MARCO LEARNING®

AP Biology Insta-Review

Unit 7: Natural Selection

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@apbiopenguins

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Today's Plan:

Special Thank You to Mrs. McClinton (Chat Q&A)

Natural Selection

Hardy Weinberg

Phylogeny/Evidence

Practice Questions

Unit 7 Q&A

Natural Selection

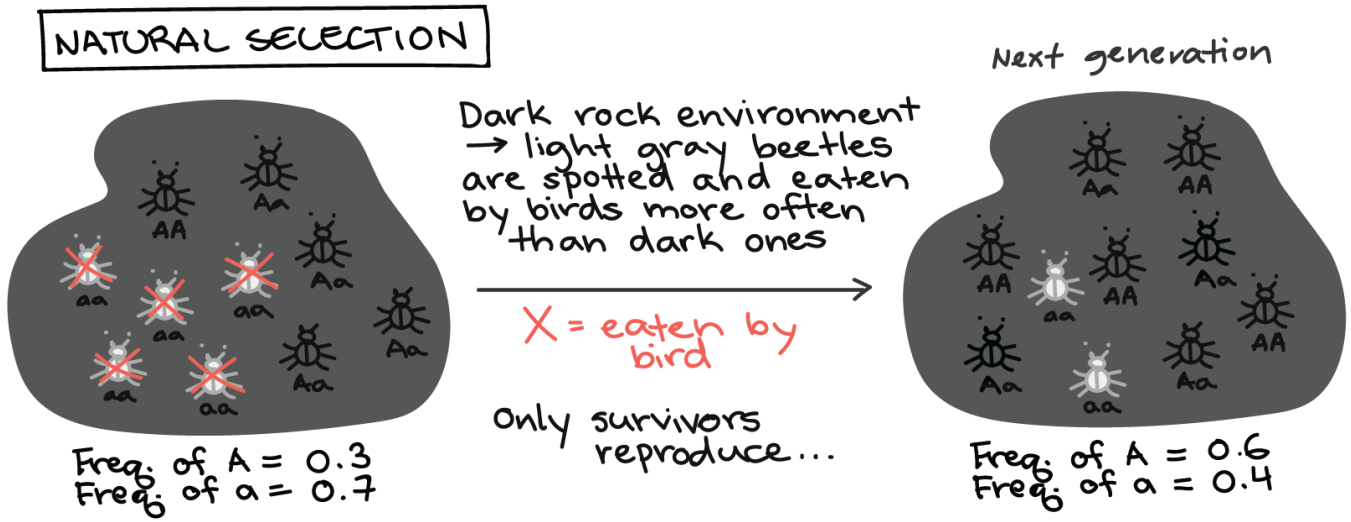
- Developed by Charles Darwin
- Establish due to variation in the population and competition for resources
- Organisms with more favorable trait, more likely to survive and produce more offspring to pass on their traits to next generation
- Examples:
  - Peppered Moths
  - Antibiotic Resistance

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

Beware of Lamarckian statements

Selection



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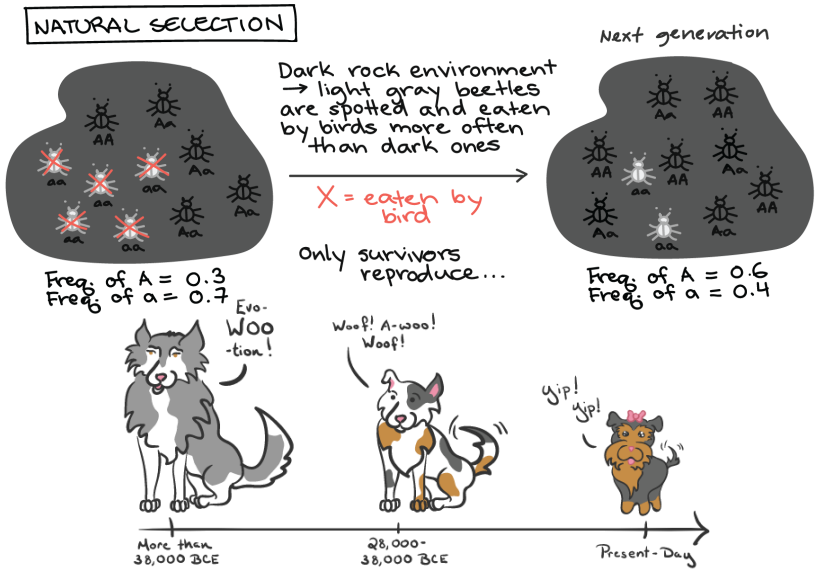

