

Obj: understand Darwin's theory of evolution based on natural selection

Agenda:

1. Do Now
2. Notes
3. Packet

DO NOW:

1. *What does it mean if I said that fashion “has evolved” over time?*
2. *Why is evolution only considered a theory?*

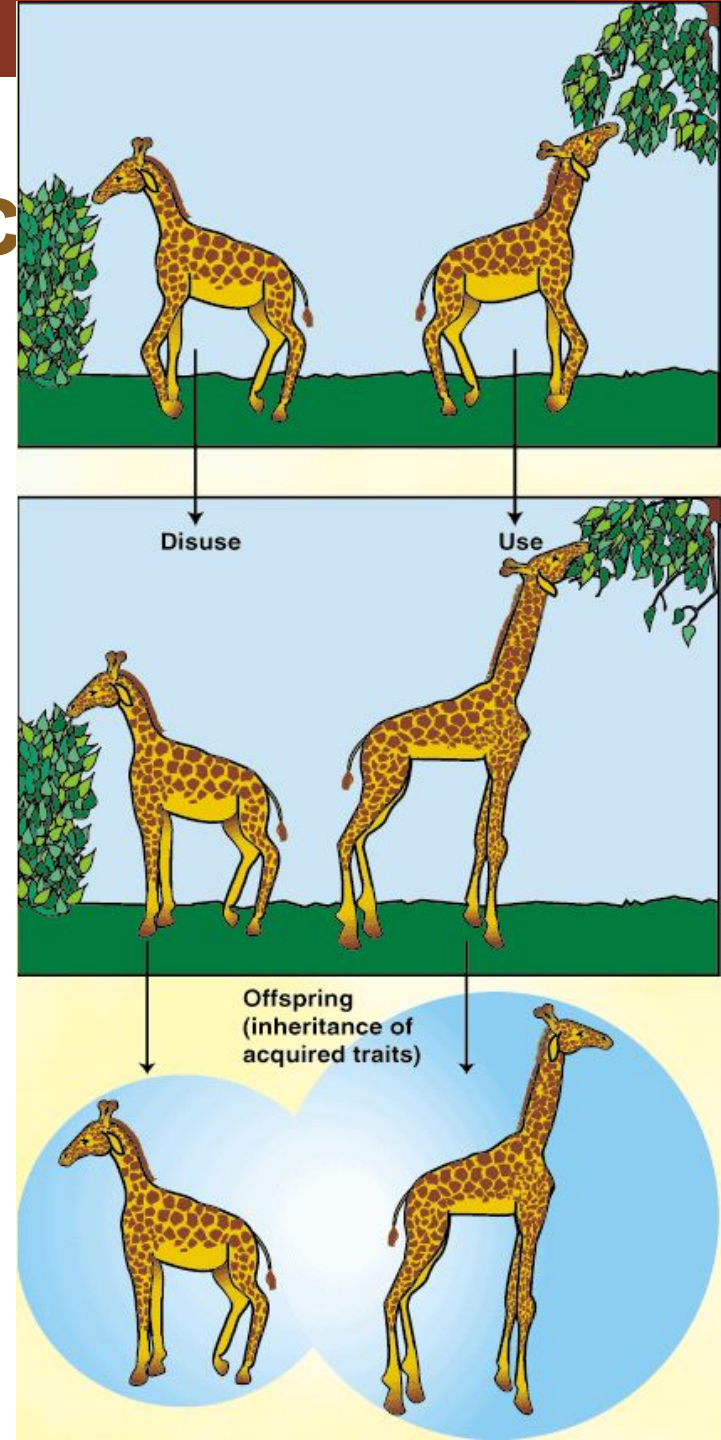
HW: Finish packet and Argumentation

Pre-Darwin Mindset

- Earth was a few thousand years old
- Animals and plants are unchanging
- Concept of gradual change over time did not exist
- Some scientists had their own theories

