Biology Unit 8 Evolution

8:1 Life comes from Life

bio – life genesis – to create a – against

BIOGENESIS: living organisms come from other living organisms

ABIOGENESIS (spontaneous generation): the idea that living organisms arose from nonliving materials

EX: decaying meat produced maggots and flies, mud turned into frogs

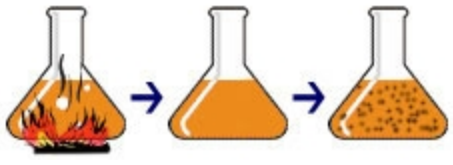
JOHN NEEDHAM: English scientist whose experiments supported abiogenesis

Needham's Experiment

1. Different meat and vegetable broths were boiled a FEW minutes, then the open flasks were cooled to room temperature.
2. Next the flasks were LOOSELY sealed.
3. After a few days Needham viewed the broths with a microscope and saw many microbes.
4. Needham concluded since boiling killed microbes those found after boiling formed spontaneously.

Needham's Flaws

1. Broth was not boiled long enough to kill all the microbes.
2. Because they were not tightly sealed, new microbes could enter flasks.



These flaws allowed Lazzaro Spallanzani to challenge Needham's conclusion.

LAZZARO SPALLANZANI: Italian scientist and biogenesis supporter who tried to disprove Needham's conclusions.

Spallanzani's first experiment

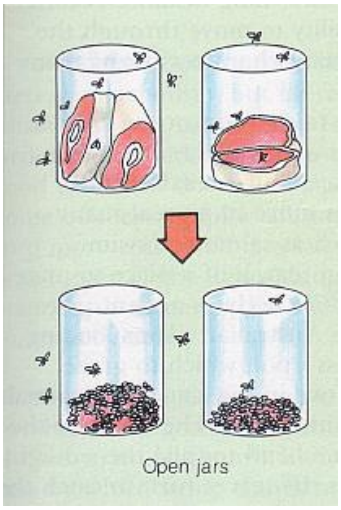
1. Tightly sealed flasks of broth were boiled for one hour.
2. After several days, microscopic examination showed no microbes in the broth.
3. Spallanzani concluded he had disproved Needham.

Abiogenesis supporters said that boiling destroyed the "vital force" or "active principle".

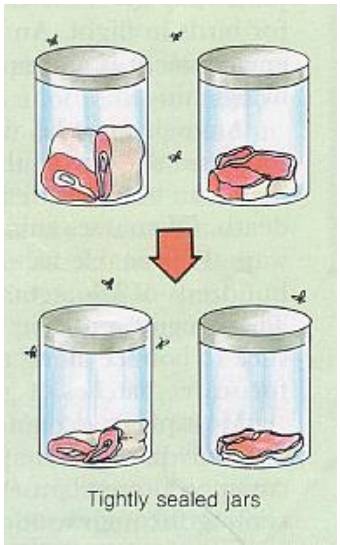
Francesco Redi and Louis Pasteur did experiments to disprove spontaneous generation.

REDI'S FIRST EXPERIMENT

Hypothesis – Rotting meat will not turn into maggots or flies.



Control sample – 4 clean jars containing 4 types of meat, NO COVER ON JARS.



Experimental sample – 4 clean jars containing 4 types of meat, JARS SEALED WITH LIDS.

Experimental factor(s) – no flies could enter experimental jars, also no air could enter.

Results – Maggots formed in control (open) jars, no maggots formed in experimental (sealed) jars.

Conclusion – Redi concluded maggots came from eggs laid by flies in the open jars.

Supporters of abiogenesis said Redi's first experiment was faulty due to 2 experimental factors and that air had to circulate in the jars to allow the meat to change to maggots.

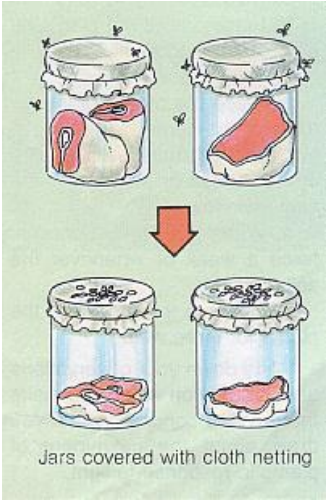
REDI'S SECOND EXPERIMENT

Hypothesis and Control sample – same as first

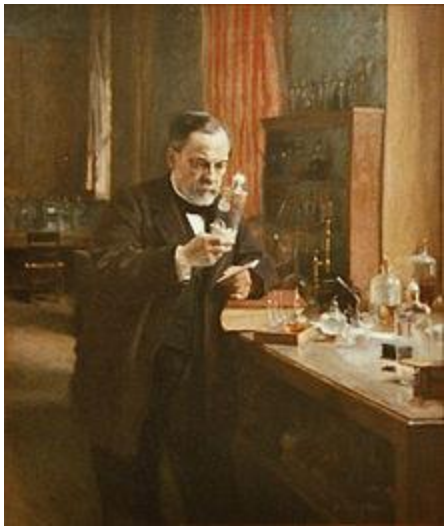
Experimental sample – 4 clean jars containing 4 types of meat, jars covered with gauze.

