MARCO LEARNING®

AP Biology Insta-Review

Big Idea 1: Evolution

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AP Biology students are penguins because they are Dressed for Success!

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Today's Plan:

Unit 2: Cell Structure & Function

Topic 2.11: Origin of Cell Compartmentalization

Unit 5: Heredity

Topic 5.3: Mendelian Genetics

Unit 8: Ecology

Topic 8.7: Disruptions to Ecosystems

Unit 7: Natural Selection

Topic 7.1: Introduction to Natural Selection

Topic 7.2: Natural Selection

Topic 7.3: Artificial Selection

Topic 7.4: Population Genetics

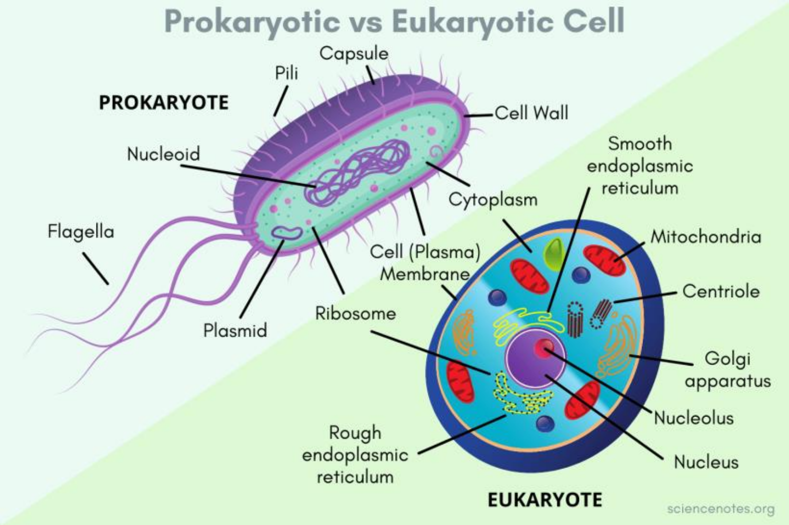
Topic 7.5: Hardy-Weinberg Equilibrium

Topic 7.6: Evidence of Evolution

Topic 7.7: Common Ancestry

Prokaryote

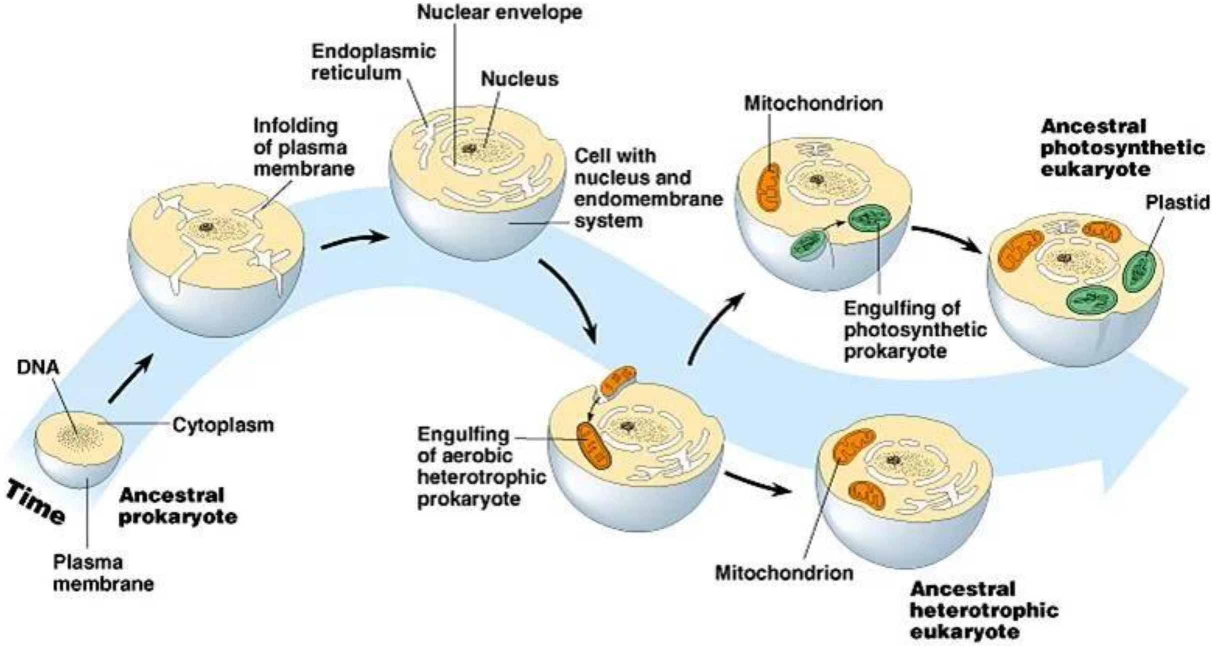
- NO membrane bound organelles
- ribosomes, plasma membrane, nucleoid
- DNA: single, circular, & lacks histones and introns



Eukaryote

- membrane bound organelles (nucleus, Golgi, ER, peroxisomes, mitochondria, etc.)
- DNA: multiple, linear, & has histones and introns

2.11: Origin of Cell Compartmentalization



Evidence of Endosymbiotic Theory

Mitochondria & Chloroplast:

- contain own circular DNA lacking histones
- can self-replicate
- ribosomes similar to prokaryotic ribosomes
- inner membrane similar to prokaryotic membrane
- perform transcription & translation
- approximately size of prokaryotes
- use prokaryote-like enzymes

Genetic Information Carriers

- All organisms have DNA/RNA
- DNA/RNA composed of pentose sugar, nitrogenous base, & phosphate

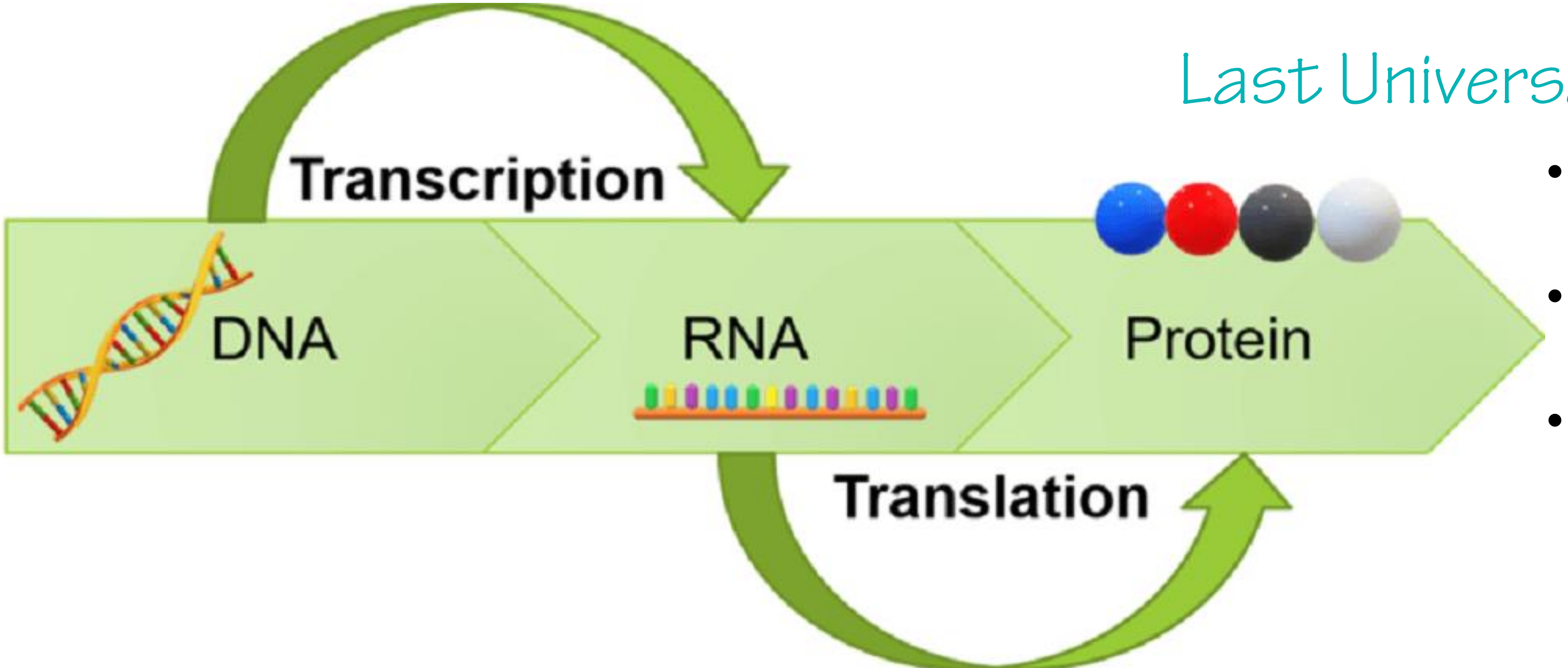
Genetic Code

- All organisms have ribosomes
- Genetic code is shared among organisms

Metabolic Pathways

- Core metabolic pathways conserved among domains
- Ex: glycolysis, creating/using carbohydrates, synthesizing phospholipids for cell membranes

