

Unit 3 Part 1

BIODIVERSITY and EVOLUTION



Evolution

_____ the relative change in genetic traits of populations that occurs over successive generations

_____ gradual change in allele frequencies in a population over time

_____ large-scale evolutionary changes including the formation of new species or other taxa

_____ a structure, behaviour, or physiological process that helps an organism survive and reproduce in a particular environment

- Structural Adaptations
- Behavioural Adaptations
- Physiological Adaptations

Develop as a result of gradual change in the genetic traits of members of a population over time, and improve the chances of survival and reproduction

_____ are physical features on an animal that have evolved over time to help them survive and breed.

Camouflage

Eagle Claws

Eagle Vision



Burnt Cape cinquefoil - Hairy Leaves to retain water

_____ are changes in behavior that certain organisms or species use to survive in a new environment.

Migration

Hibernation

Dormancy



_____ refers to the metabolic or physiologic adjustment within the cell, or tissues, of an organism in response to an environmental stimulus resulting in the improved ability of that organism to cope with its changing environment.

Harbour Seal - heart rate slows conserving oxygen during dives

Temperature regulation in animals

Antifreeze in fish



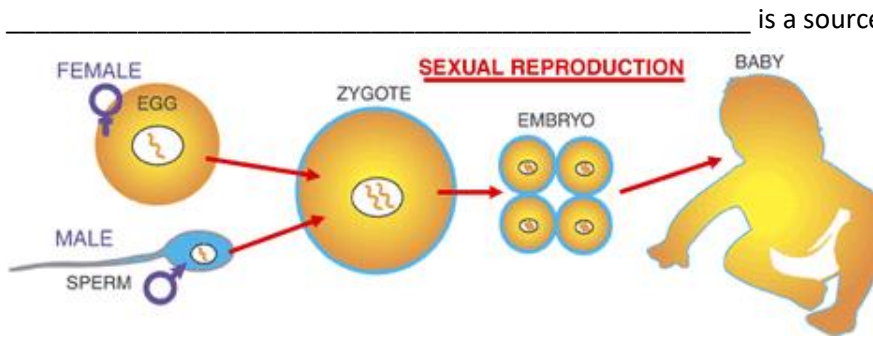
Variation within a species

_____ a visible or invisible difference among some members of a population

How does variation occur?



Variation in Species



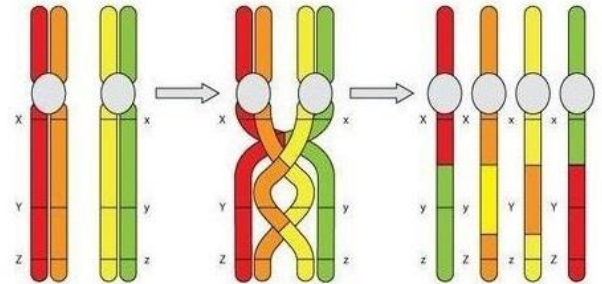
_____ is a source of variation. Through sexual reproduction, parents pass down hereditary information (genes) to their offspring.

The number of possible combinations of genes that offspring can inherit from their parents results in great genetic variation among individuals within a population.

Genetic variation is increased by meiosis

Recombination or crossing over occurs during prophase I. Homologous chromosomes – 1 inherited from each parent – pair along their lengths, gene by gene. Breaks occur along the chromosomes, and they rejoin, trading some of their genes.

_____ mutations are a source of variation in populations. Mutations happen continuously in the DNA of any living organism. They can occur spontaneously, when DNA is copied before a cell divides.



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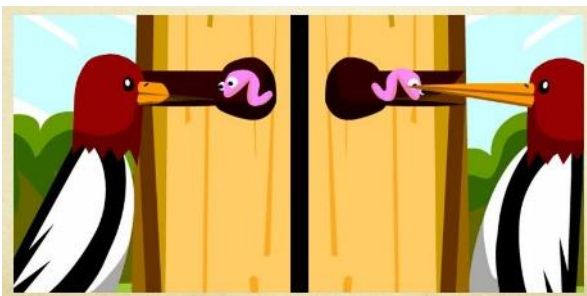


A _____ mutation occurs in a sperm or egg cell and the mutation may be passed down to succeeding generations.

Thus, mutations are a significant source of genetic variation in populations.

Mutations Can Provide a Selective Advantage

Mutations that significantly alter proteins in DNA _____ and can be _____.



In some instances a mutation enables an organism to _____ in its environment _____, which, in turn, means that the organism is more likely to _____.

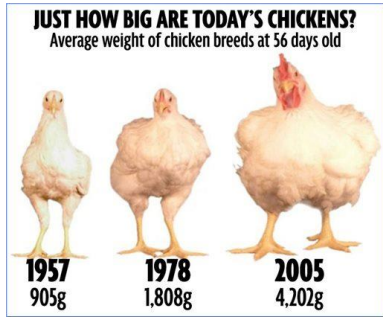
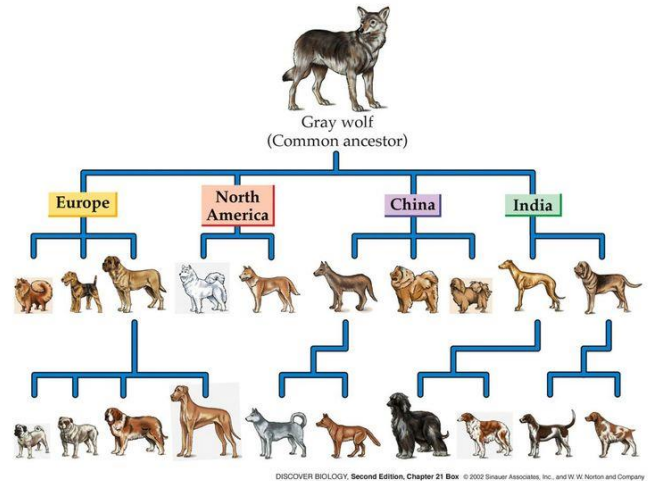
This situation is more common when an organism's environment is changing. Mutations that once were no advantage, or perhaps were even a disadvantage, may become _____.

Investigation 16.A

Artificial Selection

_____ selective breeding to obtain varieties of plants or animals with desired traits

Artificial selection during domestication and crop improvement involved selection of specific alleles of genes controlling traits resulting in _____ relative to unselected genes.



The meats sold today are the result of the selective breeding of _____, _____, and _____. Many _____ and _____ have been improved or even created through artificial selection. For example, _____, _____, and _____ were all derived from the wild _____ through selective breeding.

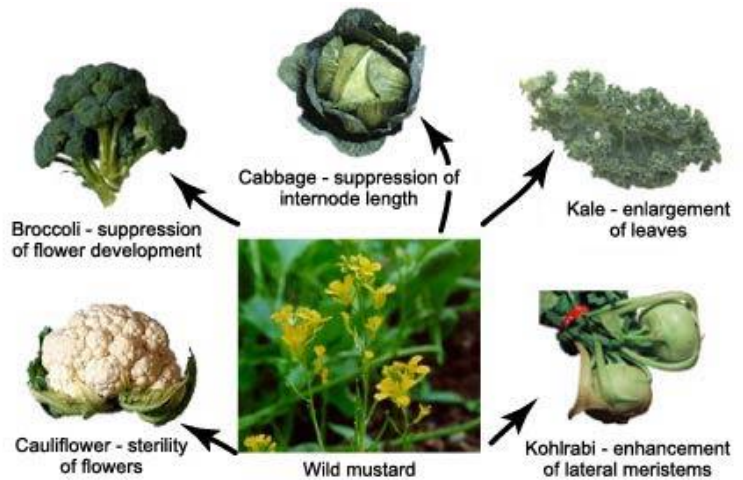
Early indigenous peoples developed the ancestral versions of the _____ that we know today from one or more ancient grasses, including teosinte.

Natural Selection

Natural Selection is the process through which populations of living organisms adapt and change. Individuals in a population are naturally variable, meaning that they are all different in some ways.

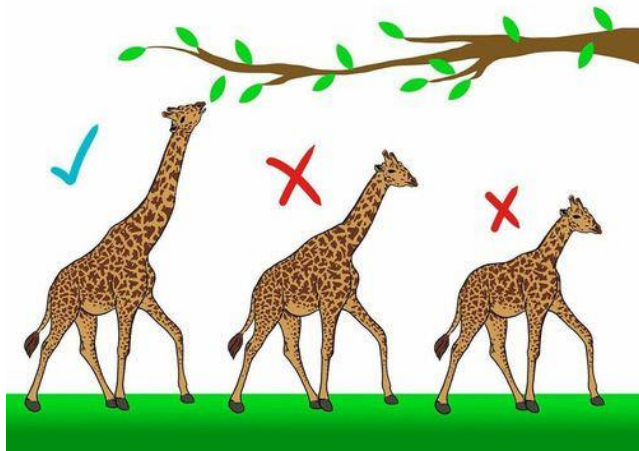
This variation means that some individuals have traits better suited to the environment than others.

Individuals with adaptive traits—traits that give them some advantage—are more likely to survive and reproduce.