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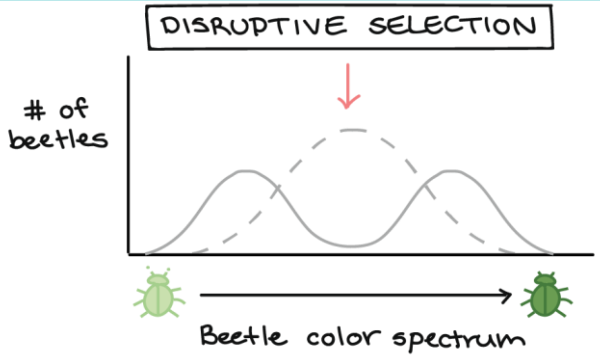
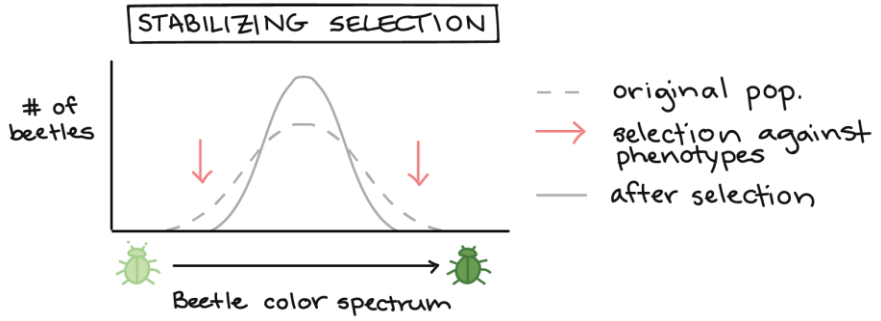


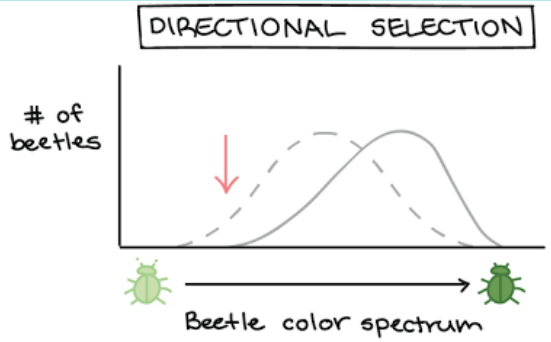
Disruptive Selection

Selection for the two extreme phenotypes
Selection against the intermediate phenotype

Stabilizing Selection

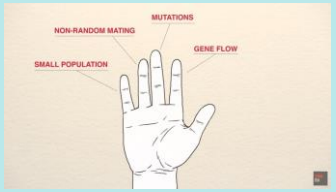
Selection for the intermediate phenotype
Selection against the two extreme phenotypes





Directional Selection

Selection for an extreme phenotype
Selection against the other phenotypes



Hardy-Weinberg

"Five Fingers of Evolution"

1. Extremely LARGE population size
2. Random mating
3. No mutations
4. No gene flow (immigration/emigration)
5. No natural selection

Genetic Drift

Founder's Effect

- Small population is isolated from original population

Bottleneck Effect

- Population is reduced by a natural disaster (fire, flood, etc) where there was no selection based on traits

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

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

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

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

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

Did the population evolve?

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

Example Problem

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

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

p	q	p^2	$2pq$	q^2
0.29	0.71	0.09	0.41	0.5

Phylogeny

Evidence of Evolution

Biochemical
DNA or protein
Comparison of the number of differences

Morphological
Homologous structures: similar structures due to common ancestry
Ex: Bat wing and Cat arm

Ancestral/Derived Traits: characteristics derived from ancestor or from descendants

✗ BEWARE: Analogous structures are due to convergent evolution

Biogeography
distribution of species and ecosystems in geographic space & through geological time

