Domain - Evolution

Chapter 20 - Genes within Populations (pages 396-416)

Chapter 21 - Evidence of Evolution (pages 417-435)

Chapter 22 - Origin of Species (pages 437-454)

Chapter 23 - Systematics, Phylogenies, and Comparative Biology (pages 455-472)

Chapter 24 - Genome Evolution (pages 473-490)

Chapter 25 - Evolution of Development (pages 491-506)

Chapter 26 - Origin and Diversity of Life (pages 507-521)

Chapter 20:
Genes within Populations

1. Darwin didn’t use the term “evolution” per se, but referred to it as “descent with modification.” How did Darwin define the latter?
2. On page 397, second paragraph, under “Many Processes Can Lead to Evolutionary Change,” it states that “Darwin proposed natural selection as the mechanism of evolution.” What did he state in the next three sentences regarding natural selection (paraphrase)?
3. Who was Jean-Baptiste Lamarck, and what did he believe in regards to evolution? Describe.
4. Compare and Contrast Darwin and Lamarck’s theories using the giraffe example.
5. What is one way to monitor how populations change through time?
6. Describe and explain how allele frequencies play a part in natural selection.
7. What is population genetics?
8. Why is genetic variation in a population necessary for evolution to occur?
9. Review- what’s the difference between phenotype and genotype—provide an example for each.
10. What confused Hardy-Weinberg in regards to phenotypes and genotypes?
11. List the five assumptions that need to be met in order to be in Hardy-Weinberg equilibrium.
12. What does each mean?
   a. p=_________
   b. q=_________
   c. 2pq=_________
13. The sum of all three genotype frequencies must equal _____
14. What will the probabilities help us predict?
15. What does each represent?
   a. \( P^2 = \) __________
   b. \( Q^2 = \) __________
   c. \( 2pq = \) __________

16. Draw out the diagram 20.3 on page 399.

17. Summarize the findings into your own words. Use page 400 to help you.

18. What could cause an excess of homozygotes and a deficit of heterozygotes (there are three)?

19. Watch the Bozeman video and answer these questions:
   a. Video 1- [http://www.bozemanscience.com/solving-hardy-weinberg-problems/]
      i. What is a phenotype?
      ii. What is a gene pool?
      iii. What does “\( p \)” represent?
      iv. What does “\( q \)” represent?
      v. \( p + q \) always equals _______
      vi. What does \( p^2 \) represent?
      vii. What does \( q^2 \) represent?
      viii. What does \( 2pq \) represent?
      ix. Why is there a “2” in “\( 2pq \)” but not in “\( p^2 \)” nor “\( q^2 \)”?
      x. 16% of a population is unable to taste the chemical PTC. These non-tasters are recessive for the tasting gene.
      xi. What percentage of individual in the population are tasters?
      xii. What is the frequency of the dominant ALLELE?
      xiii. What is the frequency of the recessive ALLELE?
      xiv. What percentage of the population is heterozygous for the trait?
      xv. The delta-32 mutation, a recessive allele, gives humans protection from HIV infection. The allele frequency in a town in Sweden is 20%
      xvi. What percentage of the population has two copies of the delta-32 allele and is therefore immune to HIV?
      xvii. What percentage of the population is heterozygous for the allele?

1. **Sample problem 1**- A population of rabbits may be brown (the dominant phenotype) or white (the recessive phenotype). Brown rabbits have the genotype BB or Bb. White rabbits have the genotype bb. The frequency of the BB genotype is .35.
   
   What is the frequency of heterozygous rabbits?
   
   What is the frequency of the B allele?
   
   What is the frequency of the b allele?
2. **Sample problem 2**- A hypothetical population of 10,000 humans has 6840 individuals with the blood type AA, 2860 individuals with blood type AB and 300 individuals with the blood type BB.

   What is the frequency of each genotype in this population (AA, BB, and AB)?

   What is the frequency of the A allele?

   What is the frequency of the B allele?

   If the next generation contained 25,000 individuals, how many individuals would have blood type BB, assuming the population is in Hardy-Weinberg equilibrium?

