3 Unit Overview:
Ecosystems and Natural Selection

Name: ______________________________

Teacher: ____________________________

3.1 Ecosystems

3.1.1 Ecosystems and Biomes: Study
3.1.2 Ecosystems and Biomes: Lesson QUIZ — Scoring: 20 points

3.1.3 Stability and Change in an Ecosystem: Study
3.1.4 Stability and Change in an Ecosystem: Lesson QUIZ — Scoring: 20 points

3.2 Populations

3.2.1 Population Structure: Study
3.2.2 Population Structure: Lesson QUIZ — Scoring: 20 points

3.2.3 Population Dynamics: Study
3.2.4 Population Dynamics: Lesson QUIZ — Scoring: 20 points

Instructions: Read each question and answer choice carefully. Choose the ONE best answer. **Use CAPITAL letters to record your answers on this page.**

Lesson Quiz 3.1.2	***Lesson Quiz 3.1.4***	***Lesson Quiz 3.2.2***	***Lesson Quiz 3.2.4***
1. ______	1. ______	1. ______	1. ______
2. ______	2. ______	2. ______	2. ______
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Score: _____ out of 20	***Score: _____ out of 20***	***Score: _____ out of 20***	***Score: _____ out of 20***

Instructions:

Students please *annotate, by highlighting or underlining*, words or sentences in the Study sections to show that you have read and studied the study sections prior to taking the quizzes.

Ecosystems and Natural Selection

Since the Earth was formed, it has gone through amazing changes. It is still changing today; the continents move, climate changes over hundreds of years, weather changes from one season to the next.
As the Earth changes, so do the living things that make the earth their home. Each living thing depends on its environment and on other living things for resources like water and food. In this unit, you will learn how organisms interact with each other and how they change in response to their changing environment.

Objectives:

- Describe a population, community, ecosystem, and biome.
- Recognize the factors that affect populations.
- Describe characteristics of aquatic ecosystems.
- Understand the factors that affect ecosystem stability and biodiversity.

3.1.1 Study: Ecosystems and Biomes

Organisms are suited for the environment in which they live.

An American crocodile in the Everglades.

If you went looking for crocodiles in the United States, your best chance of finding them would be in the Florida Everglades. The Everglades is one example of an ecosystem. In this study, you will explore relationships between organisms in an ecosystem. You'll learn about the different ecosystems on Earth, in order to understand how connected organisms are to their environment.

Species

Organisms of one species can mate to produce fertile offspring.

Many different species of organisms live on the Earth and in its waters. Male and female members of the same species are able to produce offspring that can reproduce, or in other words, offspring that are fertile. Most species cannot produce any offspring with other species, but occasionally it can happen. The offspring between two species, however, are not fertile. A crocodile and an alligator cannot produce offspring, which means they are not the same species. Although they share some common traits, their DNA is too different for them to be the same species.

These are some of the species that call the Everglades home.

Predicting Species

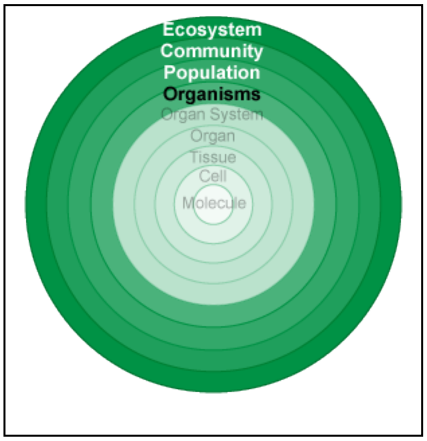
Some animals that look similar are the same species, but some look similar and are not the same species.

Can you guess how many species are on Earth? This is a question that scientists cannot answer; new species are discovered every day. There are about 1.5 million species that have been identified, but this is thought to be only a tiny fraction of the number of species. Why is it so difficult to count the number of species? Imagine this: There are about 500 different species of bacteria that live in just the human mouth!

Populations and Communities

Populations of organisms interact to form communities.

When members of the same species live in the same geographic area, it is called a population. For example, all of the crocodiles that live in the Everglades are a population. All of the humans who live in your town or city are also a population. Populations of organisms are not isolated from all other species. Every environment has a variety of species. Populations of different species interact and form a community. Biological communities can contain thousands of species. The interactions between species in a community are long lasting and complex. You have already studied some of these interactions, like mutualism, commensalism, and parasitism. You have studied how energy and matter flow through communities in a complex food web. The interactions between two species are sometimes so complex that if you remove one species, the other may not survive.



Ecosystems

Living communities and nonliving factors interact to form ecosystems.

A group of organisms of one species forms a population. A group of populations is called a community. Communities of organisms live in a particular environment called a habitat. When a community interacts with its habitat to get things like light, water, and nutrients, the organisms and the habitat form an ecosystem. While populations and communities include only living things, an ecosystem is a system of living *and* nonliving things that interact. An ecosystem can be big or small. A puddle could be considered an ecosystem, or an ocean could be considered an ecosystem. Both are habitats filled with organisms.

Factors in Ecosystems

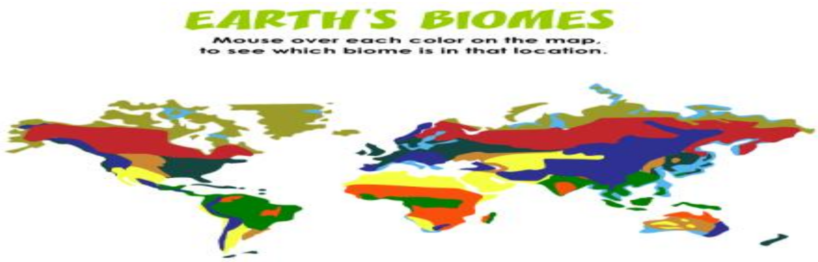
Conditions in an ecosystem could be living or nonliving.

Each ecosystem has a different set of conditions or factors that help the living things there survive.
Some of the conditions in an ecosystem are abiotic, or nonliving, like the water molecules in rain or a river. Other things in an ecosystem are biotic, or living, like plants and animals. What types of biotic and abiotic factors are present in the Everglades?

Biomes

Climate defines biomes.

The climate in an area is the long-term weather conditions, including temperature and moisture. Temperature affects the availability of water, because frozen water and water vapor are not usable to most organisms.
If you could walk from the equator to the North Pole, you would notice that the types of plants and animals you see change as you go north. You would first see a tropical rain forest, then a desert or grassland, then a temperate forest, then taiga, and then tundra. Each of these is a biome, which is defined by the rainfall, sun, and other descriptions of climate. A biome covers a specific part of Earth. Take a minute to look over the distribution of some of the major terrestrial biome of the Earth. Find your location on the map. What type of biome do you live in?



Plants and Animals in Biomes

Animals and plants are well suited to their biome.

Each biome has groupings of plants and animals that are perfectly suited to that environment. Plants that live in hot, dry areas have characteristics that allow them to prevent water loss and deal with high temperature. If you were to move a desert plant to a rain forest, where it is very wet, the desert plant would not thrive. The most productive type of biome is one with a climate that does not change over the course of the year. Areas with seasonal changes in temperature are called *temperate biomes.*

Survival of Organisms

Organisms have a restricted set of conditions in which they survive and thrive.

Can a crocodile from Florida survive in Lake Michigan? Each organism has a specific set of conditions it needs to survive and thrive. For example, plants need a certain amount of water: too much water and they will rot, too little and they will dry out. A cactus would not do very well in the Everglades; it's not designed to handle that much water. Some organisms eat only a few types of food. If they were placed in a different habitat where this food was not available, they wouldn't survive. These biotic and abiotic factors determine the range of conditions an organism can live in. Understanding why organisms are found where they are is essential to resource management, and to understanding the effects of changes in environment.

Types of Ecosystems

Ecosystems can be on land or in the water.

A biome can contain many different types of ecosystems. For example, within a tropical rainforest there could be an ecosystem in the rainforest canopy, and a different ecosystem on the ground.