Phylogenetic Tree

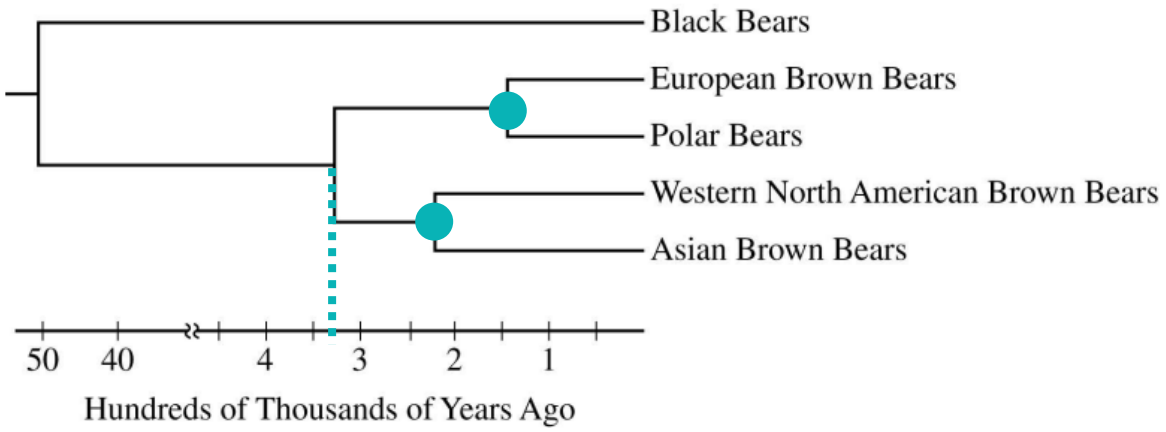
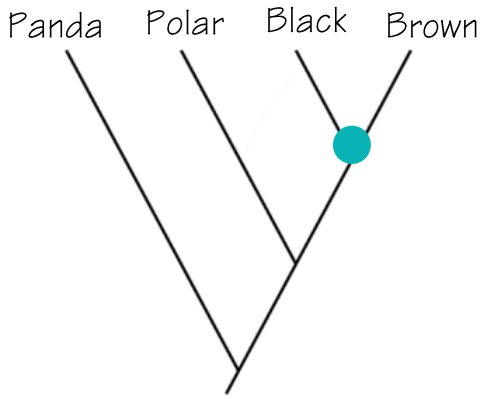


Figure 1. Phylogenetic tree representing the evolutionary relatedness among bear populations based on mitochondrial DNA sequence comparisons

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	–



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

Speciation

Creation of new species

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

Multiple Choice Practice

By discharging electric sparks into a laboratory chamber atmosphere that consisted of water vapor, hydrogen gas, methane, and ammonia, Stanley Miller obtained data that showed that a number of organic molecules, including many amino acids, could be synthesized. Miller was attempting to model early Earth conditions as understood in the 1950s. The results of Miller's experiments best support which of the following hypotheses?

a. The molecules essential to life today did not exist at the time Earth was first formed.

b. The molecules essential to life today could not have been carried to the primordial Earth by a comet or meteorite.

c. The molecules essential to life today could have formed under early Earth conditions.

d. The molecules essential to life today were initially self-replicating proteins that were synthesized approximately four billion years ago.

Multiple Choice Practice

The apple maggot fly, Rhagoletis pomonella, is native to North America and originally fed on fruit of the wild hawthorn. Since the mid-1800s, a population of flies has emerged that instead feed on domesticated apples. Apple maggot flies typically mate on or near the fruit of their host plants. Many varieties of apples ripen three to four weeks before the hawthorn fruits do.

The different fruit preferences of the two fly populations will most likely have which of the following effects?

a. The flies that eat hawthorn fruit will increase in number, while the flies that eat apples will decrease in number because of the use of insecticides on apple trees.

b. The single fly species will evolve into two distinct species because of the lack of gene flow between the two populations.

c. The ability to survive on a diet of two different fruits will help the flies learn to eat many more types of fruit.

d. The flies that eat hawthorn fruit will lay some of their eggs on the earlier ripening apples to minimize competition among the larvae.