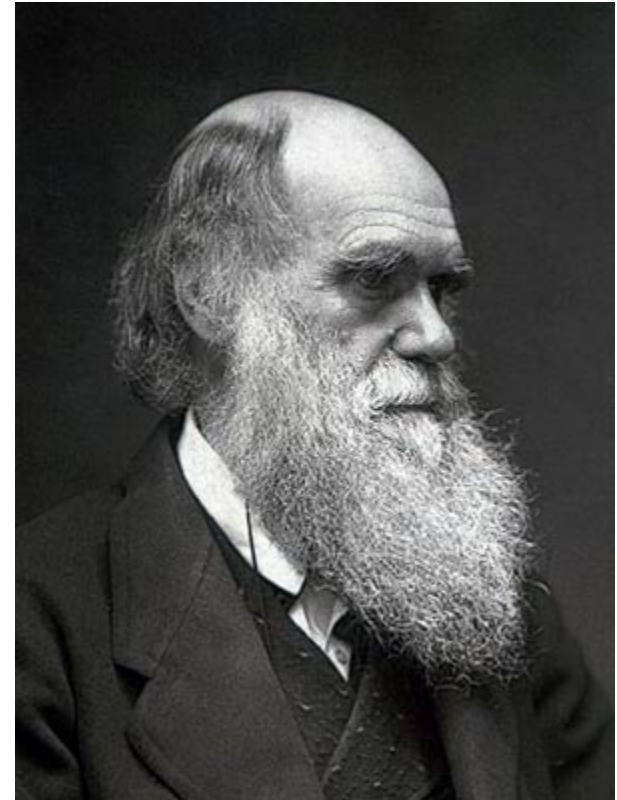
Jean-Baptiste Lamarck

- Change through **use and disuse**
- Acquired traits were passed on to offspring



Charles Darwin

- English naturalist
- 22 years old
- 1831: 5 year voyage aboard the HMS *Beagle*
- 1835: South America and the Galapagos Islands



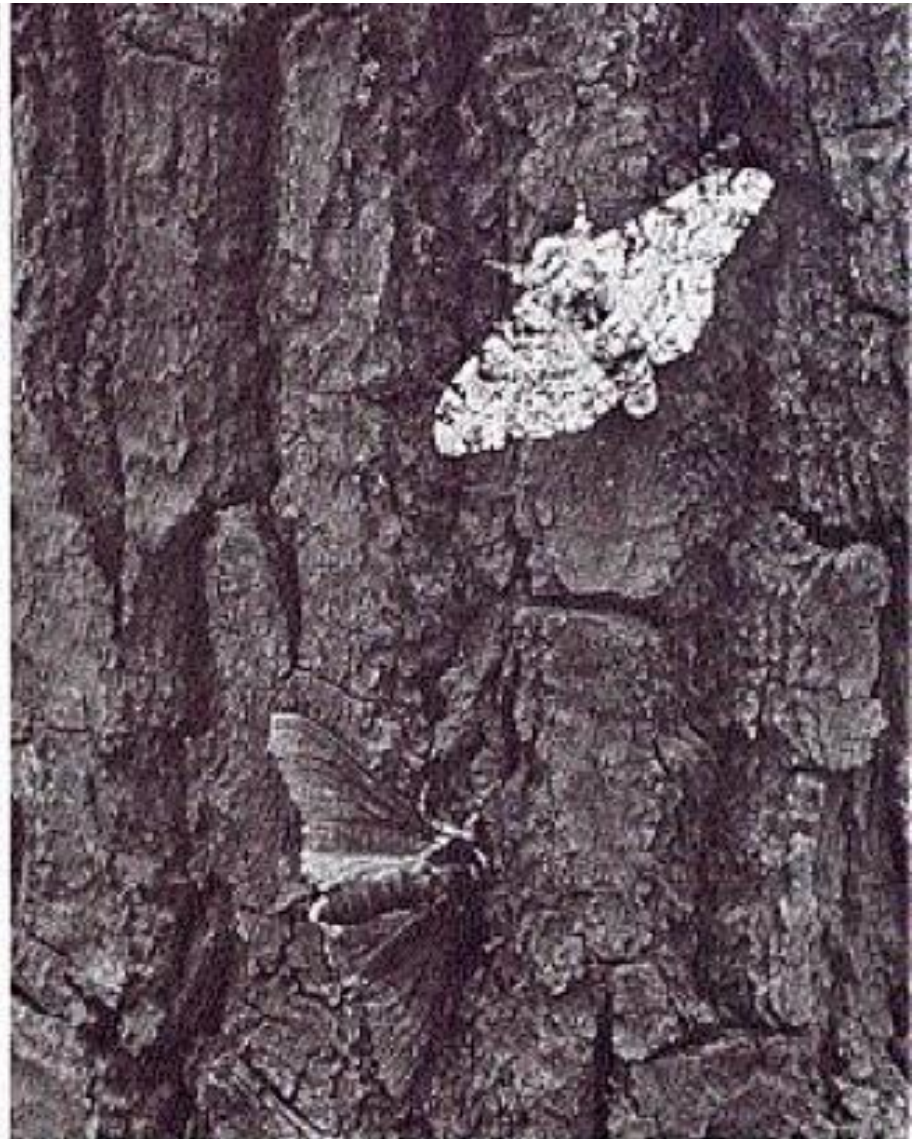
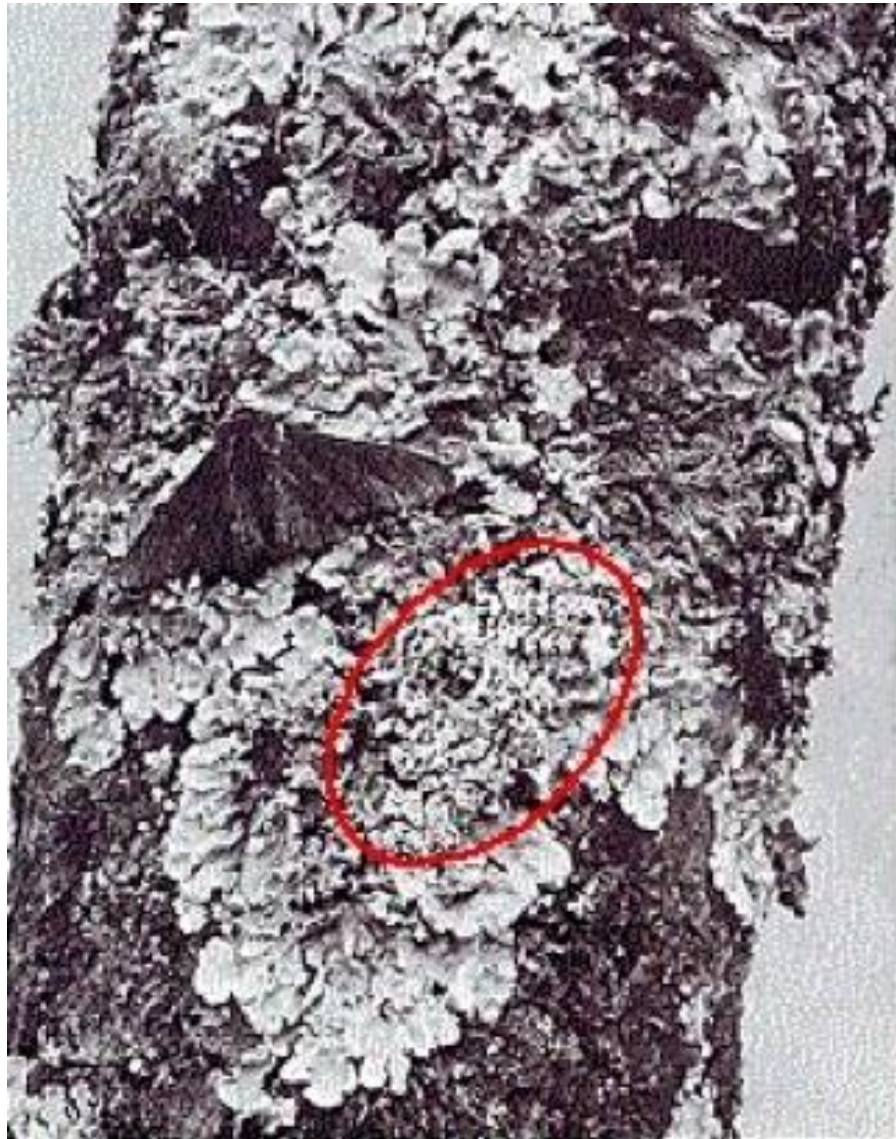
Basic Principles of Natural Selection