Results – maggots in open jars, no maggots in covered jars.

Conclusion – flies produce maggots (fly larvae)



Even after Redi disproved abiogenesis of multicellular organisms, some scientists still tried to prove microorganisms were produced by abiogenesis because with microscopes they saw microbes in broth and sugar solutions.



LOUIS PASTEUR: French chemist whose experiments completely disproved spontaneous generation of organisms of all sizes

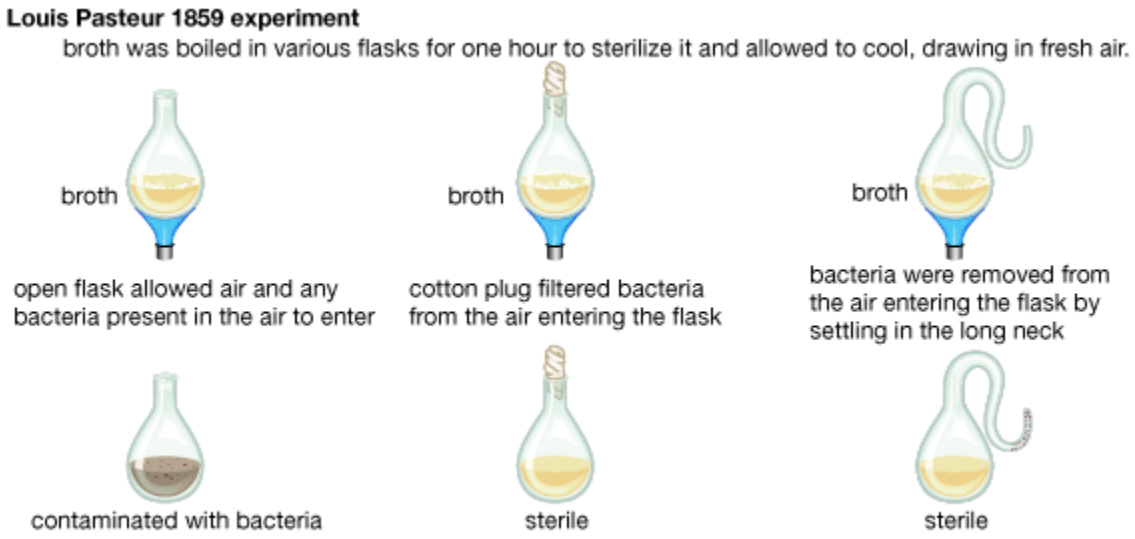
Pasteur hypothesized microbes were found in air on dust particles.

Pasteur's first experiment

1. Sealed flasks of broth were boiled long enough to kill all microbes.
2. Flasks were opened in different areas where the amount of dust in the air varied.
3. After microscopic examination a few days later, more microbial later the flasks opened in dusty areas showed growth than those opened in less dusty areas.

Pasteur's second experiment

1. Broth was placed in S flasks and the necks of the flasks were bent into different shapes.
2. Flasks were boiled, killing microbes and forcing air out of the flasks, which were left open.
3. Air re-entered flasks as they cooled. If dust could fall into the broth microbes grew. If dust could not enter the curved neck of the flask no microbes grew.



8:2 What is Evolution?

EVOLUTION: changes that occur in populations of organisms over time

Individual organisms grow and develop, but they do not evolve. Populations can evolve over time.

POPULATION: individuals of the same species that live in the same place

SPECIES: organisms of the same kind that are able to interbreed and reproduce

Populations exist over long periods of time, much longer than individual organisms in the population.

The process of evolution involves changes in populations usually over extremely long periods of time. Evolution has occurred on Earth over many millions of years.

About 200 to 300 million years after Earth cooled enough to

carry liquid water; cells similar to BACTERIA were common. These bacteria had to be anaerobic (without Oxygen) and photosynthetic (using the sun to get food).

The rise of oxygen drove some life forms to extinction; other life forms evolved new more efficient metabolic pathways that used oxygen for respiration.

8:3 Scientists that influenced Darwin

The person who contributed the most to our understanding of evolution was Charles Darwin.