5.3: Mendelian Genetics



Last Universal Common Ancestor (LUCA)

- Most recent common ancestor of all of life on Earth
- Shared features of modern genomes
- Including genes for: transcription/translation to convert DNA to RNA to proteins

EVO-1

- Evolution is characterized by change in the genetic make-up of a population over time and is supported by multiple lines of evidence

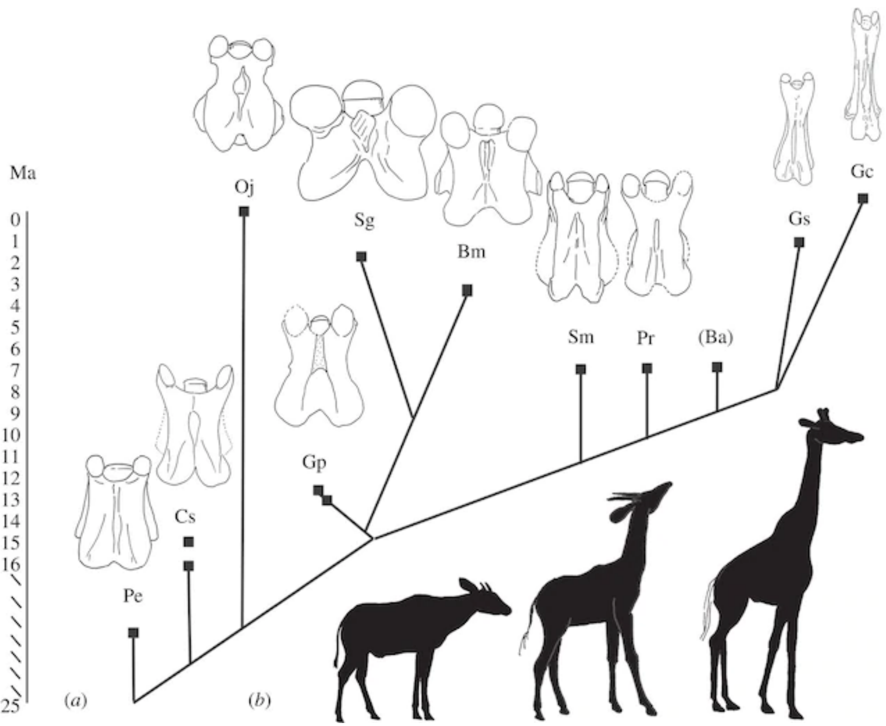
Adaptations

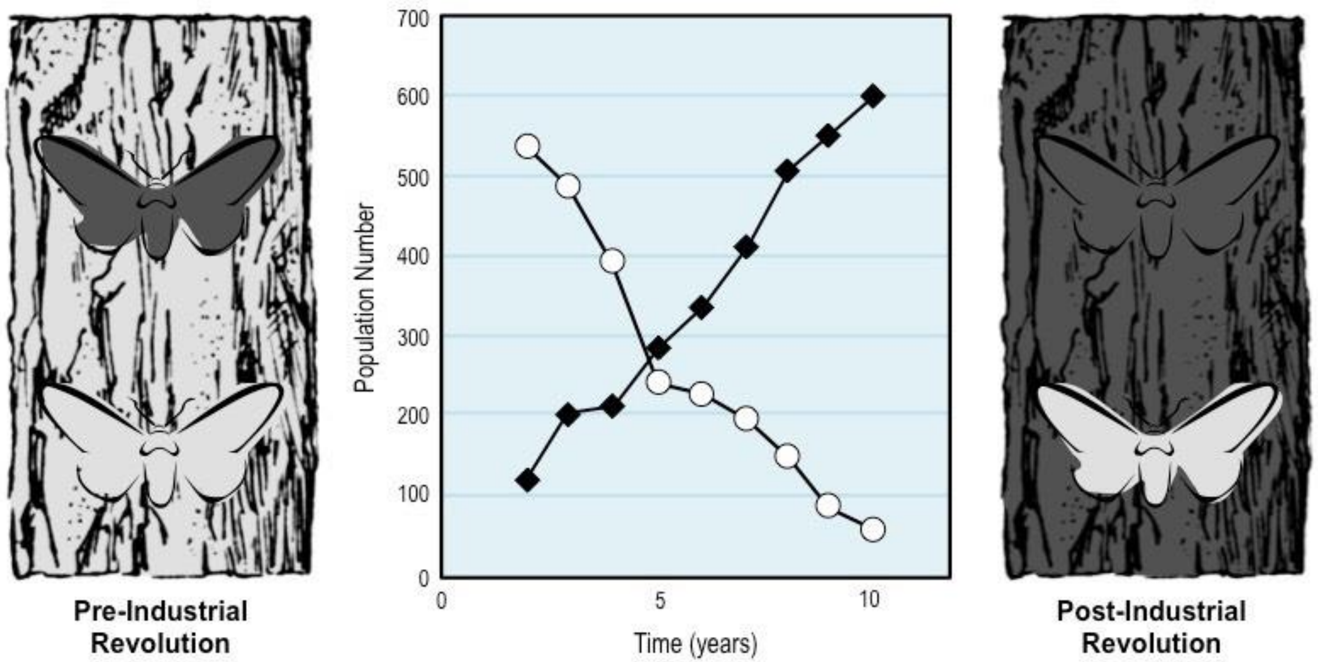
- Change to population to make better suited to environment
- Favored by selection
- Provides advantage in particular environment

Mutations

- Changes in DNA
- Random
- Not directed by specific environmental pressures

8.7: Disruptions to Ecosystems





Natural Selection

- Developed by Charles Darwin
- Establish due to variation in the population
- Competition for limited resources results in differential survival
- Individuals with more favorable phenotypes are more likely to survive and produce more offspring, thus passing traits to subsequent generations.
- Evolutionary fitness measured by reproductive success

