AP BIOLOGY NAME_____
EVOLUTION/HEREDITY UNIT
Unit 1 Part 8 Chapter 32.1 and 32.2 DATE_____PERIOD_____
Activity #11

HARDY-WEINBERG THEOREM

POPULATION

Localized group of individuals belonging to same species
Species = group of populations whose individual have potential to interbreed

GENE POOL

- Total aggregate of genes in a population at any one time
- All alleles at all loci in all individuals
- Example – flower population with white and pink flowers

Pop. of 500 individuals
20 white

320 homozygous pink

160 heterozygous pink

Allele frequency:

$$a = \frac{2(20) + 160}{1000} = \frac{200}{1000} = 0.2$$

$$A = \frac{2(320) + 160}{1000} = \frac{800}{1000} = 0.8$$

HARDY-WEINBERG THEOREM

Frequency of alleles and genotypes in a population's gene pool remain constant over generations unless acted upon by agents other than sexual recombination

HARDY-WEINBERG EQUILIBRIUM

Allele frequency is constant from generation to generation	
REQUIRED CONDITIONS FOR HARDY-WEINBERG EQUILIBRIUM	
Very large population	Random mating
Isolation from other populations	No natural selection
No net mutations	

HARDY-WEINBERG EQUATION

$p + q = 1$

p = frequency of dominant allele q = frequency of recessive allele

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

p^2 = frequency of homozygous dominant genotype (*AA*)

$2pq$ = frequency of heterozygous genotype (*Aa*)

q^2 = frequency of homozygous recessive genotype (*aa*)

HARDY-WEINBERG SAMPLE PROBLEM

In a population of mice, 245 are black, 210 are brown, and 45 are white.

1. KEY

   BB = Black = p^2 B = p

   Bb = Brown = 2pq b = q

   Bb = White = q^2

2. Calculate allele frequencies

$$B = \frac{2(245) + 210}{1000} = \frac{700}{1000} = 0.7$$

$$b = 1 - B = 1 - .7 = 0.3$$

3. Calculate genotype frequencies

$BB = (.7)^2 = .49 = 49\%$

$Bb = 2(.7)(.3) = .42 = 42\%$

$bb = (.3)^2 = .09 = 9\%$

4. Question – Is the population in H-W equilibrium?

Genotypes	Expected	Actual
BB	.49(500) = 245	245
Bb	.42(500) = 210	210
bb	.09(500) = 45	45

Answer = Yes, the population is in H-W equilibrium because the expected genotype frequencies match the actual frequencies

Note: At this point, you can run chi-square to determine if your results match with what you would expect for a population in Hardy-Weinberg equilibrium.

QUESTIONS:

23.1

1. What is microevolution? _____

_____

2. What are the three main mechanisms that can cause changes in allele frequency?

_____

_____

_____

3. *Geographic variation* may be shown in a graded manner along a geographic axis known as a *cline*. What external factors might produce a *cline*? Why does the existence of a cline suggest natural selection?

_____

_____

_____

4. What is the ultimate source of new alleles/genetic variation? _____

5. *Mutations* are any change in the nucleotide sequence of an organism's DNA. These mutations provide the raw material from which new traits may arise and be selected. What occurs in a *point mutation*?

_____

_____

6. What is translocation? _____

7. How does *gene duplication* occur? How might it play a role in evolution?

_____

_____

_____

8. Much of the genetic variation that makes evolution possible comes through sexual reproduction. What are the three mechanisms by which sexual reproduction shuffles existing alleles?

_____

23.2

9. Match the definition with the correct term.

A. Gene pool B. Population C. Population genetics D. Species

_____ Study of genetic variation within a population

_____ Localized group of individuals belonging to the same species

_____ Group of populations that have the potential to interbreed

_____ Total aggregate of genes in a population at any one time

10. State the Hardy-Weinberg Theorem.

_____

_____

11. Write the Hardy-Weinberg equation and define each of the variables.

_____

_____

_____

_____

_____

_____

12. Hardy-Weinberg equilibrium is maintained only if the population meets each of 5 conditions. List these 5 conditions.

Condition #1:_____

Condition #2:_____

Condition #3:_____

Condition #4:_____

Condition #5:_____

13. If a population has the following genotype frequencies, AA = 0.42, Aa = 0.46, and aa = 0.12, what are the allele frequencies? Show your work and circle your answers.

14. In a population with two alleles, B and b, the allele frequency of B is 0.8. What would be the frequency of heterozygotes if the population is in Hardy Weinberg equilibrium? Show your work and circle your answer.

15. In a population that is in Hardy-Weinberg equilibrium, 16% of the population show a recessive trait. What percent show the dominant trait? Show your work and circle your answer.

