (called _____ factors) interact with other living things - but they also interact with _____ (non-living) factors too, such as the sun, the wind, water, and soil that make up the natural environment.
- An ecosystem is a _____unit. There are 4 processes that continually take place.
    1. Energy Production
    2. Energy Transfers
    3. Decomposition
    4. Recycling

1. Energy Production



- The "fuel" for ecosystems is energy from the _____.
- Sunlight is captured by green plants during _____.
- In order to photosynthesize, plants need _____ and _____.
- Water enters a plant via its roots while carbon dioxide enters via tiny holes in the underside of leaves.
- Photosynthesis produces: _____ and _____.
- Glucose is needed by the plant for energy.
- Plants change glucose into starch, fats, and proteins. These nutrients are then stored in the plant and available for consumers.

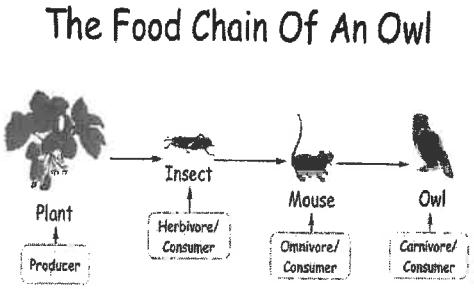
$$\underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} \xrightarrow{\text{Light}} \underset{\text{Sugar}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2}$$

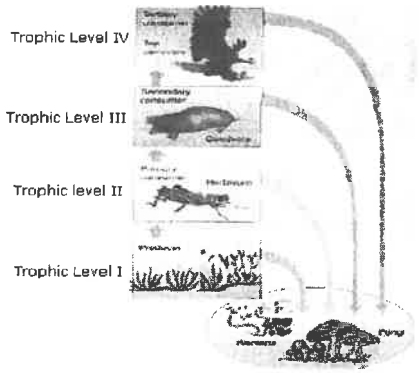
2. Energy Transfers

- Energy from plants is then transferred to the _____ (plant-eating animals) and _____ (plant and animal-eating animals) that eat them.
- The energy is transferred again to the _____ (animals that eat other animals).
- Energy transfers can be shown through the use of:
  - _____: show the flow of energy in an ecosystem.
  - _____: represent interconnected food chains.
  - _____: show the changes in available energy from one trophic level to another.

Food Chains

- Because green plants convert the sun's energy into chemical energy, they are called _____.
- Animals that eat producers are _____ _____.
- Animals that eat primary consumers are _____ _____, and so on.



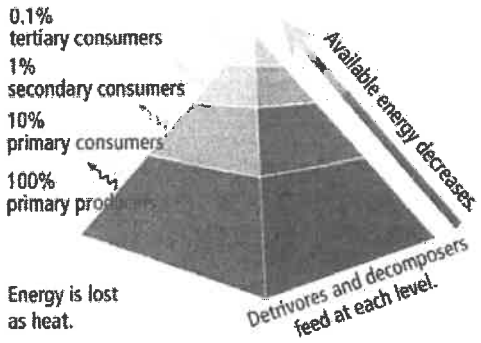


- We need to think of ecosystems as being made up of several feeding levels, called _____ levels.
- Producers make up the first trophic level, primary consumers the second, secondary consumers the third, and so on.

Food Webs

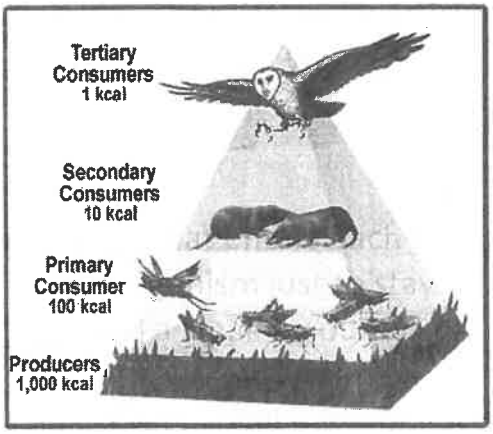
- Most organisms are part of _____ food chains.
- Arrows in a food web represent the _____ of _____ and nutrients.
- Following the arrows leads to the top consumers.

Energy Pyramids

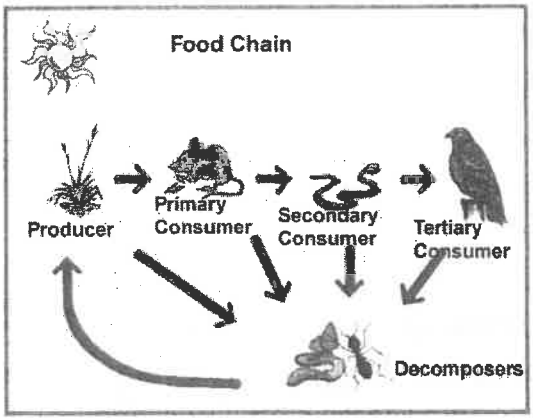


- Most of the energy that enters each trophic level is used by the organism just to stay _____ and a small amount is passed as _____.
- This leaves only a very small percentage (~ ___) to be stored as body tissues and it is this energy that gets passed on to the next _____ level.
- An _____ _____is a way to show how energy moves through a food chain.

- The _____ level of an organism identifies its _____ in the pyramid.
- The producers are on the bottom with the most energy.
- As you move ____ you will find _____ energy. Having less energy available means there will be a smaller number of organisms and a smaller overall biomass (total mass of all living things in a given area.



3. Decomposition



- When biotic things die, their bodies get consumed by _____ (ravens, ants) and _____ (earthworms, beetles, crabs) and are _____ (broken down) by microorganisms, fungi, and animals.
- Because decomposers can consume any living thing, they are said to occur at _____ _____.
- The chemicals from biotic things are _____to the soil and used again by plants.

4. Recycling

- Certain _____ and _____ are recycled within ecosystems, meaning they are never added or lost, simply used over and over again.

Interactions Within the Biotic Community

- **Biodiversity**
  : the number of different species in an ecosystem
  : the more _____ the ecosystem, the _____ it is
  : eg. a community of 300 members with 10 species is healthier than a community of 600 members with only 5 species
- many interactions occur between living organisms within ecosystem communities
- most relate to eating or are nutritional in nature
  = _____ _____ _____
- Ecologists use specific terms to describe these relationships between species
- in terms of these relationships:
  - the plus sign '+' indicates 1 species benefits
  - the negative sign '-' indicates 1 species does not benefit
  - the zero sign '0' indicates no effect

1. Predation (+,-)

- **predators** are animals which _____ _____ _____ on small animals
- -**prey** is an organism that a predator _____ _____ _____
- most predators kill their food and by doings so help control populations
  - eg. foxes kill rabbits & in doing so, limit the rabbit population, & other predators of rabbits
- some predators only feed on a part of their prey
  - eg. mosquitos hunt prey for their blood

2.Competition (-,-)

- involves 2 similar species which occupy the same _____competing for the same _____ (food, space ,sunlight, water, etc.)
- can result when food supplies become limited
- interspecies competition = **between members of different species**
- intraspecies competition = **between members of the same species**
- usually, the stronger animals get to food first or win fights for it
  - eg. - red-winged and yellow-headed blackbirds frequently compete for nest sites
    - plants may compete with each other for sunlight

3. Co-operation (+,+)

- results when animals form herds or packs and interact _____
- may take such forms as
  - hunting together (eg. wolves)
  - defensive purposes (eg. swallows swooping)

4. Mutualism (+,+)

- a relationship between two organisms where _____
  - ➢ eg. A humming bird obtains nectar from a flower & at the same time, the humming bird aids in pollinating the plant by carrying pollen from one flower to another
  - ➢ eg. A lichen is an alga & a fungus living together. The alga makes food that is used by the fungus. The fungus supplies water a habitat for the alga.

5. Parasitism (+,-)

- occurs when an organism lives_____ the surface, or _____the body, of another living organism called a _____without killing it
- the host provides food, protection, etc.
- parasites often weaken the host
- death of a host is not an advantage to a parasite as it would lose its "home" and food
  - ➢ eg. Beef tapeworms have stages in both cattle and humans. Tapeworms take away food and cause bleeding in the intestine.

6. Commensalism (+,0)

- exists when one kind of organism _____ while another is _____.
  - ➢ eg. crows feeding on the abandoned remains of kills made by wolves
    a bird nesting in a tree

***Symbiosis** = a relationship where two different kinds of organisms live close together or actually with each other

Mutualism, parasitism and commensalism are called _____relationships

DATE: NAME: CLASS:

CHAPTER 1
SCIENCE INQUIRY

BLM 1-9

Going with the Flow

Goal • Recognize the flow of energy in a food web.

What to Do

Answer each question in the space provided.

1. Consider the following food chain.

If the deer population increases, explain what could happen to

(a) the grass population

_____

_____

(b) the wolf population _____

_____

(c) The deer consumes grass in order to get energy to grow, keep warm, run, and live. Approximately 90 percent of the energy that the deer consumes is used for its daily functions. Only 10 percent is used to reproduce more deer. Complete the energy table below. Assume that the grass in this food chain contains 5000 kJ (kilojoules) of energy.