This image shows part of the Amazon rain forest in Peru, along the Río Madre de Dios.There are two main types of ecosystems:

- On the land, or a terrestrial ecosystem
- In the water, or an aquatic ecosystem

A tropical rainforest biome could include both terrestrial and aquatic ecosystems. Aquatic ecosystems could be in either freshwater or salt water. Ecosystems in salt water are often called *marine ecosystems.*

Water on Earth

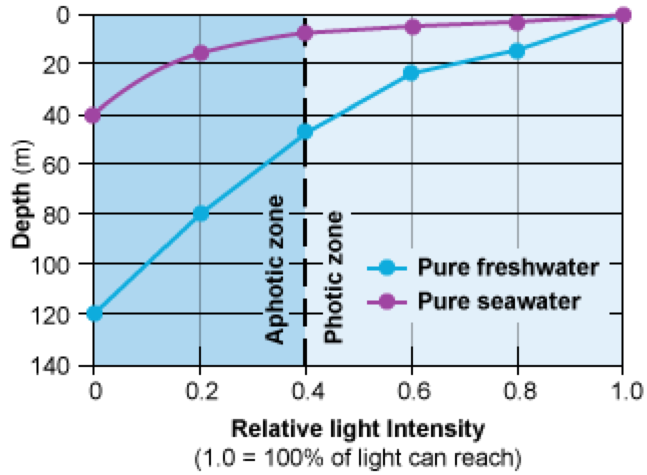
Aquatic ecosystems take up the majority of space on Earth, and are essential to human life.

Look how much of the Earth is covered by water — over 70%! How much water is that? This is what the Pacific Ocean looks like — from outer space! The four oceans of Earth are filled with over 322 *million* cubic miles of water. In fact, 99% of Earth's living space is within the oceans. How is that possible? There are areas in the oceans that are deeper than the height of Mount Everest. The waters of Earth are full of every imaginable kind of species: from 100-foot-long blue whales, to organisms made of a single cell. A handful of water from the ocean contains, on average, millions of organisms. Because the oceans are full of life, they are also full of food. About half of Earth's human population depends on the ocean for their main source of food. In the rest of this study, you will learn about many factors that affect aquatic ecosystems. As you move through those pages, keep the information on this page in mind.

Light in Aquatic Ecosystems

Photosynthesis cannot occur below a certain depth.

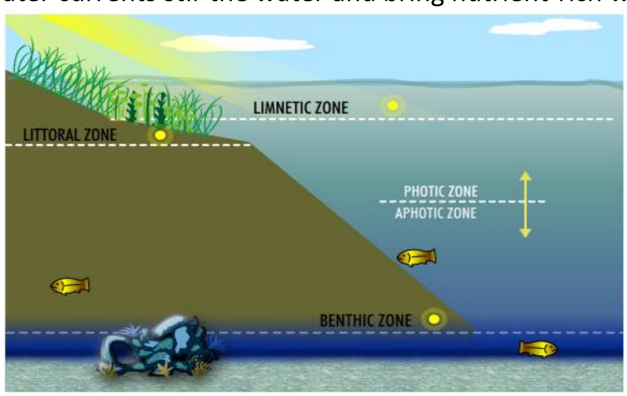
In some ways, the Everglades are an aquatic ecosystem. Many parts are underwater most of the year. Aquatic ecosystems are affected both by how much light can reach different areas and by water movement. The oceans and lakes on Earth are large and deep. The main factor that limits the amount and type of life in aquatic ecosystems is light. Light is needed for photosynthesis. Photosynthesis slows when light intensity decreases below 40% of the light available at the surface. The deeper underwater, the less light can reach. The area of water that receives enough light for photosynthesis to occur is called the photic zone. Below this zone, light is still present but at levels that cannot support photosynthesis. This zone is called the aphotic zone.



Abiotic Factors in Aquatic Ecosystems

Water movement, chemistry, and temperature have an impact on aquatic life.

In addition to light, other abiotic factors influence aquatic life. The temperature in a body of water can vary greatly from top to bottom, which affects which organisms can live in what regions. The line that marks the division between temperature regions is called a thermocline. The chemistry of the water also varies in a body of water. Life usually thrives at neutral pH. Lack of water flow and the presence of certain plants can change the pH slightly. Water without nutrients does not support life. In most bodies of water, nutrients are found only on the bottom. The nutrients come from the remnants of dead and decaying organisms. If these areas lie below the photic zone, they will not be available to the ecosystem, unless wind and water currents stir the water and bring nutrient-rich water toward the surface.



Freshwater Ecosystems

The productivity of a freshwater ecosystem depends on water movement.

In the Everglades, freshwater flows from the north toward the southwest, and eventually out into the ocean. The ecosystem is characterized by marshes, swamps, bogs, sloughs, and streams. The productivity of each area is determined by the rate of water flow. A bog has stagnant water with very low or no water flow. In stagnant water, oxygen is used during the decomposition of dead organic matter and is not quickly replaced. Bogs are highly unproductive areas with little photosynthesis. A marsh or swamp has a natural, slow flow of water, but it is not always in just one direction. Swamps have trees, and marshes are mostly grasses. The slow flow of water makes marshes and swamps highly productive areas. A stream has water that constantly moves in one direction. A creek, or slough, is a small stream, and a river is a large stream. Production in streams is low because nutrients are constantly swept away downstream.

In a bog, there is very little or no flow of water.

In marshes and swamps, water flows slowly.

In streams, sloughs, and rivers, water is constantly and quickly flowing in one direction.

Life in a Freshwater Ecosystem

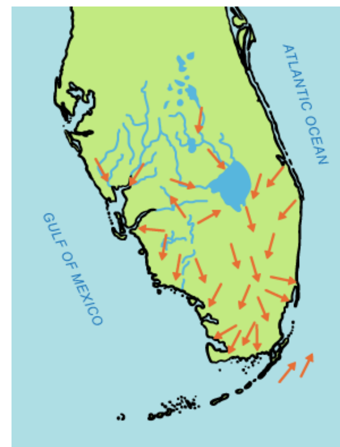
Organisms must be adapted to their unique environment.

Use the following questions to think more about the organisms that live in a marsh, swamp, bog, or slough.

Estuary Ecosystem

Organisms in estuaries must be able to adjust to changing salinity.

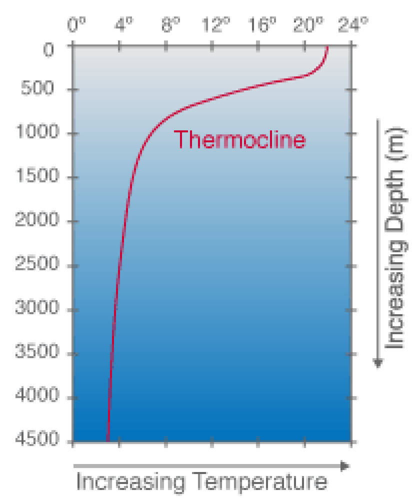
In estuaries, freshwater mixes with saltwater. The water that flows through the Everglades eventually flows into the Gulf of Mexico. In these areas, freshwater and saltwater mix. The area where this happens is called an estuary. Estuaries are extremely productive areas, because they are shallow and full of nutrients, and fresh nutrients come into the area often. The biggest challenge for organisms in estuaries is dealing with changing salinity levels. Salinity is the measure of the amount of salt that is dissolved in water. In an estuary, when the tide is rising, seawater floods the estuary and mixes with the freshwater. When the seawater comes in, the salinity of the estuary increases. When the seawater moves out with the falling tide, salinity decreases.



Marine Ecosystems

Abiotic factors vary greatly in a marine environment.

Marine environments include the oceans and seas. The salty oceans and seas make up more than 70% of Earth's surface. The two main abiotic factors that affect life in a marine ecosystem are salinity and temperature. Most ocean water has a salinity of about 3.5%. Areas where freshwater mixes with seawater have lower salinity. The temperature in the ocean varies with depth and geographical area. As you move north and south from the equator, temperature tends to decrease. Ocean currents carry warm and cold water in patterns around the earth, varying the waves create areas of upwelling. Upwelling is when water from the benthic zone is brought toward the surface, almost like the water is being stirred in a giant pot. When things die in the ocean, they sink to the bottom and decay. They break down into nutrients. When water at the bottom rises in upwelling, those nutrients come to the surface. Organisms at the surface can use the nutrients to grow. Areas of upwelling are very productive because they have both light and nutrients.