Beware of Lamarckian statements

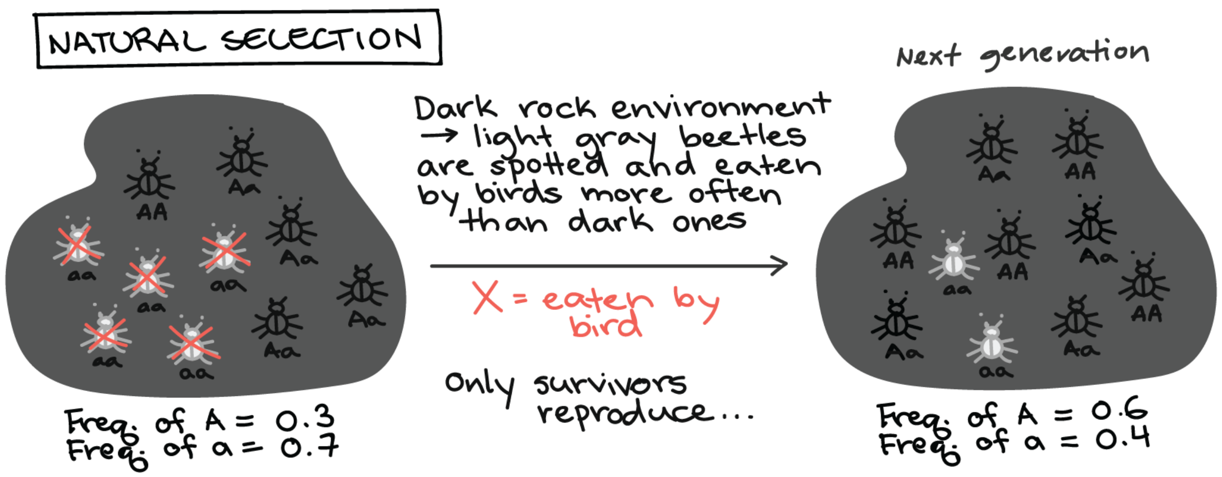
Examples

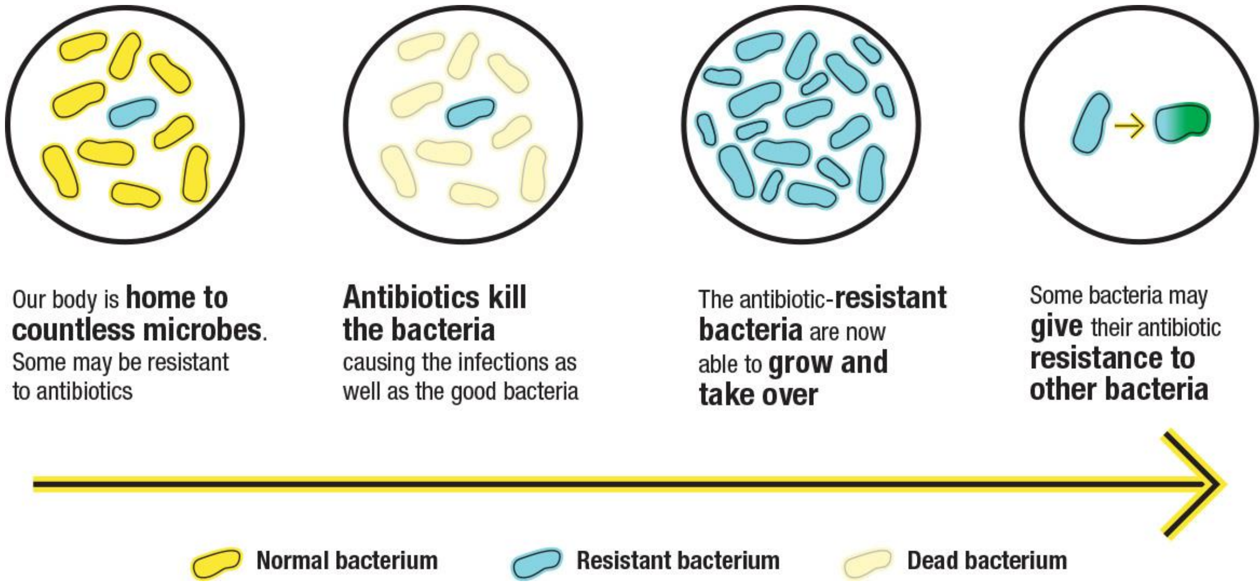
Peppered Moths
Antibiotic Resistance

Factors

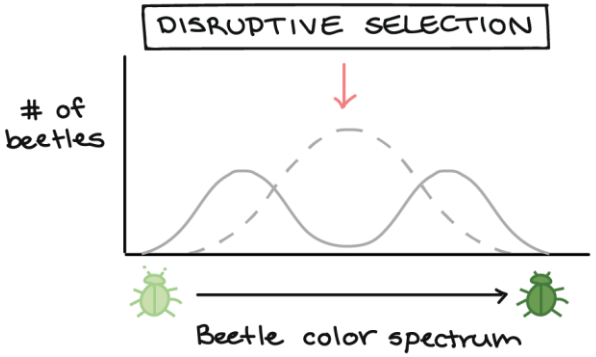
- Biotic and abiotic environments can be more or less stable/fluctuating, and this affects the rate and direction of evolution
- Different genetic variations can be selected in each generation.

7.1 Introduction to Natural Selection





7.2 Natural Selection

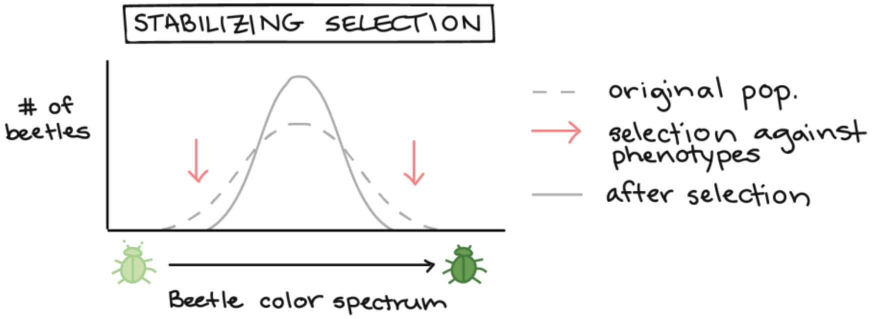


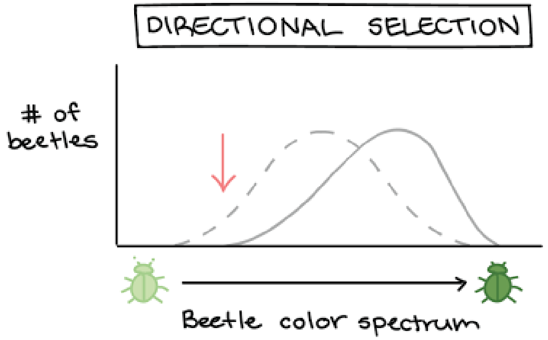
Disruptive Selection

Selection for the
two extreme phenotypes
Selection against
the intermediate phenotype

Stabilizing Selection

Selection for the
intermediate phenotype
Selection against the
two extreme phenotypes





Directional Selection

Selection for an extreme phenotype
Selection against the
other phenotypes

Natural Selection ACTS on phenotypes, but AFFECTS genotypes

INCREASE fitness of the organism in particular environment

Phenotypic Variations

- Population has a variety of traits strongly influence by genetic and environmental factors

DECREASE fitness of the organism in particular environment

Artificial Selection

- Organisms with certain traits are bred until population has that trait
- Humans affect variation in the population
- Examples:
  - Dog Breeds
  - Corn from Maize
  - Wild Mustard → Cauliflower, Broccoli, Cabbage, Kale, & Kohlrabi

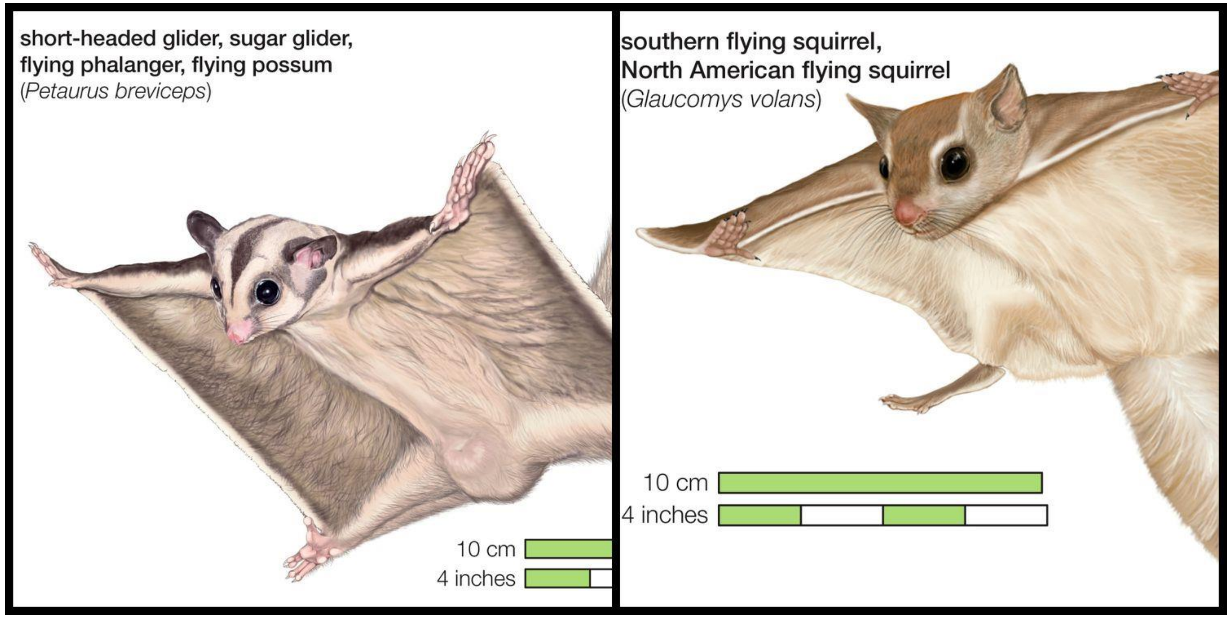
7.3 Artificial Selection

Convergent Evolution

- similar selective pressures result in similar phenotypic adaptations in different populations or species

Examples:

- Sugar Glider vs. Flying Squirrel
- Bat Wing vs, Bird Wing



Mutations

- Changes in DNA
- Random
- Not directed by specific environmental pressures
- Results in variation that natural selection can act upon

Genetic Drift

Bottleneck Effect

- Population is reduced by a natural disaster where there was no selection based on traits