Organism	Energy available	Energy used in metabolism	Energy stored
grass	_____ kJ	_____ kJ	_____ kJ
deer	_____ kJ	_____ kJ	_____ kJ
wolf	_____ kJ	_____ kJ	_____ kJ

1. Place the following organisms into the correct order (in the boxes) for a food chain.
2. Identify each organism is a producer, consumer, or decompose
3. Indicate the trophic level of each
4. Note whether the organism is a herbivore, carnivore, top carnivore, or detrivore

a) Grasshopper, hawk, bacteria, grass, frog

Organism	Grass	Grasshopper	Frog	Hawk	Bacteria
Prod/Cons/Dec	Producer				
Trophic Level	1				
Herb/Carn/Top Carn/Detr	--------- (it's a producer)				

b) Snake, hawk, seeds, grasshopper, worms

Organism					
Prod/Cons/Dec					
Trophic Level					
Herb/Carn/Top Carn/Detr					

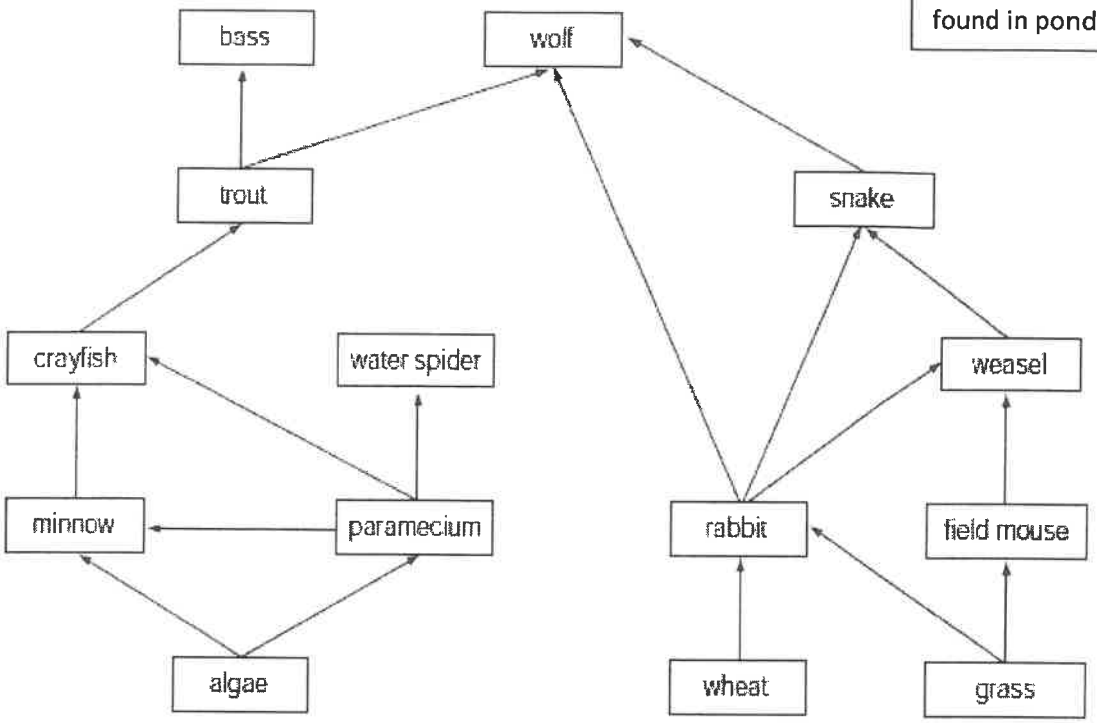
c) Algae, seal, herring, whale, bacteria

Organism					
Prod/Cons/Dec					
Trophic Level					
Herb/Carn/Top Carn/Detr					

What to Do

Study the diagram of feeding relationships. Then answer the questions that follow.

(FYI: A paramecium is a microscopic organism found in ponds)



1. What does the diagram show? _____
2. Which organisms are the producers? _____
3. Give an example of an aquatic herbivore. _____
4. Give an example of a terrestrial herbivore. _____
5. Which organism is the top carnivore in the terrestrial ecosystem? _____
6. Give an example of an organism in the second trophic level. _____
7. What is another term for "vegetarian organisms"? _____
8. In which trophic level is the snake? _____
9. Define the term "top carnivore." _____

   _____
10. Define the term "omnivore." _____

    _____
11. Which organism is clearly an omnivore? _____

12. Give 1 example of each of the following from the food web:

a) Predation: _____

b) Interspecies Competition: _____

c) Intraspecies Competition: _____

d) Co-operation: _____

13. How are Mutualism, Parasitism and Commensalism Similar? How are they different?

_____

_____

_____

Biological Magnification in Nature

Goal • Use this handout to become more aware of biological magnification in nature.

Introduction

Biological magnification occurs when toxic substances pass up through trophic levels. DDT is an insecticide that has been used since the 1940s. It provides an example of the serious effects of biological magnification.

DDT

DDT was used mostly in the tropics to kill the mosquitoes that spread the disease malaria. DDT was also used to kill the pests that feed on farm crops. Thus it helped to increase the yield of the crops. With more crops being harvested, more food was available to feed the people. One application of DDT was strong enough to work for a long time.

In the mid-1950s, the World Health Organization sprayed DDT on Borneo to try to control malaria. There were some unexpected effects of this spraying program:

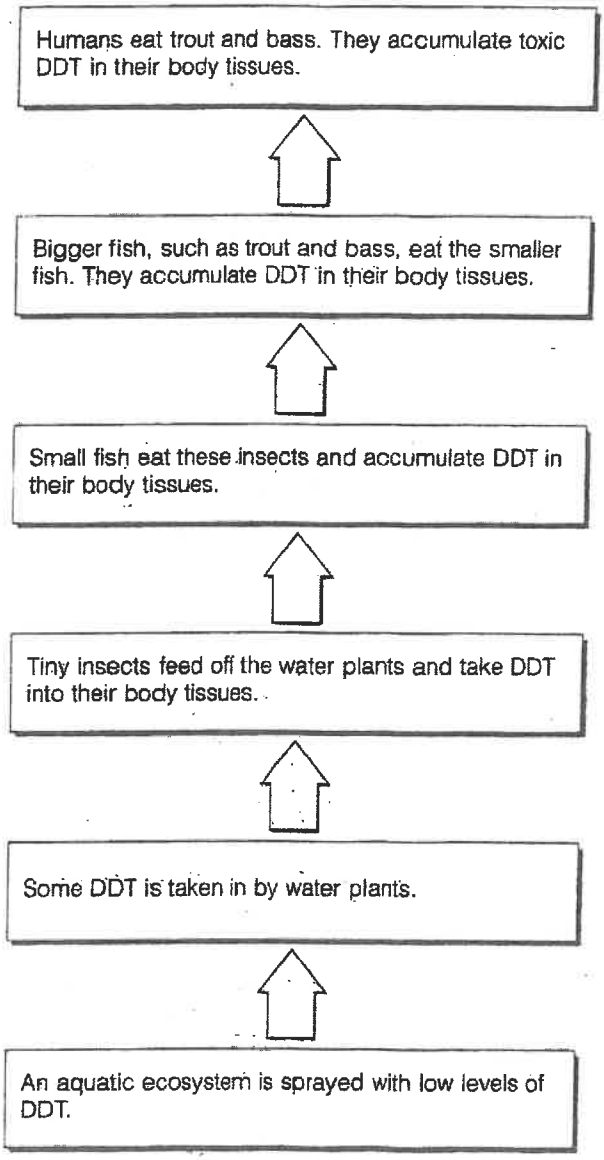
- The DDT killed a species of wasp. These wasps are natural predators of a species of caterpillar that feeds on the thatched roofs of houses. The caterpillars multiplied because they were not affected by the DDT and no longer eaten by their predator. They destroyed many roofs.
- Gecko lizards ate the poisoned insects. They were not affected by the pesticide, but DDT accumulated in their body tissues. Village cats ate the geckos and died. As a result, the rat population increased since there were fewer cats to keep it under control.

Biological Magnification

The process by which toxic substances accumulate in increasingly high concentrations in progressively higher trophic levels is called *biological magnification*. DDT and other substances that undergo biological magnification have two properties that make them dangerous:

- They are not biodegradable. This means that decomposer organisms cannot readily break them down into harmless substances.
- They are fat soluble (not water soluble). Therefore they can accumulate in the body tissues of animals, particularly in the fat. They are not broken down and excreted in watery urine.

Biological Magnification in an Aquatic Ecosystem



The DDT Story

The risks of using powerful pesticides in ecosystems first became widely known during the 1950s and 1960s, when the toxic effects of the insecticide DDT were recorded. DDT was one of the first and most powerful insecticides developed. During World War II, it was used to control populations of insects (such as body lice, fleas, and mosquitoes) that can transmit deadly diseases to people. As a result, the rate of death from malaria, bubonic plague, typhus, and yellow fever fell dramatically. DDT was also used widely on crops to control damage caused by insect pests.

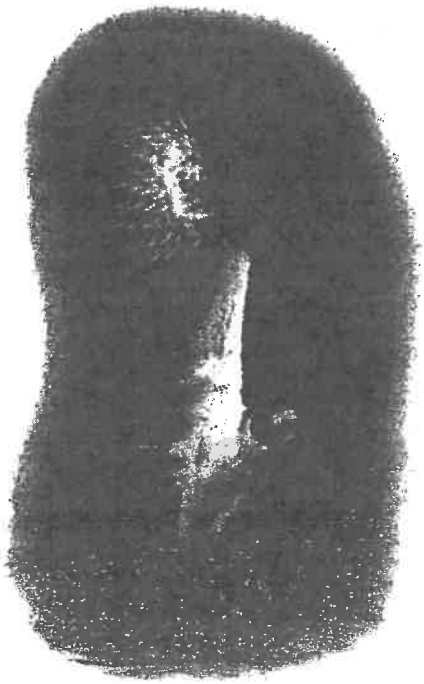
In 1962 biologist and writer Rachel Carson published a book entitled *Silent Spring*, which described how pesticides had spread through the environment. As a result of her scientific evidence and the demands from an alarmed public, the use of DDT was restricted in Canada after 1969.

Rachel Carson

About ten years after the first use of DDT, signs of trouble appeared. Dead birds, fish, frogs, and other animals were found in areas that had been heavily sprayed with DDT. The fat in their bodies contained high levels of the insecticide. Harmless or beneficial insects, such as butterflies and honeybees, also started to disappear from areas that had been sprayed.