STUDY GUIDE – next page

Main idea 1: Species make up populations, which interact to form communities. Communities interact with the environment and make ecosystems.

Species (pgs. 2-3)

Define:
A group of organisms whose members share common characteristics and can produce offspring

How many species are on Earth?
A question that scientists cannot answer; new species are discovered every day. 1.5 million species have been identified, but this is only a tiny fraction of the species on Earth.

Population (pg. 4)

Define:
Members of the same species that live in the same geographic area

Community (pg. 4)

Define:
Populations of species that interact. Biological communities can contain thousands of species.

Describe interactions:
Long-lasting and complex

Examples of interactions:
Shelter, pollination, decomposition, predation

Ecosystem (pgs. 5-6)

Define *habitat*:
The particular environment in which a community lives

Define *ecosystem*:
Organisms combine with their habitat to form an ecosystem; living things interacting with their nonliving environment.

Define *biotic*:
Living factors in an ecosystem

Define a*biotic*:
Nonliving environmental factors in an ecosytem

Main idea 2: Biomes are defined by climate, such as the average temperature and moisture level.

Biomes (pgs. 7-8)

Primary abiotic factor:
Climate

Define *biome:*
A grouping of plants and animals defined by the dominant plant species present; groupings of plants and animals perfectly suited to that environment

For each biome, describe the abiotic conditions and productivity.

Rain forest:
Daily precipitation and warm temperatures; highly productive

Subtropical desert:
Very hot; very little precipitation; unproductive

Temperate grasslands:
Variable temperature with seasons; dry; not very productive

Temperate forests:
Freezing temperatures in the winter; moderately high precipitation; moderately productive

Taiga and tundra:
Below freezing most of the year; unproductive

Main idea 3: Aquatic ecosystems are affected by light penetration and water movement.

Aquatic Ecosystems (pgs. 13-14)

Primary abiotic factors:
Light penetration, water movement, temperature, pH, nutrients

Describe light penetration:
Light can travel through water, but the water absorbs and scatters the light.

Define *photic zone:*
The area of water that receives enough light for photosynthesis to occur

Define *aphotic zone:*
Light is present, but at levels that cannot support photosynthesis

Fresh Water (pg. 15)

Productivity depends on:
Water movement

Describe and explain the productivity of each system type listed below.

Bogs :
Stagnant water with very low or no water flow; oxygen-poor; low pH; nitrogen unavailable to plants; unproductive

Swamps and marshes:
Natural flow of water in and out; water is not deep; many grasses are growing in them; highly productive areas

Streams:
Water that constantly moves in one direction; production in streams is low because nutrients are constantly swept downstream

Marine (pg. 18)

Describe abiotic conditions:
Salinity, temperature gradient, nutrient variability

Describe productivity:
Highly productive near the shore and in shallow areas and upwelling zones, but unproductive in the aphotic zone and open ocean

Estuaries (pg. 17)

Describe:
Areas where fresh water mixes with salt water

Primary abiotic challenge:
Changing salinity

Describe productivity:
Extremely productive; shallow water; nutrients constantly replaced

3.1.2 Quiz: (20 POINTS)

Record your answers on the first page.

1. What is the name for a system formed by the interaction of living organisms with the nonliving physical environment?

A. Habitat

B. Species

C. Community

D. Ecosystem

2. Which type of biome is the most productive?

A. Tundra

B. Taiga

C. Tropical rain forest

D. Desert

3. What is an estuary?

A. A bog with stagnant water

B. An area where fresh water and salt water mix

C. A biome located below the Arctic Circle

D. A very large stream

4. A grassland area has many different populations that all live together and interact. What is the name for a group of interacting populations?

A. Habitat

B. Community

C. Ecosystem

D. Population

5. A rabbit lives in a wooded area with a small stream running through it. What is the name for this wooded area and the stream?

A. The rabbit's species

B. The rabbit's habitat

C. The rabbit's biome

D. The rabbit's community

6. Which is a biotic element found in the tropical rain forest biome?

A. Water

B. Light

C. Plants

D. Wind

7. Why are marshes more productive than bogs?

A. Marshes have stagnant water.

B. Marshes get more sunlight.

C. Marshes are larger in size.

D. Marshes have more water flow.

8. Which part of a lake is most likely to be aphotic?

A. Benthic zone

B. Biotic zone

C. Littoral zone

D. Limnetic zone

9. A dam is built that changes water flow nearby. The water flowing through a marsh completely stops. What is the most likely effect of this change?

A. The marsh will have more oxygen.

B. The marsh will become less productive.

C. The marsh will grow more plants.

D. The marsh will have more photosynthesis.

10. A plant is able to survive in a temperate forest biome, but cannot survive in a desert biome. Which is most likely a characteristic of this plant?

A. Able to stop water from evaporating

B. Able to live through changes in temperature

C. Does not need very much water to survive

D. Needs sunlight year-round to survive

3.1.3 Study: Stability and Change in an Ecosystem

Stability and Change in an Ecosystem

Ecosystems can be stable for hundreds or thousands of years.

Ecosystems don't usually change very quickly. They are generally very stable, remaining the same from year to year. The abiotic factors are determined mostly by climate, which does not vary much. However, all of this can change when a new species is introduced to the ecosystem. An introduced species is an organism that is not native to the area. In other words, the organism did not previously live in that ecosystem. These organisms are also called nonnative species.

Look back to the Florida Everglades. This is an ecosystem that until recently has been stable for many years. But a new species has come to town, and has the potential to radically change the dynamic balance of the Everglades.

Niches

Every organism has a range of conditions in which it can thrive.

Resources in an ecosystem are limited. There is only so much space, food, and water to go around. Organisms in the ecosystem must compete for these resources. Competition between species helps keep ecosystems stable by keeping populations balanced and relatively constant. All of the organisms in an ecosystem must share the available water. Competition and other interactions between species results in each species having a niche. A niche is the range of resources that the species is able to use. It is its place in the community. When the same resources are used by two different species, scientists say that their niches overlap. It is not possible for species with the exact same niche to coexist for long.

Ecosystem Stability

Competition and predation are two stabilizing factors in an ecosystem.

Predation helps to maintain stability in an ecosystem. The population of prey species is kept in balance by predators that hunt the prey. Prey usually have many defensive characteristics, such as claws or a hard shell. This helps them avoid capture by predators and keeps the population of predators in balance. Predation keeps ecosystems in balance. The introduction of a new predator, like the Burmese python, to an ecosystem upsets this balance. Prey species do not have characteristics to defend themselves from the new predator, and their numbers decline rapidly. This decreases the food supply for the native predator and upsets the balance of the ecosystem. Species that are able to out-compete other species for resources are sometimes called superior competitors. The python is an example of a superior competitor. Why haven't superior competitors taken over the world? The ability to compete for a given resource, like space on a rock, is only one aspect of an organism's niche. If individuals are very good at competing for a given resource, they are probably less good at something else, like warding off disease.

Keystone Species

A keystone species has a greater effect on its environment than other organisms.

In some cases the structure of an entire community can change dramatically if a single species of predator or herbivore is removed from the community. These species are called keystone species. A keystone species has a much greater effect than its abundance or biomass would suggest. They help maintain stability and diversity of species, or biodiversity, in an ecosystem.

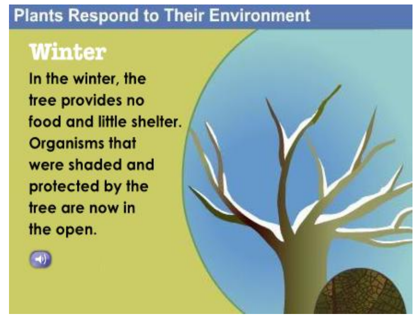
Ecosystem Disturbances

Ecosystems often have a predictable, cyclical pattern of disturbances.


Can change be part of a stable ecosystem? The removal or addition of a keystone species like the sea star to an ecosystem is a type of disturbance. A disturbance is an event that removes individuals or biomass from a community. Many communities have a natural pattern of disturbance. This rabbit changes color with the seasons. It responds to the cyclical changes of its environment.