Founder's Effect

- Small population is isolated from original population

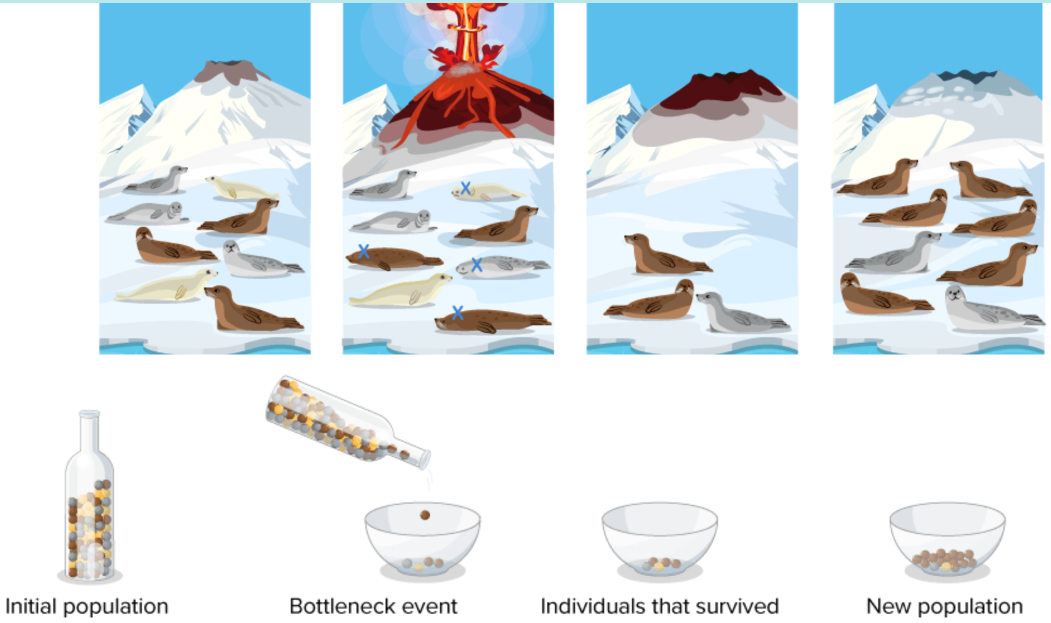
These reduce the population size and could decrease genetic diversity making them more susceptible to environmental impact or could fix harmful alleles

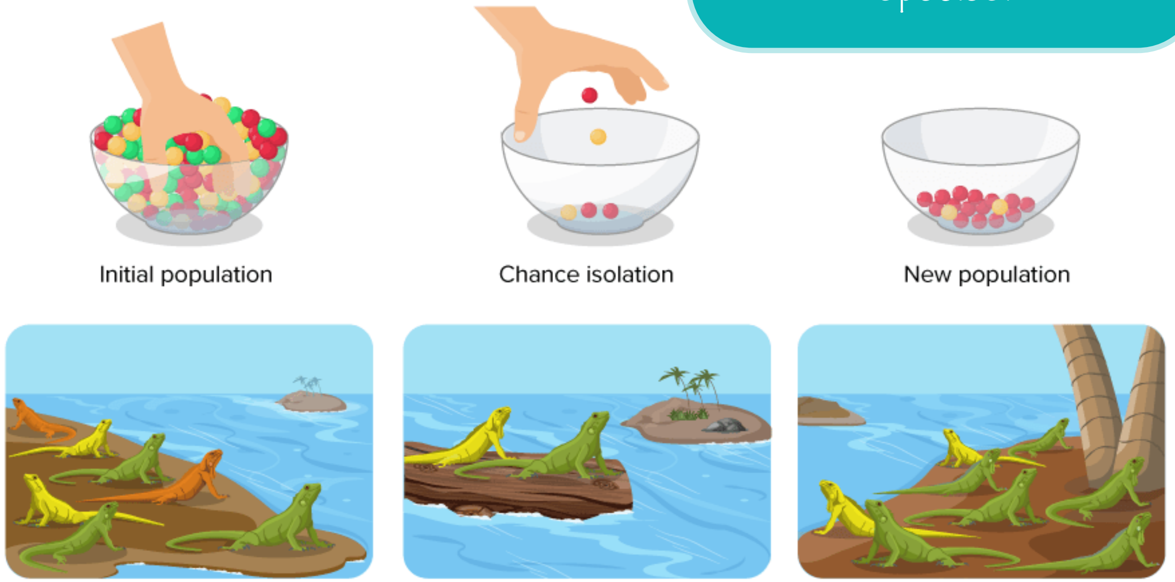
Gene Flow

- Movement of organisms into (immigration) or out of (emigration) a population
- Brings NEW alleles into the population
- Removes alleles from the population

7.4 Population Genetics

Reduction of genetic variation within a given population can increase the differences between populations of the same species.

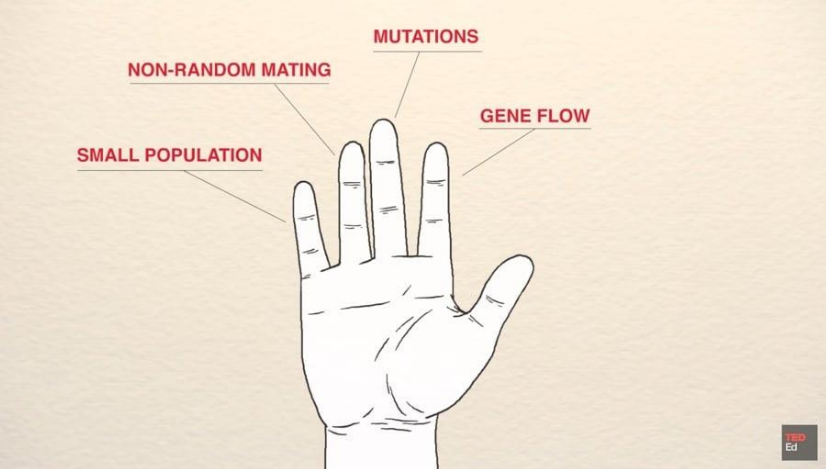




7.5 Hardy-Weinberg Equilibrium

Conditions for Hardy-Weinberg Equilibrium

1. a large population size
2. absence of migration
3. no net mutations
4. random mating
5. absence of selection



Did the population evolve?

If the allelic/genotypic frequency changes, the population has evolved.

Equations

Variables

p = frequency of the dominant allele
q = frequency of the recessive allele
p^2 = frequency of homozygous dominant
$2pq$ = frequency of the heterozygous
q^2 = frequency of the homozygous recessive

Hardy-Weinberg Equilibrium

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

p	q	p^2	$2pq$	q^2

Counting Alleles

$$p = \frac{2AA + Aa}{2 \text{ x \# individuals}}$$

$$q = \frac{2aa + Aa}{2 \text{ x \# individuals}}$$

p^2 = #AA/total
$2pq$ = #Aa/total
q^2 = #aa/total

Example Problems

The garden at your school always has red, pink, and white snapdragons. There are 200 red flowers, 300 pink flowers, and 500 white flowers. Determine the allele frequency of the flower allele color.

Red (p^2) = 200/1000 = 0.2
Pink ($2pq$) = 300/1000 = 0.3
White (q^2) = 500/1000 = 0.5

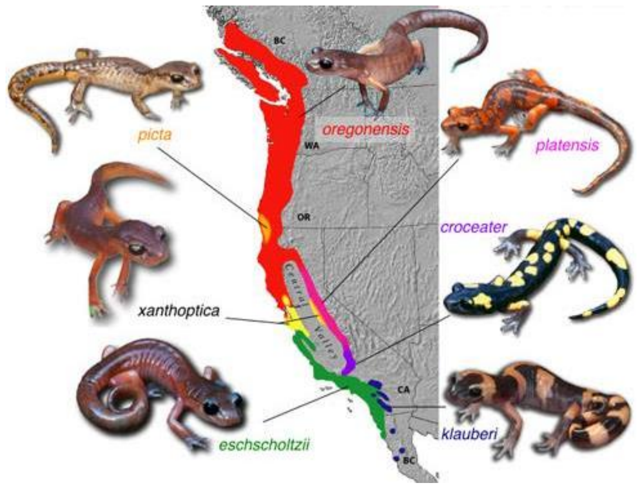
$$p = \frac{2(200)+300}{2(1000)} = \frac{700}{2000} = 0.35$$
$$q = \frac{2(500)+300}{2(1000)} = \frac{1300}{2000} = 0.65$$

In a population that is in Hardy-Weinberg equilibrium, 36 % of the individuals have the dominant phenotype for a certain trait.

p	q	p^2	$2pq$	q^2
0.2	0.8	0.04	0.32	0.64

Tip: Always start with q^2 for H-W problems

Geographical



Geological/Fossil Evidence

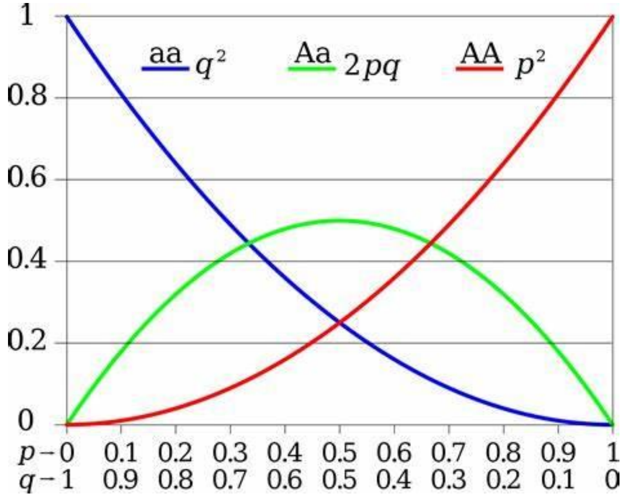
Fossil Dating:

- The age of the rocks where a fossil is found
- The rate of decay of isotopes including carbon-14
- Geographical data

Morphological Homologies:

- Homologous/Vestigial structures

Mathematical



7.6 Evidence of Evolution

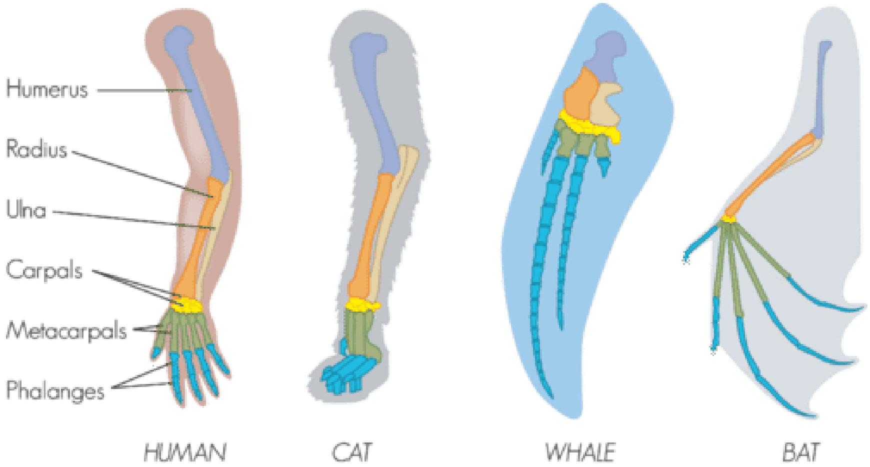
Biochemical

Species	Sequence of Amino Acids in the Same Part of the Hemoglobin Molecules
Human	Lys–Glu–His–Iso
Horse	Arg–Lys–His–Lys
Gorilla	Lys–Glu–His–Lys
Chimpanzee	Lys–Glu–His–Iso
Zebra	Arg–Lys–His–Arg

DNA or protein

Comparison of the number of differences

Physical



Homologous Structures:

Similar structures due to common descent

Vestigial Structures:

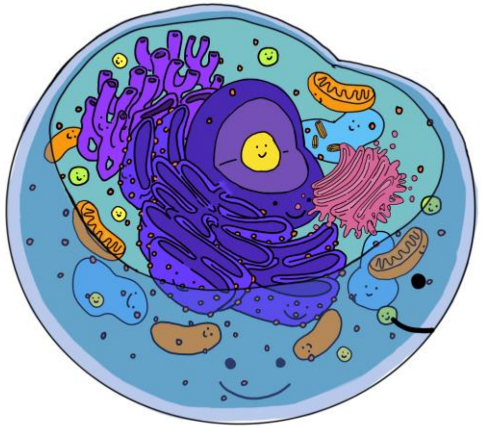
Anatomical structure with no apparent function still present from ancestral species

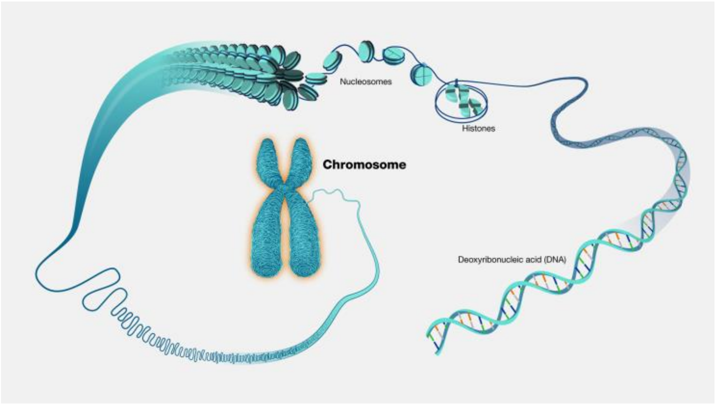
BEWARE: Analogous structures are due to convergent evolution

7.7 Common Ancestry

Evidence of Common Ancestry

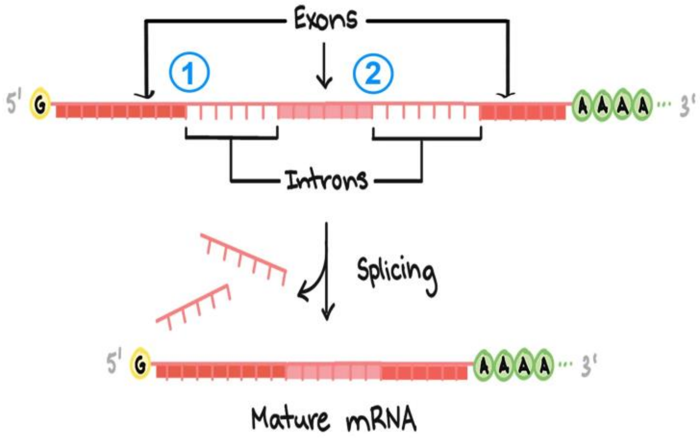
Membrane Bound Organelles



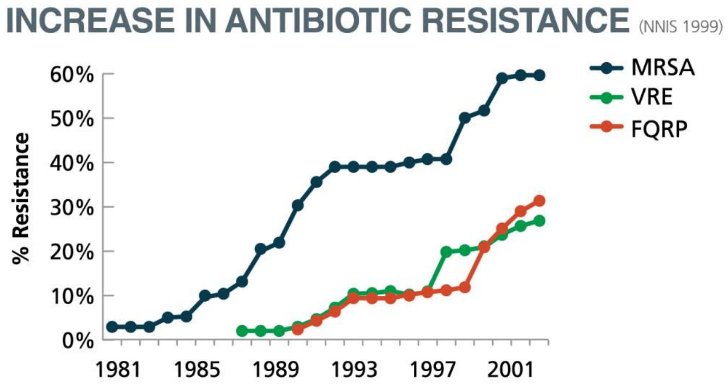


Linear Chromosomes

Genes the contain introns

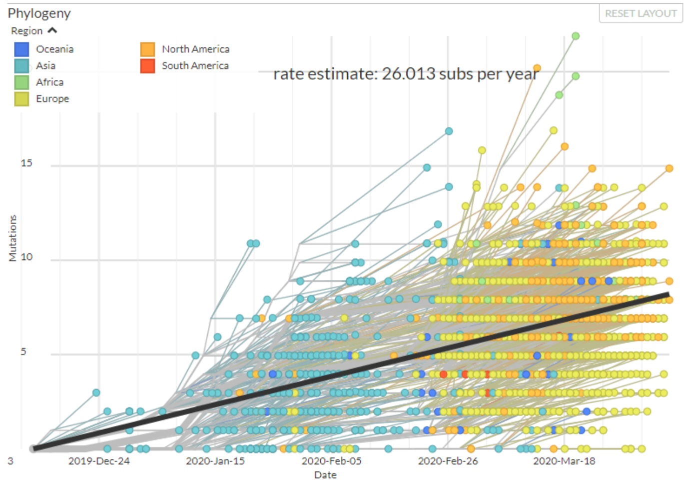


7.8 Continuing Evolution



Evolution is a continuous process

- Genomic changes over time.
- Continuous change in the fossil record.
- Evolution of resistance to antibiotics, pesticides, herbicides, or chemotherapy drugs.
- Pathogens evolve and cause emergent diseases.

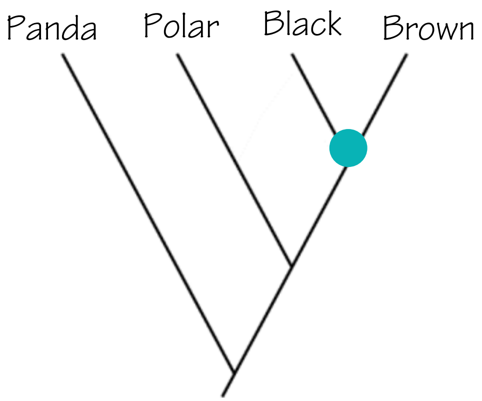


7.9 Phylogeny

Cladogram

TABLE 1. AMINO ACID DIFFERENCES IN THE LYST PROTEIN AMONG BEAR SPECIES

	Panda	Black	Brown	Polar
Panda	–			
Black	33	–		
Brown	34	1	–	
Polar	40	7	8	–



What does it show?