Tests of soil and water showed that DDT remained in the environment for many years. For example, DDT was still found in the soil of some heavily sprayed orchards ten years after the spraying was stopped. DDT was also found in the bodies of many different organisms in areas around the world where the insecticide had never been used. It also began showing up in the tissues of people.

An unexpected outcome of using DDT was its effect on populations of birds of prey. Numbers of hawks, eagles, and ospreys on farmlands across North America and Europe fell sharply during the 1950s and 1960s. Scientists discovered that DDT reduced the ability of these birds to produce normal eggshells. Affected birds laid eggs with thin shells that broke in the nest, so they were unable to produce the usual number of young. The adult birds had accumulated DDT in their bodies from the fish they ate. The amount of DDT had accumulated in the bodies of organisms, moving from producers to primary consumers, to secondary consumers, and so on. This process is called **biological magnification**. Eventually concentrations of DDT became large enough in birds of prey to affect their reproduction. Unfortunately, DDT continues to be used in some tropical countries because it is such an effective pesticide. It not only affects species that live in these countries but also species that live elsewhere in the world, including people who consume food products imported from the tropics.



Pesticides can severely affect the reproduction of birds of prey, such as this osprey.

Math

One percent is equal to 10 000 000 ppb. What percent is 5200 ppb?

DidYouKnow?

DDT is the abbreviation for the chemical named dichlorodiphenyltrichloroethane. It was first made in 1874.

CONTINUED ▶

Analyze

1. How does DDT enter a food web?
2. Which organisms contain the most DDT?
3. At what trophic level are these species?
4. What is the relationship between the trophic level of an organism and the concentration of DDT in its body?
5. How many times greater is the concentration of DDT in the fish than in the seawater? How many times greater is it in the dolphins than in the seawater?
6. In your own words, explain why animals at the top of a food chain are particularly at risk from poisons in the environment.

Conclude and Apply

7. Use an example to explain how an animal living hundreds of kilometres from an area sprayed with DDT might get DDT in its body.
8. DDT is stored in body fat and remains toxic for many years. Explain why these characteristics are undesirable in a pesticide. What characteristics would you want in a pesticide to make it less harmful to non-pest organisms?

Extend Your Knowledge and Skills

9. After spraying crops with DDT for several years, farmers found that populations of insect pests rebounded. One reason was that the insects had developed resistance to the insecticide. Suggest another reason, based on what you know about populations, pyramids, predators, and competitors.
10. When Rachel Carson published her book about the effects of pesticides on food chains and people, she had many opponents. Use your local library and/or the Internet to research Rachel Carson. How did she present her ideas to the general public and the scientific community? What methods would you use to inform people of a threat to the environment? Why were Rachel Carson's ideas initially opposed?
11. The table below gives DDT levels, in parts per million (ppm), found in the eggs of three species of seabirds. The eggs were sampled from two different locations along Canada's east coast. Pesticide levels found in birds' eggs are a good indicator of pesticide levels in the environment. Study the data and answer the questions that follow.

DDT Level in Atlantic Seabird Eggs

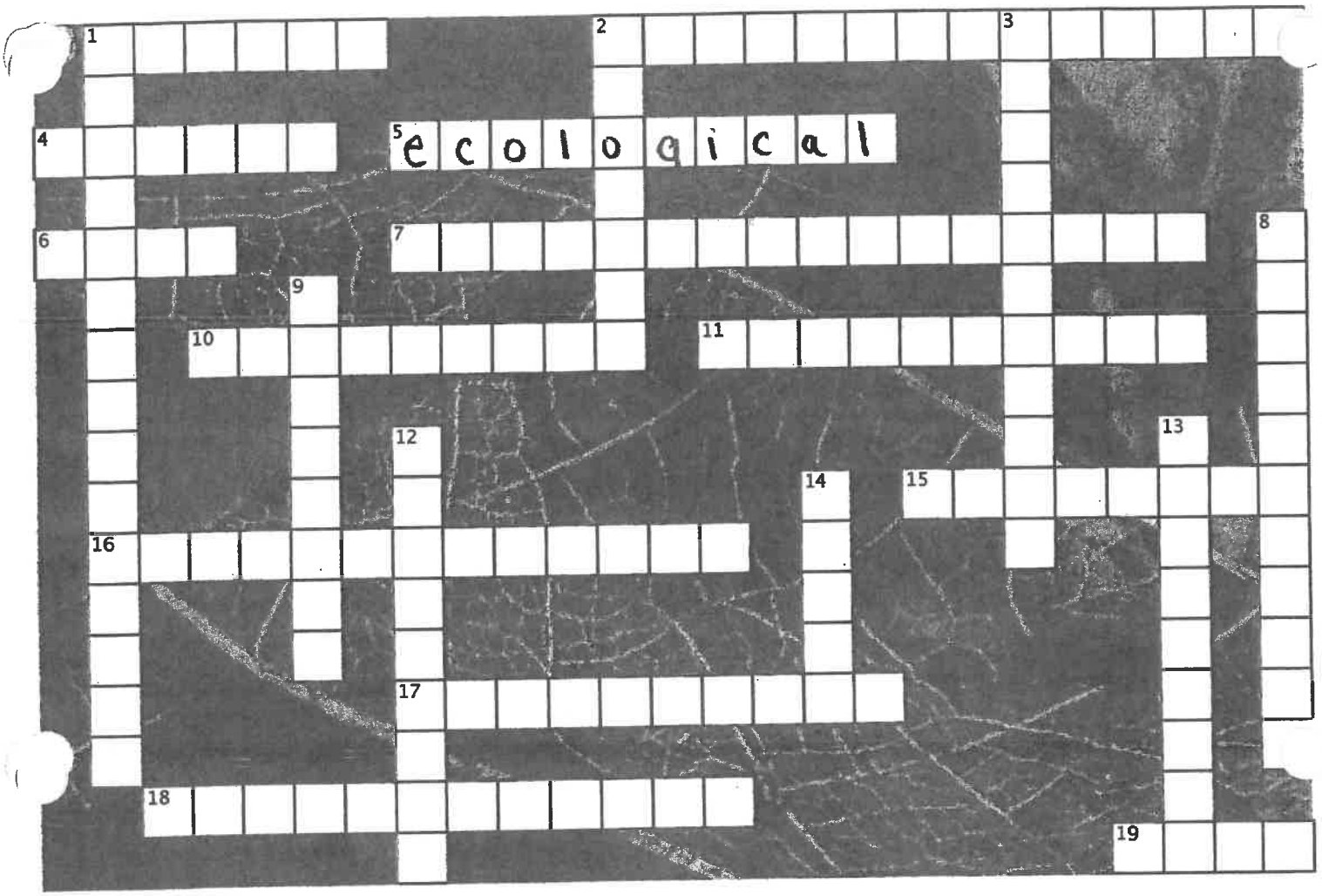
Species	Year	DDT Level in Eggs (ppm): Bay of Fundy	DDT Level in Eggs (ppm): Atlantic Ocean
Leach's Storm-Petrel (feeds on small organisms near the surface of the water)	1968	no data	1.46
	1972	6.81	2.48
	1976	1.75	0.75
	1980	1.13	0.46
	1984	1.05	0.40
Atlantic Puffin (feeds on small fish)	1968	no data	0.89
	1972	2.57	0.76
	1976	1.27	0.59
	1980	1.03	0.55
	1984	0.74	0.30
Double-crested Cormorant (feeds on larger fish)	1972	6.51	2.85
	1976	1.49	2.18
	1980	1.91	1.34
	1984	1.07	1.88

(a) Describe general differences in pesticide levels found in birds' eggs taken from the Bay of Fundy and from the Atlantic Ocean. Suggest a reason for the differences.

(b) Describe changes in pesticide levels between the late 1960s and early 1980s. What may account for the changes?

(c) Describe any differences in pesticide levels found in different species of seabirds. Suggest a reason for the differences.

2.1 Energy Flow In Ecosystems



Across

1. Food pyramids illustrate that most of the Sun's energy that is trapped by _____ flows out of an ecosystem.
2. The action of living organisms such as bacteria to break down dead organic matter.
4. The lower the trophic level, the _____ the number of organisms that can be supported by the ecosystem.
5. Food pyramids are often referred to as _____ pyramids.
6. Of these organisms, which would be at the top of the trophic level? hawk weasel rabbit grass
7. These obtain their energy by eating primary producers.
10. Plants are called _____ because they "produce" food in the form of carbohydrates during photosynthesis.
11. These consumers obtain their energy and nutrients by eating the bodies of small dead animals, dead plant matter, and animal wastes.
15. In the fourth trophic level are _____ consumers such as hawks and sea otters that feed on secondary consumers to obtain energy.
16. The breaking down of organic wastes and dead or[illegible]nisms.
[illegible] _____ such as grasshoppers, are primary consumers that [illegible]lants.
18. Each step in ~~food~~ chain is called a _____ .
19. Of the energy contained in a living organism 90% is used to survive or given off as _____ to the environment; 10% is left for the next trophic level.

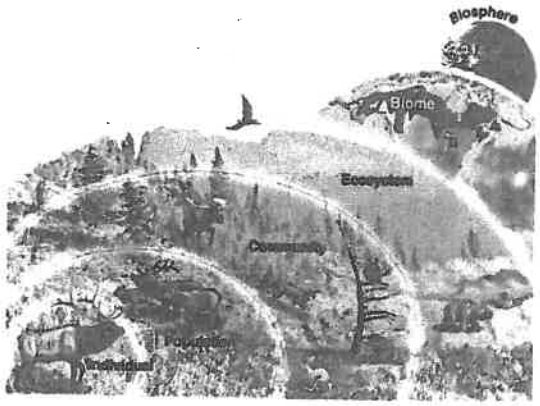
Down

1. Plants and algae are examples of a _____.
2. The total mass of living plants, animals, fungi, and bacteria in a given area.
3. These change wastes and dead organisms into usable nutrients.
8. A model that shows the loss of energy from one trophic level to another.
9. An insect such as a bee that feeds on a plant such as a sunflower is called a _____ .
12. A model that shows the flow of energy from plant to animal and from animal to animal.
13. A secondary consumer that eats primary consumers.
14. In aquatic food chains, _____ are primary producers that support marine life.