JAMES HUTTON: proposed that life on Earth was shaped by Geological forces such as erosion, earthquakes, and volcanoes

- Occurred slowly over long periods of time
- Earth is millions of years old
- His idea is called Gradualism

CHARLES LYELL: proposed that the geological processes still occurring today have slowly shaped Earth's features

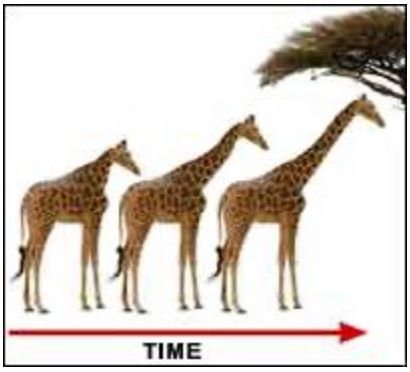
- Thought that Earth was millions, not thousands of years old
- His idea is called Uniformitarianism

GEORGE CUVIER: studied fossils in sedimentary rock

strata of Paris and found some species completely disappear in more recent layers

- His idea is called Catastrophism

<u>JEAN BAPTISTE LAMARCK:</u> French biologist that proposed that individuals could acquire traits during their lifetimes as a result of experience or behavior then could pass on those traits to offspring



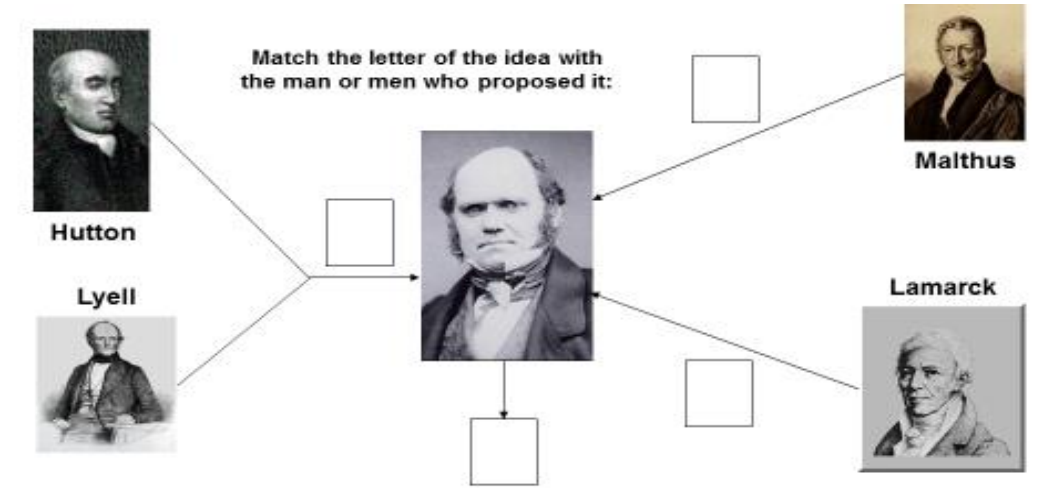
- His idea is called the Inheritance of Acquired Characteristics or Law of Use and Disuse
- Example: Lamarck believed that the long necks of giraffes evolved as generations of giraffes reached for higher leaves. According to his belief, if you dye your hair blue during your life, you could pass on a trait for blue hair to your offspring.
  - Was this idea correct?
  - Correct in that organisms adapt BUT very incorrect because Lamarck did NOT know how traits were inherited (by genes, not use)

<u>THOMAS MALTHUS:</u> observed that babies were being born faster than people were dying; reasoned that if human population continued to grow, sooner or later there would be insufficient space and food

- His idea is called Struggle for Existence

Darwin realized:

- Malthus's principles were visible in nature because plants and animals produce far more offspring than can be supported
- Therefore, most plants and animals die. If they didn't Earth would be overrun.
- Living things must compete for resources-food, shelter, space, and reproductive mates



8:4 Changes in Genes

GENE: enough DNA to make one protein, determining the traits of living things.

If the population's gene pool changes, then the species evolves.

MUTATION: a change in a gene

Two Types of Mutations:

1. Changes in genes in body cells: can affect the organism itself, but cannot be passed to sexually produced offspring.
2. Changes in genes in gametes (egg and sperm): do not affect the parent organism itself, can be passed to sexually produced offspring

Not all mutations are bad. They can result in a trait that improves an organism's chance for survival. If an animal lives longer, they reproduce more, and the favorable mutation is passed to offspring. This results in Evolution.

Mutations occur very rarely, so populations evolve slowly.