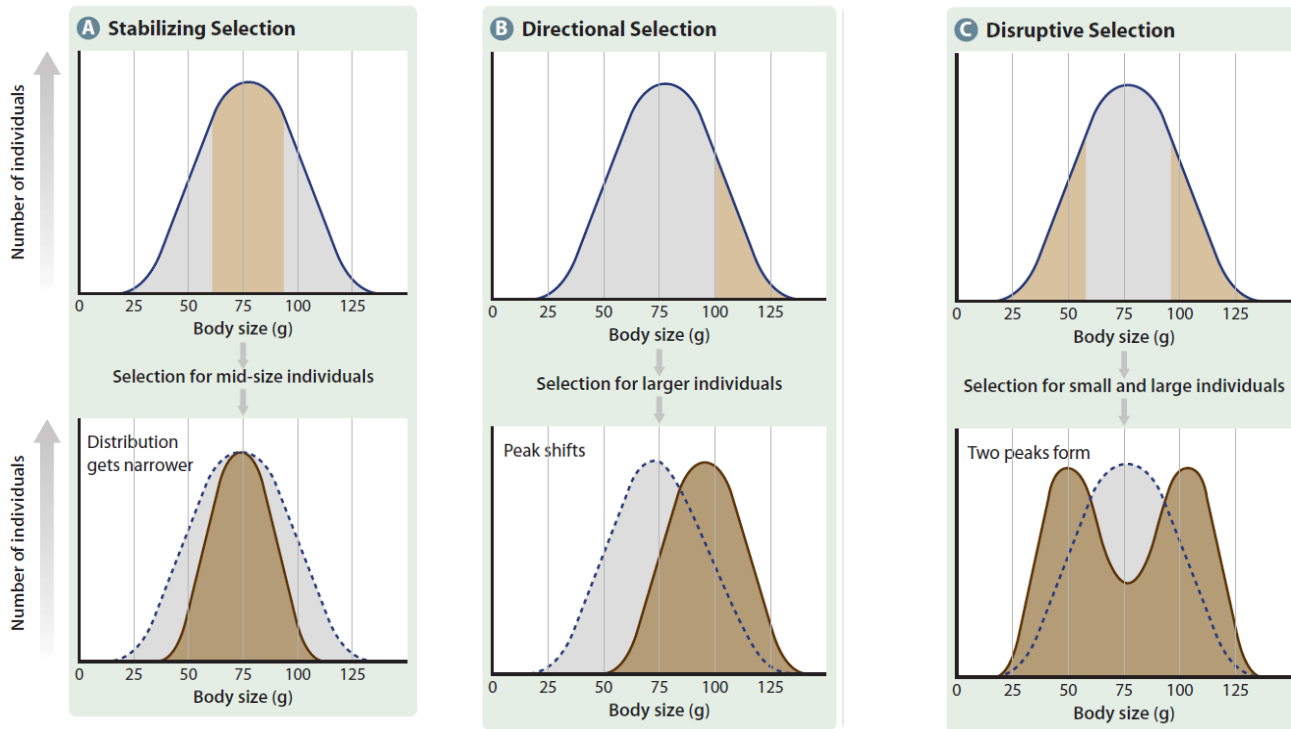


These individuals then pass the adaptive traits on to their offspring.

Over time, these advantageous traits become more common in the population.



Types of Natural Selection



_____ a form of natural selection that favours an intermediate phenotype and acts against extreme versions of the phenotype.

_____ a form of natural selection that favours the phenotype at one extreme over the other

_____ a form of natural selection that favours the extremes of a range of phenotypes over intermediate phenotypes, and may eliminate intermediate phenotypes from the population



_____ a special case of natural selection in which a particular phenotype improves an individual's chances of obtaining a mate

Industrial Melanism

_____ is an evolutionary effect prominent in several arthropods, where dark pigmentation (melanism) has evolved in an environment affected by industrial pollution, including sulphur dioxide gas and dark soot deposits.

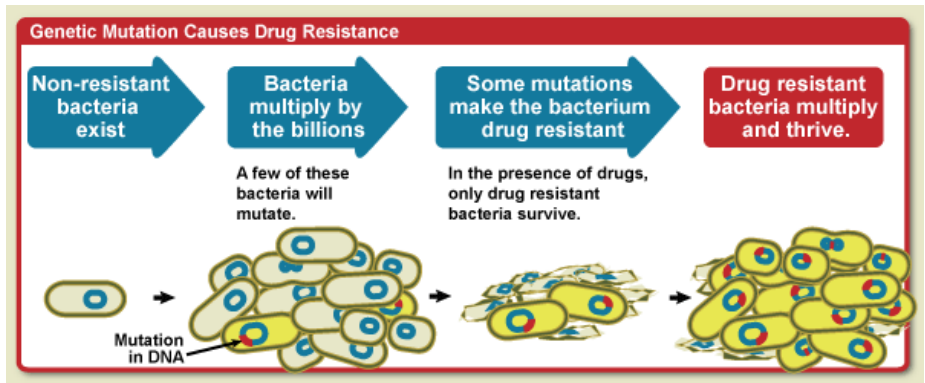
The _____ has two colour variations: greyish-white flecked with black dots and black



Individuals of flecked and dark moth populations fluctuated over relatively short periods that _____ to the amount of _____ in the moth's habitat.

Antibiotic Resistant Bacteria

Some types of bacteria not only pass down their genes when they reproduce, but also can transfer their genes to bacterial cells in their own generation. This form of gene transfer, called horizontal genetic transfer, is one reason that genes for antibiotic resistance spread quickly in bacterial populations.



_____ is the condition of a species that ceases to exist in a chosen geographic area of study, though it still exists elsewhere.

_____ is the termination of a kind of organism or of a group of kinds, usually a species. The moment of extinction is generally considered to be the death of the last individual of the species, although the capacity to breed and recover may have been lost before this point.

Extirpation Example

_____ is also the only place in the world where lemurs are found. However, the fossil record shows that _____ were once widespread throughout Africa.

So why are lemurs no longer present in Africa?

When Madagascar permanently separated from Africa 50 million years ago, monkeys had not yet evolved.

Monkeys do not appear in the fossil record until about 35 million years ago, so they had no way of reaching the island of Madagascar (because the channel between Africa and Madagascar was too wide at that time).

However, _____ eventually took over the niche that lemurs had on the _____



Environmental Conditions and Selective Pressures

Selective pressures by the environment can lead to extirpation and extinction of species.

i.e. Climate Change causing the extinction and extirpation of coral reefs.



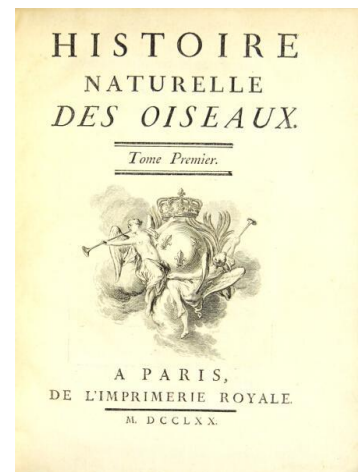
EXIT CARD 13

Evolutionary Theory and Contributors

Plato (427–347 B.C.E.) and Aristotle (384–322 B.C.E.), believed that all life existed in a perfected and unchanging form. This view of life prevailed in Western culture for over 2000 years.

By the sixteenth century the predominant _____ in western culture was that _____

French naturalist **Georges-Louis Leclerc, Comte de Buffon** (1707–1788). In 1749, he published the 44-volume _____, which compiled his understandings of the natural world



In this work, Buffon noted the _____, and speculated that they might have a common ancestor

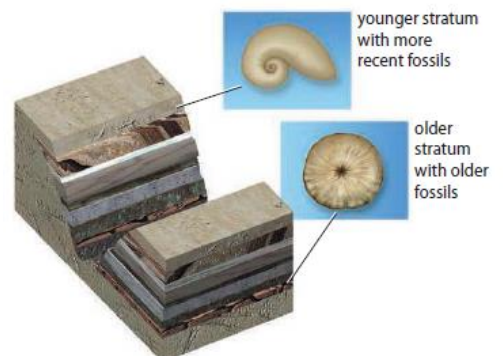
In other writings, Buffon suggested that _____, as was commonly believed.



_____ unearthed the ancient remains of a prehistoric fish called Ichthyosaurus, the specimen looked unlike any animal known to be living during Anning's time.

Anning's discoveries made people question a widely believed idea—that all forms of life came into existence at the same time and had never changed. _____

_____ (1769– 1832) is largely credited with developing the science of paleontology, the study of ancient life through the examination of fossils. Cuvier found that each stratum (layer of rock) is characterized by a unique group of fossil species. He also found that the deeper (older) the stratum, the more dissimilar the species are from modern life. As Cuvier worked from stratum to stratum, **he found evidence that new species appeared and others disappeared over the passage of time. This evidence showed that species could become extinct.** Proposed the idea that Earth experienced many destructive natural events, such as floods and volcanic eruptions, in the past. These catastrophic events, which he called _____, were violent enough to have killed numerous species each time they occurred.



_____ the theory that changes in the earth's crust during geological history have resulted chiefly from sudden violent and unusual events.

The term _____ is often used to describe Cuvier's ideas about the powerful forces that led to the extinction of species in Earth's past.

Scottish geologist _____ (1797–1875) rejected the idea of revolutions. He proposed, instead, **that geological processes operated at the same rates in the past as they do today.** He reasoned that if geological changes are slow and continuous rather than catastrophic, then Earth might be more than 6000 years old. As well, Lyell theorized that **slow, subtle processes could happen over a long period of time and could result in substantial changes.**



CATASTROPHISM

Volcanoes, floods, and earthquakes are examples of catastrophic events that were once believed responsible for mass extinctions and the formation of all landforms.



UNIFORMITARIANISM

Rock strata demonstrate that geologic processes, which are still occurring today, add up over long periods of time to cause great change.



Lyell said that geological processes operated at the same rates in the past as they do today. He _____ Cuvier's idea of irregular, unpredictable, catastrophic events shaping Earth's history.

He proposed the idea of _____, the theory that changes in the earth's crust during geological history have resulted from the action of continuous and uniform processes.

French naturalist _____ (1744–1829) outlined his ideas about changes in species over time. By comparing current species of animals with fossil forms, **Lamarck observed what he interpreted as a "line of descent,"** or progression, in which a series of fossils (from

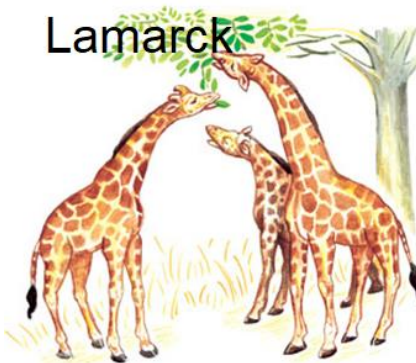
older to more recent) led to a modern species. **He thought that species increased in complexity over time, until they achieved a level of perfection.**

Lamarck also thought that characteristics, such as large muscles, that were acquired during an organism's lifetime could be passed on to its offspring. Lamarck called this concept the inheritance of acquired characteristics.

