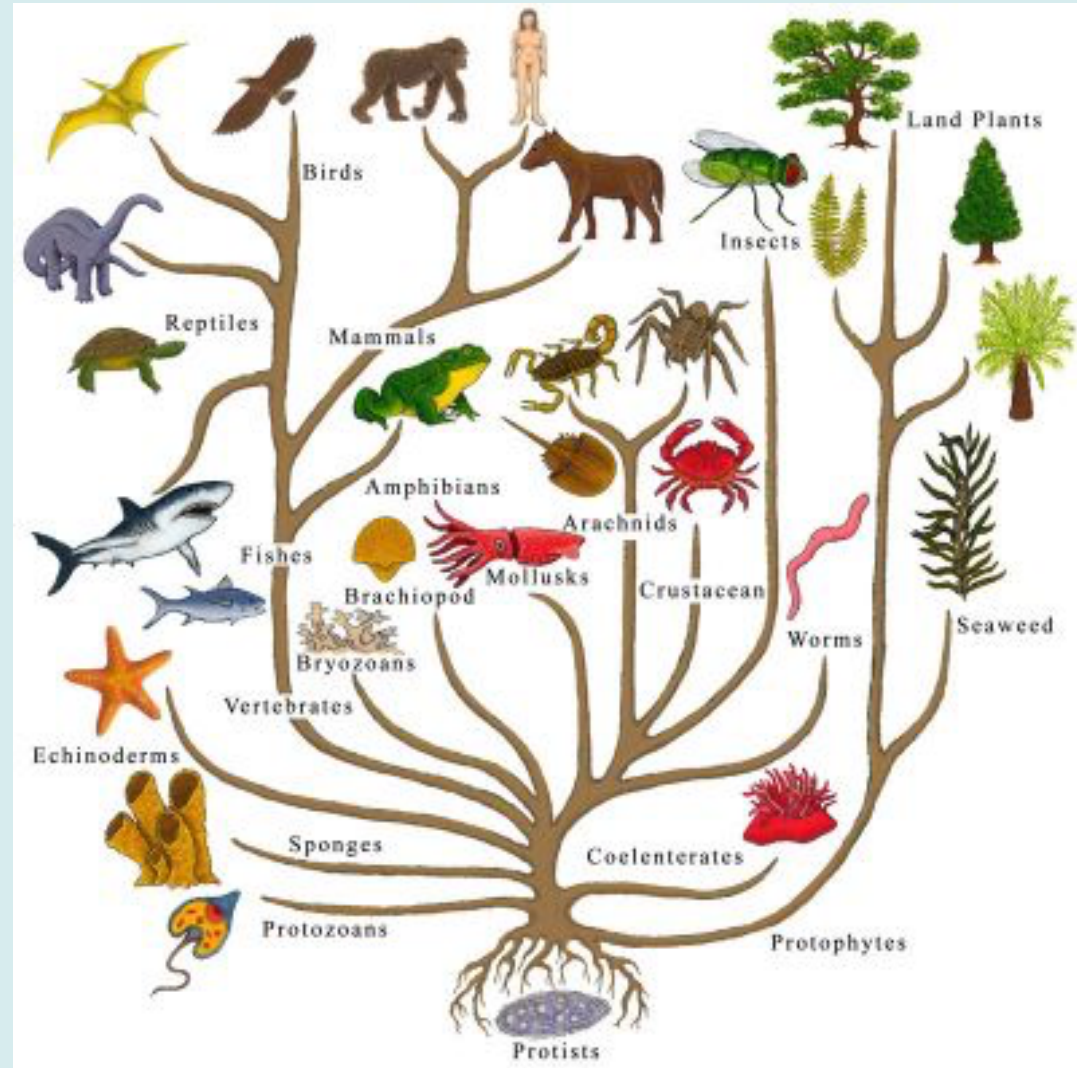


# CHAPTER 13: POPULATION GENETICS

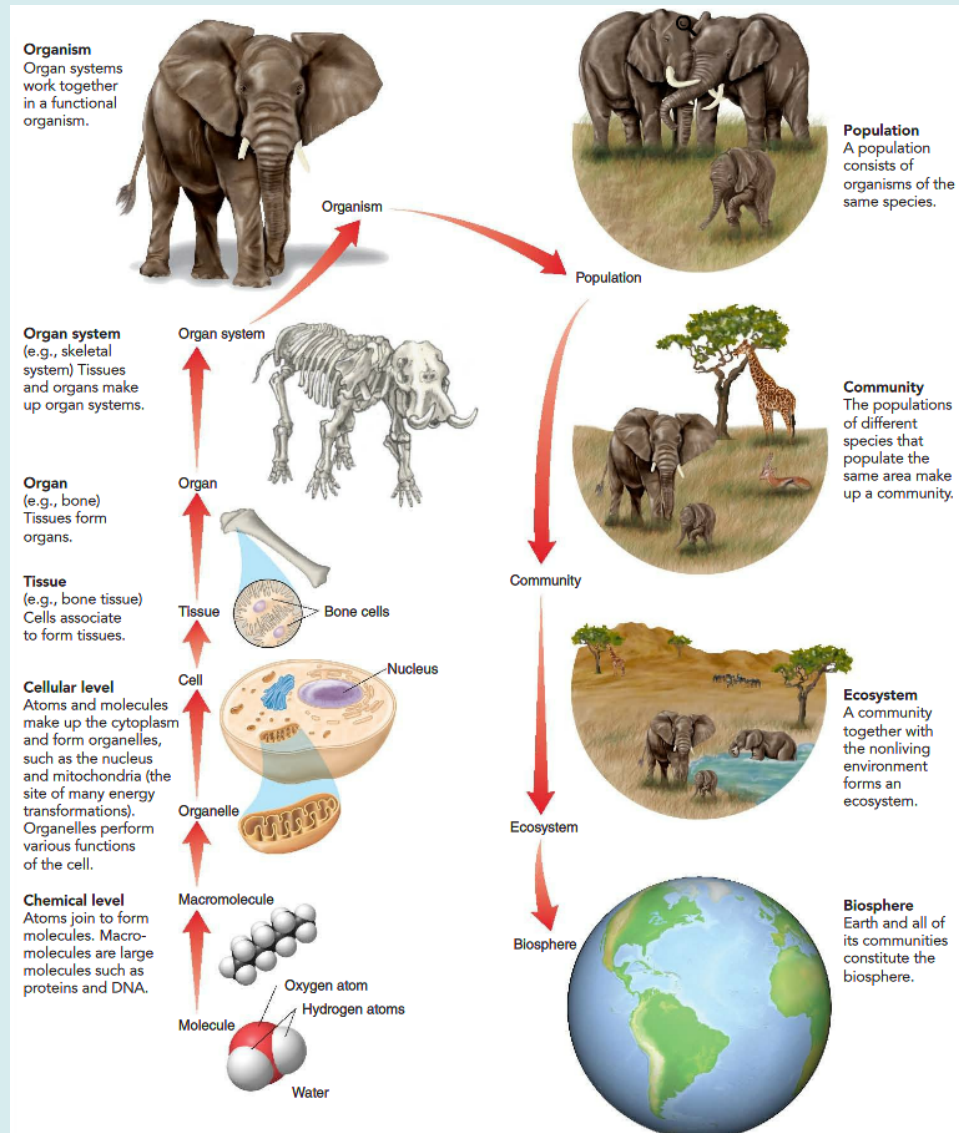
## (THE EVOLUTION OF POPULATIONS)



John Innes Foundation Historical Collections,  
courtesy of the John Innes Trustees.  
Noncommercial, educational use only.



# At what level of biological organization do you think evolution occurs at?





# A story about Natural Selection





Surface Population Moves into Caves



After Many Generations A New Form Appears



Eventually all fish in the population are blind



Activity: Work in a group of 4 and fill in the details about how you think this population of fish evolved from the surface to the cave type. Be as detailed as possible and write down your ideas.







**Darwin proposed natural selection as the mechanism of evolution:**

**Observations:**

- 1) Heritable variations in individuals**
- 2) Overproduction of offspring**

**Inferences:**

- 1) Individuals well-suited to the environment tend to survive and leave more offspring**
- 2) Over time, favorable traits accumulate in the population**