- Shows relationships
- Amount of change over time (fossil/molecular clock evidence)
- Characters gained or lost
- Recent ancestors

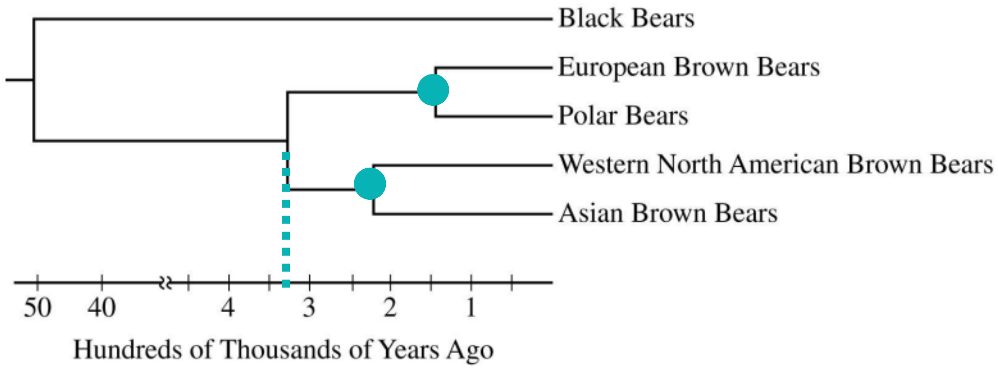


Figure 1. Phylogenetic tree representing the evolutionary relatedness among bear populations based on mitochondrial DNA sequence comparisons

Phylogenetic Tree

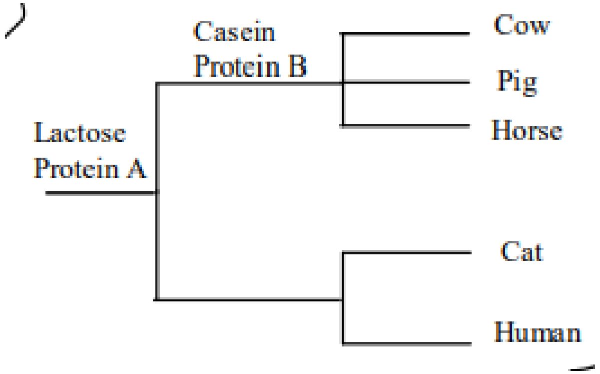
Outgroup

least closely related to the remainder of the organisms in the phylogenetic tree or cladogram.

MILK COMPONENTS IN DIFFERENT MAMMALS

Character	Cat	Cow	Horse	Human	Pig
Lactose	+	+	+	+	+
Protein A	+	+	+	+	+
Protein B	–	+	+	–	+
Casein	–	+	+	–	+

+ indicates the presence of the character, and – indicates the absence of the character



7.10 Speciation

Creation of new species

Prezygotic

Before zygote is created

Behavioral

Two organisms have different mating rituals (dance, song, etc)

Habitat/Ecological

Two organisms mate in different ecological environments

Temporal

Two organisms mate at different times (day, month, year, etc.)

Mechanical

Two organisms are incompatible anatomically

Geographic

Two organisms are separated by a geographical barrier

Gametic

Two gametes are unable to fuse

Biological Species Concept:

two organisms are of the same species if they can INTERBREED and produce FERTILE, VIABLE offspring

Postzygotic

After zygote is created

Reduced Hybrid Viability

Hybrid is not healthy/viable

Reduced Hybrid Fertiliity

Hybrid is not fertile

Hybrid breakdown

First generation hybrid is ok But second and more generations the hybrid starts decreasing viability and fertility

Sympatric

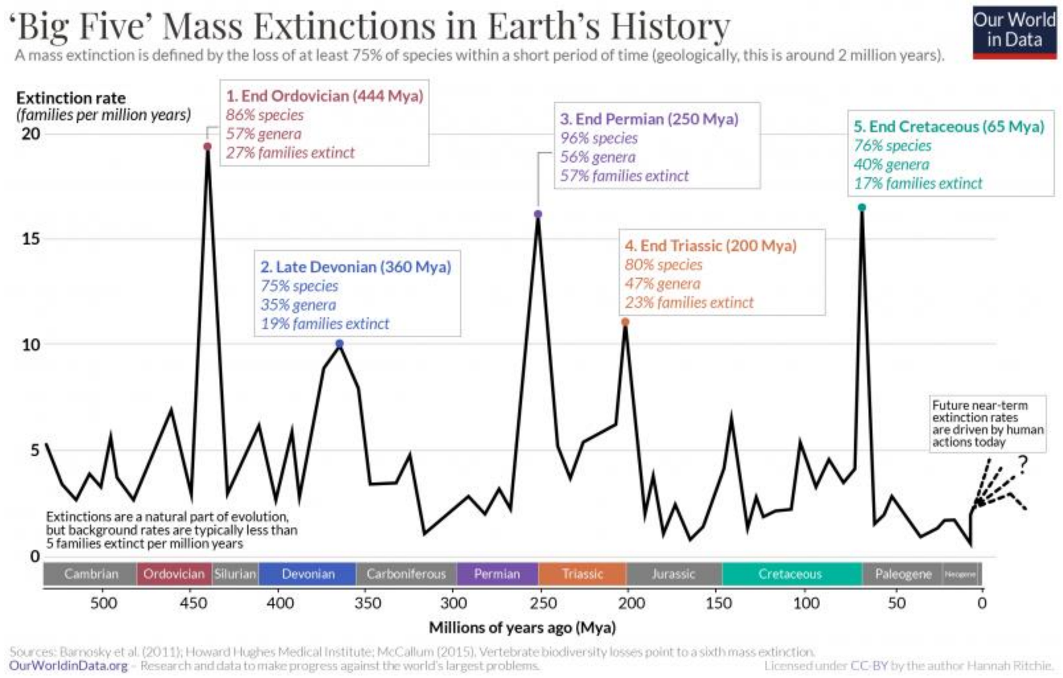
New species from a surviving ancestral species while both continue to inhabit the same geographic region

Habitat isolation, Behavioral isolation, Sexual Selection, Polyploidy

Allopatric

Occurs when biological populations of the same species become isolated due to geographical changes

Earth's History



Ecological Changes & Human Activity

Ecological Changes

- Ocean levels change
- Climate change
- Decrease in oxygen levels in ocean
- Atmospheric and ocean chemistry

Human Activity

- Introduced species
- Over-harvesting
- Burning Fossil Fuels (global climate change)
- Pollution
- Over-population

Increase Extinction

7.11 Extinction

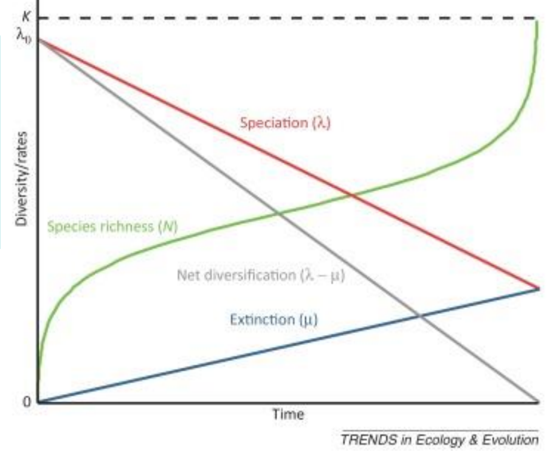
Advantages

Opens up opportunities for new species to emerge.

Animals and plants evolve to fill available niches within an existing ecosystem.

Disadvantages

- Wipes out biodiversity
- Destroys existing ecosystems and the special niches that species occupy
- New ecological niches must arise
- New species arise by filling broad ecological niches within a recovering ecosystem



The amount of diversity in an ecosystem can be determined by the rate of speciation and the rate of extinction.

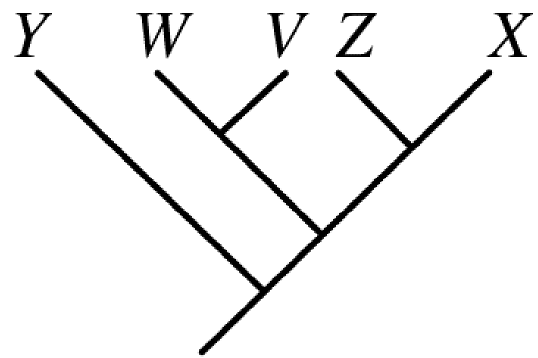
Multiple Choice Practice

Data regarding the presence (+) or absence (-) of five derived traits in several different species are shown in the table below.

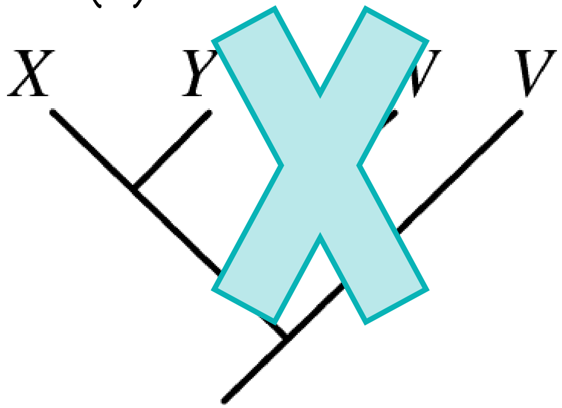
	Trait				
Species	1	2	3	4	5
V	+	+	+	-	-
W	+	+	-	-	-
X	+	-	-	-	-
Y	-	-	-	-	-
Z	+	-	-	-	+

Which of the following cladograms provides the simplest and most accurate representation of the data in the table?