POPULATION ECOLOGY

What is a Population?

- _____
  _____



Population Characteristics

There are three characteristics that all populations have:

1) population _____,
2) spatial _____,
3) and _____ rate.

1. Population Density

- Refers to the number of individuals in relation to the space
- can be calculated as:

Example: What is the density of a rabbit population of 200 living in a 5 km^2 range?

Solution:

- Population density changes over time
- For populations that are studied over a period of years this change can be calculated

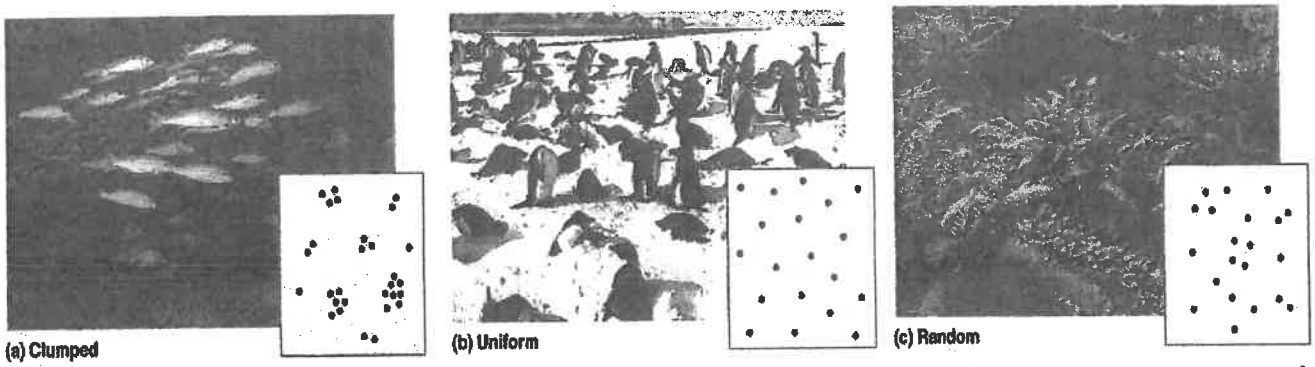
$$\text{Rate of Change} = \frac{\text{Change in Density}}{\text{Change in Time}}$$

Example: In 2000 the rabbit population density was 40 rabbits / km^2. By 2010 the rabbit population density was 112 rabbits /km^2. Calculate the Rate of Change.

Solution:

2. Spatial Distribution

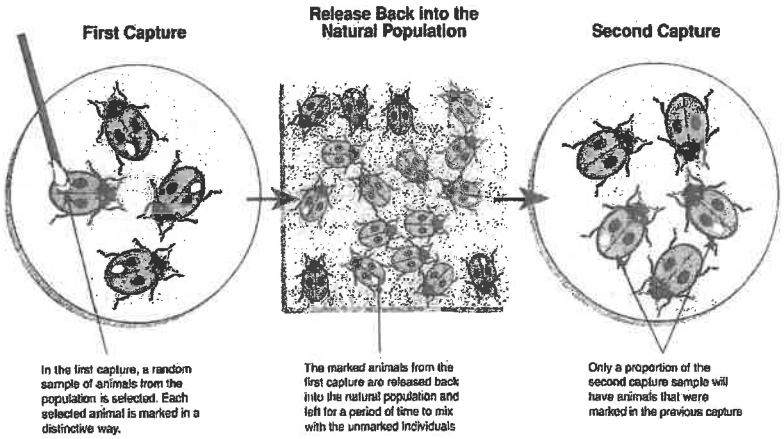
- Refers to the pattern of _____ of a population within an area
- 3 types: clumped, uniform, and random



- Results from dispersion – the _____ of organisms from one area to another
- Most often due to the _____ _____ (which may be limited to due to mountains, oceans, canopy level, or even behavior!)
- Population Estimation
  - ➢ When the number of organisms in a population is hard to count, scientists _____the total population size
  - ➢ They do this by first sampling the population and then calculating a population size based on the data
  - ➢ There are 2 main methods: Mark-Recapture and Random Sampling

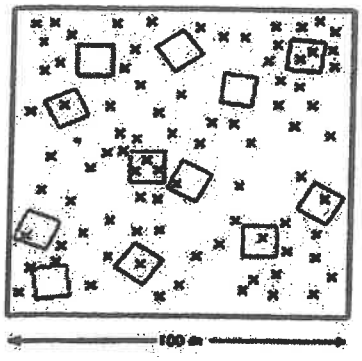
A. Mark Recapture Sampling

- Also called _____
- A sample of organisms is captured and _____ then returned unharmed to their environment
- Over time, the organisms are _____ & data is collected on how many are captured with marks



- Best for _____populations, such as fish and birds
- Problems occur when no marked organisms are captured

2. Random Sampling



- Also called _____ sampling
- The number of organisms within a _____area is counted.
- A sampling _____ (quadrat, usually $1m^2$) is used to count the individuals in a mathematical area
- The plots are often placed _____throughout the sampling area (or if a grid system is used, then plots are chosen at random).
- Population size & density are then estimated based on the plot representation.

- Best for_____ stationary populations, such as trees or coral
- Problems occur when random sampling is not followed

Population Worksheet

1. Calculate the area for the following dimension. The length of class room is 12.0 m whereas its width is 8.5 m.
2. If the student population is 12 students and 1 teacher, then calculate how much space does each person have in square meter/person.
3. How much space would each person have if the number of people in the class doubled?
4. Calculate the population density.
5. Perform and record the population density calculations for the prairie dog population. b) Calculate the rate of change in the prairie dog population for a) 1985-1995; b) 1985-2005; c) 1990-2000.

Year	# Prairie Dogs	Area (square meters)	Population Density
1985	10	10	1 prairie dog per square meter
1990	30	10	
1995	130	10	
2000	80	10	
2005	2	10	

Comparing populations

How many people live there?

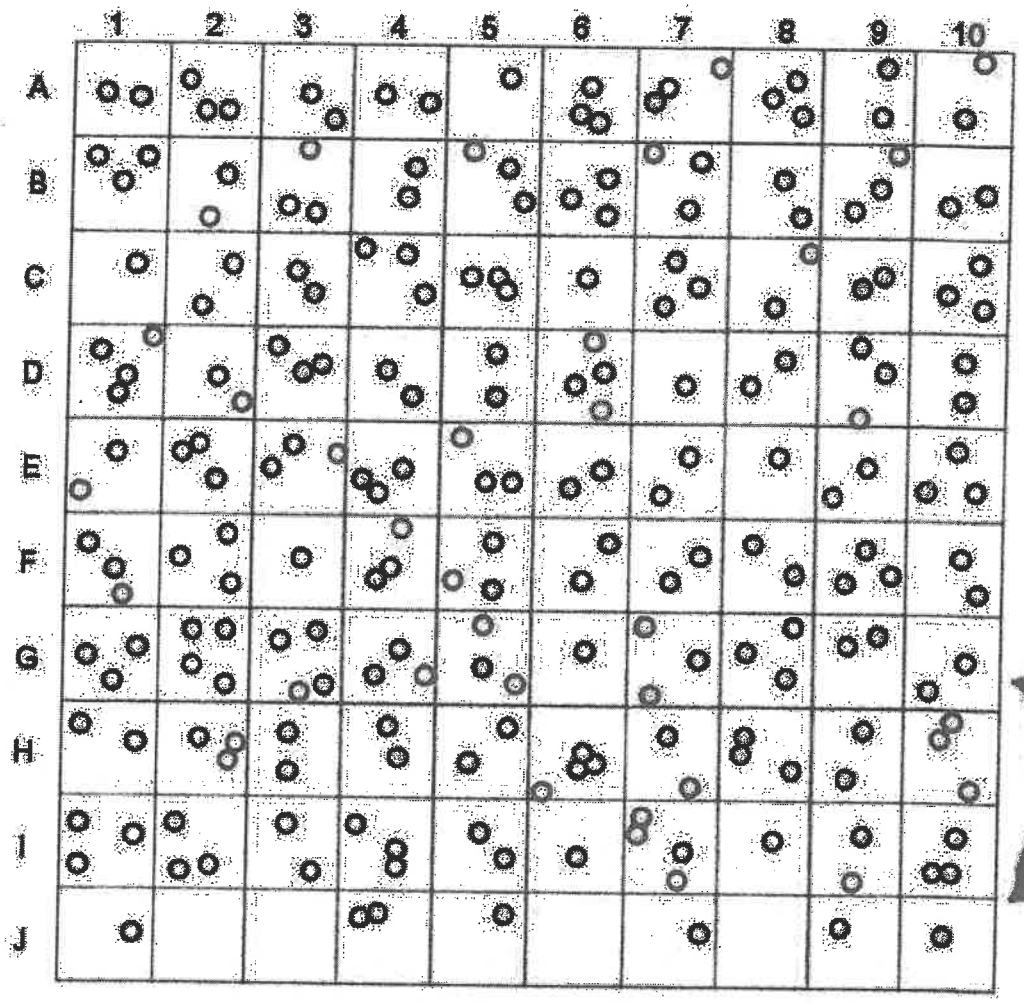
Population and dwelling counts	Clearwater County, Alberta	Shawinigan-Sud, Quebec
Population in 2001	11,505	11,544
Number of dwellings	4,649	5,198
Population density (per square km)	0.6	235.7
Land area (square km)	18,689.00	48.97

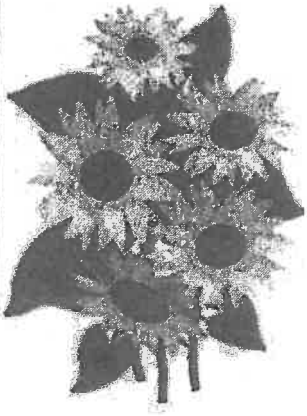
1. Which community has more dwellings?
2. Which community has a higher population density?
3. Which community has a larger land area?
4. _____ is a rural community.
5. _____ is an urban community.