Principle	Example
1. Variation: Individuals in a population differ from one another.	Students in this class look different.
2. Heritability: Variations are inherited from parents.	Tall sunflowers produce tall sunflowers, short sunflowers produce short sunflowers.
3. Overproduction: Animals have more young than can survive on the available resources	The average cardinal lays nine eggs per summer. If each baby cardinal survived and reproduced once, in 8 years there would be one million cardinals from the original pair.
4. Reproductive Advantage: Variations that increase reproductive success will be more common in the next generation.	If having a fan-shaped tail increases reproductive success of pigeons, then more pigeons in the next generation will have fan-shaped tails.

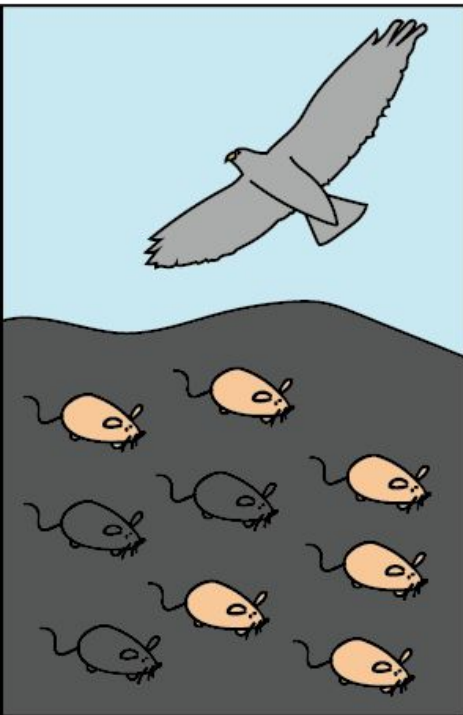
Essence of Darwin's Theory

- Populations grow exponentially
- *Overpopulation* results in competition and a “struggle for existence”
- There exists *variation* and unequal ability of individuals to survive and reproduce
- Only the best fit individuals survive and pass on their traits to offspring