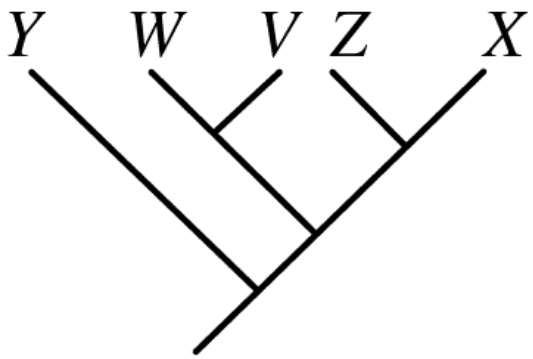
Multiple Choice Practice

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

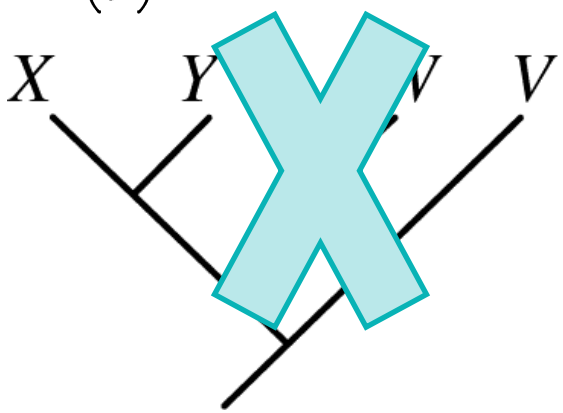
	Trait				
Species	1	2	3	4	5
V	+	+	+	-	-
W	+	+	-	-	-
X	+	-	-	-	-
Y	-	-	-	-	-
Z	+	-	-	-	+

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

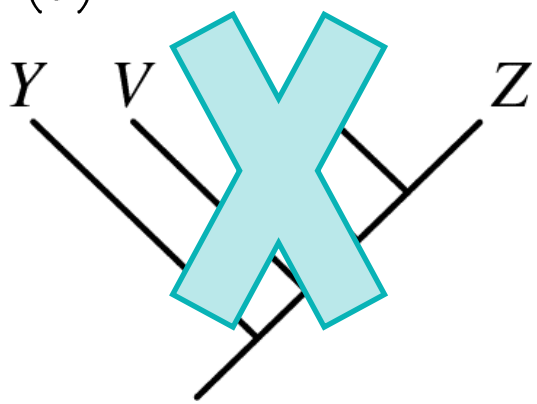
(a)



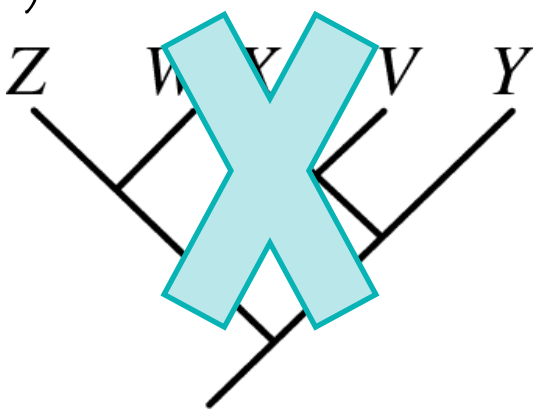
(b)



(c)



(d)