Some examples of cyclical disturbances are snow melt flooding, migration of animals through an ecosystem, seasons, and monsoons. Cyclical changes in an ecosystem are a natural part of that ecosystem. A cyclical disturbance does not disrupt the stability of the ecosystem. Small changes affect only individual organisms and not the entire ecosystem, so they don't affect the overall stability of the ecosystem.

Organisms and Seasons
As the nonliving environment changes, living things change as well.



Small Disturbances
Small disturbances can affect individual organisms.
What happens when a tree in the forest is cut down and removed? In a forest, trees reach up to the sky, creating a dense canopy of branches that lets little light to the forest floor. When a tree is removed, it may create a small disturbance that affects many individual organisms, but not the whole ecosystem. Small disturbances do not impact an ecosystem's stability if they don't happen often. Small disturbances that have a negative impact on some organisms can often have a positive effect on other organisms. For example, an extremely hot summer that causes some plants to die creates an opportunity for other plants to have access to more resources. When a tree falls in the forest, what are some of the positive and negative effects this would have on organisms in the ecosystem?

Extreme Events
Extreme events affect entire communities.
There are some disturbances that are so extreme that the entire ecosystem becomes unstable. Remember, an ecosystem is defined as a community of organisms and the nonliving things the community interacts with. An extreme disturbance removes all or most of the organisms from an area. Extreme disturbances are grouped into two classes.

1. In a primary disturbance, not only are most of the organisms removed, but the soil itself is removed or damaged. Primary disturbances include glaciers, floods, volcanic eruptions, and landslides.
2. In a secondary disturbance, most of the organisms that live above ground are removed, but the soil remains stable and underground organisms may also be stable. Secondary disturbances include things like forest fires or logging.


A volcanic eruption is a primary disturbance. It destabilizes an ecosystem above and below the ground.


Clear-cutting is a secondary disturbance. It removes all of the organisms above the ground but leaves the soil intact.

After a Disturbance

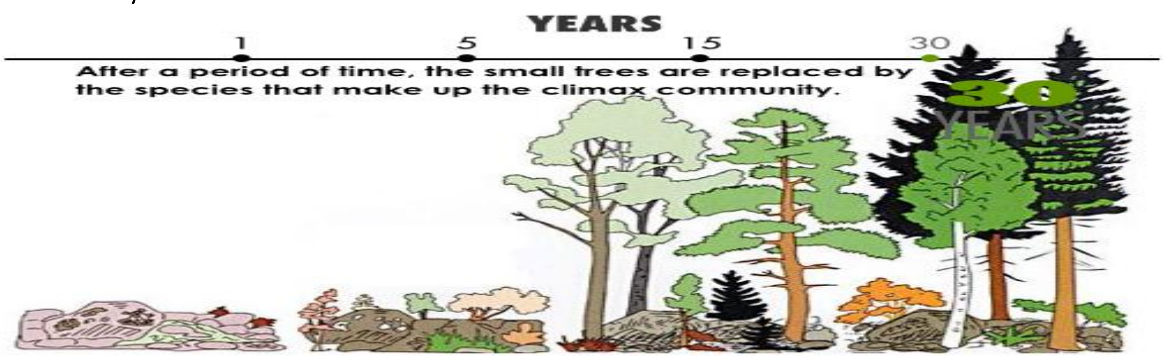
After a disturbance, the first organisms to return to the area prepare the area for other organisms.

After a forest fire, a few plants will begin to grow in the area. These plants must be able to live in harsh conditions. Imagine that a forest fire wipes out thousands of acres of forest. What will happen to this area over time? Soon after the fire, species that are small and short-lived will begin to move onto the land. These early settlers will be able to withstand extreme or harsh abiotic conditions. They will have a high rate of reproduction. These early plants change the Abiotic conditions in the area in a way that makes conditions less severe. They provide shade, reducing temperature and increasing humidity. They add organic matter to the soil. This sets the stage for other plants to move in.

Succession

When groups of organisms are replaced by new groups, it is called *succession.*

When one group of organisms comes into an area after a disturbance, it makes it easier for a second group to come in. When one group comes in and replaces another group of organisms in an area, it is called succession. This second wave of organisms does not have to handle the harsh conditions of the early settlers. They are better competitors for resources, and begin to replace the first group of organisms. This succession of organisms eventually ends, stabilizing into a climax community that can be stable for hundreds or even thousands of years. The time line below is what happens in the years after a disturbance.



Biodiversity

Biodiversity is a measure of how many different species live in a community.

Stable ecosystems lead to increased biodiversity. Biodiversity is the variety of organisms in a geographic area. It is an essential natural resource, because different organisms provide people with products including food, fibers for clothing, and medicines. Species distribution is limited by historical and biotic factors. More than half the Earth's species are found in 17 regions, known to conservation biologists as *hot spots,* covering only about 2% of Earth's land area. The regions with the greatest concentration of species are generally found in the tropics, where it is warm and moist year round. Diversity decreases as you move toward the poles. Biodiversity increases the stability of an ecosystem. A great diversity of species increases the chance that at least some organisms will survive disturbances.

Human Impact on Stability and Biodiversity

Humans are disrupting stable ecosystems and decreasing biodiversity.

Environments are changing more rapidly than at any time in the last 60 million years. These changes are due to human activity. As humans build more cities and towns for growing populations, they also destroy the habitats of many organisms. Humans are reducing the populations of many species by too much hunting and fishing, and by destroying habitats. This is reducing biodiversity. To save Earth's organisms and protect the rich biodiversity, people need to protect habitats. Wildlife reserves can be set up to protect populations. Creating laws to protect animals from overfishing and overhunting would also be a big step forward. Saving the ecosystems and organisms of Earth requires education and participation of people worldwide.


Commercial hunting of wild animals removes organisms faster then they can reproduce.


Human settlements destroy habitats.

Introduced Species

Invasive species are nonnative species that compete with native species and win.

No species can live everywhere. Historically, each species has its own range and ecosystem. In its native ecosystem, an organism has its own web of interactions keeping its population in check. Barriers like mountain ranges prevent the spread of species to new ecosystems. Barriers like lakes, oceans, and mountains prevent organisms from spreading to new locations. But humans are not limited by these types of boundaries, and they have spread species to new areas. Humans have transported thousands of seeds, birds, insects, and other species across physical boundaries to new locations, both accidentally and on purpose. Of the species introduced to new ecosystems, only about 10% become common, and even fewer become invasive. An invasive species thrives in its new ecosystem and out-competes native species. Most introduced species do not thrive in the abiotic conditions of the new ecosystem.

Extinction

Many species are in danger of going extinct.

Events like changing conditions or an extreme disturbance can lead to extinction, or loss of a species. Since life began, more species have gone extinct than are currently alive. But modern extinction rates are 100 to 1000 times greater than the average recorded over the last 550 million years. What is driving this extreme rate of extinction? Problems caused by humans like pollution, disease, competition from new species, habitat damage, and overhunting are all contributing to the extinction of species. An endangered species is in immediate danger of extinction. Without intervention, an endangered species will most likely go extinct. A threatened species is likely to become endangered in the near future.

STUDY GUIDE

Main idea 1: Ecosystems can be stable for hundreds of years. A variety of factors increases their stability.

Stabilizing Factors in an Ecosystem (pgs. 1, 3, 6)

Describe ecosystem stability:
Can be stable for hundreds or thousands of years

Effect of climate:
Determines abiotic factors; does not vary much

Competition (pgs. 2-3)

Define:
When two different species compete for the same limited resource

Effect on stability:
Keeps populations balanced and relatively constant

Define *niche*:
The range of resources that the species is able to use, its place in the community, and a sum of the interactions it has with other species

Can two species with the same niche coexist?
Eventually, one will out-compete the other because it is not possible for species with the exact same niche to coexist.

Predation (pg. 3)

How do predators keep prey species stable?
The population of prey species is kept in balance by the hunting of predators.

How do prey species keep predator species stable?
Prey have defensive characteristics that have developed over many years. This helps them avoid capture by predators and keeps the population of predators in balance.