List 1 type of variation in humans that is not visible

List 1 type of variation in plants that is not visible

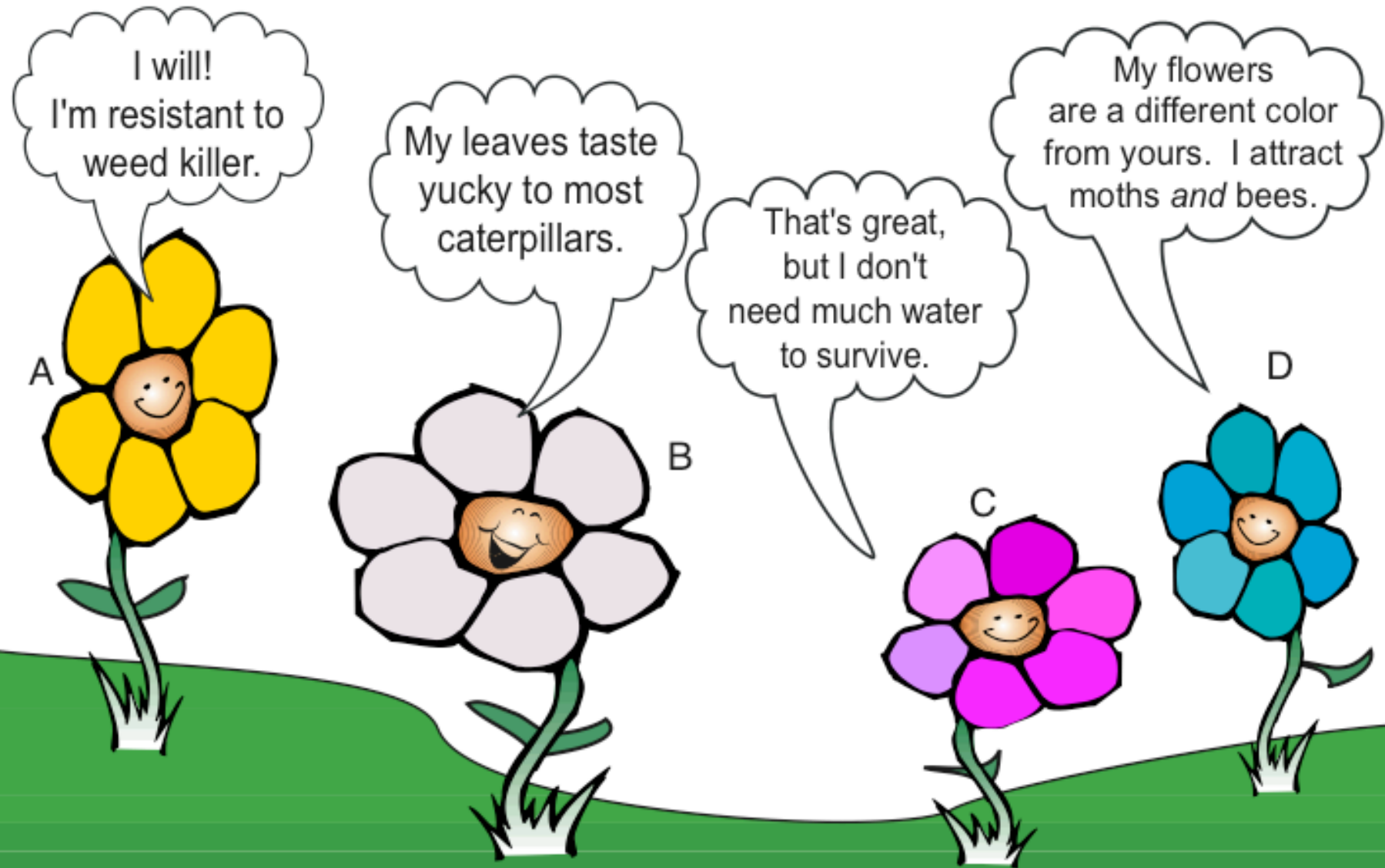
Can Natural Selection Act on Variations if they are not visible?



# What Happens to the Dandelion Seeds?

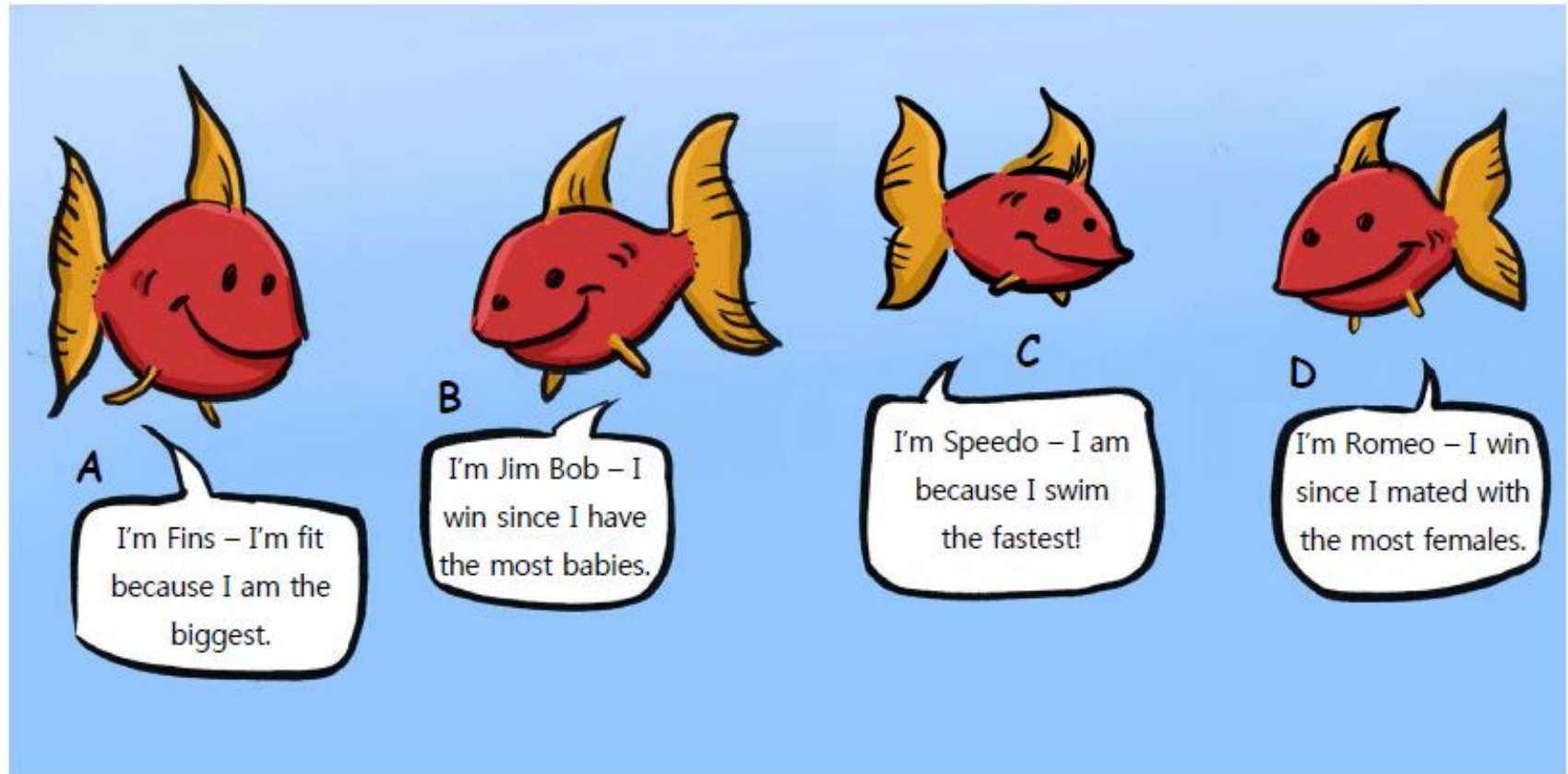


# Who will survive to reproduce?





# Guppy Hall of Fame: Who is the most fit?



© D.L.Anderson 2014

Natural selection - D.S. #1

**Evolutionary fitness:** 'survival' of genes depends on production of fertile offspring.

These sunflowers have different colored petals.

How did that happen?

Bees are most attracted to yellow so I needed this color.

A

Random changes happen in our genes.