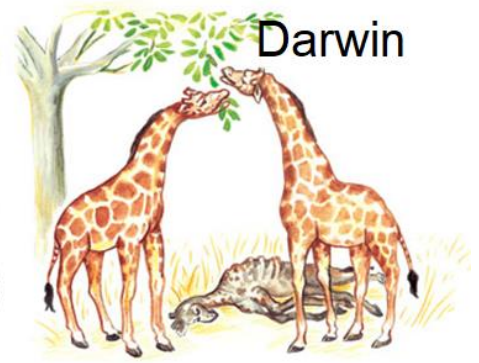
_____ idea that characteristics acquired during an organism's lifetime could be passed down to its offspring THIS IS NOT A THING, YOU DO NOT GAIN SKILLS THAT YOUR PARENTS HAD OR THE TRAITS THEY GAIN THROUGH USE.

if an adult giraffe stretched its neck to reach foliage high in the trees, then it would pass down the trait for a long neck to its offspring

Lamarck



Darwin



Lamarck provided a hypothesis for how the heredity of characteristics from one generation to the next might happen.

More importantly, he noted that an organism's adaptations to the environment resulted in characteristics that could be inherited by offspring.

Darwin

In 1831, 22-year-old _____ left England on the HMS Beagle, a British survey ship.

Charles Darwin was not the only person to organize his and others' observations and ideas into a comprehensive theory to explain how species changed over time.

Darwin called this process _____.

Darwin proposed two main ideas in

_____:

1. _____

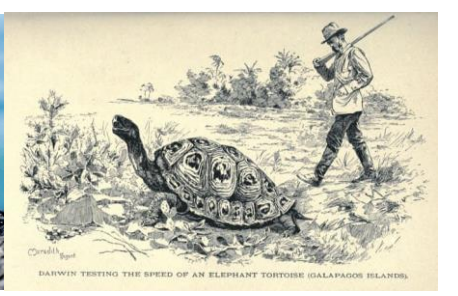
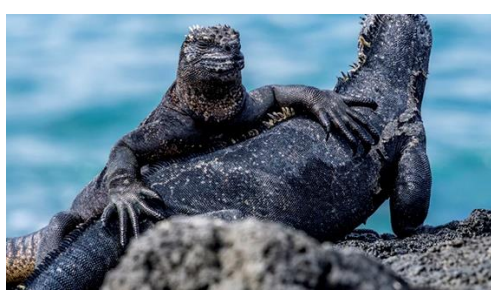
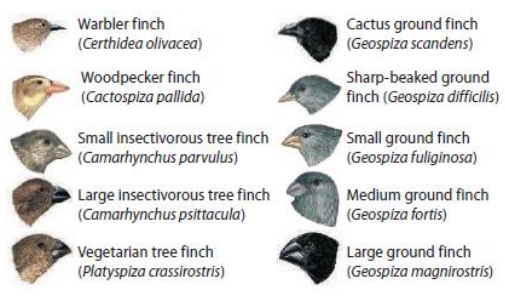
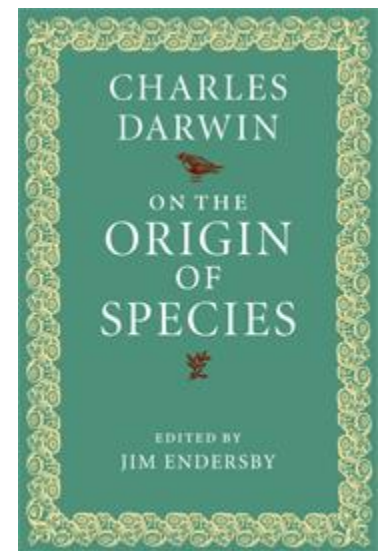
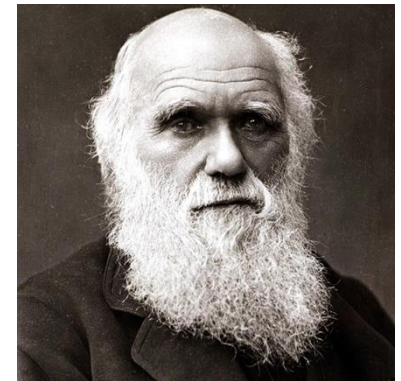
2. _____

Many of Darwin's observations surprised him. For example, he observed _____

_____ on the _____

that looked similar and yet distinct from one another and from any finch species on continental South America. He encountered _____

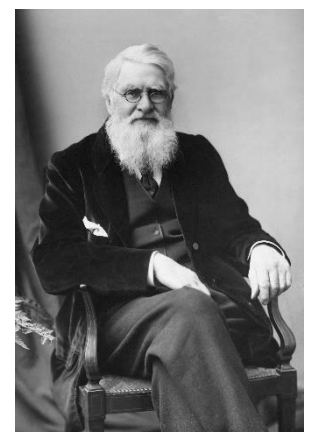
_____.



_____ (1823–1913), another British naturalist, independently reached conclusions that were similar to Darwin's.

As a result of his studies in a group of islands near Indonesia (Maluku Islands), Wallace had reached a conclusion similar to Darwin's. In the paper, Wallace outlined an essentially identical theory of evolution by natural selection.

Charles Lyell presented Wallace's paper and parts of Darwin's unpublished 1844 essay to the scientific community on July 1, 1858.



An essay by economist _____ (1766–1834), called *An Essay on the Principles of Population*, provided them with a key idea.

Malthus had proposed that populations produced far more offspring than their environments (for example, their food supply) could support and were eventually reduced by starvation or disease.

Malthus's vision of struggle and crowding helped Darwin and Wallace reason that _____ for limited resources among individuals of the same species _____ —traits that _____ their chances of _____ to _____.



Darwin's Observations

1. The flora and fauna of the different regions the Beagle visited were distinct from those Darwin had studied in England and Europe. For example, the rodents in South America were structurally similar to one another but were quite different from the rodents Darwin had observed on other continents.

If all organisms originated in their present forms during a single event, Darwin wondered, **why was there a distinctive clustering of similar organisms in different regions of the world?**



Why were all types of organisms not randomly distributed?

2. Darwin observed fossils of extinct animals, such as the armadillo-like glyptodont, that looked very similar to living animals.



Glyptodont, an ancient 4 m, 2 t animal from South America



Modern armadillo from South America (1.5 m)

Why would living and fossilized organisms that looked similar be found within the same region?

3. The finches and other animals Darwin saw on the Galápagos Islands closely resembled animals he had observed on the west coast of South America.

Why did the Galápagos species so closely resemble organisms on the adjacent South American coastline?

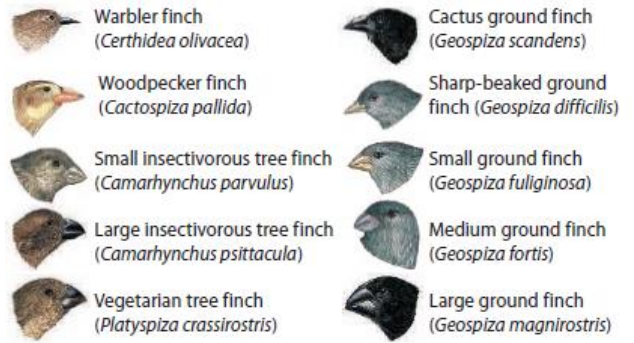


The Galápagos Islands, shown in this satellite image, include more than 20 small volcanic islands located approximately 1000 km off the coast of Ecuador.

4. Galápagos species (such as tortoises and finches) looked identical at first, but actually varied slightly between islands. Each type of Galápagos finch, for example, was adapted to eating a different type of food based on the size and shape of its beak.

Why was there such a diversity of species in such a small area?

Could these species have been modified from an ancestral form that arrived on the Galápagos Islands shortly after the islands were formed?



5. Through his experience in breeding pigeons and studying breeds of dogs and varieties of flowers, Darwin knew that it was possible for traits to be passed on from parent to offspring, and that sexual reproduction resulted in many variations within a species.

Could a process similar to artificial selection also operate in nature?

Activity 16.3

Debating Science

Further Evidence of Evolution

_____ remains or traces of past life preserved in sedimentary rock, which reveal the history of life on Earth

_____ fossils that are known to be common during a particular time, and so indicate the age of the rock they are found in

1. Fossils found in young layers of rock (from recent geological periods and usually closer to the surface) are much more

_____ than fossils found in deeper, older layers of rock.

2. Fossils appear in _____

_____. So, probable ancestors for a species are found in older rocks, which usually lie beneath the rock in which the later species is found.

3. _____

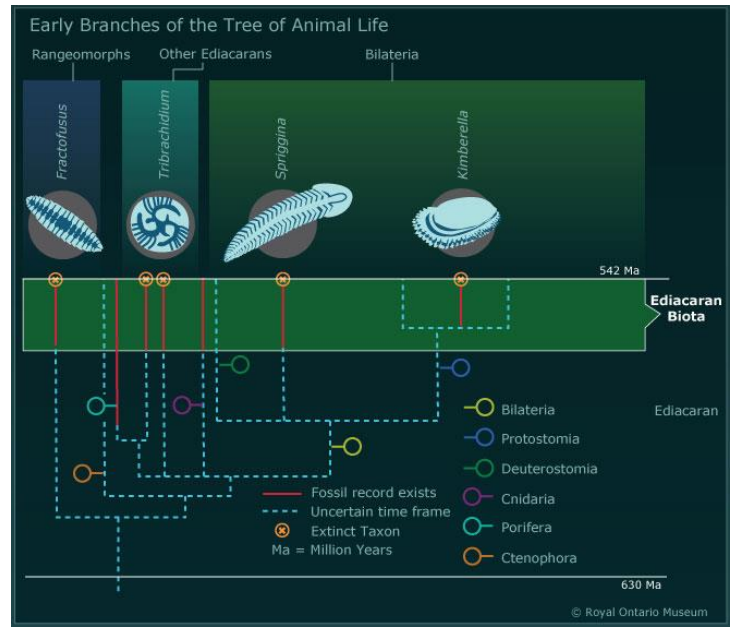
Geologic Time Scale				
Era	Period	Million Years Ago	Major Evolutionary Events	Representative Organisms
Cenozoic	Quaternary	5	Humans evolve	
	Tertiary	65	First placental mammals	
Mesozoic	Cretaceous	144	Flowering plants dominant	
	Jurassic	213	First birds, First mammals, First flowering plants	
	Triassic	248	First dinosaurs	
Paleozoic	Permian	286	Cone-bearing plants dominant, First reptiles	
	Carboniferous	320	Great coal deposits form, First seed plants	
		360	First amphibians	
	Devonian	408	First land plants, First jawed fish	
	Silurian	438	Algae dominant, First vertebrates	
	Ordovician	505	Simple invertebrates	
Cambrian	590	Life diversifies		
	Precambrian	3500	Eukaryotes, Prokaryotes, Life evolves	

The _____ is a geological period that spans 94 million years from the end of the Cryogenian Period 635 million years ago (Mya), to the beginning of the Cambrian Period 541 Mya.