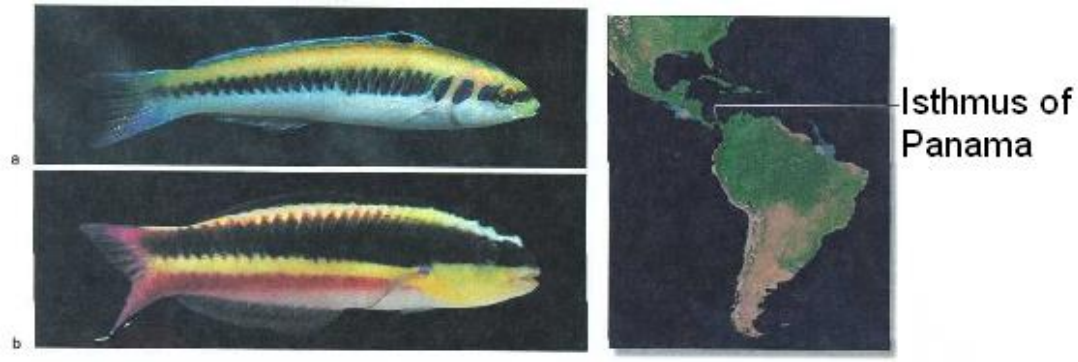
8:5 Changes in a Population's Environment

ADAPTATION: traits that allow organisms to survive in certain environments

If a population's environment changes, members of the population that have certain adaptations are more likely to survive and pass on their genes (and the adaptations/traits caused by those genes) to their offspring.
Adaptations that help the organism survive become more common and the population evolves.

GEOGRAPHIC ISOLATION: the separation of a population into two populations that have no contact with each other, caused by a change in the environment

EX: A barrier, such as a canyon or river, may form and divide a population in two.



(A) Blue-headed wrasse (Atlantic side of Isthmus) and (B) Cortez rainbow wrasse (Pacific side of Isthmus) are related by descent from a common ancestral population that split when the Isthmus formed.

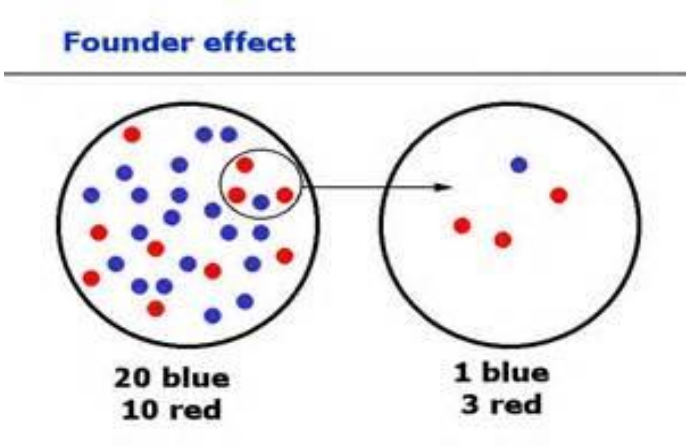
GEOGRAPHIC ISOLATION is one way that speciation can occur. SPECIATION is evolution of a new species.

REPRODUCTIVE ISOLATION: formerly interbreeding organisms that can no longer mate and produce fertile offspring

BEHAVIORAL ISOLATION: compatible mating seasons fall at different times of the year.
Example: The wood frog usually breeds in early April, and the leopard frog usually breeds in mid-April.

Populations may also divide when some members move out of the area. The newly founded population is likely to have very different gene frequencies and less genetic variation than the original larger population because of sampling error.

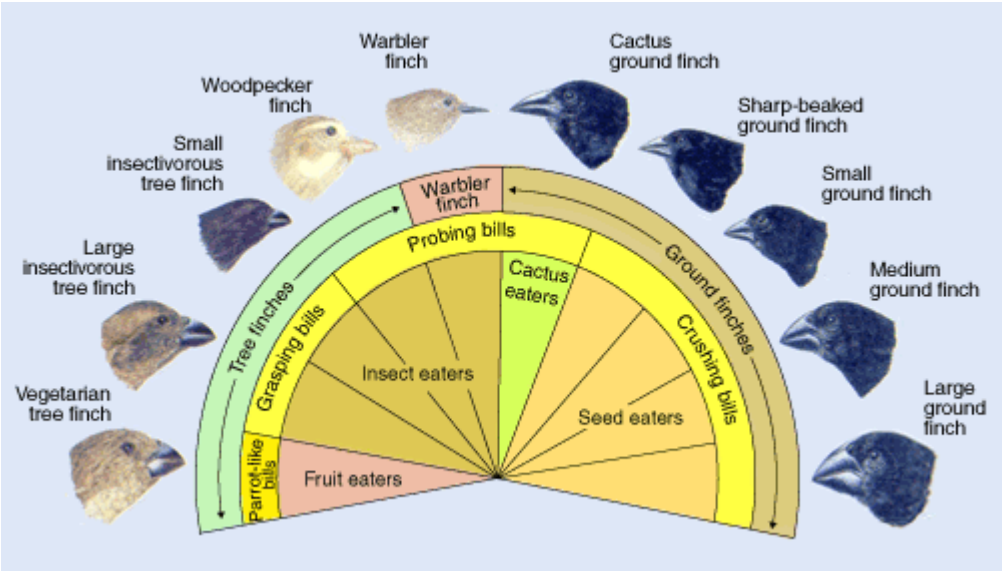
This is known as GENETIC DRIFT and the new population is a result of the FOUNDERS EFFECT.