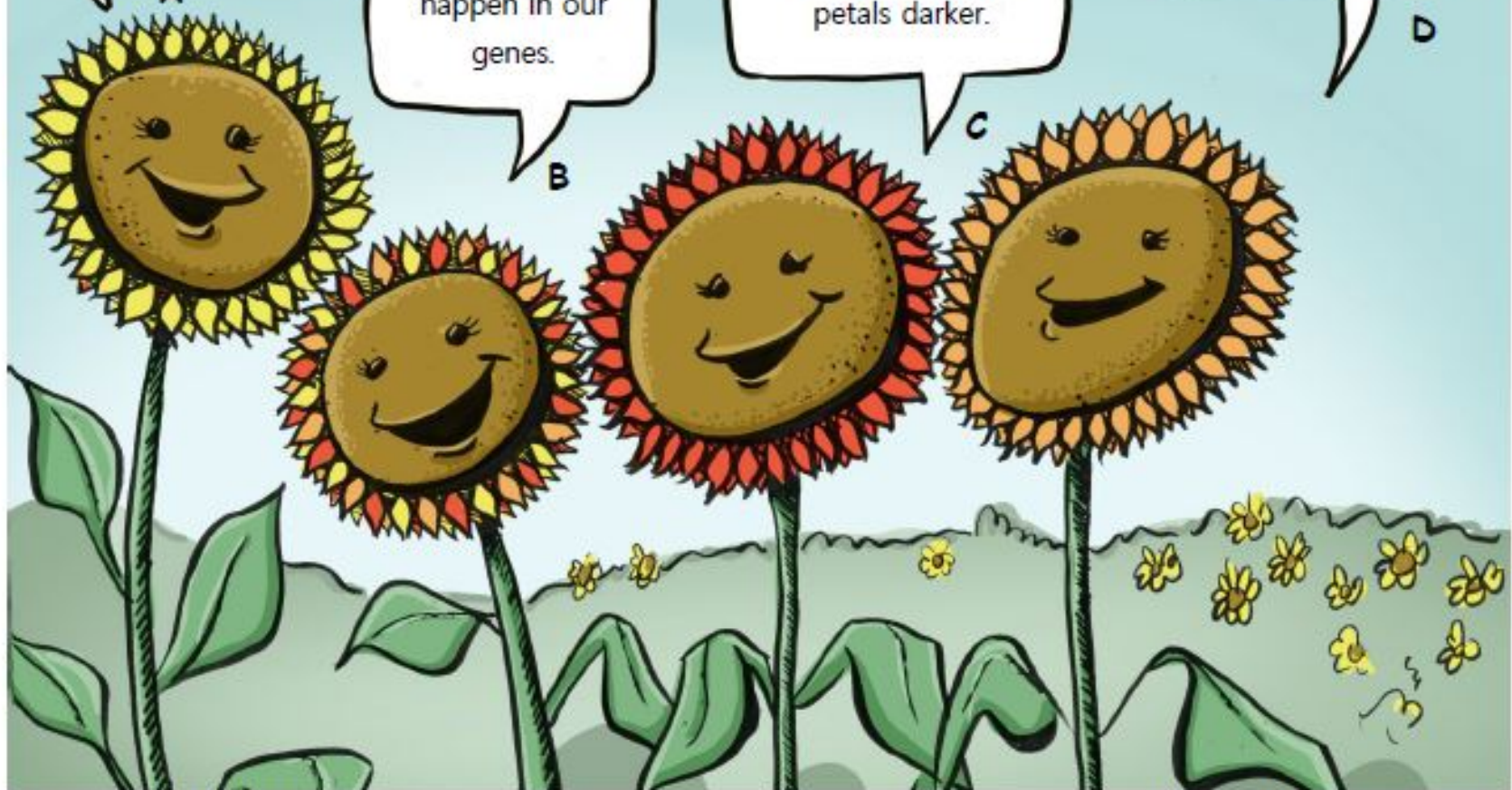
B

Being out here in the sun makes my petals darker.

C

The weather caused certain changes to happen that help us out.

D





# What is "adaptation"?



# Natural Selection Affects Individuals. However individuals don't evolve, Populations do



**1** Population with varied inherited traits.



**2** Elimination of individuals with certain traits and reproduction of survivors.



**3** Increasing frequency of traits that enhance survival and reproductive success.

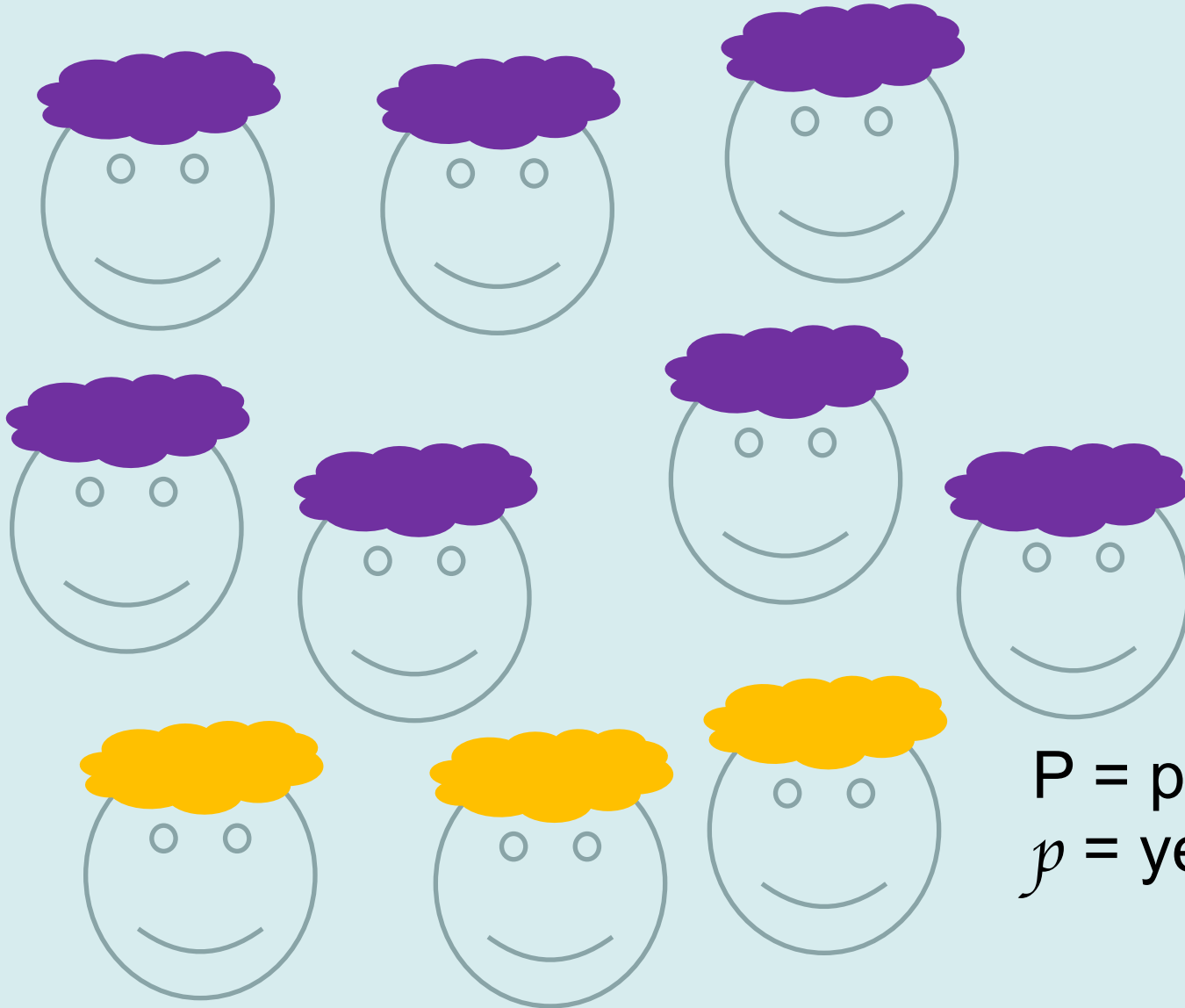
# Evolution occurs within populations (Individuals don't evolve. Populations do)

- A **population**: a group of individuals of the same species that live in the same area and interbreed.
- A **gene pool**: all alleles in all members of the population.
- Advantageous alleles accumulate in population.
- **Microevolution**: a change in the frequencies of alleles in a population's gene pool.



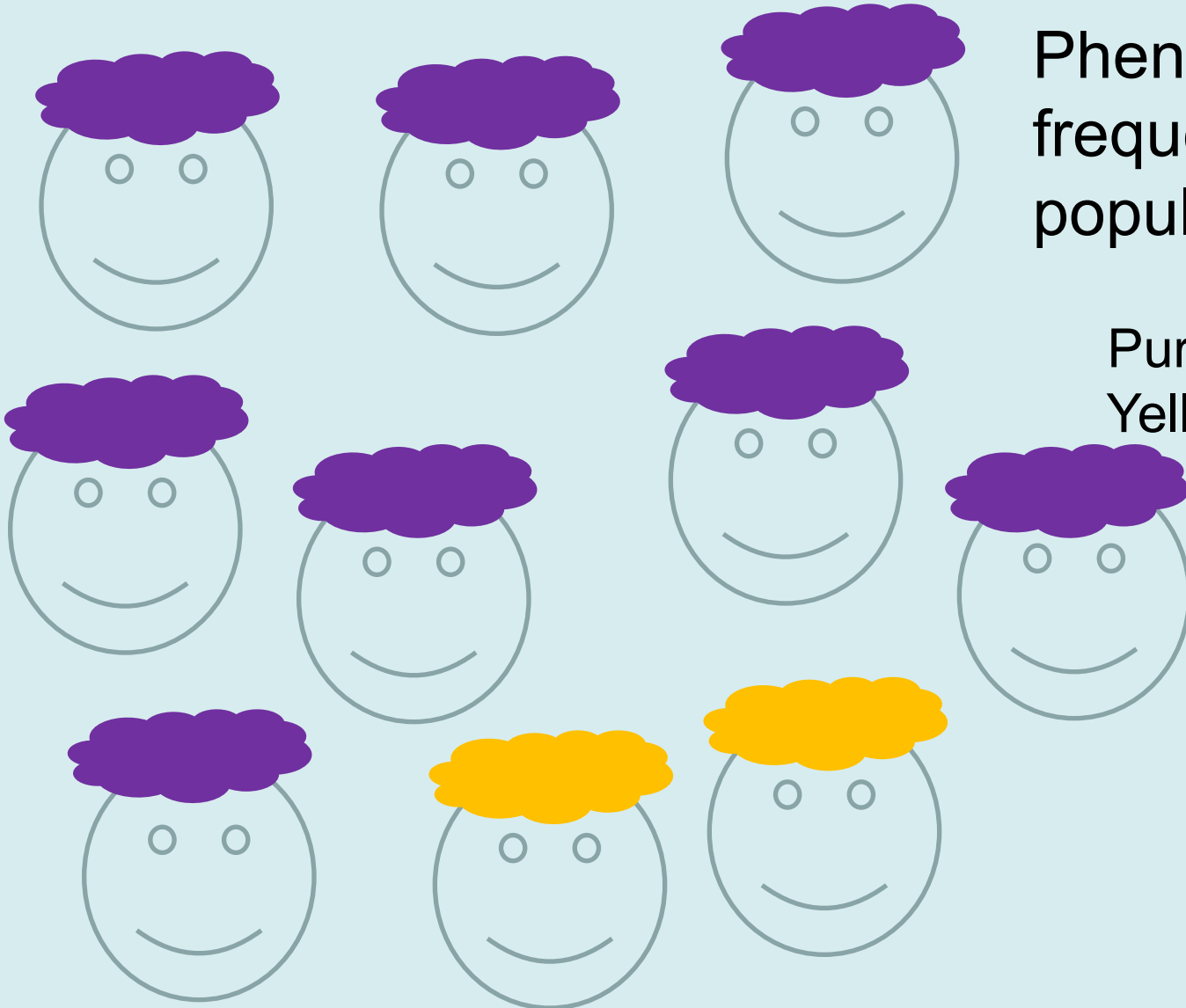
How can we measure whether a population is evolving?