The **Ediacaran Period produced some of the earliest known evidence of the evolution of multicellular animals (the metazoans).**

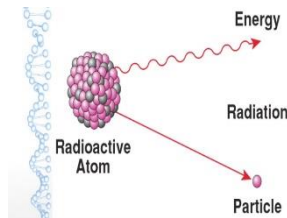
The _____ was the first geological period of the Paleozoic Era, and of the Phanerozoic Eon. The Cambrian lasted 55.6 million years from the end of the Ediacaran Period 541 million years ago (mya) to the beginning of the Ordovician Period 485.4 mya.

The Cambrian Period marks an important point in the history of life on Earth; **it is the time when most of the major groups of animals first appear in the fossil record.** This event is sometimes called the "_____", because of the relatively short time over which this diversity of forms appears.

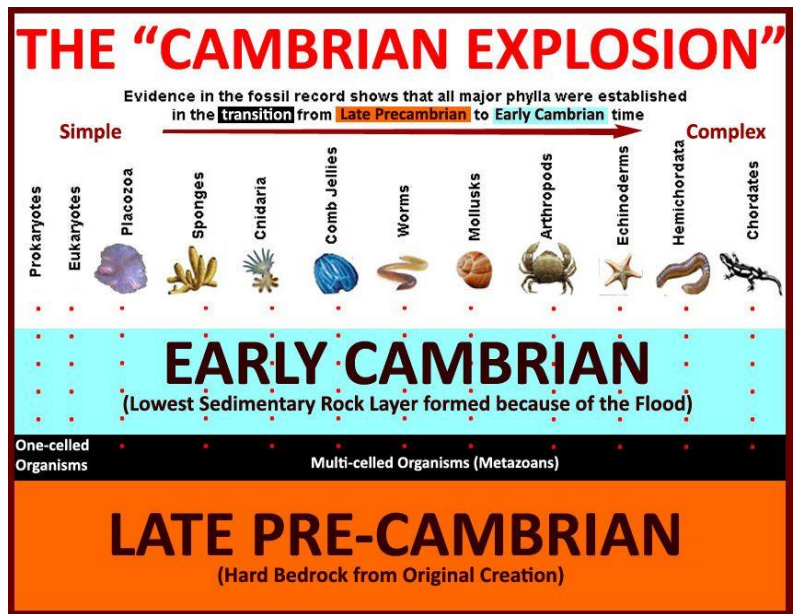


_____ method of dating

rocks and minerals that uses measurements of certain radioactive isotopes to calculate absolute age in years



_____ fossils that show intermediary links between groups of organisms



1. *Pakicetus attocki* lived on land, but its skull had already evolved features characteristic of whales.



2. *Ambulocetus natans* likely walked on land (as modern sea lions do) and swam by flexing its backbone and paddling with its hind limbs (as modern otters do).



3. *Rodhocetus kasrani*'s small hind limbs would not have helped it swim, much less walk.



4. Modern toothed whales

For example, scientists have found fossilized whales that lived 36 to 55 million years ago. These fossils link present-day whales to terrestrial ancestors. The _____ and _____ were ancient whales that had tiny hind limbs, but led an entirely aquatic life. Dorudon was about the size of a large dolphin, about 5 m long. It had a tiny pelvis (located near the end of its tail) and 10 cm legs, both of which would have been useless to an animal that lived an aquatic life. A more recently discovered transitional form, _____, had heavier leg bones. Scientists hypothesize that it lived both on land and in water.

Archaeopteryx show a transitional stage in the fossil record because this species had characteristics of both reptiles (dinosaurs) and birds. Archaeopteryx had feathers, but, unlike any modern bird, it also had teeth, claws on its wings, and a bony tail.

Biogeography

_____ the study of the past and present geographical distribution of species

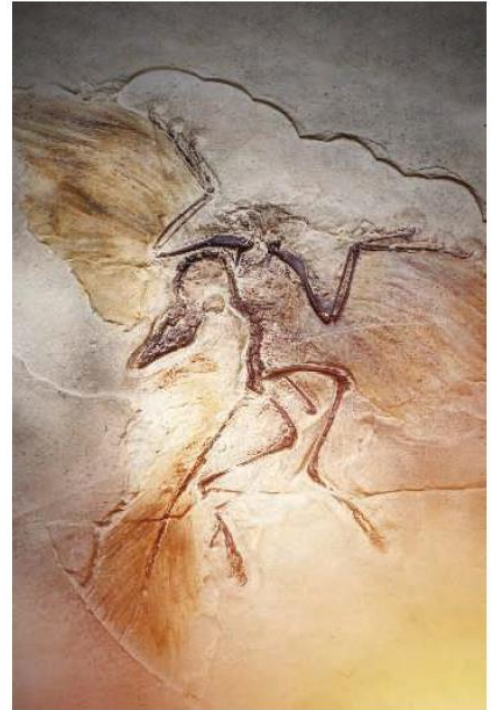


Figure 16.13 *Archeopteryx* had characteristics of non-avian dinosaurs as well as birds. It was probably able to fly.

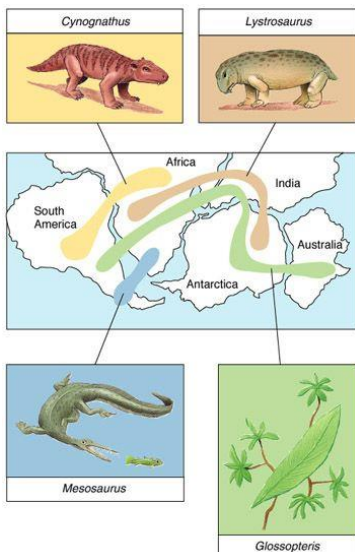
Many of the observations that _____ used to develop their theories were based on biogeography. **Darwin and Wallace hypothesized that species evolve in one location and then spread out to other regions.**

1. Geographically close environments are more likely to be populated by related species than are locations that are geographically separate but environmentally similar.

So, for instance, most species of _____ are native only to the deserts of North, Central, and South America. They are not naturally found in other deserts in the world, such as those in Australia or Africa.

2. Animals found on islands often closely resemble animals found on the closest continent. This suggests that animals on islands have evolved from mainland migrants, with populations becoming adapted

over time as they adjust to the environmental conditions of their new home. For example, **the lizards found on the Canary Islands, off the northwest coast of Africa, are very similar to the lizards found in west Africa.**



3. Fossils of the same species can be found on the coastlines of neighbouring continents. For example, fossils of the _____ have been found in Africa and South America. The theory of plate tectonics explains these observations. The locations of continents are not fixed; continents are slowly moving away from one another. At one time, the continents of Africa and South America were joined in one “supercontinent.”

4. _____

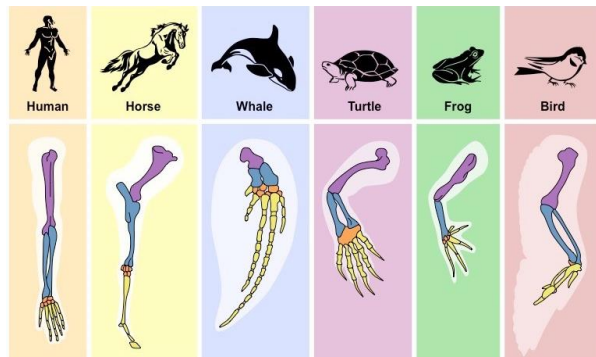


Comparative Anatomy

_____ the comparative study of the body structures of different species of animals in order to understand the adaptive changes they have undergone in the course of evolution from common ancestors.

Despite their different functions, however, all vertebrate forelimbs contain the _____ organized in similar ways.

How is this possible?

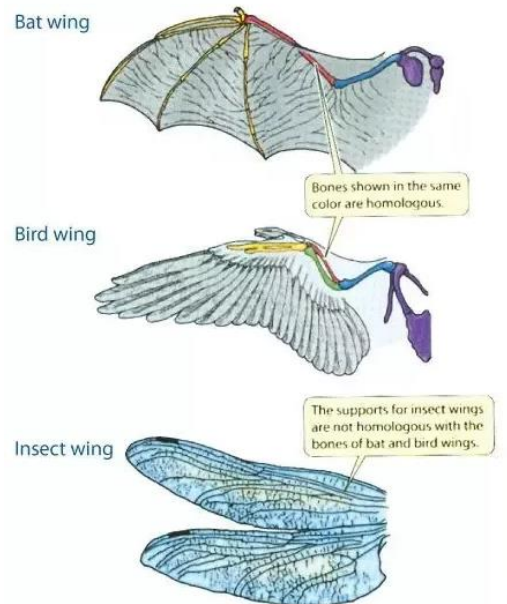


_____ physical features with the same evolutionary origin and underlying structural elements, but that may have different functions

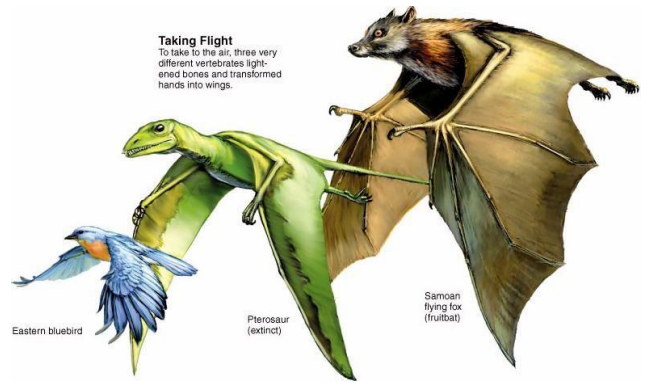
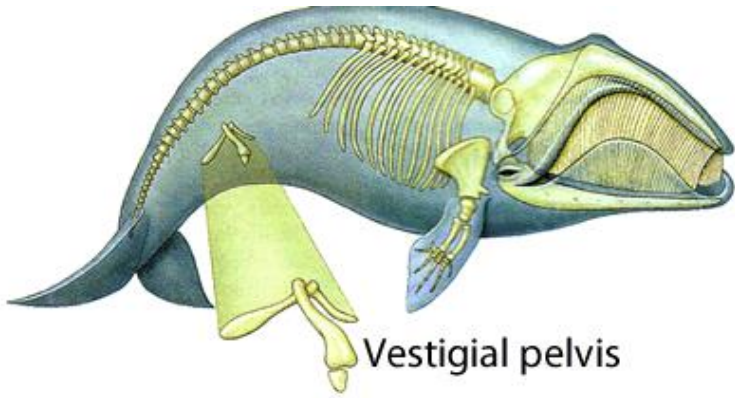
_____ physical features that evolved separately but perform similar functions in different types of organisms

Functional similarity in anatomy, however, does not necessarily mean that species are closely related.