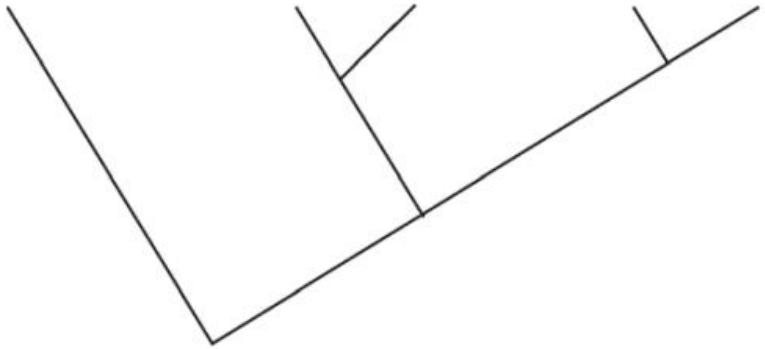
Free Response Practice

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

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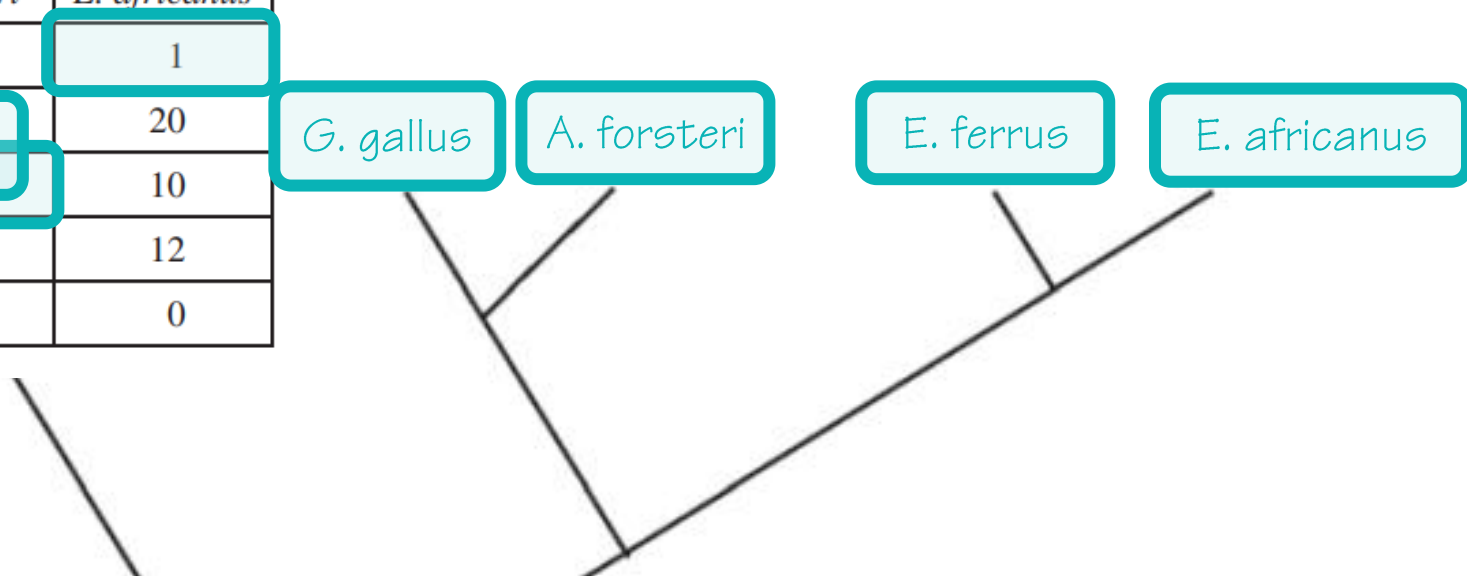
E. ferus	0	21	11	13	1
D. polylepis		0	8	17	20
G. gallus			0	3	10
A. forsteri				0	12
E. africanus					0



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

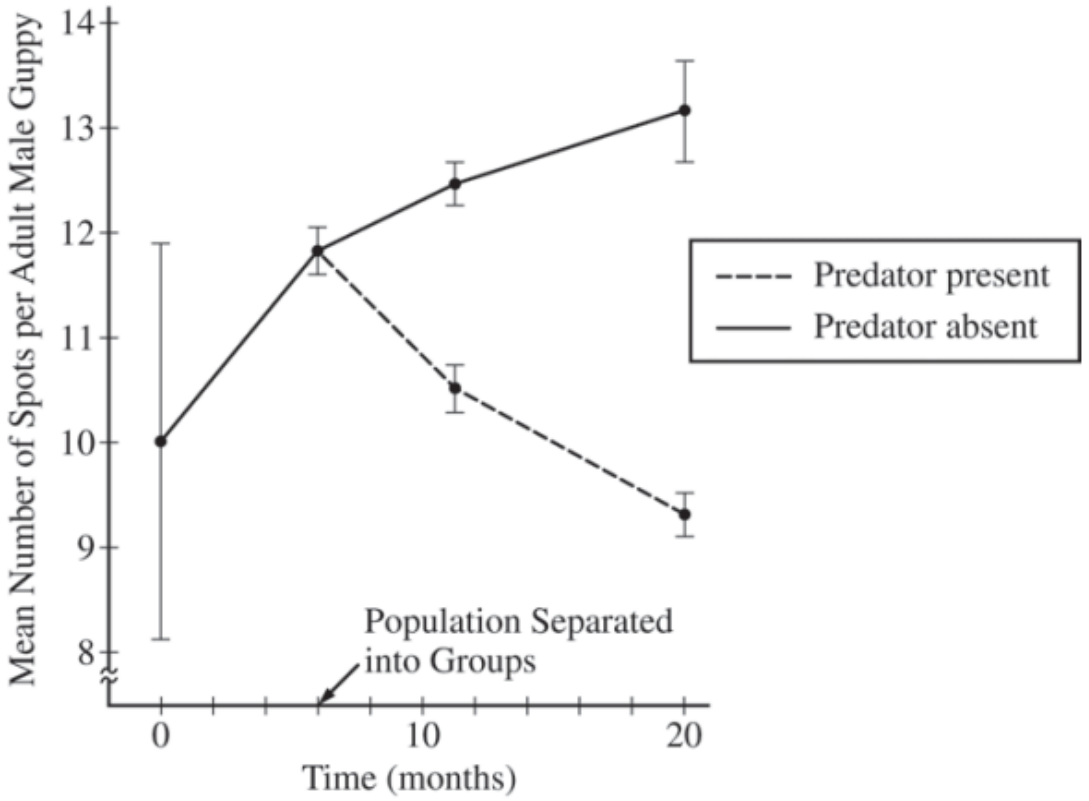
Reasoning (1 point)