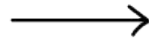
Example



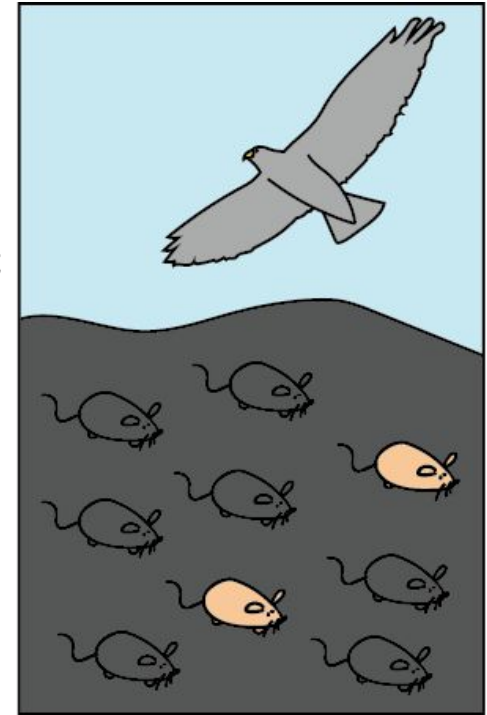
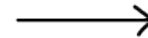
Example



Some mice are eaten by birds



Mice reproduce, giving next generation

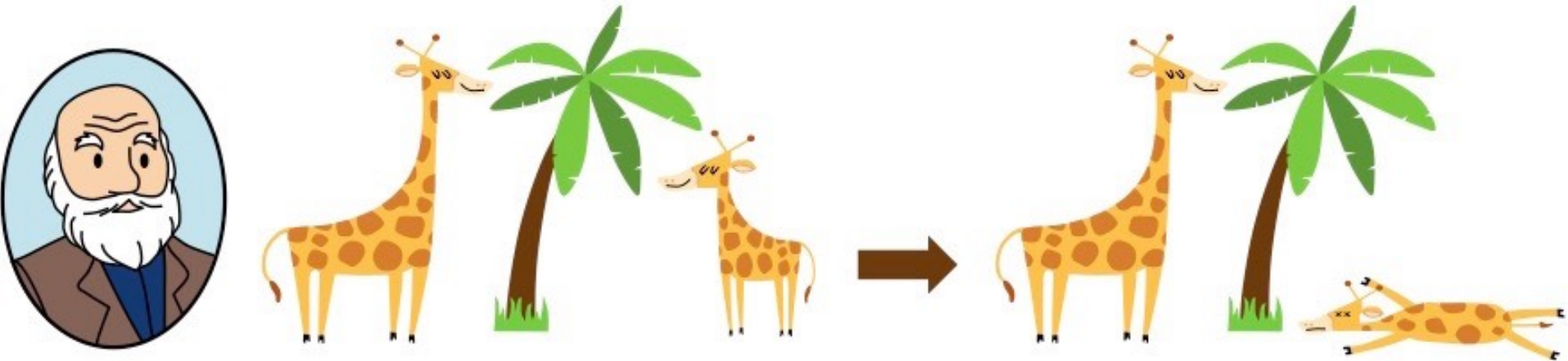


A population of mice has moved into a new area where the rocks are very dark. Due to natural genetic variation, some mice are black, while others are tan.

Tan mice are more visible to predatory birds than black mice. Thus, tan mice are eaten at higher frequency than black mice. Only the surviving mice reach reproductive age and leave offspring.

Because black mice had a higher chance of leaving offspring than tan mice, the next generation contains a higher fraction of black mice than the previous generation.