Over time, different mutations may form in each population, so the populations would have different gene pools and different traits or adaptations.

Eventually, the populations may form different species.

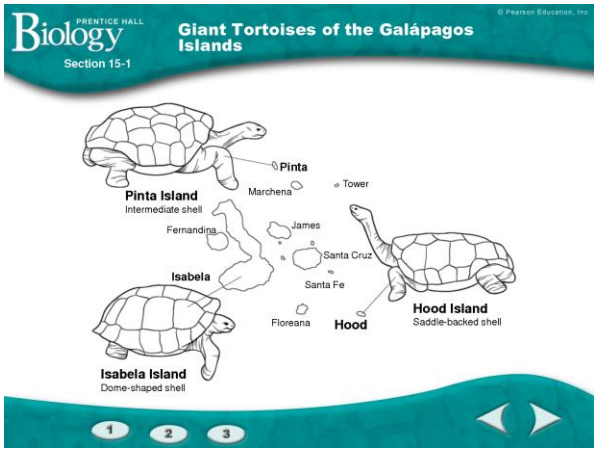
DIVERGENT EVOLUTION: process in which the descendants of a single ancestor diversify into species that each fit different parts of the environment



- Example:
  - All of the bird species pictured above evolved from a common ancestor

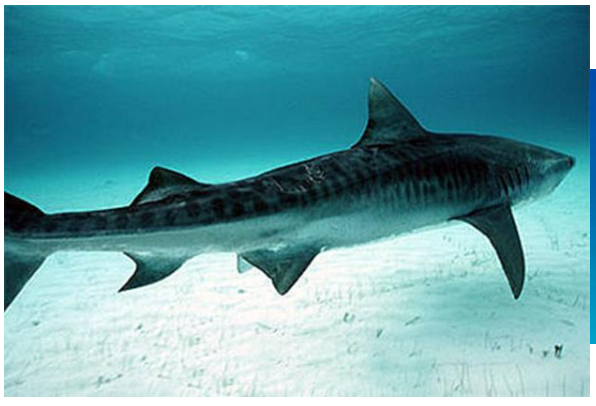
- The populations were separated from each other (geographic isolation)
- Types of food available drove those with specific beak shapes to live longer and reproduce
- Darwin used “Descent with Modification” to describe the process of evolution

- Example: Tortoises adapted to different habitats as they spread from the mainland to different islands



CONVERGENT EVOLUTION: process by which different species evolve similar traits

- Happens when different organisms evolve in different places or at different times but in ecologically similar environments; allows organisms to look similar
- Allows organisms to look similar because their environments are similar
- Example: shark-fish and dolphin-mammal



8:6 What is the Theory of Evolution?

SCIENTIFIC THEORY: a generally accepted and well-tested scientific explanation that no evidence contradicts

Theories can be changed, as scientists find new evidence.

HYPOTHESIS: a testable explanation of a question or a problem

CHARLES DARWIN: British scientist whose studies of fossils and different species support the theory of evolution

- Traveled on the H.M.S. Beagle
- Noticed that locations of similar related organisms around the world have similar body forms and occupy similar habitats but are on different continents

DARWIN'S TWO THEORIES:

1. DESCENT WITH MODIFICATION: the theory that more recent species of organisms are changed descendants of earlier species that are now extinct
   - Example: present organisms are related to past organisms
2. NATURAL SELECTION: the process by which organisms best suited to the environment survive, reproduce, and pass their genes to the next generation.

How does evolution occur through natural selection?

1. Organisms produce more offspring than can survive.
2. Individual organisms in a population have slight variations or adaptations.
3. Individuals struggle to survive, those with adaptations best suited to the environment are more likely to survive.
4. Survivors pass on genes for the adaptations to their offspring.
5. Gradually, the population changes or evolves.

Example of Natural Selection:

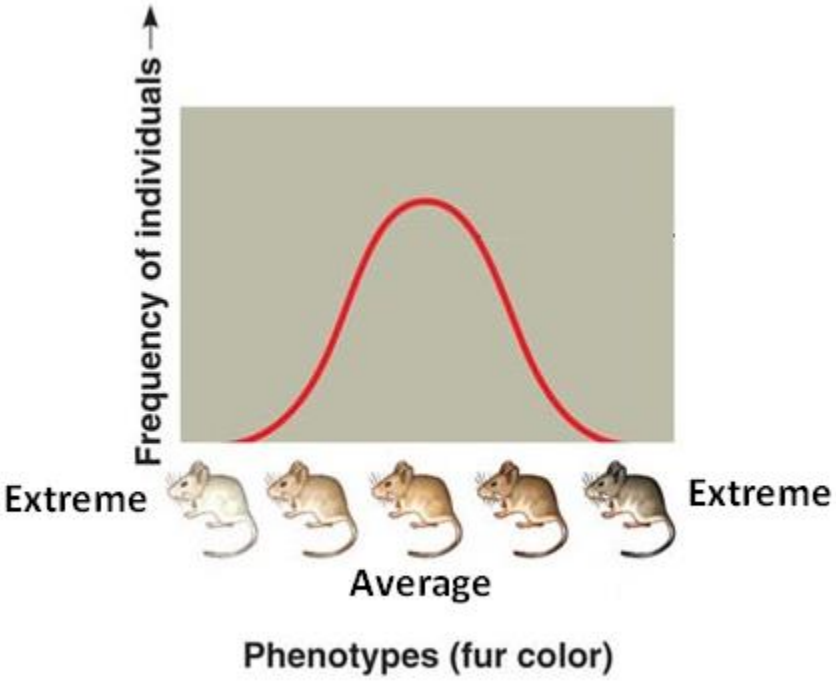
- Beetles living on brown tree bark are either brown or green.
- Predator (bird) can more easily see green beetles and will catch them more often than brown.
- Brown beetles live longer and produce more offspring, to whom they pass the gene for brown.

8:7 Types of Natural Selection

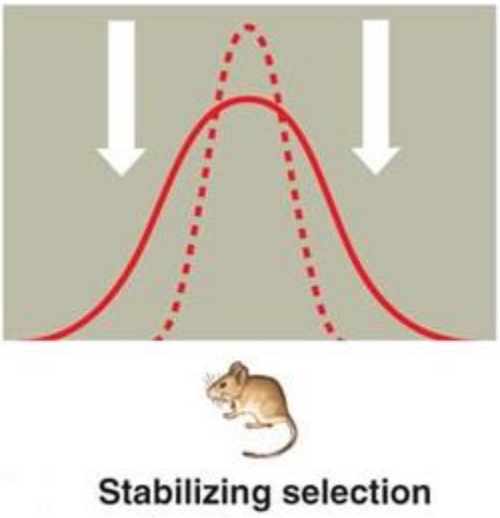
FITNESS: a measure of the number of viable offspring that an individual of a species has.

The greater the fitness of the individual, the more offspring that individual produces.

Individuals in a population exhibit a range of different traits for a characteristic. Most individuals will exhibit the same trait (the average) while some will exhibit differing traits (the extreme).

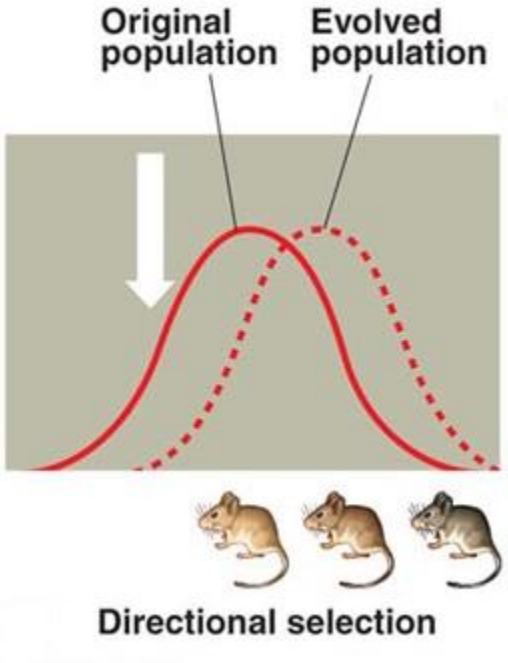


STABILIZING SELECTION: a type of natural selection that favors the average individuals in a population.



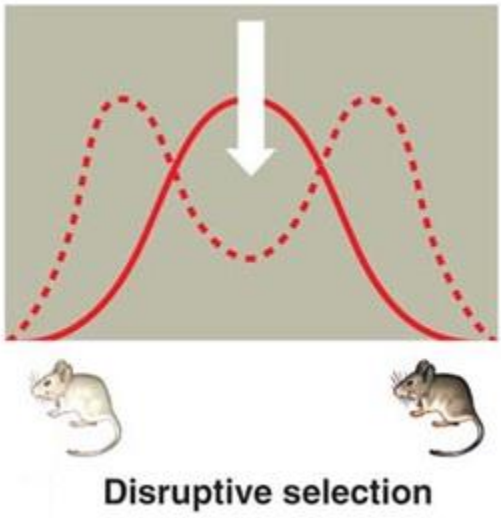
Stabilizing selection selects against the extreme phenotypes and instead favors the majority of the population that is well adapted to the environment.

DIRECTIONAL SELECTION: a type of natural selection that favors those individuals who have extreme variations in traits within a population.