# Allele frequency in a population



$P$  = purple hair allele  
 $p$  = yellow hair allele

# Allele frequency in a population

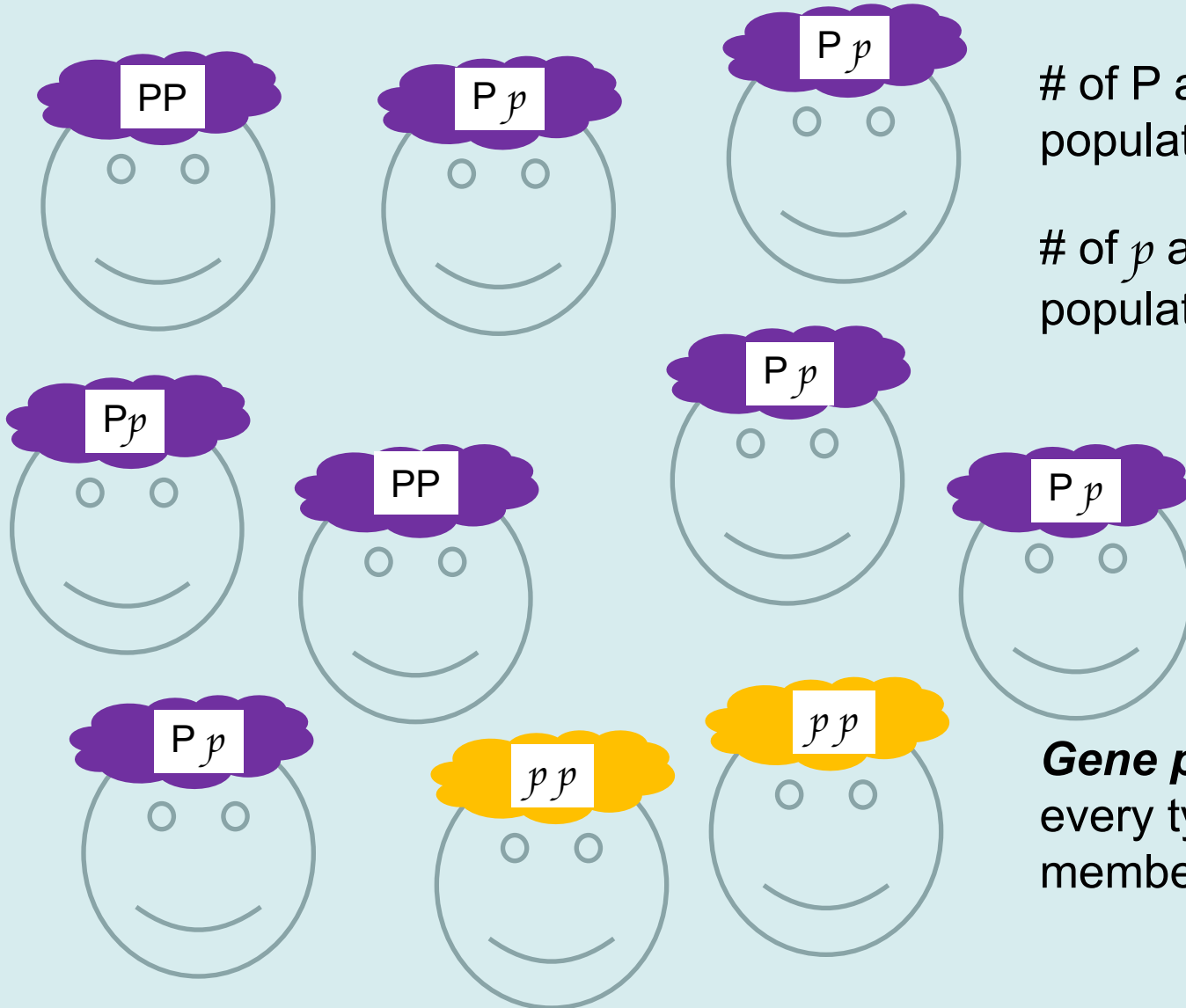


Phenotype frequency in this population?

Purple hair =  
Yellow hair =



# Allele frequency in a population

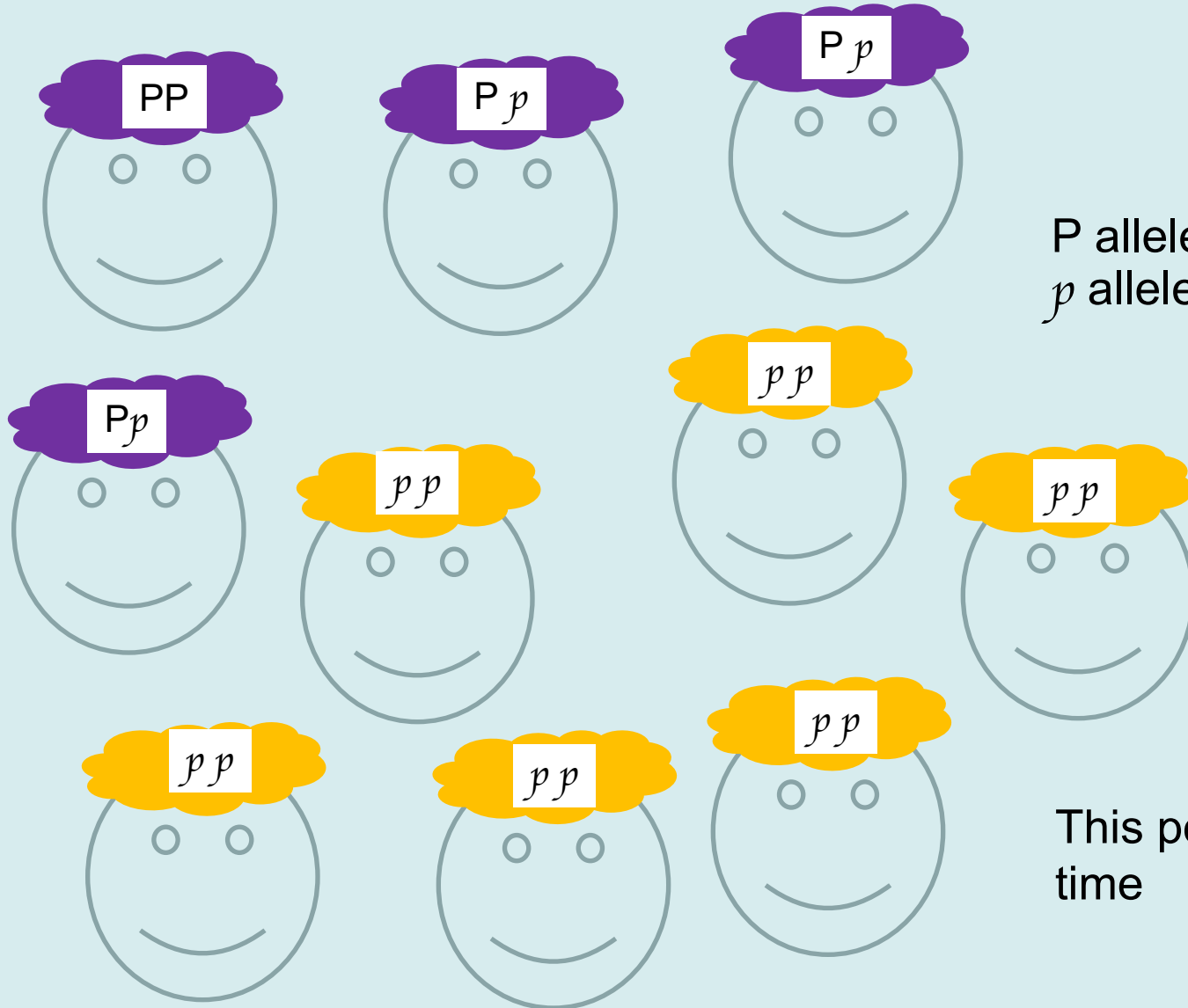


# of  $P$  alleles in this population =

# of  $p$  alleles in this population =

**Gene pool** - all copies of every type of allele in all members of the population

# Allele frequency in a population



$P$  allele frequency =  
 $p$  allele frequency =

This population evolved over  
time

Red cattle are homozygous for the red allele, white cattle are homozygous for the white allele, and roan cattle are heterozygotes. Population A consists of 36% red, 16% white, and 48% roan cattle. What are the allele frequencies?

a) red = 0.36, white = 0.16

b) red = 0.6, white = 0.4

c) red = 0.5, white = 0.5



In evolutionary terms, an organism's fitness is measured by its \_\_\_\_\_.

- a) stability in the face of environmental change
- b) contribution to the alleles of the next generation
- c) genetic variability
- d) mutation rate
- e) health

# 5 Microevolution Mechanisms that can change allele Frequency

- 1) Natural selection
- 2) Mutations
- 3) Genetic drift
- 4) Genetic flow
- 5) Sexual selection (Nonrandom mating)

<http://ed.ted.com/lessons/five-fingers-of-evolution>

# Mechanisms of microevolution:

## Mechanisms that can change allele Frequency

- 1) Natural selection :The only mechanism that consistently leads to adaptive evolution.