Lab: Quadrat Sampling

Name:_____

In this lab activity we will simulate the quadrat sample method for determining population size. Below is a simulated field. Each filled in circle represents one individual sunflower plant. Assume that each square represents a 1 meter by 1 meter square.





Procedure:

1. Begin by randomly picking 5 squares and highlighting them and count the individuals within those 5 quadrats. Record you data on the table on the back
2. Choose 10 new squares, highlight them in a different colour and count the individuals inside those quadrats
3. Use a proportion to estimate the total population based on your two samples.
4. Calculate the population density using each sample.
5. Record your results in the data table.

Lab: Quadrat Sampling

Name:_____

Data Table

Number of Quadrats	Area of the samples (m^2)	Number of individuals within the quadrats	Estimation of the total population	Estimation of population density
5	5			
10	____			

6. Which one was more accurate, the first trial or the second on? Why?

7. What type of population distribution does this population appear to have?

8. How does the population distribution affect the number of quadrats that should be used to sample the population?

9. Do you think your results were accurate? Why or why not? What could make the estimation more accurate?

10. Give an example of a population where the quadrat method would ***not*** work

3. Population Growth

- Populations are not stagnant, they change over time
- 4 factors determine how a population changes:
  1. _____ (birth rate)
  2. _____ (death rate)
  3. _____ (individuals moving into a population)
  4. _____ (individuals moving out of a population)

Population change can be calculated as:

Example: Calculate the population change in a wolf pack where the wolves experience the birth of 3 pups, the death of a lone wolf, and 1 wolf leaving the pack. No animals moved into the pack.

Solution:

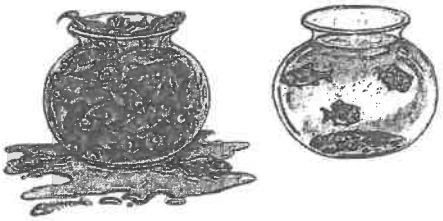
- Population growth rate refers to how_____a population grows
- It is expessed as a_____
- Population Growth Rate can be calculated as:

The pack originally had 15 wolves. What is the Population Growth Rate for this wolf pack?
Solution:

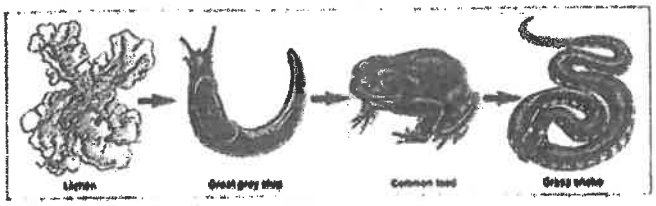
Carrying Capacity

- Is the number of organisms an ecosystem can support

There are 4 main factors which affect carrying capacity:



1. _____– Species require energy from the sun, water, and nutrients to survive.

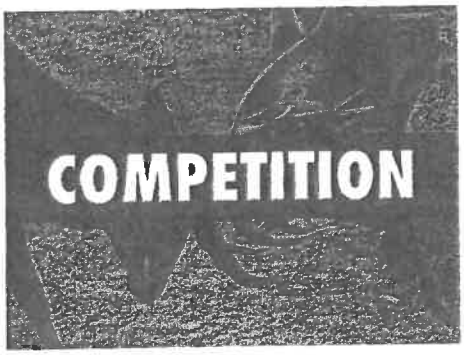


2. _____- All populations are limited by their source of energy. Interestingly, populations are also limited by their predators.

3. _____ – Individuals compete for resources such as food (animals), nutrients (plants), shelter, light, and water.

Competition occurs among members of the same species (_____ _____) and between species (_____ _____).

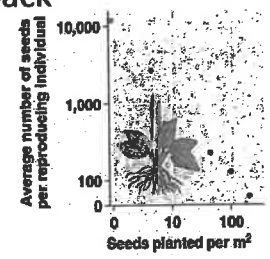
4. _____- Populations need space to live.
- Population health is often affected by its density.



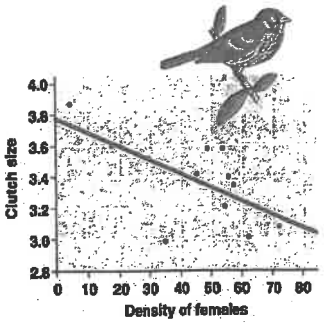
Density-Dependent Factors

- Factors that affect a population because of its density are called _____.
- E.g. Food supply, competition for mates, spread of disease. (usually _____ factors)
- Density-dependent factors _____ their effect on a population as population density increases. This is a type of _____ feedback.

Examples of Negative Feedback



(a) Plantain

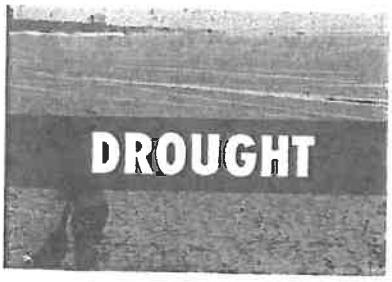


(b) Song sparrow

Resource limitation in crowded populations can stop population growth by _____ _____.

Density-Independent Factors

- Factors that affect a population regardless of its density are called _____.
- E.g. Forest fires, Flood, Habitat destruction, Pollution (usually _____ factors)



- Density-independent factors are _____ to population density, and there is no _____ to slow population growth.

Introduction to Populations - Worksheet

1. If an aquarium holds 80 L of water and contains 170 guppies, what is the approximate density of the guppy populations?
   a) 1 guppy / L
   b) 2 guppies / L
   c) 3 guppies / L
   d) 4 guppies / L

2. If 300 blue jays are found in a 20 hectare plot, what is the density in blue jays/hectare of that plot?
   a) 0.07
   b) 15
   c) 20
   d) 600

3. If 3400 maple trees are counted in a 3 km x 4 km rectangular patch of land, what is the density of maple trees per square kilometer?
   a) 283
   b) 1133
   c) 850
   d) 3400

4. Suppose the population density of sample of deer is 50 per square kilometer. Assuming that the population is uniformly distributed, what would the population size be if the deer encompassed an area that was 20 km x 200 km?
   a) 80
   b) 100
   c) 1000
   d) 200,000

5. Which is a density-independent factor?
   a) an intestinal parasite
   b) severe overcrowding
   c) a severe flood
   d) a fatal virus

6. Which limiting factor is dependent on the density of the population?
   a) dumping of toxic waste in a river
   b) contagious bacterial infection
   c) wide-spread drought
   d) forest fire

7. Match each description with the expected type of spatial distribution, where a = clumped, b = uniform, and c = random.
   ____herding animals
   ____territorial black bears
   ____fish that form schools
   ____mushrooms in a forest
   ____birds that flock together
   ____dandelions in a lawn

8. There are 252 deer in a population. There is no net immigration or emigration. If 32 deer die and 47 deer are born in one month, what is the population size at the end of the month?
   a) 15
   b) 252
   c) 267
   d) 331

9. There are 2,000 mice living in a field. If a 1,000 mice are born each month and 200 mice die each month, what would be the change in population over one year?
   a) 800
   b) 7600
   c) 9600
   d) 11,600

10. There are 19 frogs living in a swamp. In June, 2 frogs immigrate into the swamp while 3 frogs die due to predation. In July, 6 more frogs have been lost to predators and 2 have emigrated. How many frogs live in the swamp in August?
   a) 9
   b) 10
   c) 13
   d) 24

Working Towards Mastering the I Can Statements—Practice

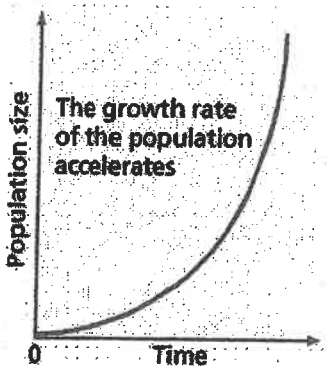
1. Read each situation in the chart below. Then, state if it is a density-independent limiting factor or a density-dependent limiting factor. Then, state the specific limiting factor that is occurring. The first one is done for you as an example.

Situation	Density-independent, or density-dependent?	Limiting Factor:
Mrs. Engelbrecht has 32 students assigned to her Biology class, but she only has room for 28. Because the room is so crowded, the extra 4 students leave the room to go to Guidance and have their schedules changed.	density-dependent	emigration
Northern pike (it's a fish) feed on another fish, the yellow perch. An increase in the yellow perch population causes an increase in the northern pike population.		
The BP oil spill in the Gulf of Mexico has harmed many aquatic organisms that live in the Gulf region.		
A new strain of influenza (the flu) breaks out in New York City.		
A population of rabbits and a population of deer are both feeding off the same plants in the same habitat.		
Hurricane Katrina forced thousands of people to leave New Orleans.		
65 million years ago, a large asteroid collided with the Earth. As a result, large amounts of ash were ejected into Earth's atmosphere.		
Due to humans putting increasing amount of greenhouse gases into the atmosphere and cutting down trees that would normally take up some of those gases, the Earth slowly gets warmer and changes climates around the globe.		