Keystone Species (pg. 4)

Define:
A species with a much greater effect than its abundance or biomass would suggest

Effect on stability:
They help maintain stability in an ecosystem. The structure of an entire community can change dramatically if a single species of predator or herbivore is removed from the community or added to the community.

Describe starfish experiment:
In a series of tide pools, when sea stars were removed, the mussel population exploded, crowding out other life. The number of species in the tide pool was reduced by more than half, and biodiversity decreased.

Main idea 2: Disturbances can destabilize ecosystems.

Destabilizing Factors in an Ecosystem

Ecosystem Disturbances (pg. 5)

Define *disturbance:*
An event that removes individuals or biomass from a community

Define *cyclical disturbances:*
A natural pattern of disturbance that may disrupt the ecosystem for only a short time. Because the ecosystem can recover, the disturbance does not affect the stability of the ecosystem.

Examples of cyclical disturbances:
Snowmelt flooding, migration of animals through an ecosystem, seasons, monsoons

Effect on organisms:
Organisms have characteristics or behaviors that allow them to survive these changes.

Small Disturbances (pg. 7)

Describe:
A disturbance that affects many individual organisms but not the whole ecosystem; does not affect an ecosystem's stability if it happens infrequently

Extreme Events (pg. 8)

Effect on ecosystems:
Entire ecosystem becomes destabilized

Primary disturbances:
Most severe; most of the organisms removed, and soil itself is removed or damaged. Examples include glaciers, floods, volcanic eruptions, and landslides.

Secondary disturbances:
Less severe; organisms that live aboveground are removed; the soil remains intact and underground organisms may also be intact; examples include forest fires or logging.

Succession (pgs. 9-10)

Define:
The pattern of colonization of disturbed areas. The succession of plants in an area often follows predictable patterns because of species traits and interactions.

Describe pioneering plants:
Plants that can disperse their seeds over long distances, are able to withstand extreme or harsh abiotic conditions, have high reproductive rates, and change the abiotic conditions in the area so that they're less severe

Describe climax community:
The succession of plants eventually stabilizes and can be stable for hundreds or even thousands of years.

Main idea 3: Biodiversity is an important natural resource that has been severely affected by human activity.

Biodiversity **(pgs. 13-14)**

Define:
The variety of organisms in a geographic area

Importance to humans:
An essential natural resource; different organisms provide us with products including food, fibers for clothing, and medicines

Biological hot spots:
More than half of Earth's species are found in 17 regions, known to conservation biologists as "hot spots." These areas are generally found in the tropics and cover only about 2% of Earth's land area. Diversity decreases closer to the poles.

Human Effect on Stability and Biodiversity

How are humans decreasing stability and biodiversity? **(pg. 15)**

Effect 1:
Habitat destruction

Effect 2:
Excessive hunting and fishing. We are killing many species faster than they can replace themselves.

Effect 3:
Introduced species

Define *invasive species*:
A nonnative species that out-competes native species

Effect on ecosystems:
Destabilizes ecosystems; reduces food for native species; increases predation

Extinction **(pg. 18)**

Describe current pattern of extinction:
Modern extinction rates are 100 to 1,000 times greater than the average rate recorded over the last 550 million years.

Define *endangered*:
In danger of extinction throughout most or all of the area it lives in

Define *threatened*:
Snowmelt flooding, migration of animals through an ecosystem, seasons, monsoons

3.1.4 Quiz: (20 POINTS)

Record your answers on the first page.

1. What is a nonnative species?

A. A species that does not normally live in an area

B. A species that is a poor predator

C. A species that has no permanent home

D. A species that increases biodiversity

2. What is the process of succession?
A. When a species changes from one niche to another niche
B. When an ecosystem changes from one biome to another biome
C. When one disturbance replaces another disturbance
D. When a community is replaced by another community

3. What is a cyclical disturbance?
A. A disturbance that removes most organisms
B. A disturbance that destroys soil
C. A disturbance that kills keystone species
D. A disturbance that repeats over and over

4. What happens when two species occupy the exact same niche?
A. Only one will survive.
B. They will both increase in population.
C. One will cause a primary disturbance.
D. They will help each other.

5. An oak tree falls in a forest. It kills some ants and stops grass from growing below it. What type of disturbance is this?
A. Small
B. Cyclical
C. Secondary
D. Primary

6. What type of organisms first move into an area after a primary disturbance?
A. Animals with long lives
B. Organisms that reproduce slowly
C. Large predators
D. Small organisms

7. Why are the tropics the most diverse areas?
A. They have no predators.
B. They have the most nonnative species.
C. They have many secondary disturbances.
D. They have stable temperatures.

8. An extreme disturbance happens in an ecosystem. How does an ecosystem change as succession happens after this disturbance?
A. Biodiversity in the ecosystem increases.
B. The ecosystem has more keystone species.
C. There is less biodiversity in the ecosystem.
D. The population of most species decreases.

9. How does predation cause stability in an ecosystem?
A. It prevents competition between species.
B. It causes primary disturbances in ecosystems.
C. It prevents populations from getting too high.
D. It decreases biodiversity in ecosystems.

10. A nonnative species of squirrel is introduced into a forest. Which would most likely prevent this squirrel from becoming an invasive species?
A. The squirrel must compete with stronger organisms for resources.
B. There are no natural predators for the squirrel in this ecosystem.
C. The forest ecosystem has very low biodiversity.
D. The squirrel is able to reproduce quickly in this ecosystem.

Lesson 3.2 Study: Populations

3.2 Populations

If there are more brown-eyed people than blue-eyed people, will there eventually only be brown-eyed people? Or will there eventually be half blue-eyed people and half brown-eyed people?
This lesson is about how groups of organisms look and behave, and how that can change over time.
Objectives:

- Describe the factors that affect population size.
- Explain the significance of studying populations over time.
- Identify the requirements for a population to be in Hardy-Weinberg equilibrium.
- Use the Hardy-Weinberg equation to understand allele frequencies.
-

3.2.1 Population Structure

Population Structure

Ecosystems are made up of many different populations of organisms.

An ecosystem is all of the organisms that live in a particular place, together with the abiotic environment. To study an ecosystem, biologists look at all of its species and how they interact with one another. Yellowstone National Park is an ecosystem of more than two million acres and spans three different states. Ecosystems are made up of populations of organisms together with the nonliving environment. A population is all of the members of one species that live together in a particular place. To learn about populations, in this study you will look at organisms in the ecosystem of Yellowstone National Park. Yellowstone is mainly a temperate forest that has seasonal changes in temperature and rainfall.

Populations and Change
A change in environment affects a population of organisms.
What type of change would affect a population of organisms living in the Yellowstone area?

Introduction to Wolves
The gray wolf is a large wild dog that travels and hunts in packs.
The gray wolf totally changed the Yellowstone ecosystem. To understand how this happened, you need to understand a little bit about the gray wolf. The gray wolf is the largest wild dog in North America. It is five to six feet long from nose to tail, and can weigh up to 175 pounds. Gray wolves can actually be tan,

brown, black, or gray in color. Wolves live, travel, and hunt in packs of four to seven animals. A wolf pack can travel over 100 miles in a day, although it usually travels 10 to 20 miles per day

Keystone Species

In the early 1900s, wolves were removed from Yellowstone National Park.

Historically, wolves have been a keystone species and a predator in Yellowstone National Park and the surrounding areas. A wolf and its offspring.

At the beginning of the 19th century, the population of gray wolves in the Yellowstone area was about 35,000 animals. Wolves fed mostly on elk and buffalo. When more ranchers and farmers moved into the wolves' territory, their livestock became easy prey for hungry wolves. By the 1890s, farmers were losing many of their calves to wolves. A program to get rid of wolves began. Hunters and trappers earned rewards for each wolf killed. The last sighting of wolves in the park came in 1926, and government hunters killed the last known wolf in the Yellowstone area in the 1940s.

Ecosystem Impacts

Removing wolves destabilized the Yellowstone ecosystem.

The loss of the gray wolf had a big impact on Yellowstone. One of the biggest impacts on the stability of the Yellowstone ecosystem was the destruction of cottonwood populations.

Population Size

The size of a population depends on birth, death, and movement.