<http://ed.ted.com/lessons/five-fingers-of-evolution>



# What is the source for variation in this population of snails?

- Mutations
- Sexual reproduction

Remember that Mutations are the only source of new variation!



## The Evolution of Bacteria on a “Mega-Plate” Petri Dish

<https://www.youtube.com/watch?v=plVk4NVIUh8>

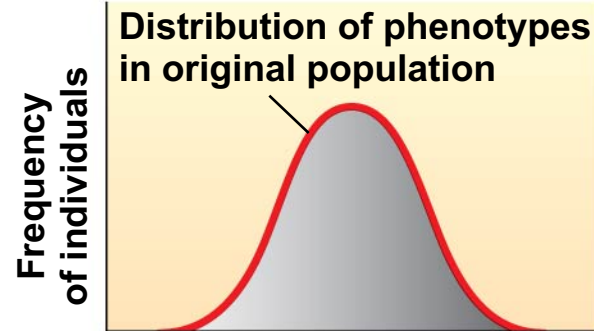
The bacteria **responded** to the high concentrations of the antibiotics by developing mutations.

- A) True
- B) False

Mutation frequencies in bacteria grown without antibiotics is lower compared to bacteria grown in the presence of antibiotics.

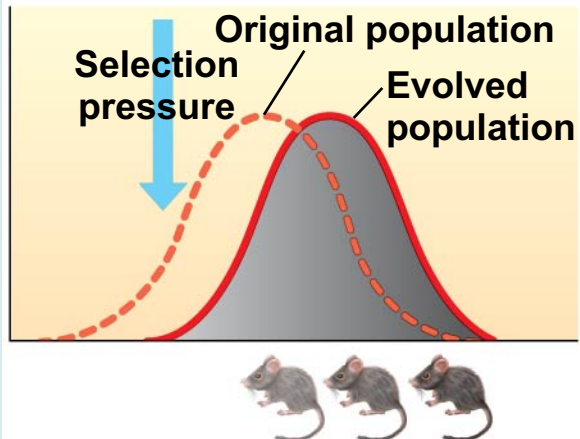
- A) True
- B) False

# Modes of natural selection

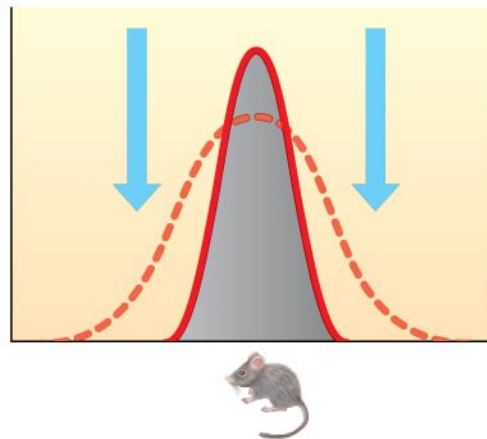


Phenotypes (fur color)

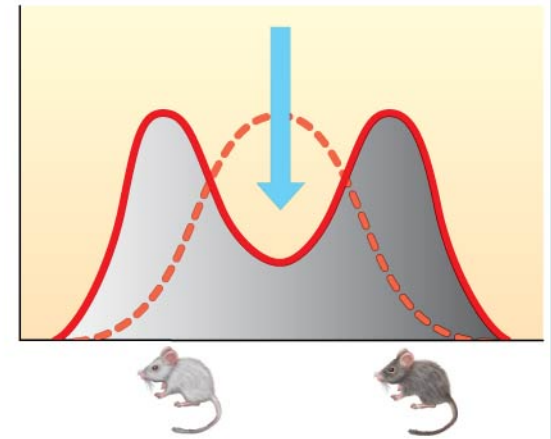
## Directional selection



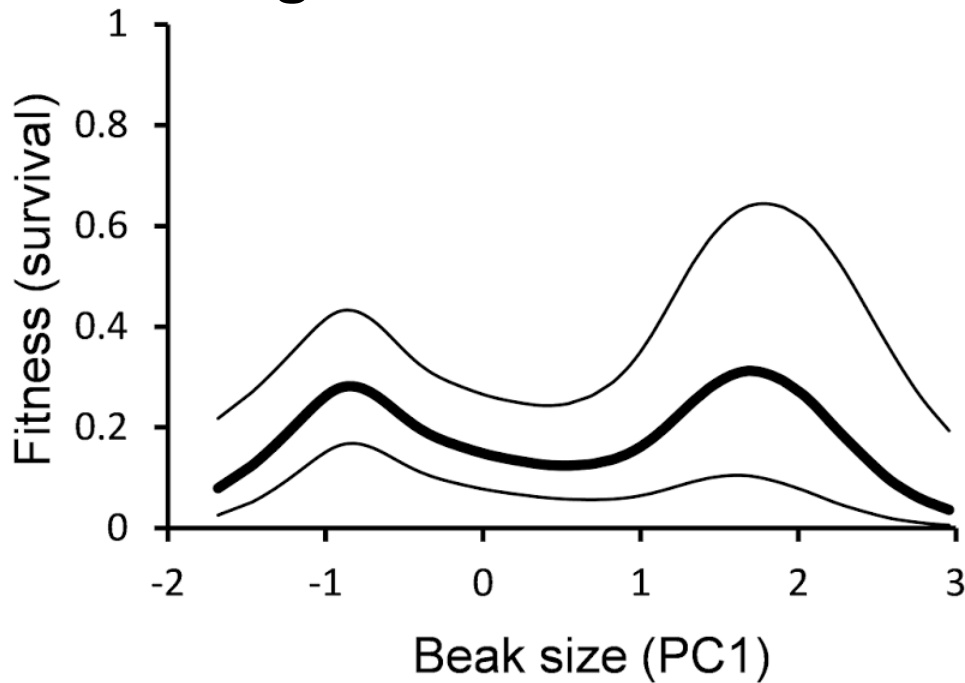
## Stabilizing selection



## Disruptive selection



# What kind of Natural Selection is occurring in the figure below



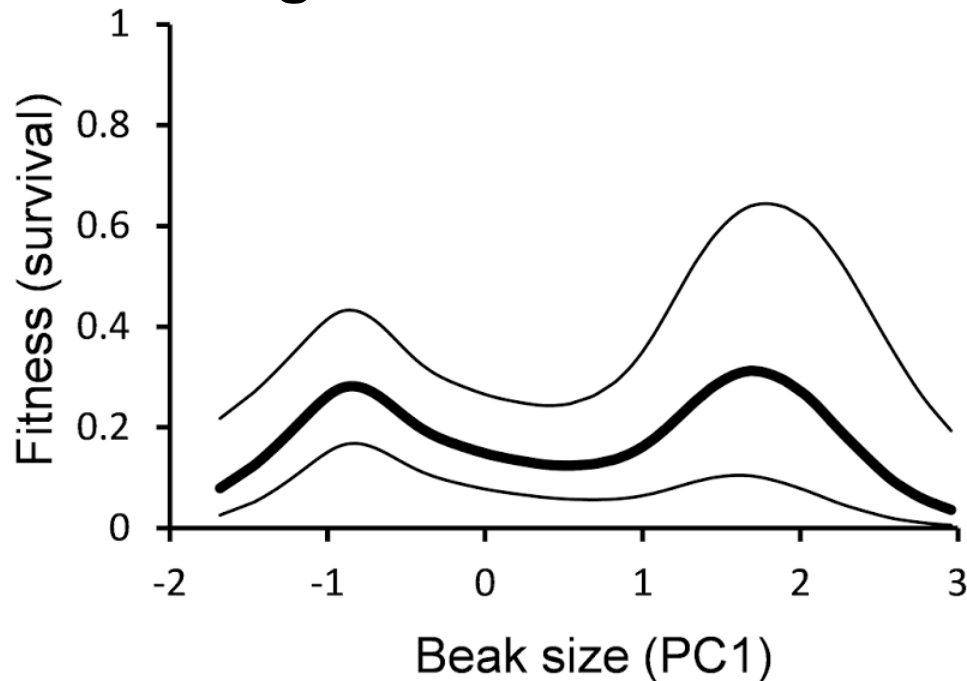
- A) Directional
- B) Disruptive
- C) Stabilizing



Hendry et al. [2009](#)



# What kind of Natural Selection is occurring in the figure below



- A) Directional
- B) Disruptive**
- C) Stabilizing



Hendry et al. [2009](#)

# Natural Selection is limited

## Natural selection cannot produce perfection

- Selection can only modify existing variations
- Organisms are limited by evolutionary constraints