3. **Sample problem 3**- A population of birds contains 16 animals with red tail feathers and 34 animals with blue tail feathers. Blue tail feathers are the dominant trait.

   What is the frequency of the red allele?

   What is the frequency of the blue allele?

   What is the frequency of heterozygotes?

   What is the frequency of birds homozygous for the blue allele?

4. **Sample problem 4**- Brown hair (B) is dominant to blond hair (b). If there are 168 brown haired people in a population of 200:

   What is the predicted frequency of heterozygotes?

   What is the predicted frequency of homozygous dominant?

   What is the predicted frequency of homozygous recessive?

5. **Sample problem 5**- If 98 out of 200 individuals in a population express the recessive phenotype, what percent of the population are heterozygotes?

6. **Sample problem 6**- The ability to taste PTC is due to a single dominate allele "T". You sampled 215 individuals in a biology class, and determined that 150 could detect the bitter taste of PTC and 65 could not.

   What is the predicted frequency of the recessive allele (t)?

   What is the predicted frequency of dominant allele (T)?

   In a population of 10,000 people, how many would be heterozygous (assuming Hardy-Weinberg equilibrium)? Homozygous dominant? Homozygous recessive? Calculate all of the potential frequencies- TT, Tt, and tt.
### Five Agents of Evolutionary Change - Use the reading and figure 20.4 to fill in the table.

<table>
<thead>
<tr>
<th>Agent</th>
<th>Mutation</th>
<th>Gene flow</th>
<th>Nonrandom Mating</th>
<th>Genetic Drift</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define- use the table to fill in the define portion.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Additional Notes (refer to the reading)**

- **Mutation rates are** _____________.
  A typical gene mutates about _____ per 100,000 cell divisions.

- **Mutation** is the ____________ of ________ variation and thus makes ________ possible.

- **Mutations** **DO Not** occur more frequently in situations in which they would be favored by ________.

- **Gene flow** is the ____________ of ________ from one ________ to ________. Some is **obvious** / physical- migration.

- **Not obvious**- drifting of gametes or immature stages of plants and marine animals. Ex- pollen and larval organisms carried by currents.

  Gene flow may also result from the mating of individuals belonging to adjacent populations.

- **Assortative mating**- ________

- **Disassortative mating**- different individuals mate, produces an excess of heterozygotes.

- See notes below regarding genetic drift.

- See notes below chart regarding selection.

### Detailed Example (can draw it out or write it out)

Mrs. Stahl
Genetic Drift -

- **Small populations** - frequencies of alleles change drastically by chance.
- Occur randomly
- Can cause BIG losses of genetic variation in small populations.

Genetic drift -

- Look at diagram 20.5 and summarize each step:
  - Parent Population -
    - 
    - 
  - Bottleneck (drastic reduction in population) -
    - 
    - 
  - Surviving individuals -
    - 
    - 
  - Next generation -
    - 
    - 

- Genetic drift can lead to an important conclusion:

- Can genetic drift occur in any population? ______
- More likely in populations that were founded by a ____ ____________ or in which the population was ____________ to a very ________ at some point.

THE FOUNDER EFFECT

- **Founder Effect** -

- Sometimes one or a few individuals disperse and become the founders of a new, isolated population at some distance from their place of origin.
• Do these pioneers carry all the alleles present in the source population? ________
  o What happens to the alleles?
    __________________________________________________________
    __________________________________________________________
    __________________________________________________________

• How have founder effects been important in the evolution of organisms on distant oceanic islands? Provide examples to support your answer.
  ______________________________________________________________
  ______________________________________________________________
  ______________________________________________________________
  ______________________________________________________________

• How have human populations evolved this way? Provide a detailed example.
  ______________________________________________________________
  ______________________________________________________________
  ______________________________________________________________
  ______________________________________________________________

**THE BOTTLENECK EFFECT**

• **Bottleneck effect**-
  ______________________________________________________________
  ______________________________________________________________

• Occasionally populations may be drastically reduced by:
  o Flooding
  o ________________
  o ________________
  o ________________