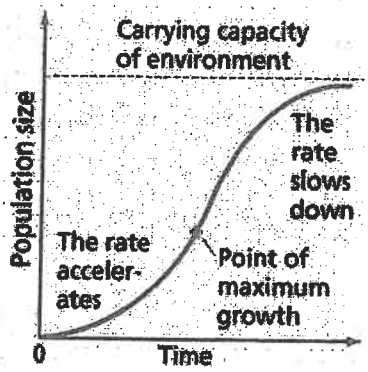
Population Growth Models

- There are two main types of population growth:

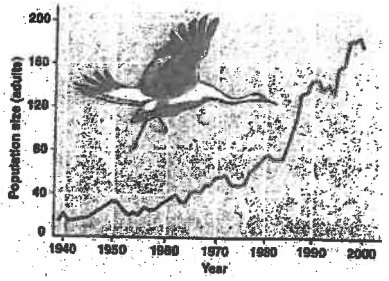
(a)Exponential (un-restricted) growth



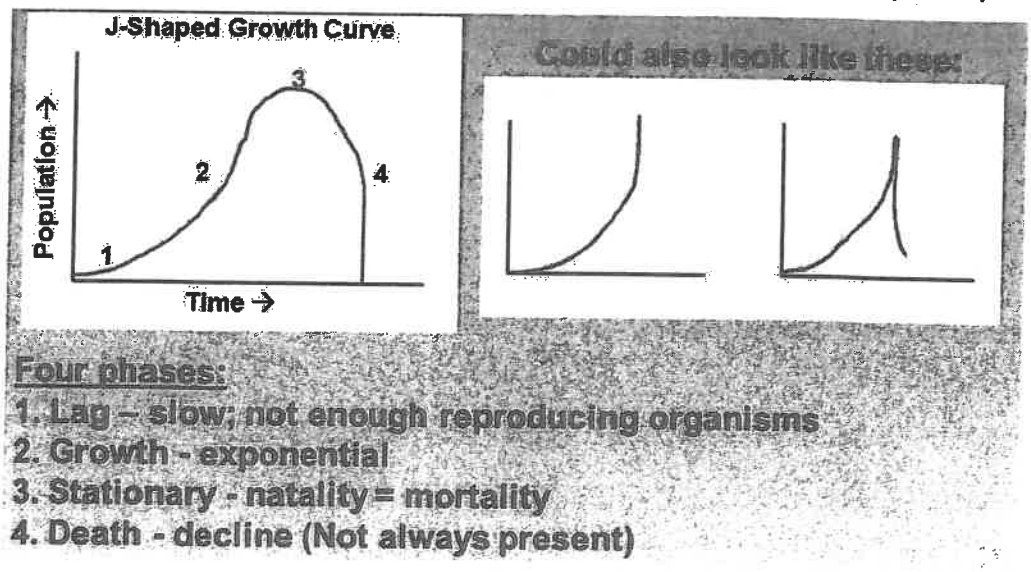
(b)Logistic (restricted) growth



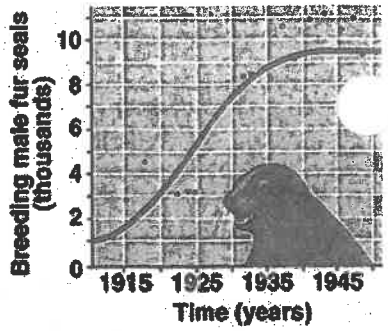
(a) Exponential Growth



- describes an idealized population in an _____environment
- J shaped curve
- Occurs as long as there is a plentiful _____ of the resources it needs
- When resources run out, the population _____
- Characteristic of_____ populations
  = affected by only _____ (game farm, biosphere)



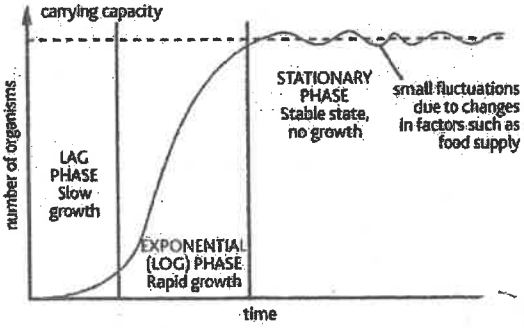
(b) Logistic Growth



- S shaped curve
- Typically, resources in an ecosystem are limited - _____ _____!
- This results in a maximum number of organisms that an ecosystem can support – called the _____ _____.
- The population will remain at this level as long as there is the same amount of resources.
- Characteristic of _____ populations = affected by all 4 growth factors (natality, mortality, immigration, emigration)

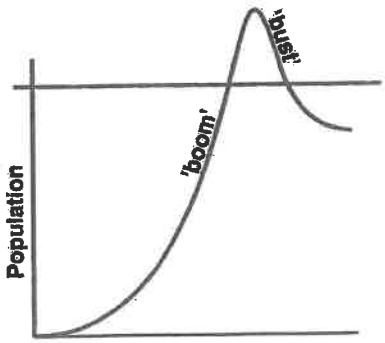
Carrying Capacity

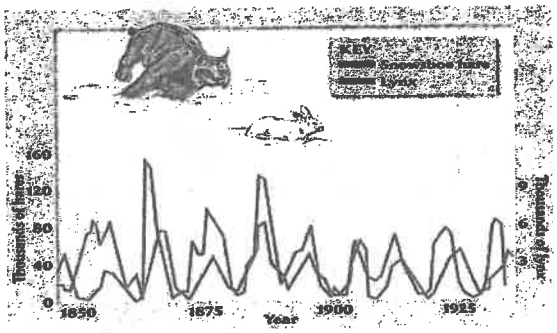
- If the number of organisms in a population is _____ the ecosystem's carrying capacity, births exceed deaths and the population _____.
- If the number of organisms rises _____ the carrying capacity, the _____ will exceed the _____. This pattern will continue until the population is once again at or under the carrying capacity.



Population Dynamics

- Population dynamics reflect a _____ interaction of biotic and abiotic influences.
- Carrying capacity can vary.
- Year-to-year data can be helpful in analyzing population growth.
- Some populations fluctuate erratically, based on many factors.
- Other populations have regular _____cycles.
- A good example involves the lynx and snowshoe hare that cycle on a ten year basis.





SNC2D

Population Problems

Name: _____

1. A biologist studied a population of box turtles in a wood lot for a period of 10 years. The average natality was 40 per year. The mortality was 30 per year. Immigration was 3 turtles per year, while emigration was 8 per year.

   (a) Was the population increasing or decreasing?
   (b) What was the net gain or loss of turtles per year?
   (c) If the original turtle population in the wood lot was 23 turtles, what was the population after 10 years?
   (d) What was the population growth rate per year?

2. On Sept. 10, 1989, biologists measured the squirrel population in a 20 hectare area. It was found that there were 84 squirrels. Two months later, on Nov. 10, the count in the same area was 50 squirrels.

   (a) Calculate the population density of squirrels (number per hectare)
   (b) Give 3 reasons why the population apparently declined in this two month period.

3. On a range of 1400 hectares, there is a population of 1280 rabbits. Studies show the following rates for this population:

Natality	— 2220 per year
Mortality	— 1130 per year
Immigration	— 200 per year
Emigration	— 430 per year

   (a) Is the population increasing or decreasing?
   (b) How much is the population changing each year?
   (c) What will the population be at the end of 4 years, if all rates shown above remain the same?
   (d) What will the population density be at the end of 4 years?

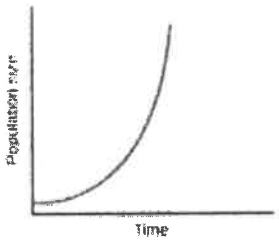
4. In a 25 hectare field in 1980, it was estimated that there was a total of 45 000 grasshoppers. Over a 8 year period, the following average rates of population change were found:

Natality	— 11 000 per year
Mortality	— 7 500 per year
Immigration	— 9 000 per year
Emigration	— 2 500 per year

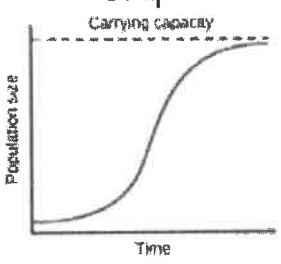
   (a) What was the grasshopper population density in 1980?
   (b) What was the population at the end of 8 years?
   (c) What was the population density at the end of 8 years?
   (d) What was likely to happen to the producers in this area over the 8 year period? Why?
   (e) Calculate the rate of change for the grasshopper population.

I. Population Biology

Graph A



Graph B



1. What type of population graph is shown in Graph A? Explain this type of growth.
2. Which graph shows the most likely growth of a squirrel population living in a forest?
3. Which graph shows a population's growth under ideal conditions?
4. Why don't populations of organisms grow indefinitely?

Use each of the terms below to complete the passage. They can only be used **once.**

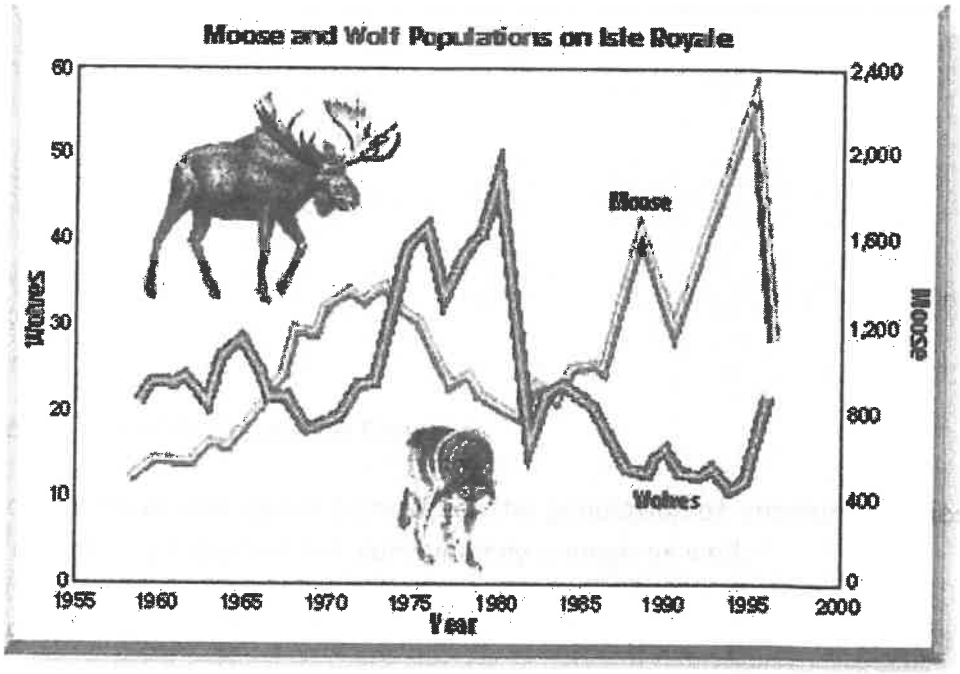
grows	**below**	**below**	**births**
above	**under**	**deaths**	**carrying capacity**

The number of organisms of one species that an environment can support is called its **(5)**_____. If the number of organisms in a population is **(6)**_____, the environment's carrying capacity, births **(7)** _____ deaths and the population **(8)**_____. If the number of organisms rises **(9)**_____ the carrying capacity of the environment, **(10)**_____ will exceed **(11)**_____. This pattern will continue until it is once again at or **(12)**_____ the carrying capacity.