The wings of _____, _____, _____, and _____ are similar in function, but not in structure. (For example, _____ support bird wings, whereas a tough material called _____ makes up insect wings.)



tendency among species that are not closely related to develop similar body plans when living under the same conditions



_____ anatomical features that no longer retain their function. Some species have anatomical features that appear to serve no function, such as _____. Vestigial structures are homologous to functioning structures of other species.

_____. Their small, unused hip bones are homologous to the hip bones that support the hind limbs of other vertebrates.

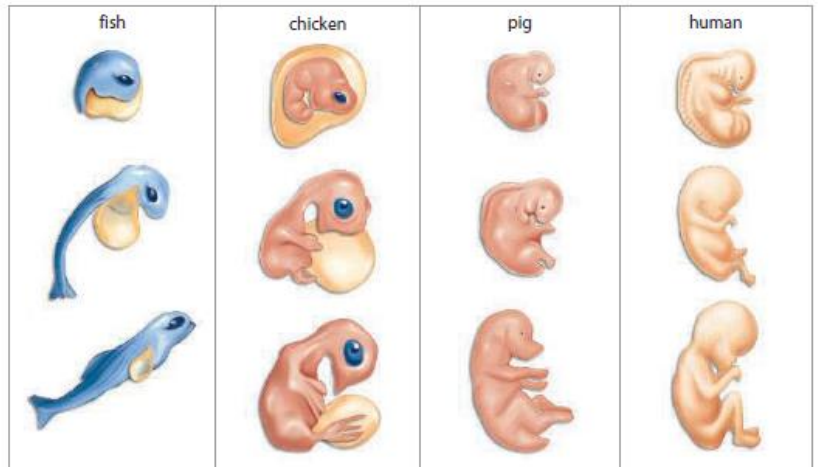
Embryology

The embryos of different groups of organisms exhibit similar stages of embryonic development.

All _____ have paired _____, _____

In _____ and some _____, the pouches develop into _____.

In _____, the pouches become parts of the _____.



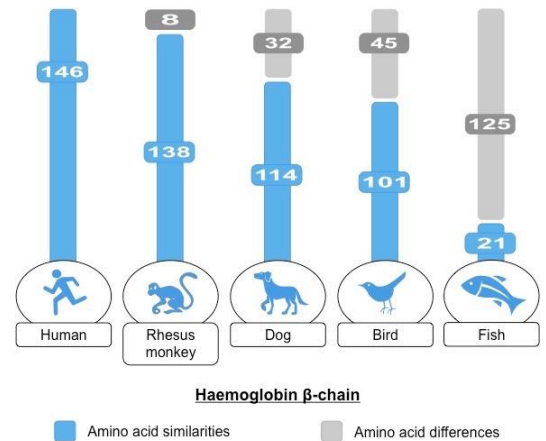
The similarities among embryos in related groups (such as vertebrates) point to a _____.

Molecular Biology and Genetics

The evolutionary relationships among species are reflected in their DNA and proteins.

The field of _____ developed as technologies to identify molecules such as _____ developed.

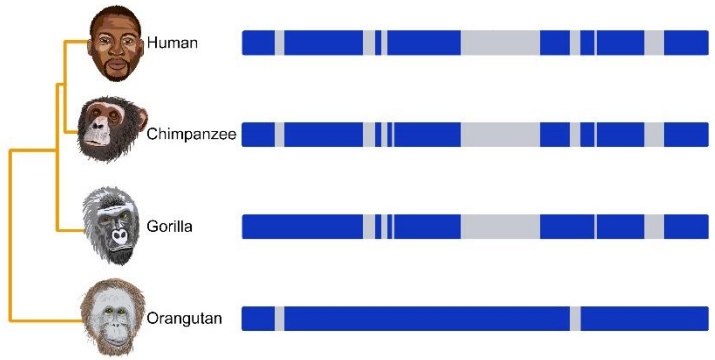
This field has provided evidence that helps to support the idea of common ancestry and evolution through natural selection.



The fact that all organisms use DNA as their genetic material supports the idea that all life has a common ancestor.

Even seemingly unrelated species share some of the same genes. The chimpanzee (*Pan troglodytes*) and the potato (*Solanum tuberosum*), for example, have 2700 genes in common.

Scientists can infer how closely related two species are by comparing sequences in amino acids, RNA, and DNA, or by comparing chromosomes as a whole.



For example, _____ and its chimpanzee counterpart show the same pattern of bands, except for an inverted portion near the centromere. _____

Exit Card 14

The Evolution of New Species

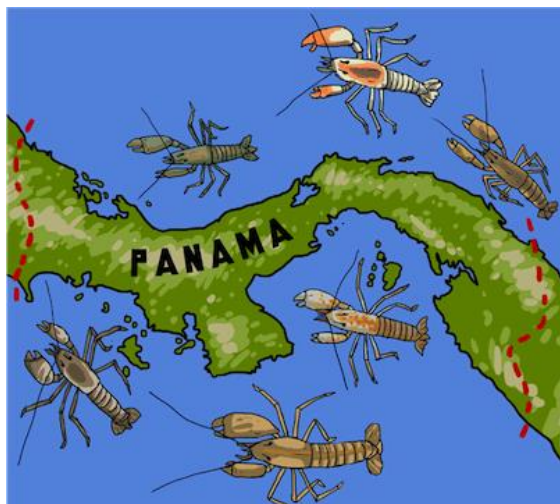
_____ the formation of new species

_____ a new species gradually develops as a result of mutation and adaptation to changing environmental conditions, and the old species is gradually replaced.

The evolution of mammoths followed this pathway. The ancestral mammoth lived approximately 2.6 million to 700 000 years ago. It slowly evolved into the steppe mammoth that lived 700 000 to 500 000 years ago, and finally into the woolly mammoth that lived 350 000 to 10 000 years ago.

_____ (_____) one or more species arise from a parent species that continues to exist.

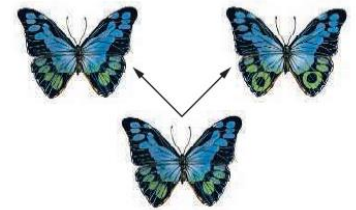
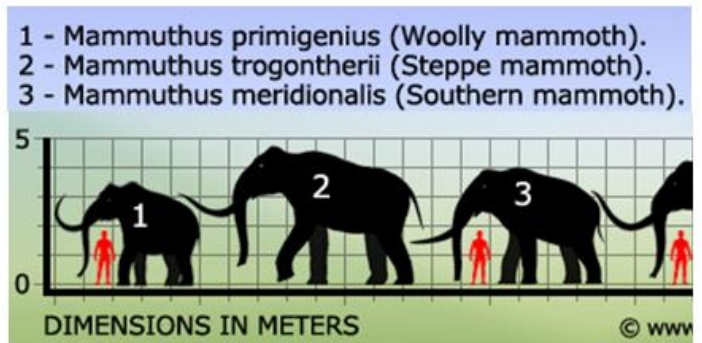
Keeping Populations Separate



_____ feature such as mountain that physically separates populations and so prevents them from interbreeding.

Lava flow may isolate populations, changes in ocean levels may turn a peninsula into an island, or a few colonizers may reach a geographically separate habitat

After a long period of time, speciation will occur. The separated populations will no longer be able to mate and reproduce successfully with other members of the original population.



B Divergence

_____ features of different populations that keep them reproductively isolated, even when they exist in the same geographic area

_____ the inability of a species to breed successfully with related species due to geographical, behavioral, physiological, or genetic barriers or differences.

Scientists studying the _____ hypothesize that many of the species in the lake today originated after the



_____ about 14 000 years ago.

Populations were isolated in these pools of water until the water level rose again. The speciation of cichlids has produced a remarkable variety of cichlids with a fascinating _____, _____, _____.

_____ a mechanism that blocks reproduction from taking place by preventing fertilization.

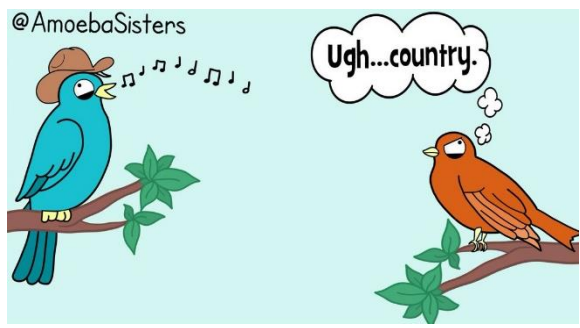
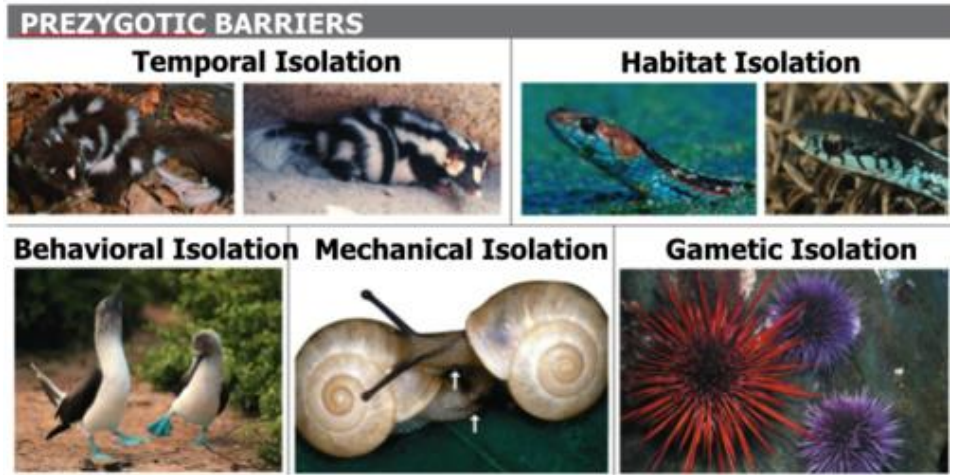
Behavioural isolation

Ecological/habitat isolation

Temporal isolation

Mechanical Isolation

Gametic isolation



_____ biological barrier in which species-specific signals or behaviours prevent interbreeding with closely related species.