Many ecosystems, like Yellowstone, are stable and can remain stable for hundreds of years. In a stable ecosystem, populations of species are stable as well. What affects the size of those populations? The first two factors are known as the birthrate and death rate. If the birthrate is higher than the death rate for a significant period of time, the population will increase. Likewise, if death rates are higher than the birthrates, populations will normally decrease.

Immigrants to the United States enter the country at Ellis Island, New York, in 1902.

The third major reason populations change is due to movement:

- Individuals can move into a population through immigration from another population.
- Individuals can leave one population and go to another; this process is known as emigration.

You can remember that *immigrants* come *in* and *emigrants exit.*

Competition for Resources

Interactions between species affect the population.

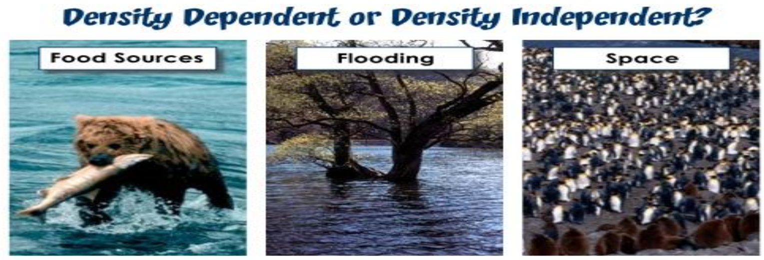
Organisms must use resources like food and water to survive. In any environment, resources are limited. Individuals in a population must compete for the available resources. Competition occurs when organisms fight for access to the same resources. When the wolves were removed from the Yellowstone area, fewer elk were killed. This decreased the elk death rate. More elk reached reproductive age, increasing the birthrate. The increased elk population meant more competition for the same food source. Because the amount of food available is limited, elk would either need to leave the area or some would starve. How do limited resources affect populations?

Population Density

Some of the factors that affect population growth are based on population density.

The competition for resources can be fierce. When population size increases, competition increases, making life more difficult for all of the members in the population. The availability of food, nesting sites, and water all have a dramatic effect on population growth. When the number of organisms exceeds the amount of the resources available, population growth slows or even stops.

Some factors that determine growth are density dependent. Density-dependent factors affect a population more and more as the population grows. Not all population changes are density dependent. For example, a fire is density independent, it will affect the population regardless of that population's size or density. Natural disasters are density independent. Are these biotic and abiotic factors density dependent or density independent? Make a prediction and then click the image to see if you were correct.



Population Growth

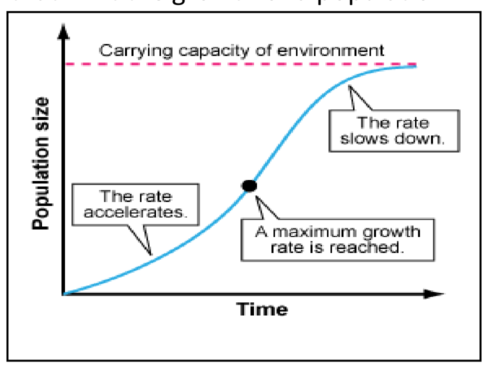
If resources are unlimited, populations grow exponentially.

When scientists began thinking about population growth, they asked the question, "What would happen to a population of organisms that had unlimited food to eat and unlimited space in which to grow?" The answer is unlimited growth. This is known as exponential growth. When a population grows exponentially, the larger the population gets, the faster it grows. Given unlimited resources, certain bacteria can double in number by splitting in half every 20 minutes. So after 20 minutes, one bacterium becomes two bacteria. Twenty minutes later you have four, then eight within the first hour. How many bacteria would be in the population after 24 hours?

Logistical Growth

Exponential growth does not occur in real-world situations.

Given unlimited resources, populations grow exponentially. In real world situations, exponential growth doesn't happen, or at least not for long. Under normal circumstances, there are many factors that limit the growth of a population. A population will grow as large as its environment will allow, and then stabilize. It stabilizes at the environmental carrying capacity. Once all of the populations in an area have reached their carrying capacity, the ecosystem becomes very stable and populations do not change much over time.When population growth begins as exponential growth then levels out at the carrying capacity, it is called logistical growth.



Relationships Between Species

Relationships between species can impact the population of both species.

Even in a stable ecosystem, there are population cycles that include both periods of growth and periods of decline. No one species lives in isolation, as you have seen in your studies of ecosystems. The interactions between species are complex and difficult to predict. The relationship between organisms and the animals that eat them can be especially complex.

Predation and Prey

Predation effects the population of prey species.

Another relationship that affects population size is the interaction of predators and their prey. Like oak trees and squirrels, the population sizes of both the predator and prey depend on each other and follow predictable cycles. When there are a lot of predators around, they eat a lot of prey. This will cause the numbers of prey animals to decrease. As the number of prey animals decreases, there is no longer enough food available for the predators and some of the predators die. This relief from predators gives the prey a break and allows them to reproduce and increase in numbers. Eventually there will be enough food for the predators, and they'll increase in numbers again. The cycle continues. More predators means less prey. But once there is less prey, predators will decrease as well.

This cycle is true of populations of lynx and hares. As the number of lynx increases, the number of hares decreases. When the hare population gets too low, the lynx population falls off. Then the hare population recovers, and, eventually, the lynx population recovers

Reintroducing Wolves

In 1994, wolves were reintroduced into Yellowstone.

The reintroduction of wolves into Yellowstone National Park began in 1994. It took the work of many biologists and wildlife scientists. The reintroduction represented a compromise between park managers, scientists, and ranchers. It was only able to proceed when measures were taken to reduce the negative impact of wolves on agriculture, and to allow for a process to remove problem wolves from surrounding areas.

STUDY GUIDE

Main idea 1: The size of a population is affected by three main factors.

Ecosystems (pg. 1)

Describe an ecosystem:
Ecosystems are made up of many different populations of organisms together with the abiotic environment.

Populations (pg. 1)

Define *population:*
All of the members of one species that live together in a particular place

Population Growth (pgs. 12-13)

Describe exponential growth:
Unlimited growth; the larger the population gets, the faster it grows

Define *carrying capacity:*
A population will grow as large as its environment will allow and then stabilize at its carrying capacity.

Describe logistical growth:
A population will grow as large as its environment will allow and then stabilize at its carrying capacity.

Factors That Determine Population Size

Birthrate and Death Rate (pg. 7)

Describe birthrate:
The number of organisms born into a population

Describe death rate:
The number of organisms that die in a population

Describe the size of a population in these situations:
Birthrate > Death rate
If the birthrate exceeds the death rate for a significant period of time, the population will increase.

Death rate > Birthrate
If death rates exceed birthrates, the population will normally decrease.

Movement of Organisms (pg. 7)

Define *immigration:*
When organisms move into a population from another population

Define *emigration:*
When organisms leave one population and go to another

Main idea 2: Competition for resources and interactions between species can make population dynamics complex.

Competition for Resources (pg. 9)

Define *competition:*
Competition occurs when organisms fight for access to the same resources.

Describe the effect of competition on population size:
When resources are limited, the size of a population can only grow until the resources run out.

Population Density (pg. 10)

How does the density of a population affect competition?
When population size increases, competition increases, making life more difficult for the entire population.

Define *density-dependent growth factors*:
Density-dependent factors affect a population more and more as the population grows.

Examples of density-dependent factors:
Food availability, nesting sites, access to water

Examples of density-independent factors:
Natural disasters, fires

Relationships Between Species (pgs. 15-16)

Use an example to show how relationships between species can affect the populations of both species:
Answers may vary; students may use the squirrel and acorn example or the lynx and hare example from the study, or they can use their own example.

3.2.2 Quiz: (20 POINTS)

Record your answers on the first page.