Darwin vs Lamarck



Charles Darwin – Evolution by *Descent with Modification* (1859)

Long-necked giraffes are randomly born and have more offspring due to their competitive advantage

Other Scientists

- **Jean-Baptiste Lamarck**

- Linked physical traits to environments

- **Charles Lyell**

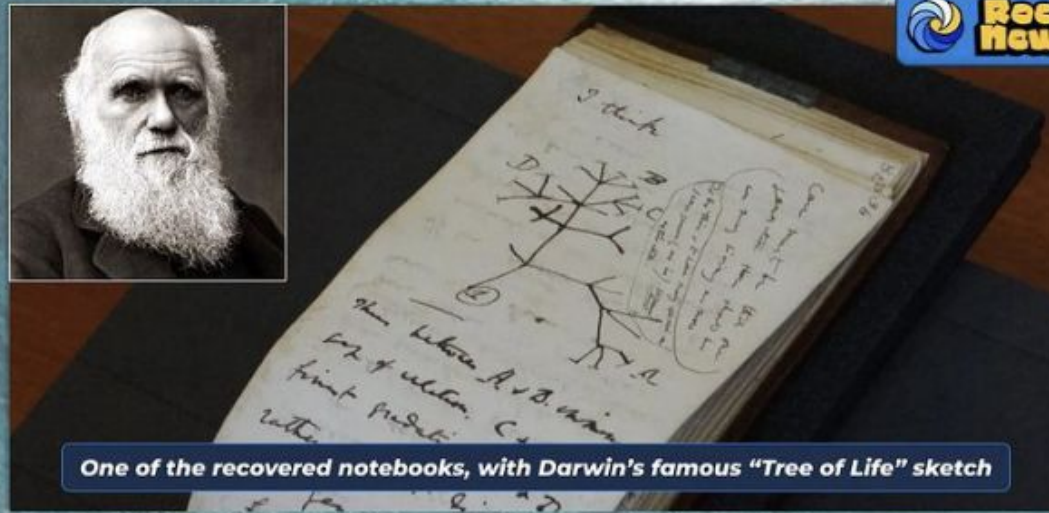
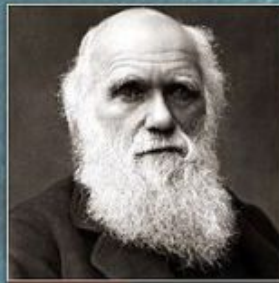
- *Principles of Geology*
- Proposed Earth was millions of years old

- **Thomas Malthus**

- Artificial selection





- **Alfred Russel Wallace**

- Proposed a theory identical to Darwin's
- Pushed Darwin to publish *The Origin of Species*



One of the recovered notebooks, with Darwin's famous "Tree of Life" sketch

Darwin's Notebooks Recovered

-  2 of Charles Darwin's notebooks were anonymously returned to a Cambridge University library, 21 years after they disappeared
-  A note on the return package – a pink gift bag – said, "Librarian, Happy Easter X." The books were reported lost in 2001 and reclassified as stolen in 2020
-  The theft sparked an international hunt that was never solved. The library's director said she cried upon discovering the notebooks' return
-  The director said one notebook was "like a diary of [Darwin's] intellectual process." Darwin conceived of the theory of natural selection in 1838, at age 29

Theory Over Time

- New understandings
 - Mutations □ variation
 - Change in populations = change in allele frequency
- Like all theories, as new evidence is discovered, the theory of evolution will continue to be refined