Male birds use distinct calls that are recognized by other birds of the same species during their mating season.

Their calls are different enough from the calls of neighbouring

species to provide a biological barrier to reproduction.

Female spiders use pheromones (chemical signals) to attract mates of the same species.

Some male spiders use specific movements to identify themselves to the females.



_____ biological barrier in which different species live in the same general area, but use different habitats, and so rarely encounter each other

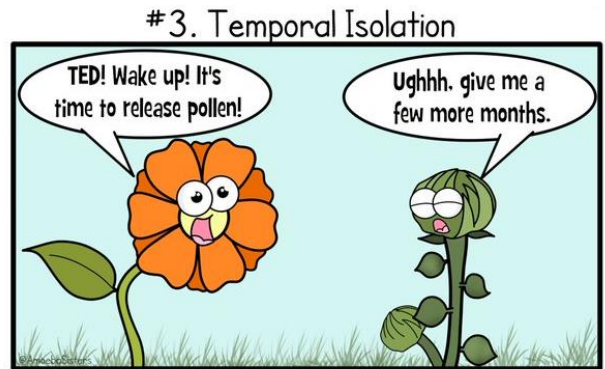
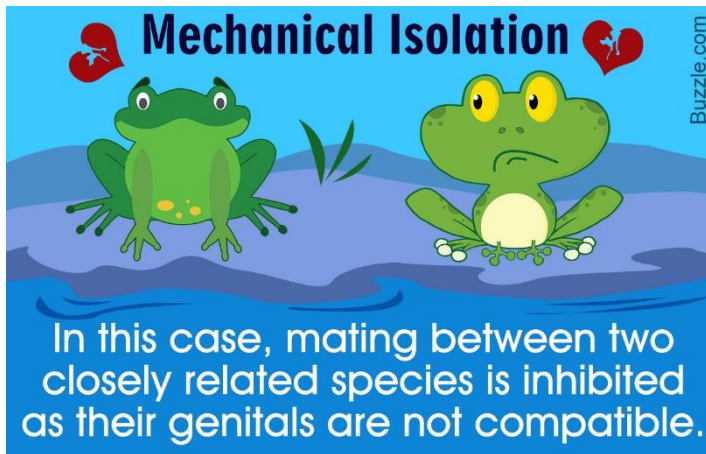


Habitat isolation



The _____ builds nests in brackish waters, where seawater and fresh water mix; the _____ builds nests in fresh water. Habitat isolation is different from a geographical barrier, because there is no physical impediment that keeps the populations apart.

_____ timing barriers that prevent species in the same habitat from interbreeding; species may mate or flower at different times of the day, in different seasons, or in different years



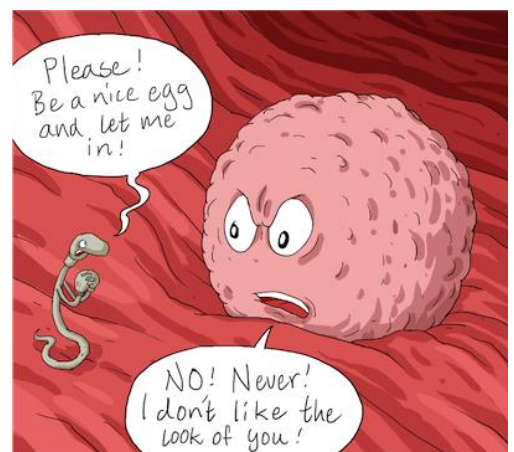
_____ biological barrier in which closely related species have incompatible reproductive structures, and so either cannot mate, or, in the case of plants, cannot be pollinated by the same species of pollinator

Pollen may be carried on the backs or wings of bees and flowers may have different anatomy for pollination.

Insects have very distinct locations of their genital anatomy.

_____ biological barrier, such as a chemical marker on an egg, that prevents eggs and sperm from different species fusing to form a zygote

Many marine animals, including corals, clams, and sea cucumbers, release their gametes into open water. The sperm recognize eggs of their own species through chemical markers on the surface of the eggs. The sperm will not recognize an egg of a different species, and so will not fertilize this egg.



_____ a mechanism that blocks reproduction after fertilization and zygote formation.

Hybrid inviability

Hybrid sterility

Hybrid breakdown



_____ a genetic incompatibility of interbred species that stops development of the hybrid zygote during its development

hybrid embryos between _____ and _____ die in early

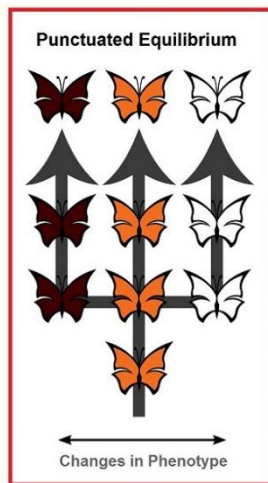
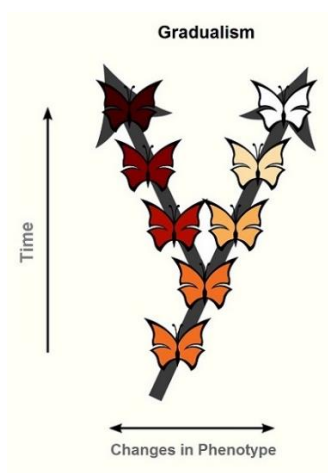
_____ a biological barrier that exists between two species because, although they can mate and produce hybrid offspring, the offspring are sterile

The offspring of a _____ and a _____.

Meiosis fails to produce normal gametes in hybrid offspring.

_____ a biological barrier that occurs when first generation hybrids mate with each other or with an individual from either parent species, and the offspring are either sterile or weak.

The Pace of Evolution



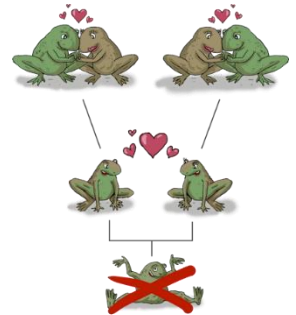
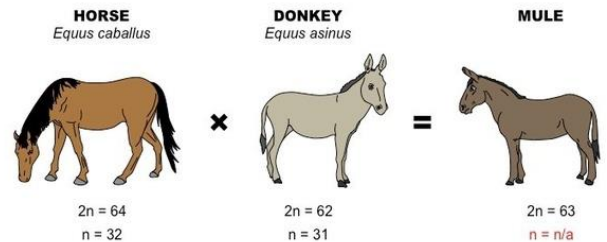
_____ model that describes evolution as slow, steady, and linear, with the accumulation of many small changes producing large changes

According to this model, big changes (such as the evolution of a new species) occur as a result of many small changes.

The fossil record, however, rarely reveals fossils that show this gradual transition but _____.

_____ model that describes evolution as consisting of long periods of stasis, interrupted by periods of rapid change

Evidence in the fossil record that show periods of rapid change happen after mass extinctions.



_____ to evolve together, as occurs with closely associated species so that the evolution of one depends on the evolution of the other

_____ has co-evolved with its only pollinator the _____.

Darwin predicted that it must have evolved along with an insect pollinator that had a tongue long enough to reach the nectar in the orchid's spur.

The giant hawkmoth, endemic to Madagascar, was _____ . Its existence, however, was _____ .



Exit Card 15

Describing Genetic Diversity in Populations

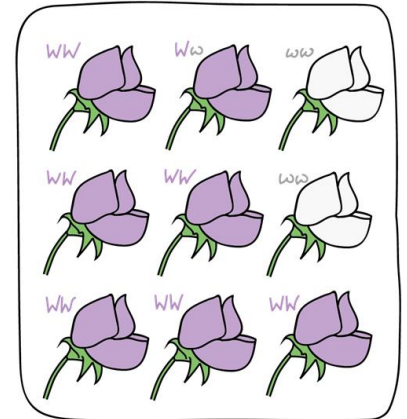
_____ the study of genetic variation in populations

_____ sum of all alleles for all the genes in a population




_____ proportion of a population with a particular genotype, usually expressed as a decimal

_____ proportion of a population with a particular phenotype, expressed as a decimal or percent

_____ rate of occurrence of a particular allele in a population with respect to a particular gene



$p = \text{Frequency of } W = 13/18 = 0.72$
 $q = \text{Frequency of } w = 5/18 = 0.28$

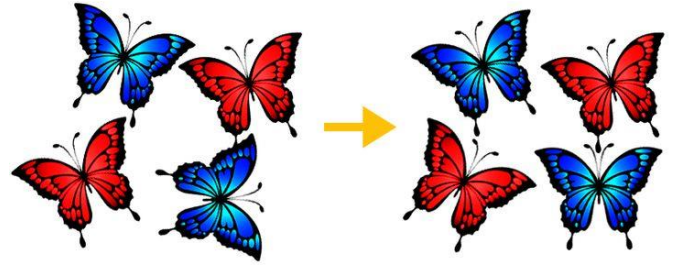
Phenotype			
Genotype	<i>BB</i>	<i>Bb</i>	<i>bb</i>
Number of mice (total = 200)	72	96	32
Genotype frequency	$\frac{72}{200} = 0.36$	$\frac{96}{200} = 0.48$	$\frac{32}{200} = 0.16$
Number of alleles in gene pool (total = 400)	$72 \times 2 B = 144 B$	$96 \times 1 B = 96 B$ $96 \times 1 b = 96 b$	$32 \times 2 b = 64 b$
Allele frequency	$\frac{240}{400} = 0.60$	$\frac{160}{400} = 0.40$	

condition of a gene pool in which allele frequencies remain constant over time, and therefore the population is not evolving

a state where allele frequencies remain the same

Five Conditions of The Hardy-Weinberg principle

1. The population is large enough that chance events will not alter allele frequencies.
2. Mates are chosen on a random basis.
3. There are no net mutations.
4. There is no migration.
5. There is no natural selection against any of the phenotypes.



genetic equilibrium

The Hardy-Weinberg Principle

frequency of homozygous dominant genotype

frequency of homozygous recessive genotype

frequency of heterozygous genotype

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

Solving Hardy-Weinberg Problems

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

$$p + q = 1$$

P^2 = frequency of homozygous dominant genotype (BB)

q^2 = frequency of homozygous recessive genotype (bb)

$2pq$ = frequency of heterozygous genotype

p = frequency of dominant allele

q = frequency of recessive allele

Sixteen percent of a **population** is unable to taste the chemical PTC. These non-tasters are recessive for the tasting gene

The word **population** means P^2 , $2pq$, or q^2

The question is telling us $q^2 = 0.16$ always change to decimal form.