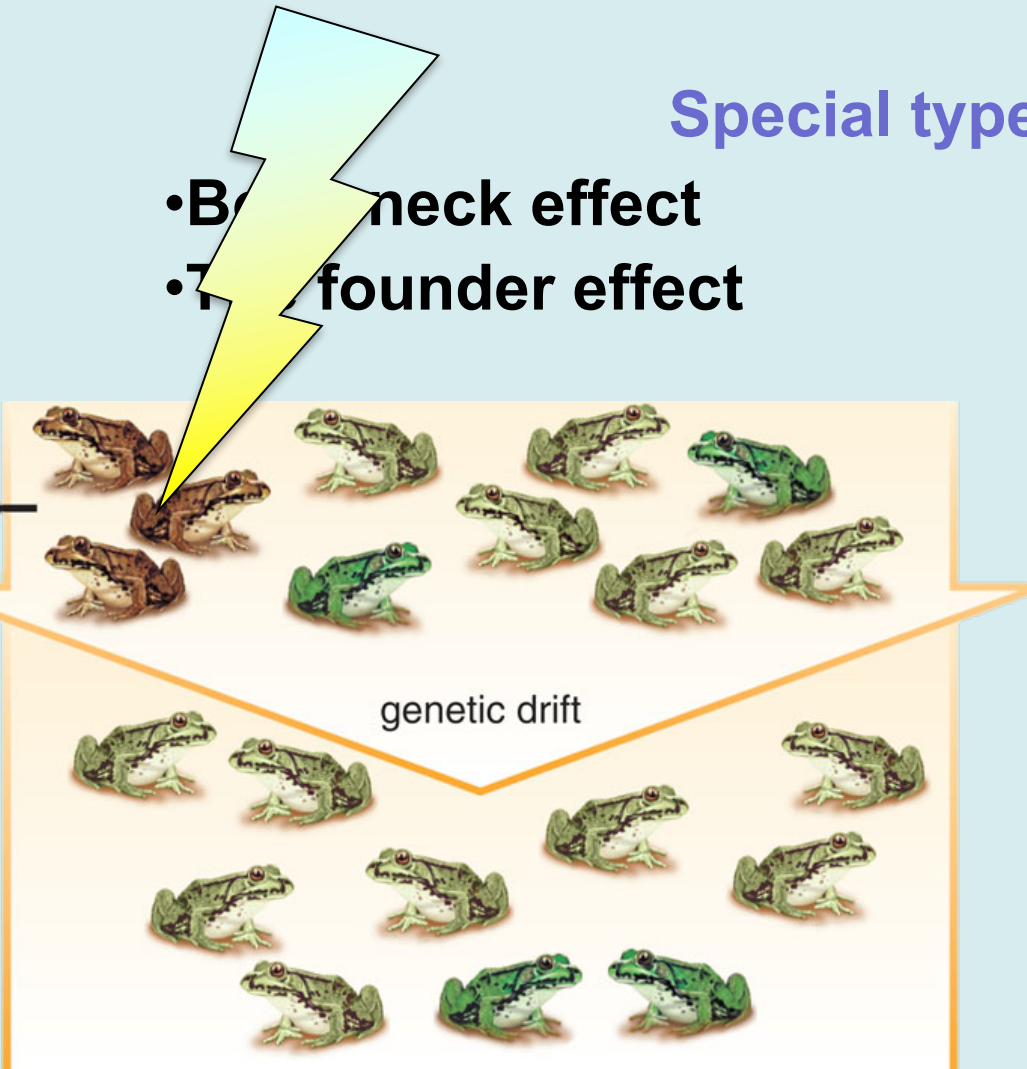


# Microevolution by genetic drift

allele frequencies change from generation to generation based on random circumstances

## Special types of genetic drift

- Bottleneck effect
- Founder effect



How Does Population size affect the impacts of genetic drift?

## 2 Mechanisms of genetic drift

- **Bottleneck effect**
- **The founder effect**

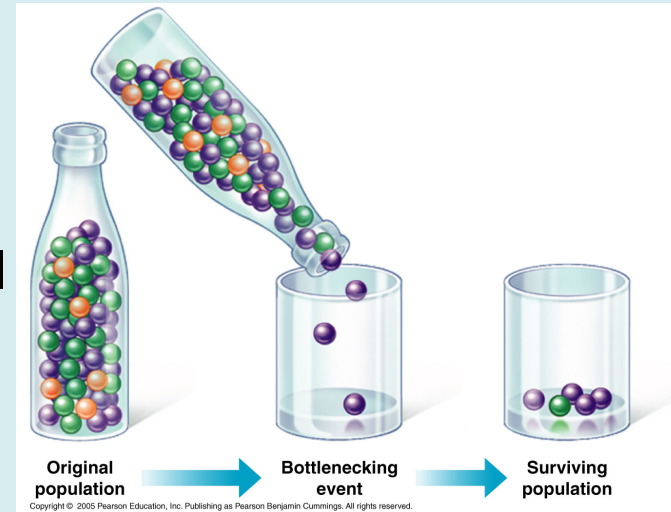


# Microevolution by genetic drift

## Bottleneck effect:

sudden reduction in population size due to a change in the environment

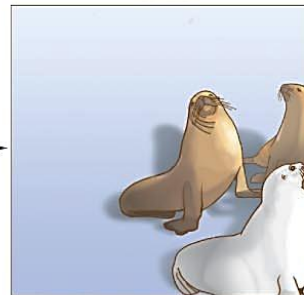
The resulting gene pool differs from the original population's gene pool



Original population, original allele frequency.



Hunting of seals in late 1800s greatly reduced population size.



Surviving population had different allele frequency and little genetic diversity.

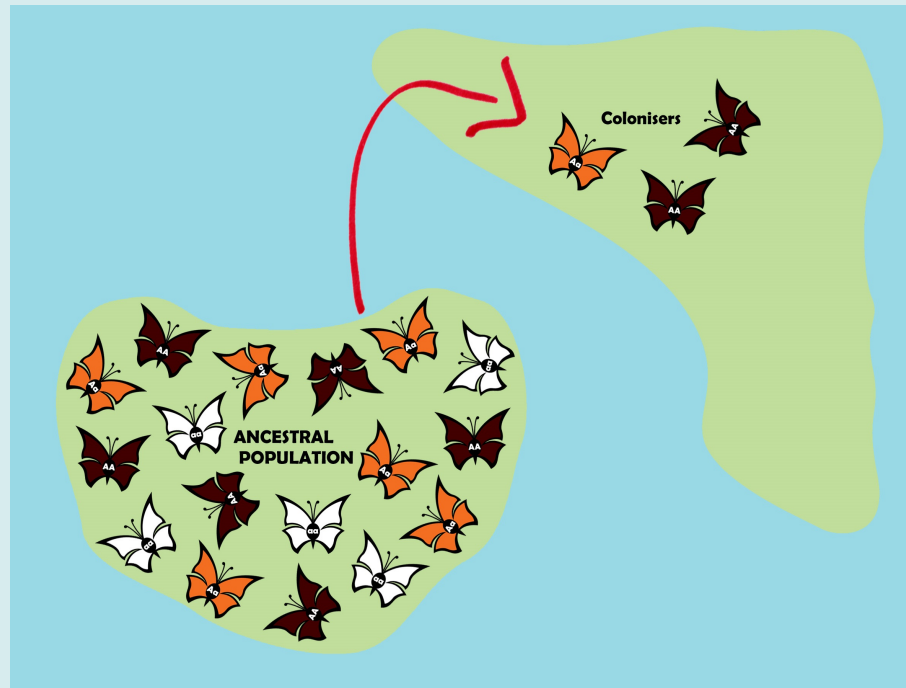


This different allele frequency is reflected in today's population.

# Microevolution by genetic drift

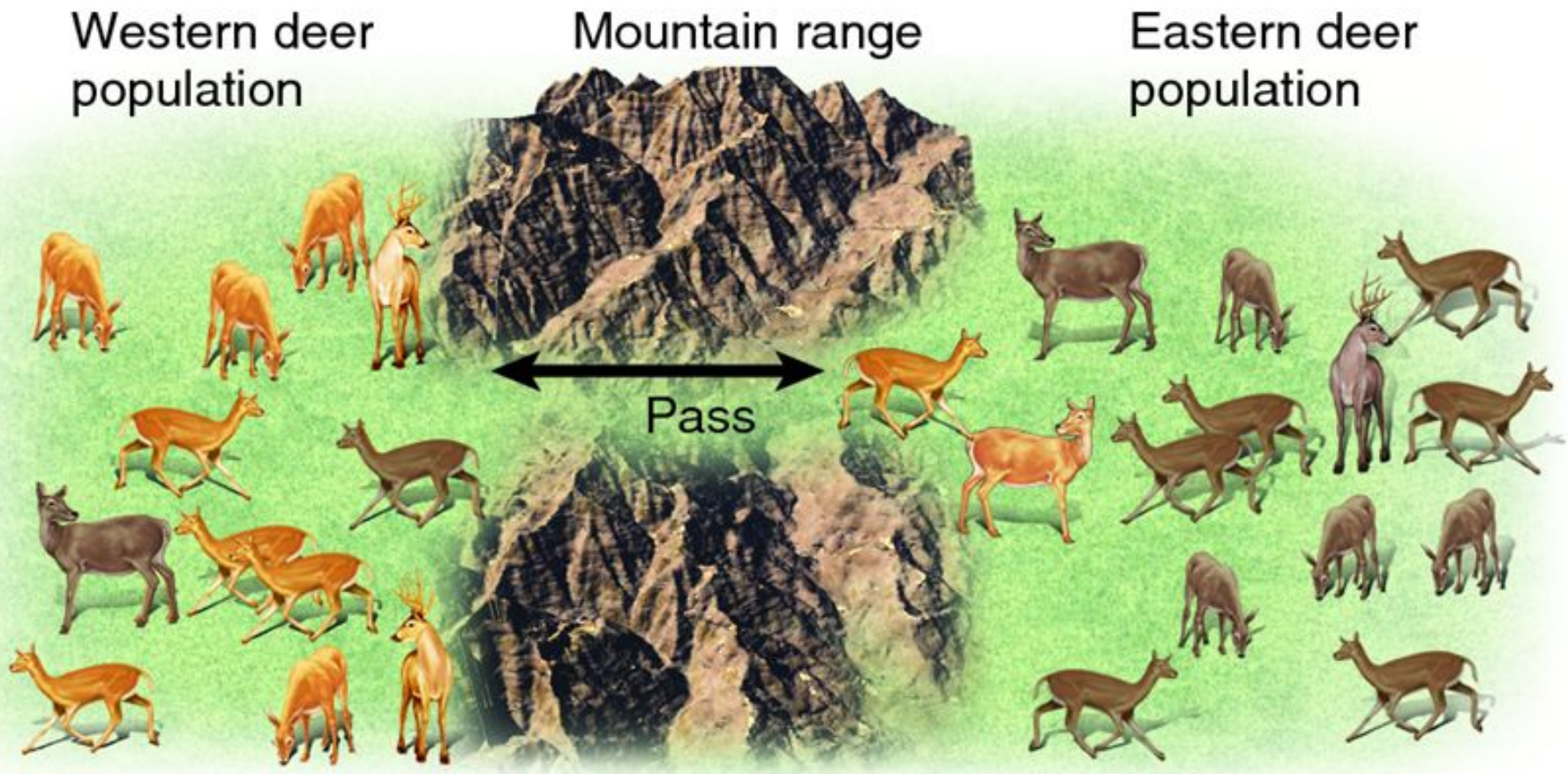
## The founder effect:

The genetic makeup of a small group of colonists will not represent the gene pool of the larger population they left.