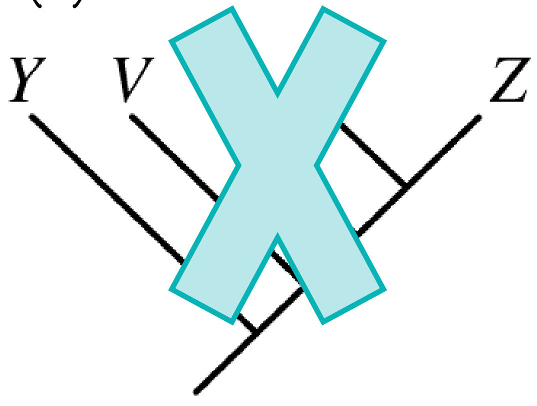
(a)



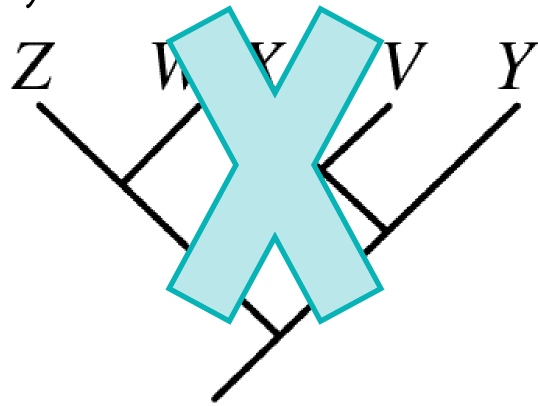
(b)



(c)



(d)



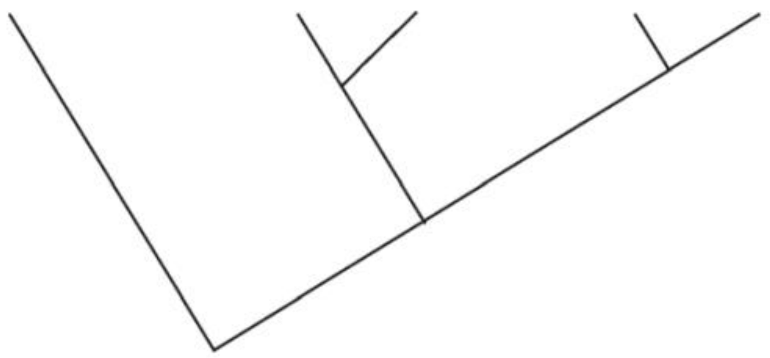
Free Response Practice

The amino acid sequence of cytochrome c was determined for five different species of vertebrates. The table below shows the number of differences in the sequences between each pair of species.

(a) Using the data in the table, **create** a phylogenetic tree on the template provided to reflect the evolutionary relationships of the organisms. **Provide reasoning** for the placement on the tree of the species that is least related to the others.

THE NUMBER OF AMINO ACID DIFFERENCES IN CYTOCHROME *c* AMONG FIVE SPECIES

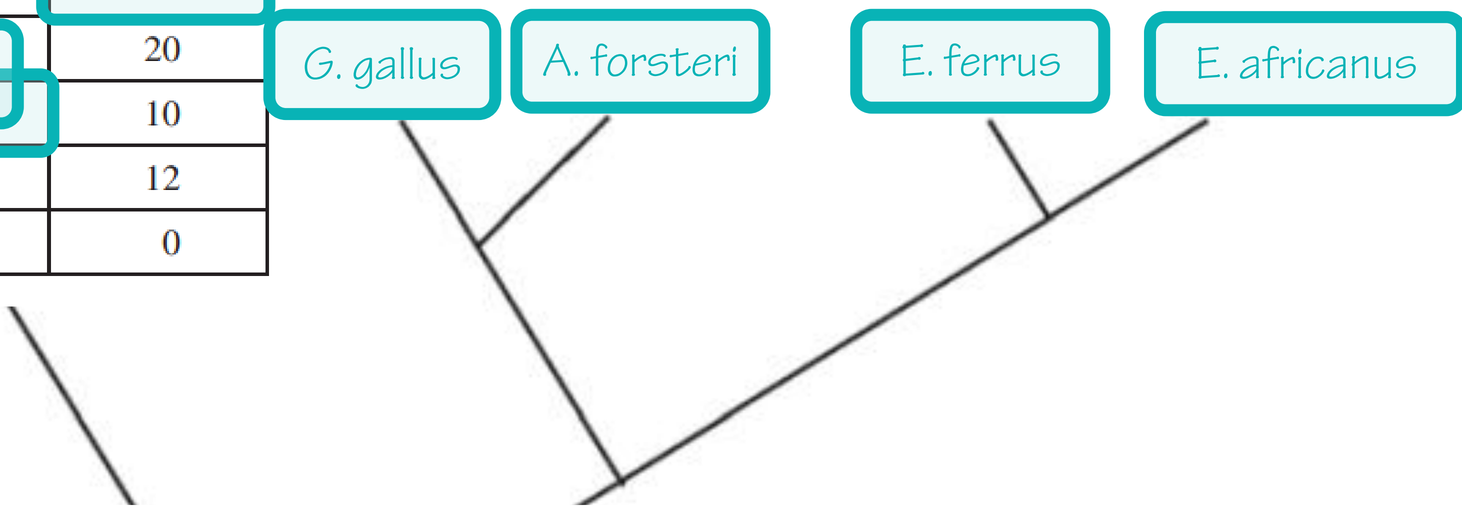
	E. ferus	*D. polylepis*	*G. gallus*	*A. forsteri*	*E. africanus*
E. ferus	0	21	11	13	1
D. polylepis		0	18	17	20
G. gallus			0	3	10
A. forsteri				0	12
E. africanus					0



Free Response Practice

THE NUMBER OF AMINO ACID DIFFERENCES
IN CYTOCHROME *c* AMONG FIVE SPECIES

	E. ferus	*D. polylepis*	*G. gallus*	*A. forsteri*	*E. africanus*
E. ferus	0	21	11	13	1
D. polylepis		0	18	17	20
G. gallus			0	3	10
A. forsteri				0	12
E. africanus					0



Reasoning (1 point)

- D. polylepis has the most differences in amino acids (or changes in DNA or proteins as they relate to amino acids).

Free Response Practice

(b) **Identify** whether morphological data or amino acid sequence data are more likely to accurately represent the true evolutionary relationships among the species, and **provide reasoning** for your answer.

Identification (1 point)

- Amino acid/molecular data

Reasoning (1 point)

- Morphology may be similar (due to convergent evolution/analogous structures) even if there are differences in amino acid/DNA sequences.
- Molecular data (e.g. amino acid changes, DNA changes) directly show genetic make-up/ reveal evolution.

Identification (1 point)

- Morphological data

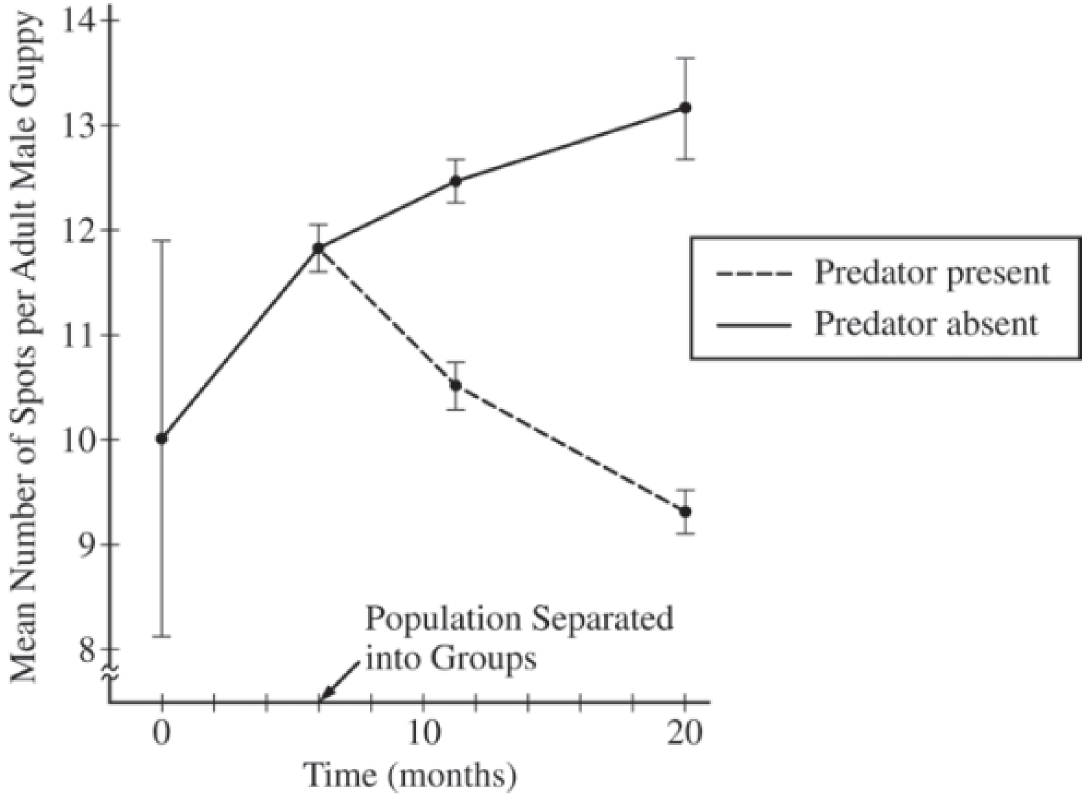
Reasoning (1 point)

- Similar molecular sequences may result in different morphologies.
- An example of species with similar proteins but different morphology (e.g., chimps and humans).