Always solve for p and q, in this case $\sqrt{q^2} = \sqrt{0.16} = 0.4$ which means $p = 0.6$

- 1.) What percentage of the population are tasters?
- 2.) What is the frequency of the dominant allele and recessive allele?
- 3.) What percentage of the population are heterozygous for the trait?

The delta-32 mutation, a **recessive gene**, gives humans protection from HIV infection. The **allele frequency** for a town in Sweden is 20%.

The question is telling us $q = 0.2$

So $p = 0.8$

- 1.) What percent of the population have two copies of the gene and are therefore immune to HIV?
- 2.) What percent of the population are less susceptible to HIV because they are heterozygous?

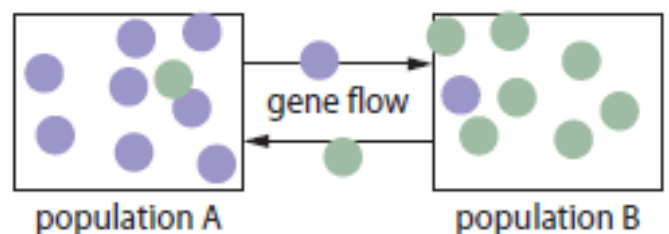
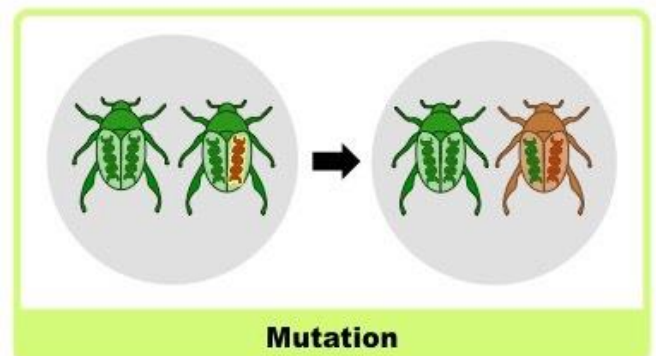
Investigation 17.B

Exit Card 16

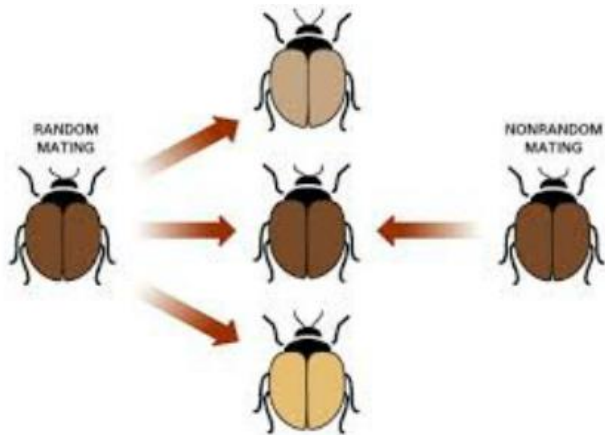
Causes of Gene Pool Changes

_____ an inheritable mutation has the potential to affect an entire gene pool. Recall that while most mutations are neutral, some are harmful and a few are even beneficial.

_____ net movement of alleles from one population to another due to the migration of individuals



mating among individuals that prevents those with particular phenotypes from breeding, as in mate selection or inbreeding



_____ a special case of natural selection in which a particular phenotype improves an individual's chances of obtaining a mate – a form of non-random mating

Sexual selection generally involves competition among males through combat (as with rutting woodland caribou) or visual displays to females. A male ruffed grouse (*Bonasa umbellus*), for example, attempts to attract females by displaying—fluffing up his neck feathers and rapidly beating his wings to produce a drumming sound.



self-fertilization



_____ occurs when closely related individuals breed together. – also non-random mating

An extreme example of inbreeding is the self-fertilization of some flowers.

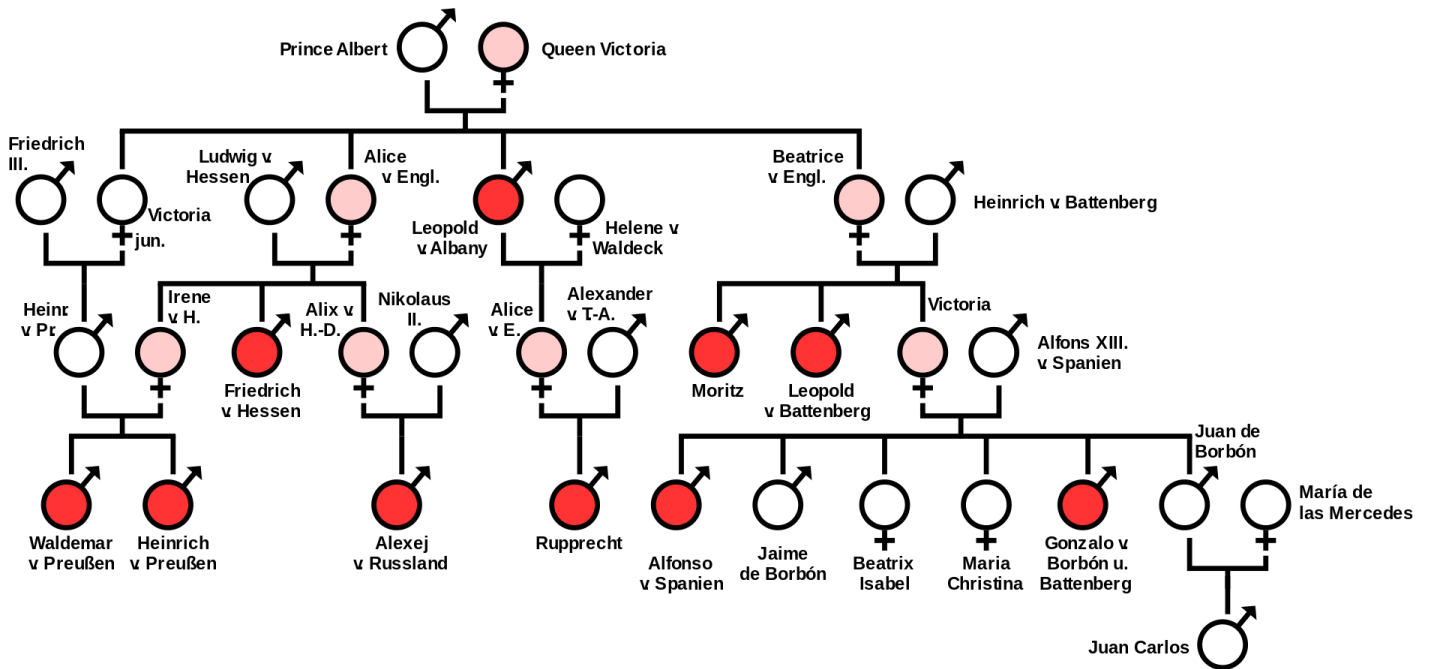
Since close relatives share similar genotypes, inbreeding increases the frequency of homozygous genotypes.

As homozygous genotypes become more common, harmful recessive alleles are more likely to be expressed.

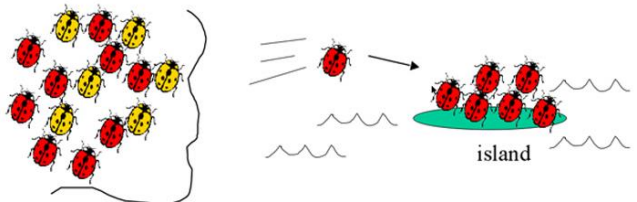
Inbreeding can also have a positive effect on a population, however. If homozygous recessive individuals fail to breed, and there are fewer heterozygous individuals each generation, harmful recessive alleles will be eliminated from the gene pool over time

The Royal Family - Hemophilia

The presence of hemophilia B within the European royal families was well-known, with the condition once popularly known as "the royal disease".



_____ change in allele frequencies (gene pool) in a small breeding population due to chance events



_____ gene pool change that occurs when a few individuals start a new, isolated population



_____ gene pool change that results from a rapid decrease in population size

WE DID THESE EARLIER – REMEMBER FROM BEFORE

_____ a form of natural selection that favours an intermediate phenotype and acts against extreme versions of the phenotype.

_____ a form of natural selection that favours the phenotype at one extreme over the other

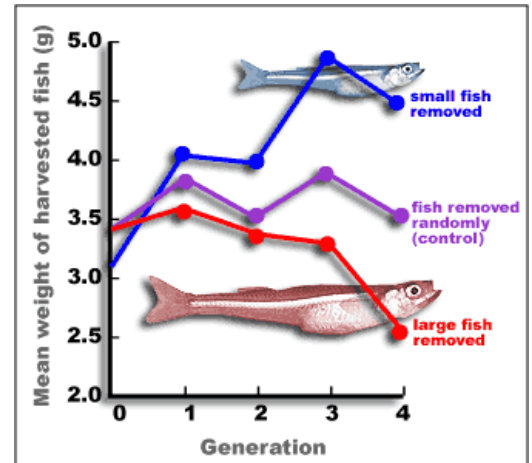
_____ a form of natural selection that favours the extremes of a range of phenotypes over intermediate phenotypes, and may eliminate intermediate phenotypes from the population

How Humans affect genetic diversity of Populations

Human activities can affect the genetic diversity of populations in various ways.