1. What is immigration?

A. When animals die in an ecosystem
B. When animals leave an ecosystem
C. When animals move into an ecosystem
D. When animals are born in an ecosystem

2. Which is a density-dependent factor?

A. Flood
B. Space
C. Fire
D. Natural disaster

3. What is the carrying capacity of an ecosystem?

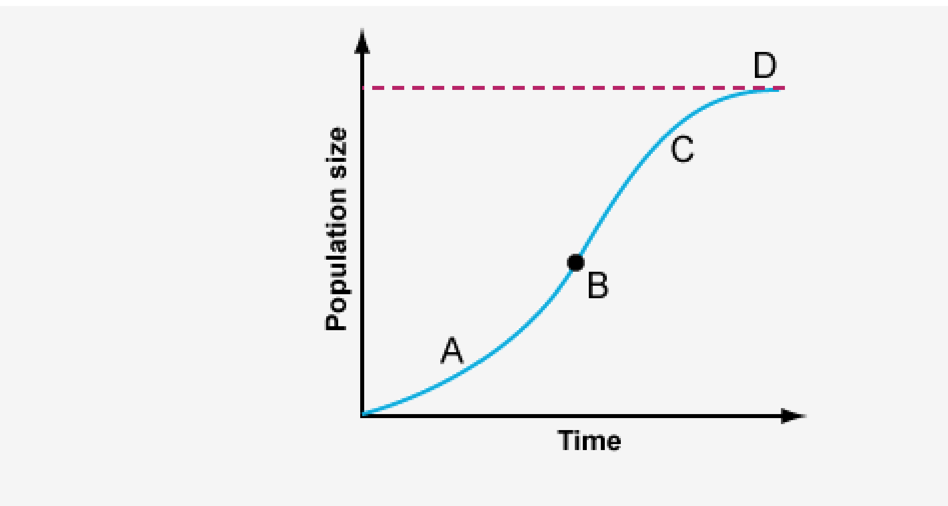
A. The number of keystone species in the ecosystem
B. The total number of organisms at any time
C. The largest population that can be supported
D. The number of predators in the ecosystem

4. When can exponential growth happen?

A. When there is high population density
B. When the death rate is high
C. When there is competition for resources
D. When there are unlimited resources

5. What causes populations to compete?
A. Low population density
B. Emigration
C. High death rates
D. Limited resources

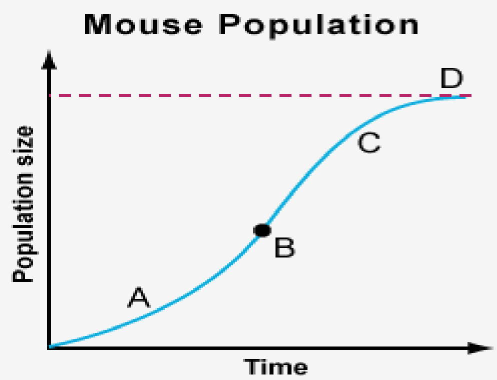
6. Why did the removal of wolves affect the entire Yellowstone ecosystem?
A. The wolves ate most of the species in the ecosystem.
B. The ecosystem has a complicated series of interactions.
C. Wolves were the only predators in the ecosystem.
D. The wolves were the only producers in the ecosystem.



7. Where is exponential growth happening in the graph shown above?
A. Point A
B. Point B
C. Point C
D. Point D

8. In a certain ecosystem, owls are predators for mice. The owl population increases, and they eat more mice. This causes the mouse population to decrease. What happens next?
A. The population of mice increases.
B. The birthrate of owls increases.
C. The birthrate of mice increases.
D. The population of owls decreases.

The graph below shows the population of mice in an ecosystem where the mice are not allowed to enter or leave.



9. Which best describes the population at point A?

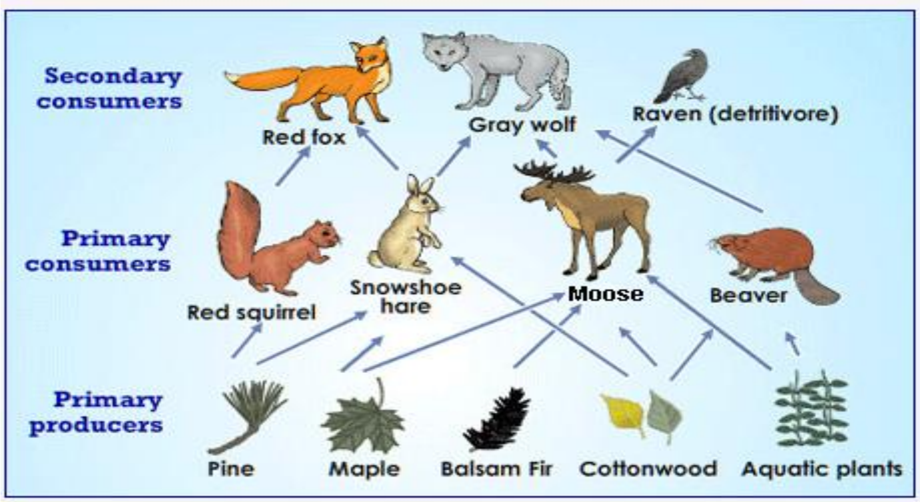
A. The death rate is higher than the birthrate.

B. The population is decreasing.

C. It has reached carrying capacity.

D. The birthrate is higher than the death rate.

The Yellowstone National Park food web is shown below.



10. What would be the *most* likely effect of adding wolves to the park?

A. Decreased cottonwood population

B. Increased moose population

C. Increased balsam fir population

D. Increased snowshoe hare population

3.2.3 Study: Population Dynamics

Population Dynamics

A population can be described by the number and frequency of alleles.

Populations, like the wolves of Yellowstone, are groups of organisms of the same species. Studying the factors that impact how populations grow and change over time is a main part of studying populations. Another way to study populations is to look at the organisms as a collection of genes and alleles. The study of how collections of genes in a population are passed from generation to generation is called population genetics. How many sea stars in each generation will be red or purple? Do phenotypes change from generation to generation? These types of questions can be answered using the ideas of population genetics.

The genes that determine traits are passed down from generation to generation in DNA.

Each sea star has different alleles of the gene for color. This results in sea stars with different color phenotypes.

How phenotypes change from generation to generation is studied in population genetics.

Mathematical Models

Scientists wanted to know what happened to alleles in populations over time.

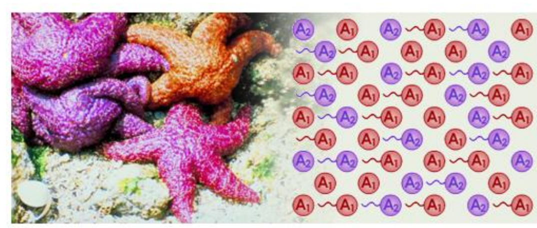
Godfrey Hardy (left) and Wilhelm Weinberg

In the early 1900s, scientists Hardy and Weinberg began to look at populations of organisms in a new way. They wanted to find out what happens to the frequencies of alleles in a population over time. Many people thought that given enough time, two alleles for one gene would each be found 50% of the time in a population. Other people thought that dominant alleles would eventually increase in frequency until the recessive allele was lost.

Gene Pools

All of the gametes produced in a generation represent the gene pool.

In order to study the traits in a population, a gene pool is used as a model. The gene pool is the sum of all the alleles, or variations, of all the genes in a population of organisms. Imagine a species that releases its eggs and sperm, or gametes, into the environment. These gametes are free to fuse with any other gamete. All of the free gametes would represent the gene pool for that species.



A sea star releases gametes into the water, where they are free to fuse with the gametes of other sea stars. These gametes represent the gene pool for the population of sea stars.

Distribution of Alleles

The distribution of alleles in a population is the allele frequency.

The gene for color in a sea star contains two alleles. But for many genes, there are more than two alleles in a population. No matter how many alleles exist in a population, they are not always evenly distributed. For example, if there are four different alleles for a gene, it doesn't necessarily mean that 25% of the population has each allele. How often an allele is found in a population is called the allele frequency.

Determining Allele Frequency

Alleles can be represented by variables and calculated using an equation.

Does the allele frequency in a population change from generation to generation? Do the allele frequencies eventually reach 50/50, as many scientists thought? To answer these questions, Hardy and Weinberg developed a mathematical model to measure the frequency of each allele from generation to generation.

First, the frequencies of the alleles in the gene pool must be measured. To determine the frequency of an allele, the number of that allele is divided by the total number of alleles in the pool. *p* represents the allele frequency of the dominant allele.

$$p = \frac{\text{number of dominant alleles}}{\text{total alleles in gene pool}}$$

Hardy-Weinberg Equation

The Hardy-Weinberg equation shows genotype frequencies.