Free Response Practice

Adult male guppies (*Poecilia reticulata*) exhibit genetically determined spots, while juvenile and adult female guppies lack spots. In a study of selection, male and female guppies from genetically diverse population were collected from different mountain streams and placed together in an isolated environment containing no predators.

The study population was maintained for several generations in the isolated area before being separated into two groups. One group was moved to an artificial pond containing a fish predator, while a second group was moved to an artificial pond containing no predators. The two groups went through several generations in their new environments. At different times during the experiment, the mean number of spots per adult male guppy was determined as shown in the figure below. Vertical bars in the figure represent two standard errors of the mean (SEM).

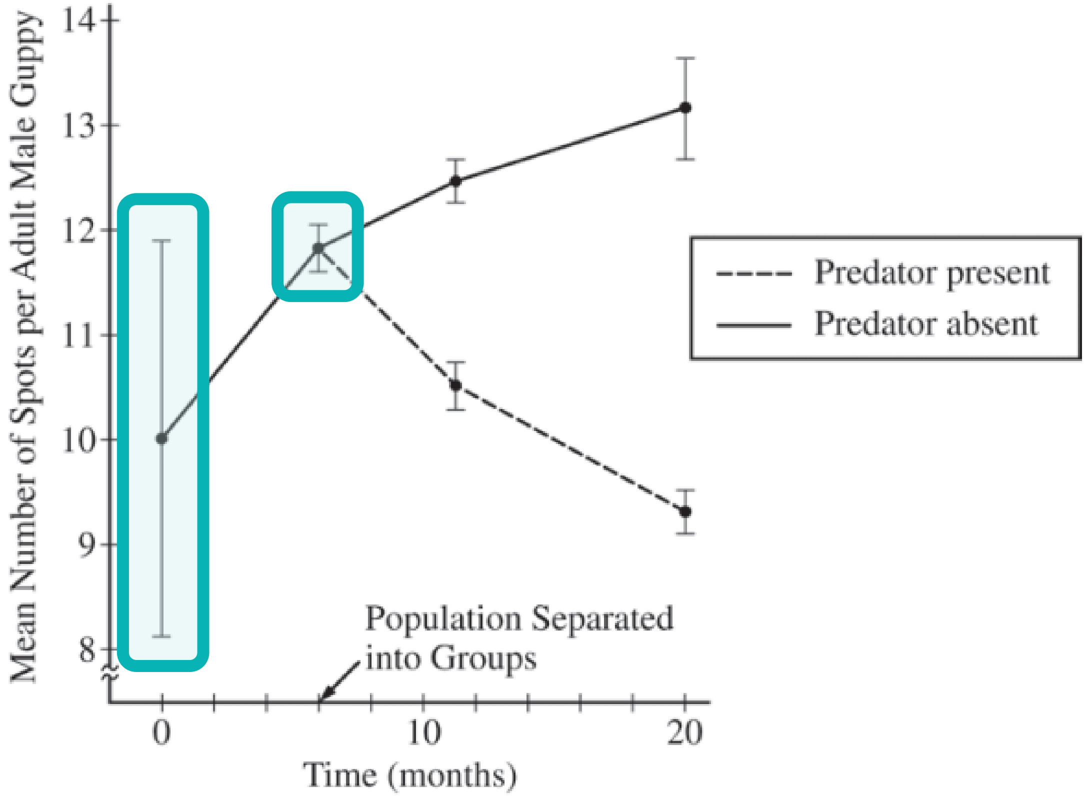


Free Response Practice

(a) **Describe** the change in genetic variation in the population between 0 and 6 months and **provide reasoning** for your description based on the means and SEM.

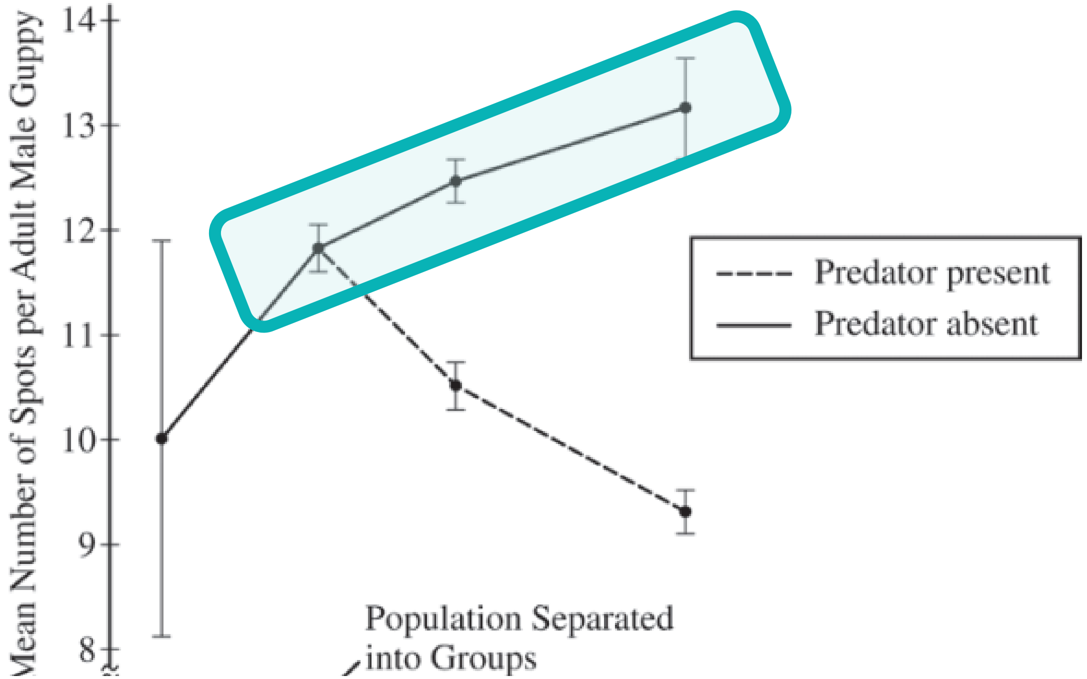
Describe change (**1 point**)
Genetic variation is decreasing

Provide reasoning (**1 point**)
SEM gets smaller



Free Response Practice

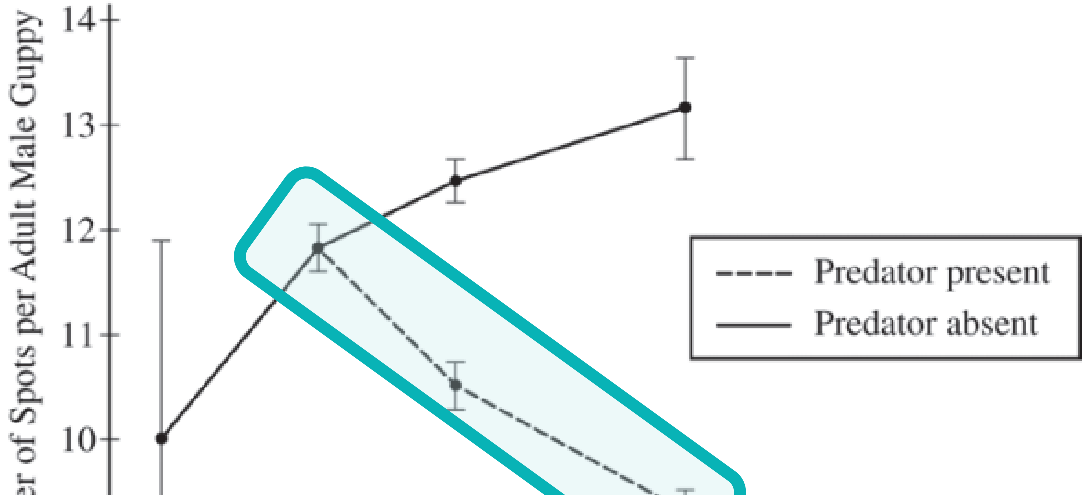
(b) **Propose** ONE type of mating behavior that could have resulted in the observed change in the number of spots per adult male guppy between 6 and 20 months in the absence of the predator.



- Sexual selection for individuals with more spots
- Random mating behavior resulted in increased number of spots by chance

Free Response Practice

(c) **Propose** an evolutionary mechanism that explains the change in average number of spots between 6 and 20 months in the presence of the predator.



- Directional selection against individuals with large numbers of spots
- Directional selection for individuals with fewer spots
- Natural selection used in context
- Genetic drift resulted in several generations of decreased numbers of spots

Q & A

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