- commercial fishing
- habitat loss
- invasive species
- over harvesting
- dam/ road construction
- climate change
- selective hunting
- insecticide/ herbicide use
- antibiotic/antimicrobial cleaner use

Due to genetic drift each population will likely have little genetic diversity within it.



_____ - For many marine species, fishing probably has the greatest impact of any human activity on the loss of within-species diversity, both within and among populations.

Net mesh size/type can determine who is caught and who escapes

Method of fishing can determine who is caught and who survives

_____ - degradation of habitat will eventually lead to less genetic diversity

Any organisms that cannot withstand the change will die off leaving only a specific population to reproduce

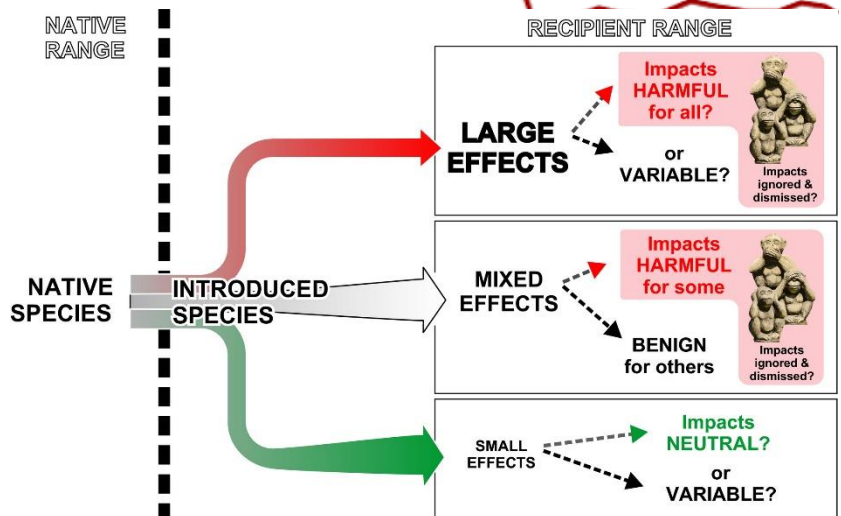
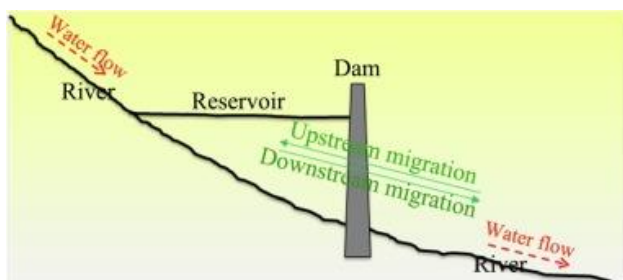
_____ - move into an area and then the natural populations of some other organisms drop because they cannot handle the change.

Often causes loss of genetic diversity

Usually transported to a new area accidentally by humans

_____ - catching or harvesting too much of a resource can lead to loss of genetic diversity.

_____ / _____ - Creates a barrier which stops individuals from mixing with one another.



CLIMATE CHANGE AND LOCAL COMMUNITIES

EFFECTS ON MARINE BIODIVERSITY

OCEAN TEMPERATURE INCREASE



As climate change has warmed the Earth, oceans have been increasing their temperature.

OCEAN ACIDIFICATION



Increasing amounts of carbon dioxide (CO₂) in the oceans combined with seawater produces carbonic acid, increasing the acidity of the water.

SEA LEVEL RISE



Climate change is causing the oceans to heat up, melting polar glaciers, resulting in rising sea levels.

CHANGES IN OCEAN CURRENTS



Increasing ocean temperatures and significant amounts of melting fresh water may result in a slowing of the ocean conveyor belt, altering oceanic current patterns, changing global weather conditions and disrupting marine food webs.

EXTREME WEATHER EVENTS



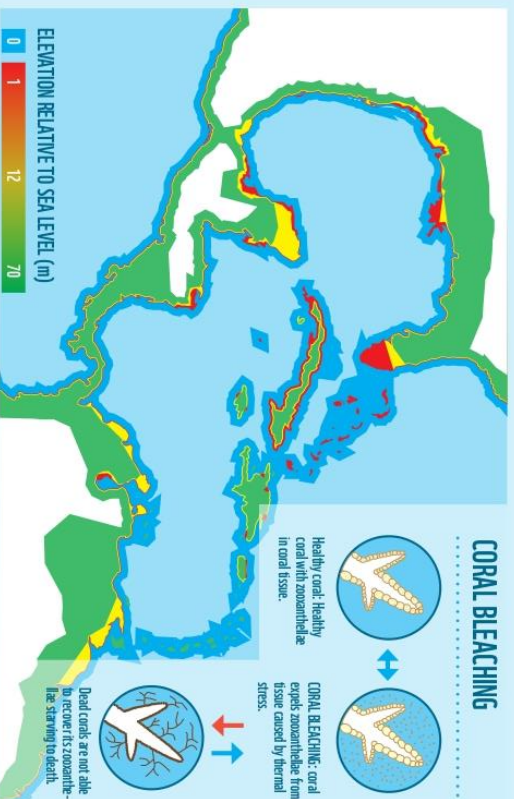
Increasing sea surface temperatures increase evaporation and atmospheric moisture, creating and facilitating environmental conditions for ocean storms to escalate into larger and more powerful systems.

Climate change is affecting the world's oceans modifying their temperature, nutrient supply, water chemistry, wind systems, and ocean currents, dramatically impacting marine biodiversity. The situation is no different in the Mesosamerican Reef, the second largest reef in the world.

Climate change is exacerbating anthropogenic (e.g., water pollution, land run off, overfishing) and natural (e.g., storms, coral disease) threatening the heart of Caribbean culture and economies.

VULNERABILITY TO SEA LEVEL RISE

- Numerous model predictions foresee a sea level rise of 1 additional meter by 2100, which would displace millions of people and would cause bilionnaire losses in infrastructure.



IMPACTS ON BIODIVERSITY

MANGROVES

- Redistribution of mangroves due to increases in temperature and rising seas.
- Damage and loss of mangrove forests by more action and strong winds, previously sheltered by coral reefs.

SEA GRASS BEDS

- Alteration of growth rates due to increasing sea surface temperature.
- Redistribution of sea grasses causing rising seas, increasing sea water temperature, salinity and fresh water regime changes.
- Reduction in plant productivity as a result of increased water depth, limiting the amount of light, water motion and tidal circulation.

CORAL REEFS

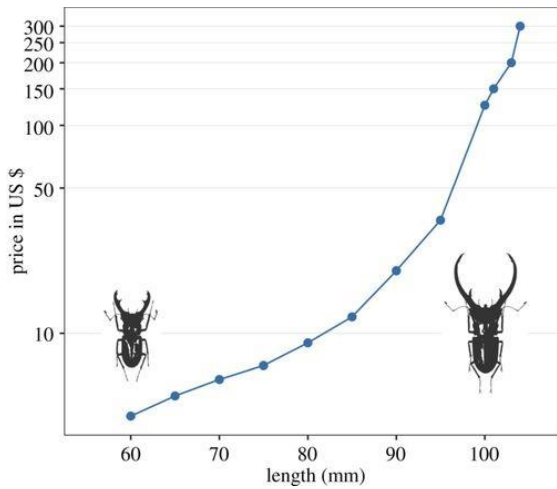
- Coral bleaching and mortality promoted by increasing sea surface temperatures.
- Coral loss due to the skeleton weakening and reduced growth rate of their calcium carbonate skeleton caused by ocean acidification.
- Degradation of reefs caused by an increase in the severity and frequency of storms and hurricanes.

MARINE TURTLES

- Reduction and lack of nesting habitats due to sea level rise and beach erosion.
- Higher sand temperatures can skew hatching sex ratios favoring females, compromising species survival, as sand temperature plays a critical role in defining sea turtle sex.
- Reduction of foraging sites and prey availability as a result of coral bleaching and sea grass mortality.

SHARKS

- Lack of food sources may induce sharks to change their geographical distribution and migration patterns, increasing their interactions with humans.
- Degradation and loss of nesting, nursery and foraging areas (mangroves, sea grasses, coral reefs) critical for sharks survival and development.



When selective hunting the trait that is being chosen is at risk of being lost, this leads to biodiversity loss.

use

Insecticides or herbicides target specific organisms or traits and eliminate them.

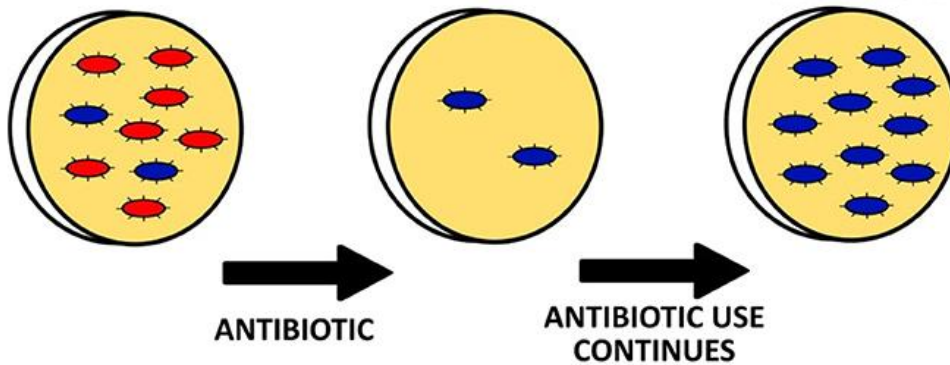
DECREASES BIODIVERSITY

Pesticides have been linked to declines in bees and pollinators, beneficial insects, birds, mammals, aquatic animals and non-target plants etc.

Initially, few bacteria have the antidote (antibiotic resistance): blue bacteria.

Only the bacteria that have the antidote will survive.

Soon, the bacteria that survived will multiply and form an adapted bacterial population where **everyone has the antidote!**



If different antibiotics are indiscriminately used in human and animal health, discarded into the environment, soon several bacteria will suffer the same process described above, acquiring the antidote to different antibiotics, becoming **superbugs!**

STSE Biotechnology and Gene Pools

Test