# Microevolution by genetic flow

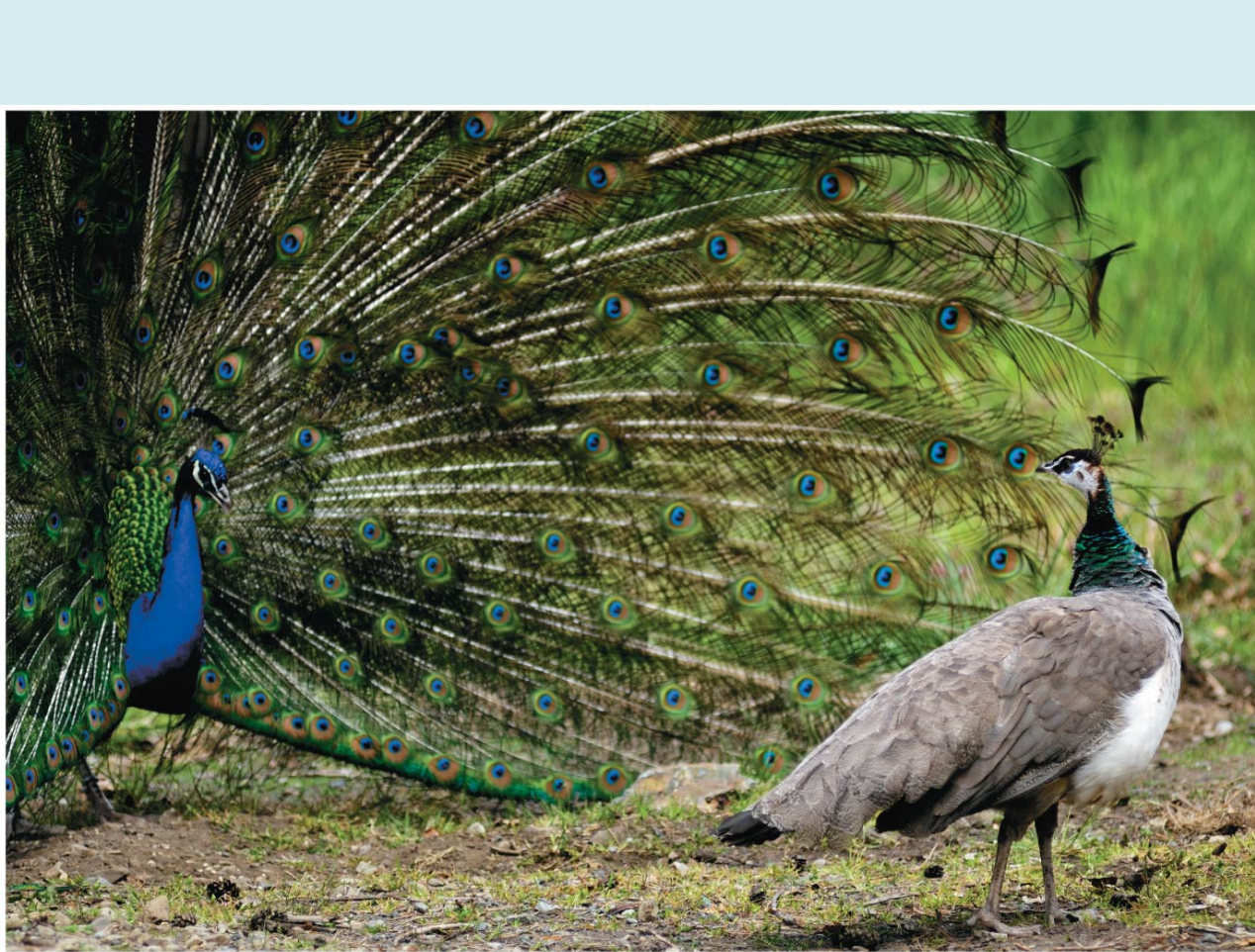
## Movement of alleles between populations



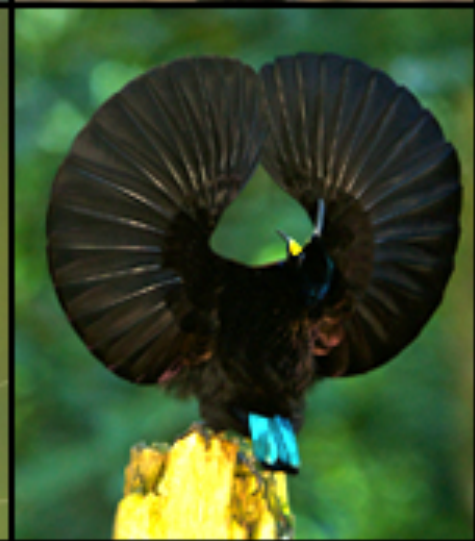
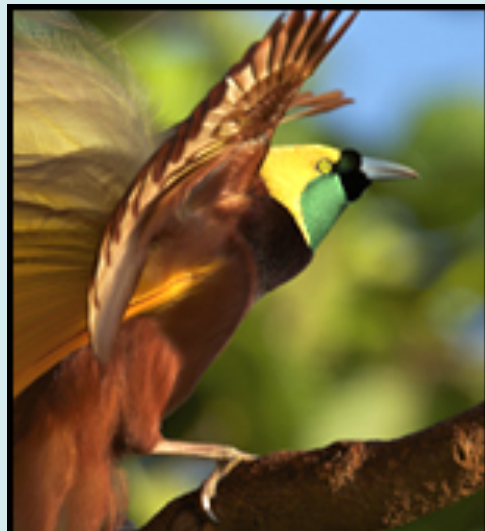


# Sexual selection

a form of natural selection in which individuals with certain characteristics are more likely than other individuals to obtain mates.







# Artificial Selection

Insights into how incremental change occurs could be seen in examples of **artificial selection**.



# What is the best way to describe the evolutionary changes that occur in a beetle population over time?

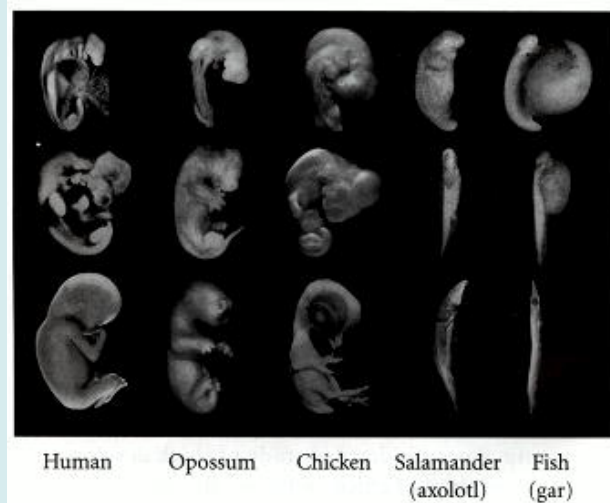
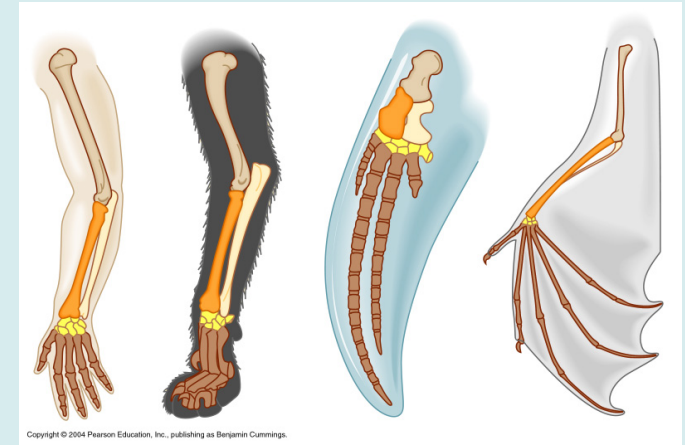
- A. The traits of each individual beetle within a population gradually change.
- B. The percentage of beetles having different traits within a population change.
- C. Successful behaviors learned by certain beetles are passed on to offspring.
- D. Mutations occur to meet the needs of the beetles as the environment changes.