Directional selection is a type of natural selection that favors one extreme phenotype over the mean (average form) or other extreme. Changes in weather, climate, or food availability lead to directional selection.

DISRUPTIVE SELECTION: a type of natural selection that selects against the average individual in a population and favors phenotypes of both extremes.



Disruptive selection, like directional selection, favors the extremes traits in a population. Disruptive selection differs in that sudden changes in the environment create sudden forces favoring that extreme.

The average is the least common.

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- Stabilizing-P:\PLC Biology\Unit 8 - Evolution\Video, Web, and PPT Supplements\Stabilizing Selection.wmv
- Directional-P:\PLC Biology\Unit 8 - Evolution\Video, Web, and PPT Supplements\Directional Selection.wmv

8:8 What do Fossils Show?

FOSSIL: the remains or traces of organisms that lived in the past

FOSSIL RECORD: the history of life on Earth, based on fossils that have been discovered

The fossil record shows how organisms have changed over time and shows that the Earth is about 3.5 billion years old. The fossil record shows that some species have lived then disappeared during the Earth's history.

EXTINCT: a species no longer living on Earth

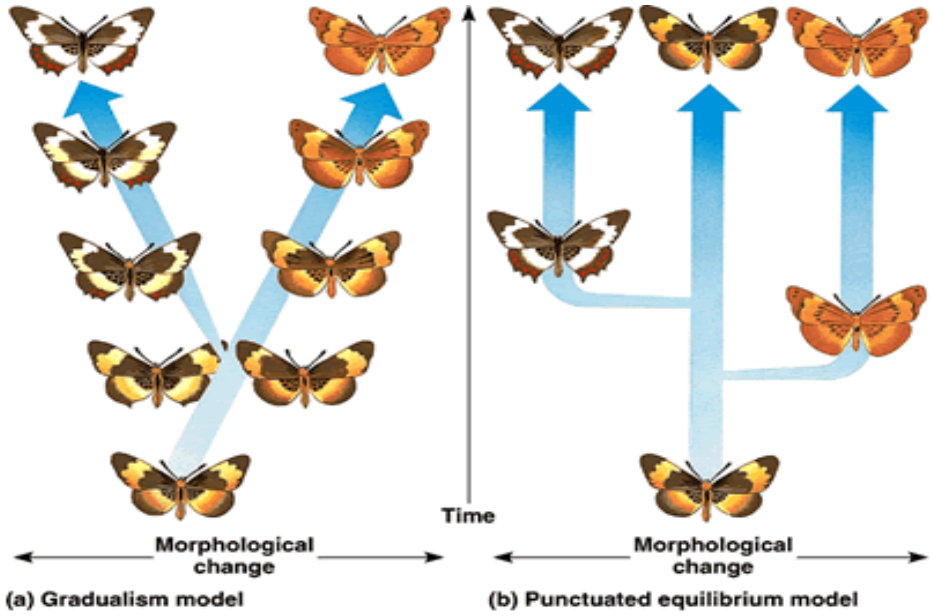
- EX: dinosaurs

Extinctions occur when there are major changes in the environment and the species is not adapted to survive.

The fossil record helps scientists to discover relationships between different groups of organisms and determine common ancestors.

Fossil record shows evolution happens slowly (gradualism)

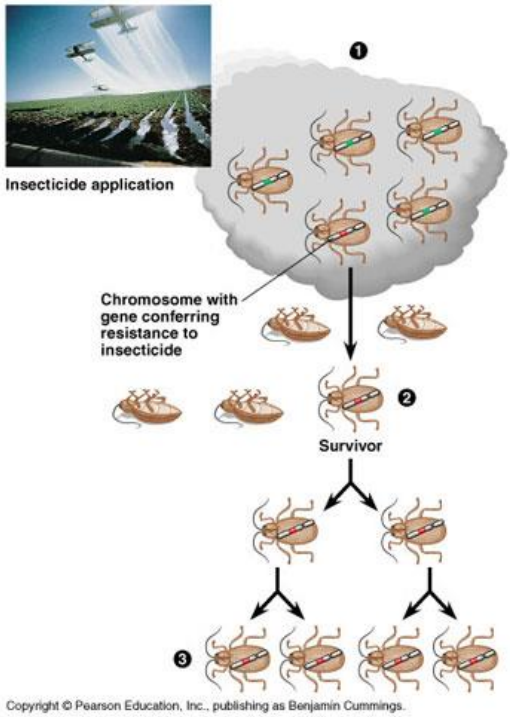
PUNCTUATED EQUILIBRIUM: pattern of a long stable period interrupted by a brief pattern of more rapid change



- Can be caused by a genetic (mutation) change, major or sudden changes in the environment