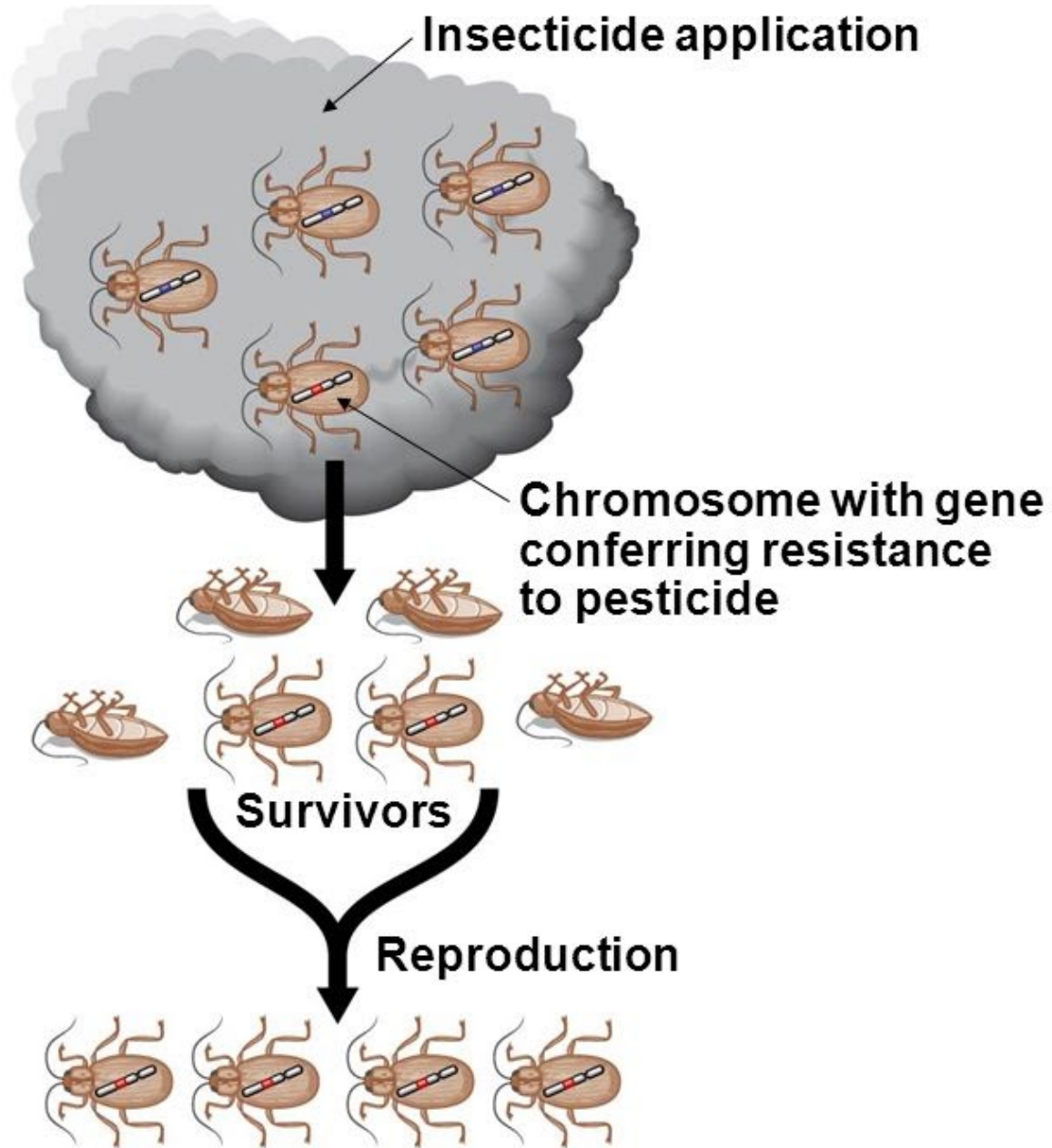
Important Concepts of Evolution

- Evolution is not always a slow process
 - Bacteria resistance to antibiotics (few months)
- Evolution does not occur at the same rate in all organisms
 - Humans have changed a great deal, whereas horseshoe crab has hardly changed at all
- Evolution does not always cause organisms to become more complex
 - Sea star used to have bilateral symmetry (more advanced), however now it has radial symmetry (more simple)
- Evolution occurs in populations, not individuals
- Evolution is directed by changes in the environment
 - Animals that evolved in the ocean must be streamlined in order to move freely

Big Picture Question

How does evolution hinder attempts to eradicate a disease?

- *Hint:* DDT, a pesticide, was used to kill mosquitoes that carry the parasite from person to person
- Answer using what we learned about natural selection



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Summary

- Lamarck theorized 2 mechanisms for evolution: the inheritance of acquired traits and the concept of use and disuse
- Darwin drew from his observations on the HMS *Beagle* and later studies to develop his theory of evolution through natural selection
- Natural selection is based on 4 principles: variation, heritability, overproduction and reproductive advantage

*HW: finish packet and
argumentation write-up*

1. Natural selection (4 basic principles)
 - a. Variation
 - b. Overproduction
 - c. Heritability
 - d. Reproductive advantage
2. Natural vs. artificial selection
3. Evidence for evolution
 - a. Fossil record
 - b. Comparative anatomy
 - c. Comparative biochemistry
 - d. Comparative embryology
4. Pace or tempo of evolution
 - a. Gradualism
 - b. Punctuated equilibrium
5. Types of Evolution
 - a. Convergent
 - b. Divergent
 - c. Coevolution
6. Patterns of Selection
 - a. Stabilizing
 - b. Directional
 - c. Disruptive
7. Types of Speciation
 - a. Allopatric
 - b. Sympatric
8. Reproductive isolation
 - a. Pre-zygotic
 - i. Temporal
 - ii. Mechanical
 - iii. Behavioral
 - iv. Ecological
 - b. Post-zygotic
 - i. Hybrid inviability
 - ii. Hybrid breakdown
 - iii. Hybrid infertility/sterility

Obj: understand the different types of selection and describe the factors that influence speciation

Agenda:

1. Do Now
2. HW check
3. Notes
4. Handout

DO NOW:


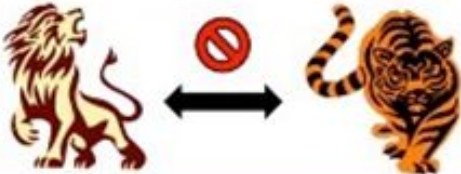
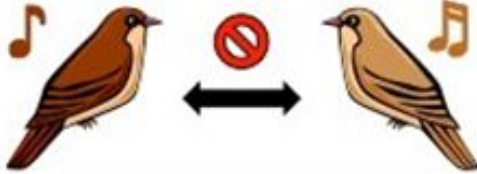

1. ***Define coevolution.***
2. ***What is a zygote?***

HW: complete handout

Reproductive Isolation

- *Reproductive isolation* is a mechanism that keeps species from mating with others
- **Prezygotic**: occurs before fertilization
 - Pre-mating
- **Postzygotic**: occurs after fertilization
 - Post-mating

Prezygotic

Isolating Mechanisms		Example	
Temporal	Occurs when two species mate at different times of year	Frogs live in same pond but breed during different seasons (summer vs spring)	
Ecological	Occurs when two species occupy different habitats	Lions and tigers can potentially interbreed, but usually occupy different habitats	
Behavioural	Occurs when two species have different courtship behaviours	Certain groups of birds will only respond to species-specific mating calls	
Mechanical	Occurs when physical differences prevent copulation / pollination	Certain breeds of dog are morphologically incapable of mating due to size	

Temporal

- Individuals of different species do not mate because they are active at different times of day or in different seasons

Example: Northern Leopard Frog
& North American Bullfrog



Mates in April



Mates in July



Ecological

- Individuals mate in their preferred habitat, and rarely encounter members of other species in different habitats
- Artificial situations can lead to *hybrids*



lions & tigers could hybridize, but they live in different habitats:

- lions in grasslands
- tigers in rainforest

Behavioral

- Individuals of different species do not mate due to differences in mating or courtship behaviors

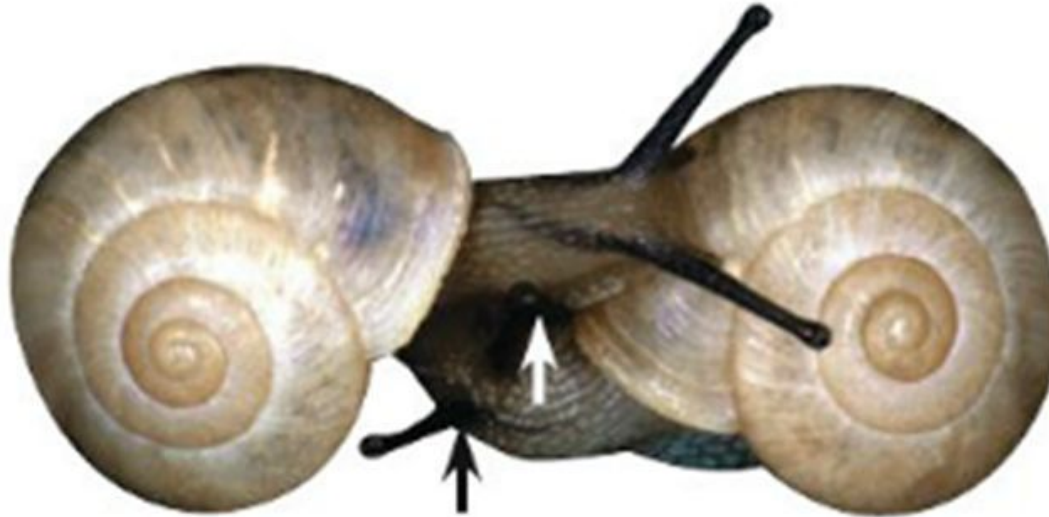
(different courtship rituals)

♂ Male birds sing a mating song that females like, East and West have different songs. Females only respond to their subspecies song.




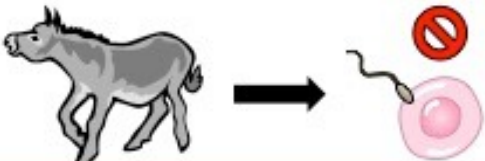

Mechanical

- Biological or anatomical differences prevent successful mating
- Common in insects and plants



▲ **Figure 14.3E Mechanical Isolation:** The genital openings (indicated by arrows) of these snails are not aligned, and mating cannot be completed.