• Genetic variation seems to be depleted.
• Example: Northern Elephant Seal (summarize what happened below)
  o ______________________________________________________________
    ______________________________________________________________
    ______________________________________________________________
    ______________________________________________________________
    ______________________________________________________________
    ______________________________________________________________
    ______________________________________________________________
    ______________________________________________________________
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    ______________________________________________________________
    ______________________________________________________________
    ______________________________________________________________
    ______________________________________________________________
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Selection (begins on page 403)

- Define progeny-

- Selection-

- Artificial selection-

- Natural Selection-

- Evolution by natural selection occurs when the following conditions are met - write and describe each one:
  1. ___________________________  
     ___________________________  
     ___________________________  
     ___________________________
  2. ___________________________  
     ___________________________  
     ___________________________  
     ___________________________
  3. ___________________________  
     ___________________________  
     ___________________________  
     ___________________________

- How are natural selection and evolution different?
  ___________________________  
  ___________________________  
  ___________________________  
  ___________________________

- Natural selection can lead to ___________________________, but natural selection is only ONE of several processed that can result in change.
- What is the result of evolution driven by natural selection?
Selection to avoid predators:

- The most dramatic examples of adaptation involve genetic changes that decrease an organism’s chance of being captured by a predator.
  - Example 1 - Common sulphur butterfly (explain)-
    -
    -
    -
    -
    -
  - Example 2 - Lava flows in the deserts of the American Southwest (explain)-
    -
    -
    -
    -
    -
  - Explain figure 20.7-
    -
    -
    -
    -
    -

Selection to match climatic conditions:

- Many scientists and studies focus on genes encoding for specific _________.
- Why focus on enzymes?
  -
  -
  -
  -
  -
- What’s the relationship they have found between latitude and enzyme allele frequency?
  -
  -
  -
  -
  -
- Explain the mummichog example- BE SPECIFIC WITH DETAILS
  -
  -
  -
  -
  -
Selection for pesticide and microbial resistance

- Insecticides & Pesticides
  - The widespread use of ________________ has led to the rapid __________ of resistance in more than ______ pest species.
  - Housefly (describe)-
    ____________________________________________________
    ____________________________________________________
    ____________________________________________________
    ____________________________________________________
  - Norway rat (describe)-
    ____________________________________________________
    ____________________________________________________
    ____________________________________________________
    ____________________________________________________
  - Staph infections (describe)-
    ____________________________________________________
    ____________________________________________________
    ____________________________________________________
    ____________________________________________________

How do each of the processes we have been talking about cause populations to vary from Hardy-Weinberg equilibrium?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
=====================================================================
FITNESS

- Define-

________________________________________________________________________

- The most fit ___________ is simply the one that ___________, on average,

________________________________________________________________________

- Different components of fitness (explain each one and provide an example to support):
  - Attracting mates-

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

  - Number of offspring produced-

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

- Fitness is a combination of three things:
  - 1.___________________
  - 2.___________________
  - 3.___________________

- Selection favors phenotypes with the greatest fitness, but sometimes traits favored by one component, can be a disadvantage for others. Explain this by reading about the water strider. Use figure 20.9 to explain the situation.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Explain each one and provide an example.

<table>
<thead>
<tr>
<th>Negative frequency – dependent selection</th>
<th>Positive frequency – dependent selection</th>
<th>Oscillating selection</th>
<th>Heterozygote advantage</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

**Selection Acting on Traits Affected by Multiple Genes**

Describe each one and draw the graph that represents each type. See page 409, figure 20.13.

Disruptive Selection (take notes below)

Graph
Directional Selection (take notes below)

Graph

Stabilizing Selection (take notes below)

Graph

For section 20.7; beginning on page 410. Read the section carefully and take detailed notes regarding guppy color variation.
The Limits of Selection (begins on page 413)

- Define pleiotropy (reference chapter 12, page 232-233)
  - Example:
  
  - Why haven’t horses improved their performance times over the last 50 years?
  
- Define epistasis (also seen in chapter 12, page 235)
  - Example (use the corn one on page 236):
  
  - How can epistasis and pleiotropy constrain the evolutionary response to natural selection?
  
Follow up:

Go to Bozeman science and scroll down to Evolution. Watch all of the following podcasts referencing evolution.

http://www.bozemanscience.com/ap-biology/