8:9 Three Pieces of Evidence for Evolution

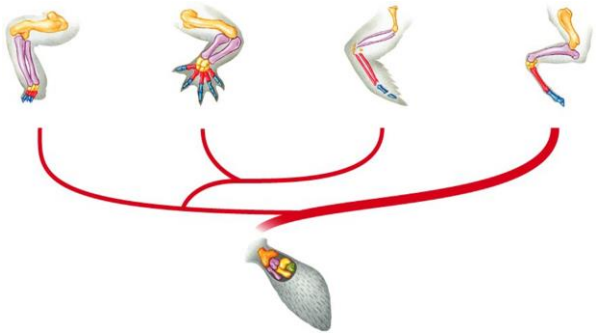
1. You can see natural selection happen, it is the driving force for evolution
    a. Some differences between individuals will impact survival and reproduction, are inheritable by genetic variation
    b. Struggle for resources→Stronger survive→reproduce→Pass on advantageous traits

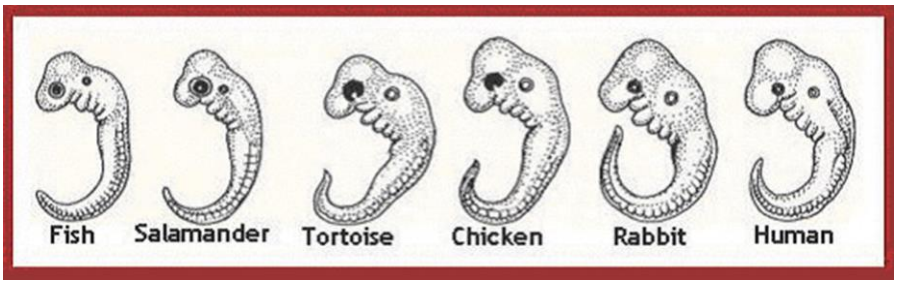


2. Homologous body structure and embryonic development

HOMOLOGOUS STRUCTURE: anatomical structures in one species that, compared to other anatomical structures in another species are similar from a common ancestor

a. Example: Limb bones develop in similar patterns but may differ in form or function
b. Strong evidence that all four-limbed animals with backbones descended with modification from a common ancestor
c. DNA differs in mature forms but developed from the same embryonic tissue
d. Some are VESTIGIAL STRUCTURES: a structure that is no longer useful even though it is still present, suggesting it was valuable in the organisms ancestors
    i. Example: hip bones in whales or boa constrictors

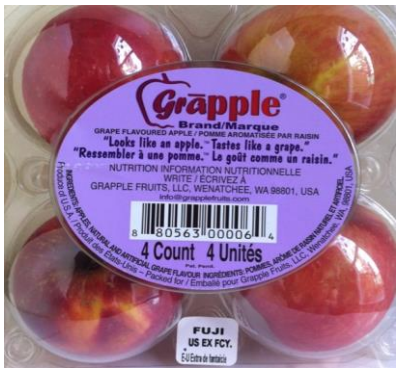


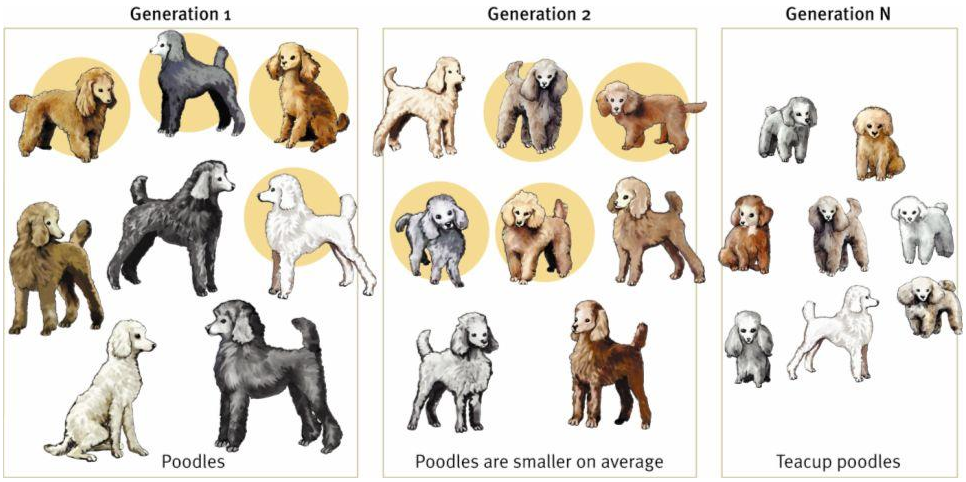


3. Artificial Selection

ARTIFICIAL SELECTION: selective breeding of organisms (by humans) for specific desirable characteristics

a. Examples: seedless watermelons, various dog breeds, grapples




Generation 1
Generation 2
Generation N
Poodles
Poodles are smaller on average
Teacup poodles