- 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).

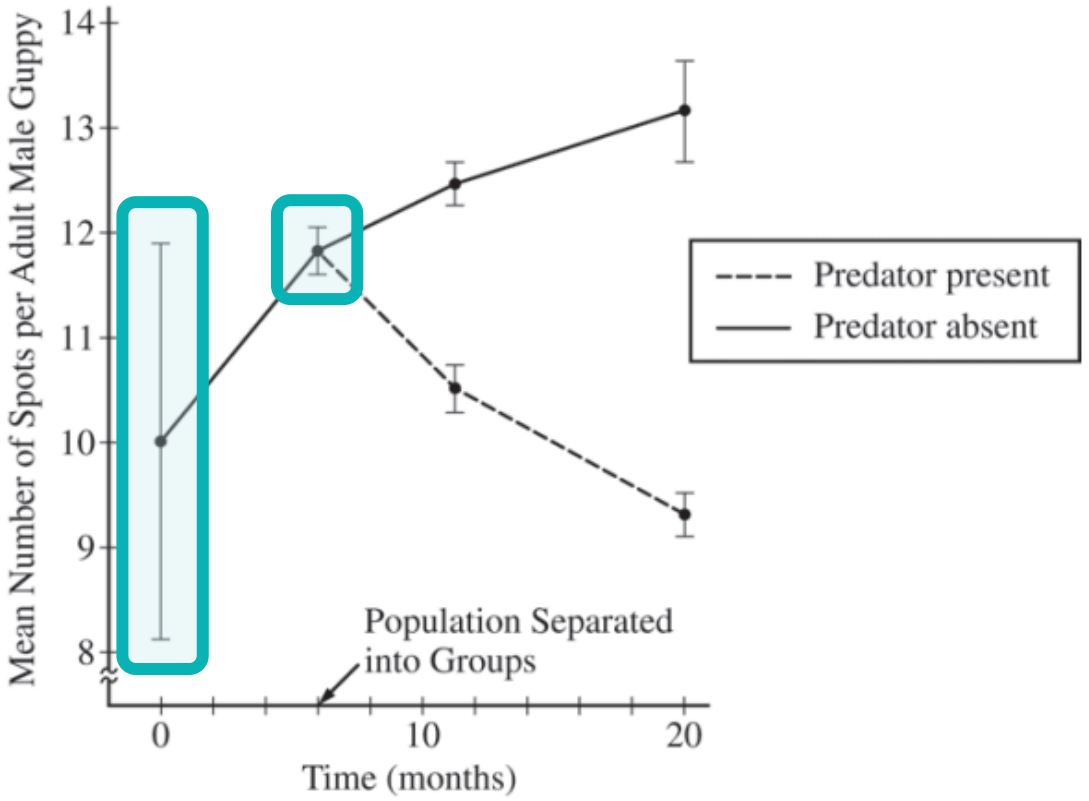


Free Response Practice

(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.