# Lines of Evidence for Evolution

- Fossil Record
- Comparative Anatomy
- Comparative Embryology
- Molecular Biology



# Evolution Evidence: Fossil Record



Copyright © 2005 Pearson Education, Inc. Publishing as Pearson Benjamin Cummings. All rights reserved.



Copyright © 2005 Pearson Education, Inc. Publishing as Pearson Benjamin Cummings. All rights reserved.



Copyright © 2005 Pearson Education, Inc. Publishing as Pearson Benjamin Cummings. All rights reserved.



# Fossil Record and Radiometric Dating



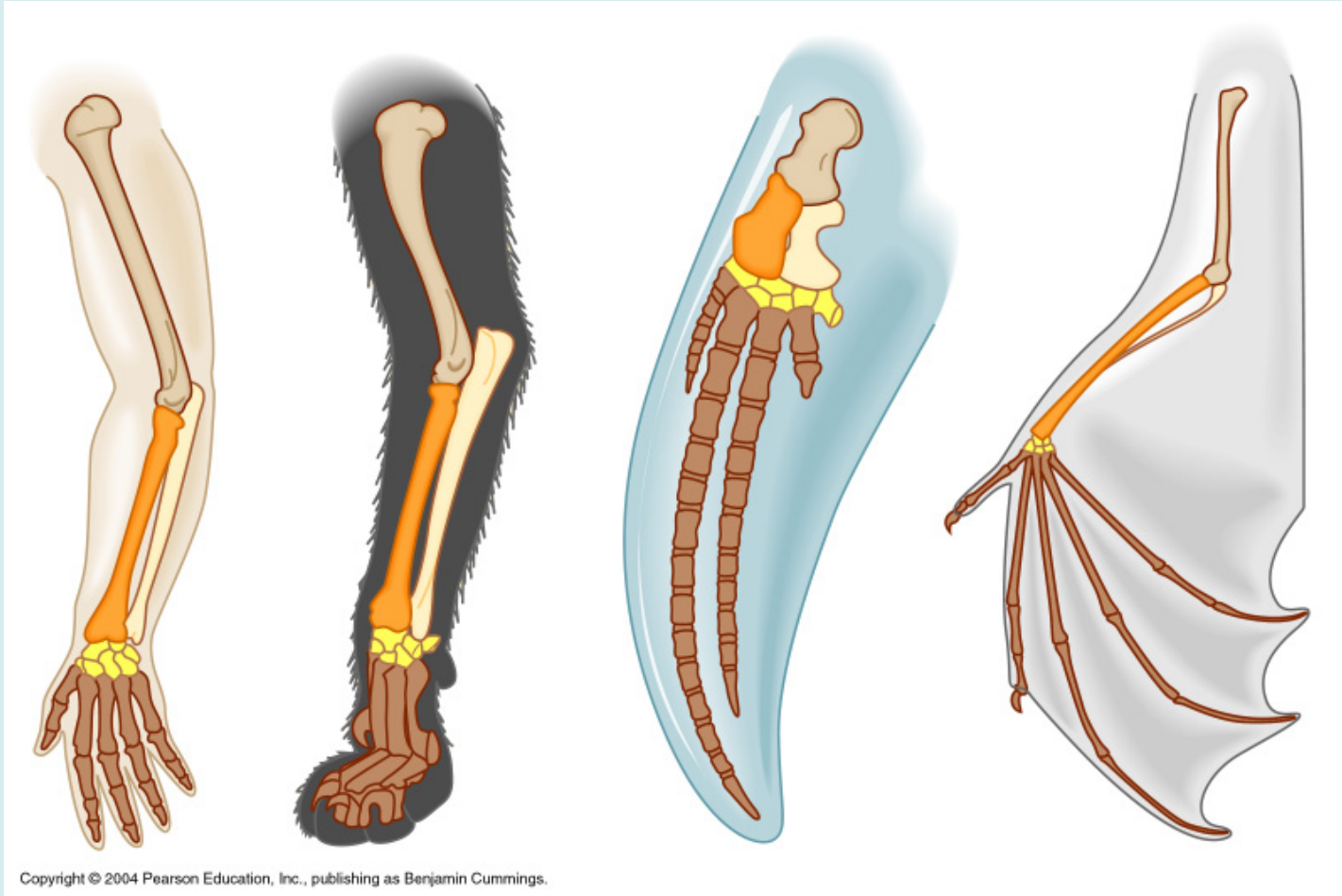
Copyright © 2005 Pearson Education, Inc. Publishing as Pearson Benjamin Cummings. All rights reserved.

**fossils within layers of sedimentary rock: strata**

[http://media.hhmi.org/biointeractive/click/Scientific\\_Process/04-vid.html](http://media.hhmi.org/biointeractive/click/Scientific_Process/04-vid.html)

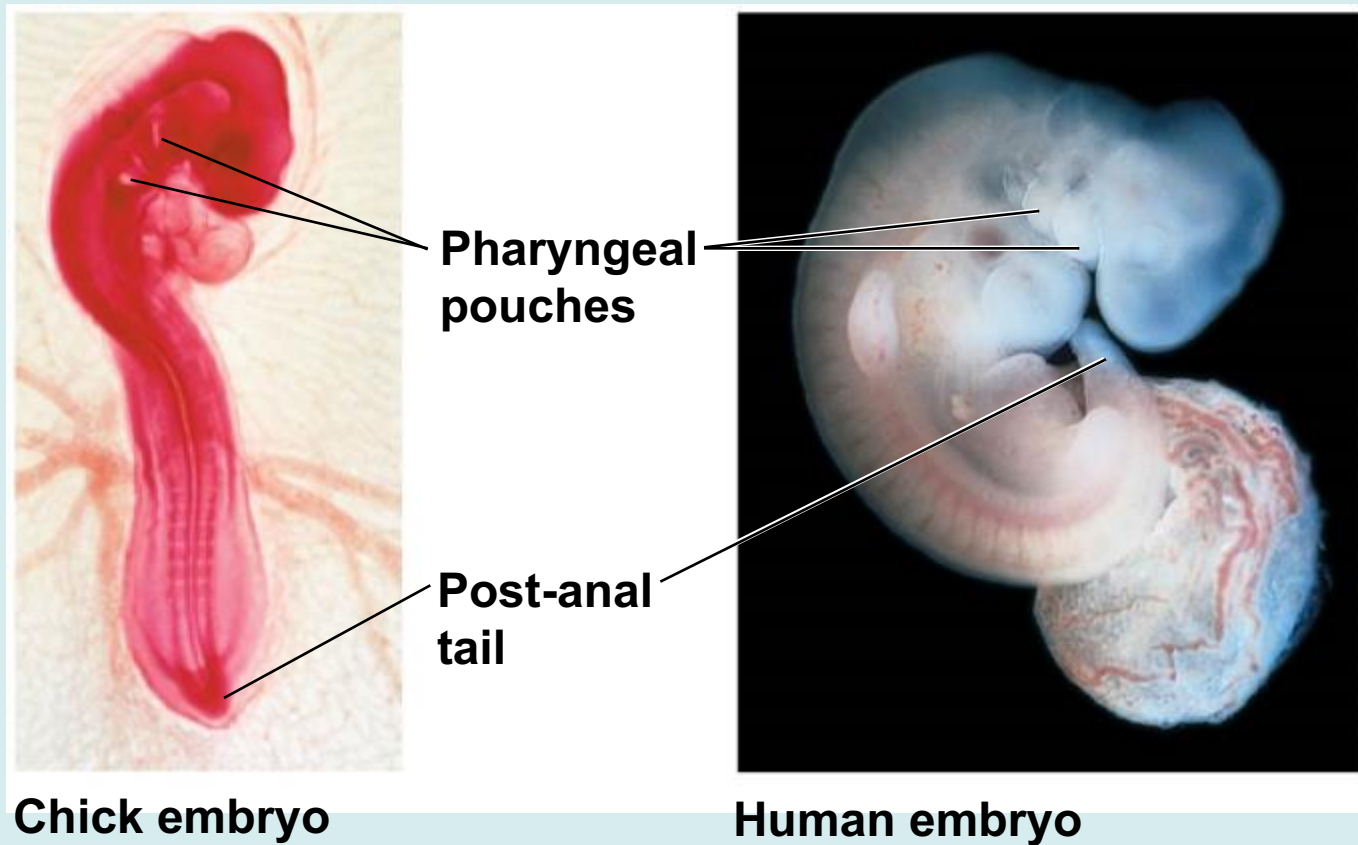
# Evidence: Comparative anatomy (homologous structures)

Homology - similarity resulting from common ancestry



**vertebrate forelimbs**







# Evidence: Comparative embryology in vertebrates





# Evidence: Molecular Biology

**TABLE 13.4 COMPARISON OF A PROTEIN  
IN DIFFERENT SPECIES**

Species	Percent of amino acids that are identical to the amino acids in a human hemoglobin polypeptide
Human 	100%
Rhesus monkey 	95%
Mouse 	87%
Chicken 	69%
Frog 	54%
Lamprey 	14%

Which of the following represents a pair of homologous structures?

- a. the wing of a bat and the scales of a fish
- b. the wing of a bat and the flipper of a whale
- c. the antennae of an insect and the eyes of a bird
- d. the wing of a bat and the wing of a butterfly



Which of the following represents a pair of homologous structures?

- a. the wing of a bat and the scales of a fish
- b. the wing of a bat and the flipper of a whale**
- c. the antennae of an insect and the eyes of a bird
- d. the wing of a bat and the wing of a butterfly