II. Moose and Wolf Population Graph

As the population of one species changes, the population of another species that depends on the first species for survival may change as well.

Use the graph below to answer the questions below.



1. How did the Isle Royale wolf population change between 1977 and 1980?

2. How did the moose population change during that same period?

3. How did the wolf population change between 1986 and 1988?

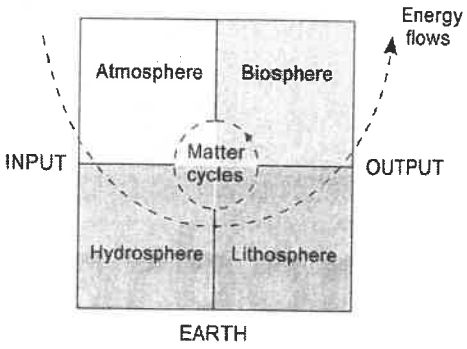
4. How did the moose population change during that same period?

5. What is one reason the moose population dropped between 1974 and 1981?

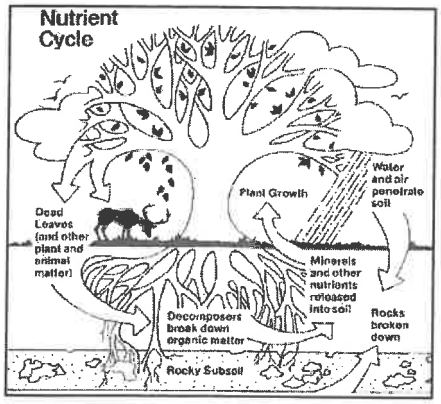
NUTRIENT CYCLES IN ECOSYSTEMS

Introduction

- The Earth is a _____ system.
- Energy _____ and _____ via radiation but matter does ____ enter or leave earth.
- In ecosystems, both energy and matter constantly circulate.



- Energy _____ through ecosystems while matter _____.



Nutrient Cycles

- A _____ _____ is the movement and exchange of matter throughout an ecosystem.
- A _____ is any substance needed by an organism for proper growth, repair, and function (i.e. C, N, P, O).

BIOSPHERE CYCLES

1. The biosphere operates as a closed system that contains only a finite amount of matter available for life, thus the materials are_____ over and over again.

2. Jean-Baptiste van Helmont is the first person to study the _____ Cycle. He experimented by growing a willow cutting in a pot containing 90.6 kg of soil and found that even though the cutting grew into a tree, the mass of soil in the pot was hardly _____.

3. The carbon-oxygen cycle is divided into two parts: _____ and _____.

4. Through photosynthesis, plants use some of the sun's energy to combine water and carbon dioxide into _____ _____ compounds as sugars or simple carbohydrates.

5. The carbohydrates (and oxygen) produced are used in the _____ _____ of all living things.

6. In cell respiration the _____ are reversed, thus carbon dioxide and water are produced and _____ is liberated to be used for all the organism's life activities.

7. The nutrients in soil come from various sources, the most important of which is the _____ of dead animal and plant matter by decomposers.

8. Decomposition releases _____into the soil and _____ into the air.

9. Phosphorus is an essential element in and a building block of certain parts of animals, such as _____and _____.

10. Phosphorus is often the limiting factor for _____ _____, thus fertilizers containing phosphates have been applied to farmland sometimes in disproportional amounts.

11. Plants cannot use atmospheric nitrogen. It must first be "fixed" by specialised organisms or by industrial processes into _____ or nitrate salts that can be used by the plant.

12. Special nitrifying _____ turn ammonia into nitrites, then nitrates, a form of nitrogen plants can absorb.

13. Some nitrates are turned back into _____ nitrogen by denitrifying bacteria.

14. Other bacteria in the root nodules of plants called_____, convert nitrogen from the atmosphere directly into compounds usable by the plant.

15. Healthy _____ _____ allow plants to harness the energy from the sun and continue with healthy, balanced growth.

16. The better our understanding of the way these cycles work, the more we can do to modify our actions and work towards a _____ future.

The Carbon Cycle

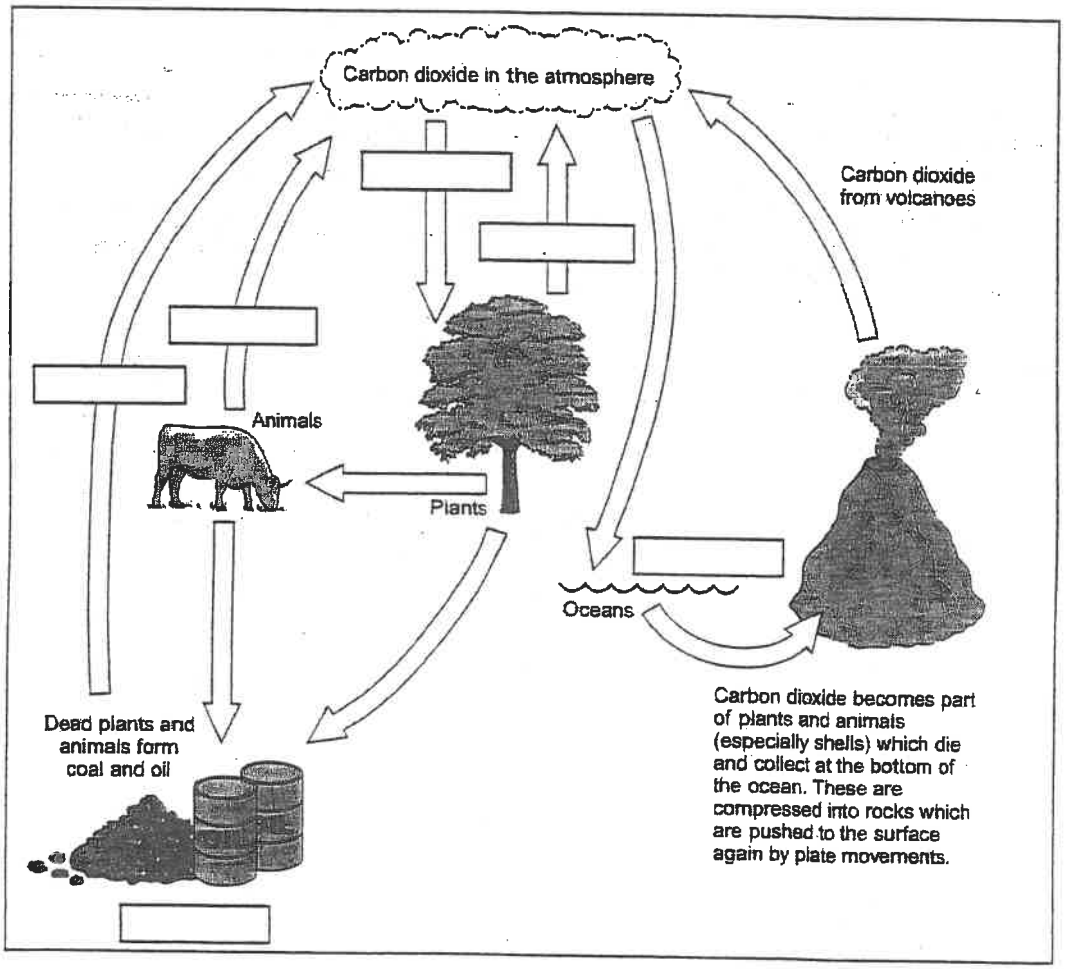
Name_____ Date _____

Carbon compounds are found dissolved in oceans, in fossil fuels, in the atmosphere and as part of plants and animals. The carbon cycle shows how carbon is recycled constantly.