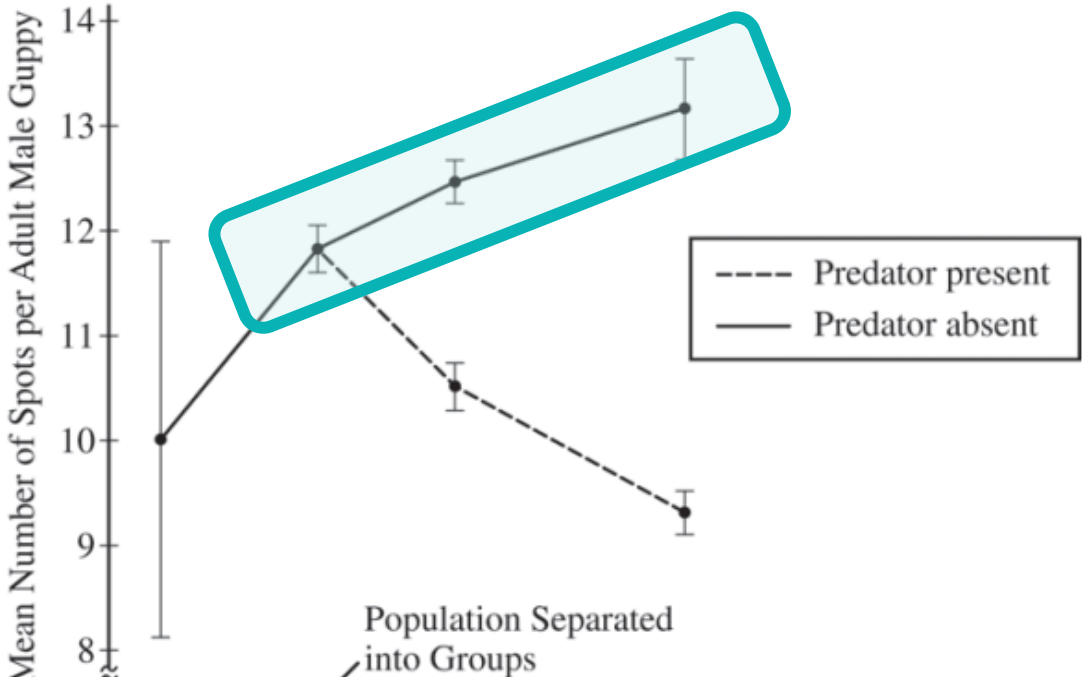
Describe change (**1 point**)
Genetic variation is decreasing

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



Free Response Practice

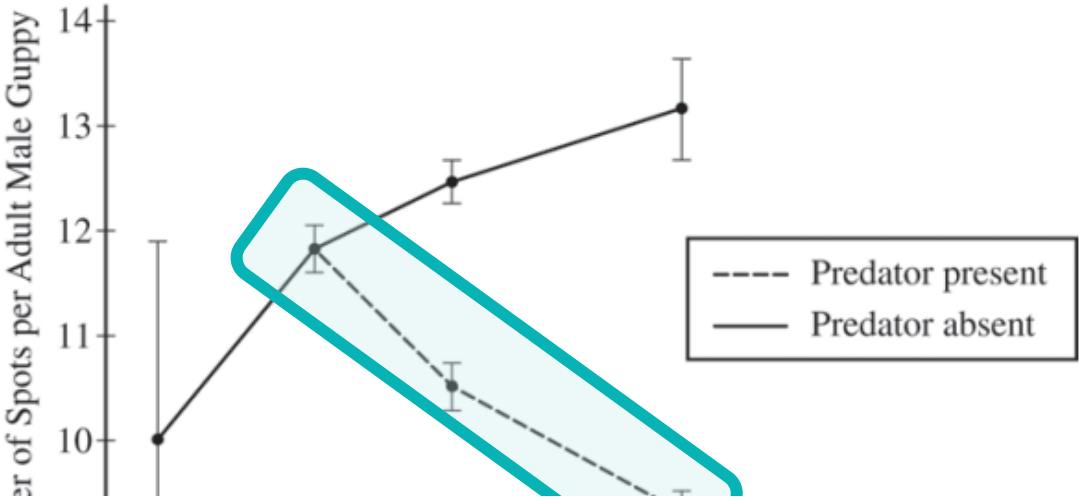
(b) **Propose** ONE type of mating behavior that could have resulted in the observed change in the number of spots per adult male guppy between 6 and 20 months in the absence of the predator.



- 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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