Postzygotic

Post-zygotic Isolating Mechanisms		Examples	
Hybrid Inviability	Hybrids are produced but fail to develop to reproductive maturity	Certain types of frogs form hybrid tadpoles that die before they can become a frog	
Hybrid Infertility	Hybrids fail to produce functional gametes (sterility)	Mules are sterile hybrids resulting from mating between a horse and a donkey	
Hybrid Breakdown	F ₁ hybrids are fertile, but F ₂ generation fails to develop properly	The offspring of hybrid copepods have less potential for survival or reproduction	

Hybrid

- Produced by interbreeding of two organisms of different species or of genetically distinct populations within a species



Male donkey (*Equus asinus*)

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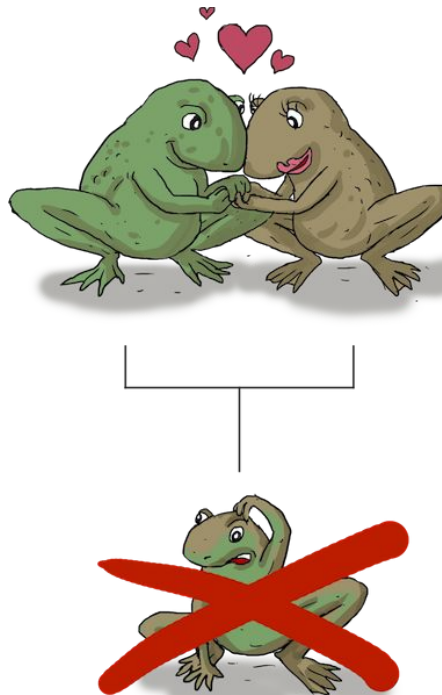
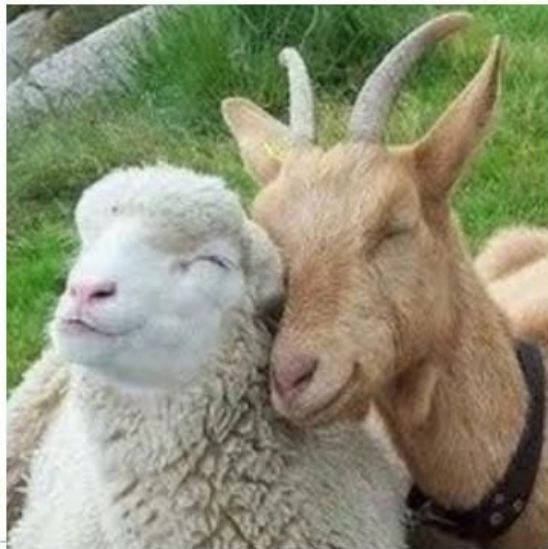
Female horse (*Equus caballus*)



Mule

Hybrid inviability

- The failure of an offspring of two species to survive to maturity
- Hybrid embryo forms, but of reduced viability



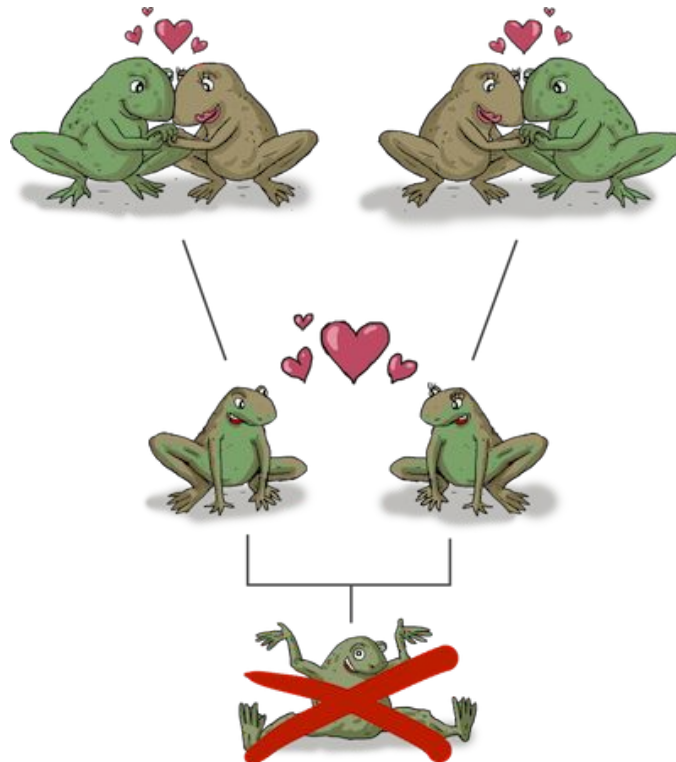
Hybrid infertility (sterility)

- The hybrid offspring of two species is infertile
 - Donkey + horse = mule
 - Lion + tiger = liger



Hybrid breakdown

- First generation hybrids are viable and fertile, but further hybrid generations may be inviable or sterile



Summary

- Speciation often begins in small isolated populations
- Isolating mechanisms prevent populations from interbreeding

HW: complete handout