1

a) An outline of the carbon cycle is shown below. Fill in the boxes using the following words:

FUELS **COMBUSTION** **ANIMAL RESPIRATION** **PHOTOSYNTHESIS** **DISSOLVING** **PLANT RESPIRATION**



b) Write down **three** ways in which carbon dioxide is put into the atmosphere

i)_____

ii)_____

iii)_____

(3)

Nitrogen

Match the following words with their definitions:

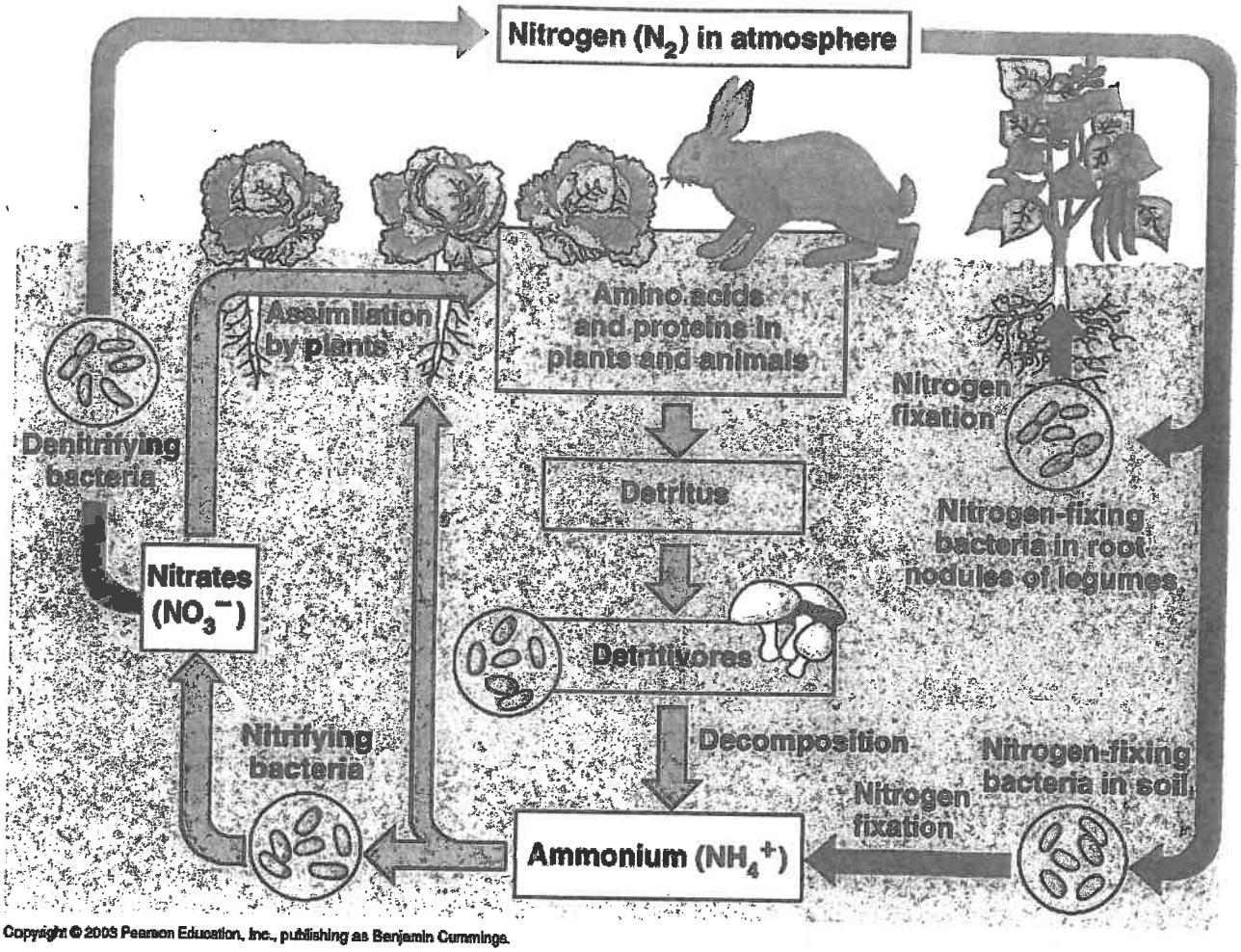
Nitrogen fixation, denitrification, nitrifying bacteria, nitrate, nitrogen uptake, nitrification, ammonium, denitrifying bacteria, nitrite, nitrogen-fixing bacteria, nitrogen

Term	Definition
	The process of making nitrates
	Provide for the host plant and in return obtain sugars
	Certain bacteria that convert nitrate back into nitrogen gas
	Nitrogen gas is converted into nitrate using electrical energy from lightning
	The process where nitrates are converted into nitrogen gas
	The process where nitrates enter plant roots
	Certain bacteria that convert ammonium into nitrite or nitrite into nitrate
	NO_3^-
	NO_2^-
	N_2
	NH_4^+

Nitrogen Cycle

Atmosphere	78%	ammonia	proteins	denitrificating	
Nitrate	nitrogen-fixing	plants	animals	waste	plants

1. Our atmosphere is _____ nitrogen gas.
2. Animals and plants cannot directly use all the nitrogen found in our _____.
3. Only special bacteria can directly use nitrogen in our atmosphere and "fix" it so other organisms can benefit. These bacteria are called _____-_____ bacteria.
4. Higher organisms use nitrogen to make their _____.
5. Animal waste decay by the action of bacteria which create _____and _____ products rich in nitrogen, and useful for plants to use again.
6. _____ bacteria in the soil can break down the ammonia into the gaseous form of nitrogen, which is not available for use by plants or animals.
7. In another part of the cycle, animals eat _____ containing nitrogen, which is again returned to the soil by animal _____ or decaying _____ and _____.



Biogeochemical Cycles Webquest

In this webquest, you will use the given websites to find the answers to questions about the water, carbon/oxygen, nitrogen, and phosphorous cycles. Answer all questions in the spaces provided.

Water Cycle Introduction

Precipitation, evaporation, and condensation are all terms that you recognize, but what do they mean? They are all part of the water cycle, which is a complex process that not only gives us water to drink and food to eat, but also helps our plants grow. Only about 3% of the Earth's water is fresh, and 1% of that water can be used for many human purposes. Why can't we use the other 2% of the fresh water found on the Earth? What about the other 97% of the water found in the world? To find these answers and to discover more, come along for an interactive journey through the water cycle!

Website #1: http://www.epa.gov/ogwdw/kids/flash/flash_watercycle.html (choose auto, or start with Rain)

1. Another name for rain, snow, sleet, and hail is _____. This occurs when there is so much _____in the_____that it cannot hold onto it anymore.
2. Name some locations where water is stored on earth._____
3. _____ is when water vapor comes from_____, _____, and land.
4. Which temperature causes water vapor to turn back into clouds?_____
5. What is the name for the process that forms clouds?_____

Website #2:
http://oceanservice.noaa.gov/education/pd/oceans_weather_climate/media/watercycle.swf

6. How much of the Earth's water exists in each of the following locations?

Oceans	Atmosphere	Underground Aquifers	Rivers	Lakes	Soil	Glaciers/ Ice Caps

7. Click on "Person" and record two interesting facts about how individual people use water.
   a. _____
   b. _____
8. Click on "Agriculture" and record two interesting facts about agricultural uses of water.
   a. _____
   b. _____

Carbon Cycle Introduction

Carbon is an element that is found in all organisms, fossil fuels, soil, the ocean, and the atmosphere. We take part in the carbon cycle by breathing CO_2 into the air; autotrophs participate by removing atmospheric CO_2 for use in building leaves, stems and other organs through the process of photosynthesis. As we burn more and more fossil fuels such as oil and coal, we release large amounts of carbon dioxide into the atmosphere more than can be removed by oceans and photosynthetic organisms. Within the atmosphere, this extra CO_2 traps heat. As more CO_2 accumulates, the Earth becomes warmer through a process known as the greenhouse effect.

Website: https://www.windows2universe.org/earth/climate/carbon_cycle.html

Introduction:

1. How long has carbon been underground? _____
2. Underground, carbon can be stored in _____, which humans_____ _____.

Carbon in the Atmosphere:

3. When carbon is in the atmosphere, it's usually in the form of molecules of _____, which is a _____.
4. More _____in our atmosphere makes our planet _____.

Go towards the plant:

5. Which process in plants removes carbon from the atmosphere?_____
6. If carbon were to leave the plant, which process would allow for that to happen? _____

Go towards the soil:

7. What happened to the plant the carbon was part of?_____
8. Carbon is now part of detritus; what is detritus? _____
9. Where does carbon go to from the soil? _____

Go towards the atmosphere, and then continue towards the surface ocean:

10. List the 3 ways carbon can enter the ocean.
    a. _____
    b. _____
    c. _____
11. Which absorbs more carbon, the land or the ocean? _____

Move towards marine life.

12. _____absorb carbon through the process of_____.

When you get the congratulations screen, call me over for my initials.

Adapted from http://www.firelandsschools.org/Downloads/Biogeochemical_Cycles_Webquest1.pdf

Nitrogen Cycle Introduction

The nitrogen cycle is one of the most important nutrient cycles found in terrestrial ecosystems. Nitrogen is used by living organisms to produce a number of complex organic molecules like amino acids, proteins, and nucleic acids. The majority of nitrogen is found in the atmosphere, where it exists as a gas (mainly N_2). Other major reserves of nitrogen include organic matter in soil and the oceans. Despite its large quantity in the atmosphere, nitrogen is often the most limiting nutrient for plant growth. This problem occurs because most plants can only take up nitrogen in two solid forms: the ammonium ion (NH^{4+}) and the nitrate ion (NO^{3-}). Specialized bacteria "fix" nitrogen, converting it to a form that can be used by organisms. By fixing nitrogen, these bacteria are a critical link between atmospheric nitrogen and life on Earth.

Website: http://www.pbslearningmedia.org/asset/lsps07_int_nitrogen/

Opening Screen

1. Nitrogen is essential to life. Where in all living things (including humans) is nitrogen found?

   _____

Begin the activity and hover over "Nitrogen in the Atmosphere."

2. Nitrogen makes up about what percent of the atmosphere? _____
3. Nitrogen exists in what form in the atmosphere? _____

Read through "Nitrogen Fixation" and "Ammonification."

4. What is the role of nitrogen-fixing bacteria in the nitrogen cycle?

   _____

Read over both "Nitrifications."

5. Ammonia can form _____, which can then be converted into _____.

   Both can be taken in by _____.

Read over "Denitrification."

6. _____bacteria can convert _____back into _____, which goes into the___

   _____.

Read "Ammonification."

7. Ammonification is when decomposers do what? _____

Finally, read "Assimilation" and hover over the chipmunk.

8. What is the only way in which humans and other animals can obtain nitrogen?

   _____

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