Hardy and Weinberg represented the frequencies of the two alleles of a gene with the symbols *p* and *q*. The two frequencies add up to 100% of the total, or a frequency of 1. $p + q = 1$

The two scientists developed the Hardy-Weinberg equation, which shows the frequencies of the three possible genotypes:

- homozygous dominant, which is written like: *NN*
- heterozygous, which is written like: *Nn*
- homozygous recessive, which is written like: *nn*

These are all the possibilities, so the frequencies of these three must add up to 1.

Homozygous dominant + Heterozygous + Homozygous recessive = 1

$$p^2 + 2pq + q^2 = 1$$

Genetics and Hardy-Weinberg

The Hardy-Weinberg equation can be used to determine allele frequencies from phenotype frequencies.

Generation to Generation

The Hardy-Weinberg equation shows how allele frequencies are transmitted from generation to generation.

Once the frequency of an allele in one generation has been determined, the allele frequency in the next generation can be determined.

The Hardy-Weinberg Equilibrium

In the Hardy-Weinberg equilibrium, allele frequencies do not change from generation to generation.

Hardy and Weinberg described a situation in which the frequency of alleles in the population does not change over time. They disproved the idea that alleles would eventually reach 50/50. They also disproved the idea that dominant alleles would eventually increase in frequency.

If an allele is at a frequency of 0.4 in one generation, it will be found at 0.4 for the next generation as well. Hardy and Weinberg's models show that allele frequency is inherently stable. The idea that *p* and *q* do not change from generation to generation is called the Hardy-Weinberg equilibrium.

Conditions of the Hardy-Weinberg Equilibrium

Forces acting on populations cause allele frequency to change.

For a population to be in Hardy-Weinberg equilibrium, no competitive factors can be acting on the population. This is because forces like competition and predation change the allele frequency of a population. For the Hardy-Weinberg equation to describe a population over a period of time, the following seven conditions must be met:

Requirements for a Population to Be in Hardy-Weinberg Equilibrium

1. No mutation occurs.
2. Each allele must be equally beneficial.
3. The population must be infinitely large.
4. All members of the population must breed.

5. All mating must be totally random.
6. All individuals must produce the same number of offspring.
7. No immigration or emigration can occur.

Models vs. the Real World

The conditions for Hardy-Weinberg equilibrium are rarely met.

Hardy-Weinberg equilibrium rarely exists for a population over a long span of time. Many forces can affect allele frequency in the gene pool. Examine each of the conditions of the Hardy-Weinberg model and how it compares to the natural world.

Importance of Hardy-Weinberg

The Hardy-Weinberg equilibrium shows how much allele frequencies change.

The Hardy-Weinberg equilibrium represents an ideal state. None of the seven conditions is likely to be met, and it's extremely unlikely that all seven of them will be met at the same time. So, in the real world, change in the allele frequency occurs. Then what's the point of the model? The Hardy-Weinberg equation gives scientists a way to determine how much a population changes in a period of time.

STUDY GUIDE

Main idea 1: Population genetics studies how alleles of genes move through populations and how they change from generation to generation.

Population Genetics (pg. 1)

Describe:
The study of how collections of genes are passed from generation to generation

How is a population described in population genetics?
By the number and frequency of alleles

Gene Pool (pg. 3)

Describe:
This is the sum of all the alleles, or variations, of all the genes in a population; all of the gametes produced in a generation

Hardy-Weinberg Equation (pg. 7)

Write the equation:
$p^2 + 2pq + q^2 = 1$

What does this equation tell you?
The Hardy-Weinberg equation shows how allele frequencies are transmitted from generation to generation.

Allele Frequency (pgs. 4-6)

Define:
The distribution of alleles in a population

How is allele frequency determined?
The number of that allele is divided by the total number of alleles in the gene pool.

What does p represent?
The allele frequency of the dominant allele

Equation for p:

$$p = \frac{\text{number of dominant alleles}}{\text{total alleles in gene pool}}$$

What does q represent?
The allele frequency of the recessive allele

Equation for q:

$$q = \frac{\text{number of recessive alleles}}{\text{total alleles in gene pool}}$$

Hardy and Weinberg (pg. 2)

What question were they trying to answer?
What happens to the frequencies of alleles in a population over time?

How did they go about answering this question?
They developed a mathematical model.

Hardy-Weinberg Equilibrium (pg. 13)

What did Hardy and Weinberg discover about the frequencies of alleles from one generation to the next?
Allele frequencies do not change from generation to generation.

What two hypotheses did they disprove?
They disproved the idea that alleles would eventually get to 50/50. They also disproved the idea that dominant alleles eventually increase in frequency.

Importance of Hardy-Weinberg (pg. 15)

What is the importance of the Hardy-Weinberg equation?
Hardy-Weinberg serves as a comparison for experimentation. It gives scientists a way to determine how much allele frequencies change in a period of time.

Main idea 2: Forces acting on populations cause allele frequency to change.

Condition for Hardy-Weinberg Equilibrium	Real-Life Situation (pg. 13)
Each allele must ensure equal survival. (pg. 13)	Some traits give organisms an advantage over other organisms.
The population must be infinitely large.	Populations are limited in size.
All members of the population must breed.	Only certain members of populations breed.
All mating must be completely random.	Individuals select mates.
All individuals must produce the same number of offspring.	Mating events result in variable numbers of offspring.
Immigration and emigration cannot occur.	Individuals frequently move into or out of populations.
Mutations cannot occur.	Mutations do occur.

3.2.4 QUIZ (20 points)

1. What idea did Hardy and Weinberg disprove?

A. There are seven conditions for equilibrium.

B. The gene pool for a population frequently changes.

C. Allele frequency is stable between generations.

D. Dominant alleles become more common in each generation.

2. What is the allele frequency?

A. The total number of different alleles in a population

B. The number of different alleles an organism can have

C. The number of different traits in a population

D. The distribution of alleles in a population

3. In the Hardy-Weinberg equation shown below, *p* is the frequency of the dominant allele, and *q* is the recessive allele.

$$p^2 + 2pq + q^2 = 1$$

What does p^2 represent in the equation?

A. The frequency of the heterozygous dominant genotype

B. The frequency of the homozygous dominant genotype

C. The frequency of the homozygous recessive genotype

D. The frequency of the heterozygous recessive genotype

4. Which of these is one of the conditions for Hardy-Weinberg equilibrium?

A. The population must be infinitely large.

B. Immigration must occur.

C. Organisms must choose mates.

D. Mutation must occur.

5. What happens when a population is in Hardy-Weinberg equilibrium?

A. Mutations are common.

B. Allele frequency is stable.

C. There are infinite alleles.

D. Organisms produce no offspring.

6. The phenotype frequency in a population changes after each generation. Which would most likely be causing this?

A. An infinitely large population

B. Competition between organisms

C. A lack of mutation

D. Random mating

7. A trait has two alleles, represented by p and q. If $p = 0.35$, what is q?

A. 0.35
B. 0.65
C. 0.42
D. 0.59

8. A plant has two alleles for color. The red allele is recessive, and is represented by q. The purple allele is dominant, and is represented by p. If 30 of 100 organisms are red, what is q?

$$p^2 + 2pq + q^2 = 1$$

A. 0.30
B. 0.49
C. 0.70
D. 0.55

9. A species of fly has two alleles for the length of their legs. The allele for long legs is dominant, and is represented by p. The allele for short legs is recessive, and is represented by q. If 21 of 100 organisms have short legs, what is p?

$$p^2 + 2pq + q^2 = 1$$

A. 0.54
B. 0.79
C. 0.46
D. 0.21

10. A biologist measures the allele frequencies of pea plants in a very controlled environment. The plants can either have a dominant tall allele (*T*) or a recessive short allele (*t*). Which of the following would be a reason that this population is not at Hardy-Weinberg equilibrium?

A. Both alleles ensure equal survival.
B. One pea plant mutates to have a new allele.
C. Every pea plant reproduces exactly once.
D. The pea flowers are pollinated at random.

Next Week's Lessons:
Lesson 3.3 and 3.4

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