16. A Pangorian trait which results from simple Mendelian inheritance is antenna shape. Corkscrew antennae (A) are dominant over straight antennae (a). When the entire Pangorian population was screened (all 9,904 of them), 3,565 had corkscrew, while the rest had straight antennae.

    a. What is the frequency of each allele? Show your work and circle your answers.

    b. What percentage of the population has each of the genotypes? Show your work and circle your answers.

c. How many Pangorians are heterozygous for antennae shape? Show your work and circle your answer.

d. The great ruler of Pangoria has determined that Pangorians born with straight antennae have a greater tendency toward violent behavior than do those with corkscrew antennae. He also had determined that neutering stops the violent behavior. He decrees that all Pangorians born with straight antennae shall be neutered shortly after birth. In general, what will happen to the allele frequencies in the population over the next six generations?

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17. You collect 100 samples from a large butterfly population. Fifty specimens are dark brown, 20 are speckled, and 30 are white. Coloration in this species of butterfly is controlled by one gene locus: BB individuals are brown, Bb are speckled, and bb are white.

What are the allele frequencies for the coloration gene in this population? Show your work and circle your answers.

Is this population in Hardy-Weinberg equilibrium? Explain your answer.

18. A recessive mutation causes short sightedness (ss) in cats. The frequency of homozygous wild type (+/+), heterozygous (+/s) and homozygous recessive (ss/ss) individuals was assessed in two populations of cats. The data is shown in the chart below.

CAT POPULATION	**+/+**	**+/ss**	**ss/ss**
Country cats	0.49	0.42	0.09
City cats	0.52	0.45	0.03

a. Are the two populations in Hardy-Weinberg equilibrium? Explain.

b. If one population is not, what might cause this deviation?

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19. Another classification of blood group antigens is known as MN. Individuals are either homozygous for M (MM) or N (NN), or they express both antigens (MN). You are studying the distribution of alleles in a population of people. You determine that 90 people are MM, 60 are MN, and 50 are NN. Assign symbols for the allelic frequency of the M and N alleles in the population. Determine the frequency of each allele. Based on the allelic frequencies, determine (out of 200 individuals) the number of individuals in the population that are **expected** for each genotype. Test, by **chi square**, whether the population is in Hardy-Weinberg equilibrium. Show your work and circle your answer.

20. For an X-linked recessive trait, 9% of the females in the population are affected. What percent of the males would be affected? What percentage of the population is represented by carriers? Show your work and circle your answers.

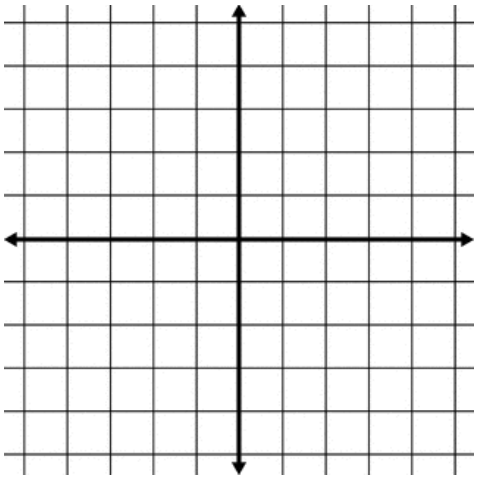
21. You have been commissioned to study the genetic make-up of an ancient tribe of Arabs whose descendants live in northern Saudi Arabia. They hire you to test for the frequencies of a number of well-known genetic traits. The only hitch is that these people won't let any outsiders go near the women. "No problem" you say, "as long as I can test the men to determine the allele frequencies, I can figure out the gene frequencies in women. That is, if the mode of inheritance is known, and if we can assume Hardy-Weinberg equilibrium." Prove you can by completing the following chart.

TRAIT	Mode of Inheritance	Frequency of trait in males	P	Q	Frequency of trait in females
PTC taster	Autosomal dominant	0.75			
Blue eyes	Autosomal recessive	0.09			
Colorblindness	X-recessive	0.05			
Xg blood type	X-dominant	0.40			
Pattern baldness	Autosomal dominant in males, recessive in females	0.36			

End of the Chapter Synthesis and Evaluation

1. Do questions 1-7, 8. Then check and correct your answers in the back of text.
   1. _____
   2. _____
   3. _____

4. _____
5. _____
6. _____
7. _____
8. Read problem 8. Follow directions (note: you will need chart, graph, analysis).



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Study Guide/ISN (20 points)

1. In your study guide book, review pages 155-157 **AND** 289-293. I. In your ISN, title a page as follows: **Chapter 23.1/23.2 Evolution of Populations/Hardy Weinberg Must Know!** In one color, copy down the must know items listed on page 155 **AND** 289 in study guide leaving space underneath to include in an different color a brief description, diagram, model, or pneumonic device that will help you study for the unit test and more importantly the AP Test in May.
2. Answer questions 1-3 from study guide book. Then check and correct your answers from back of text.

1._____ 2._____ 3. _____

Bozeman Science/ AP Biology/ISN (See Syllabus for format) **(20 points each)**

1. Hardy-Weinberg Punnett Square (supplemental AP Bio Resources)
2. Solving Hardy-Weinberg Problems (Supplemental AP Biology resources)
3. Population genetics and evolution (AP bio labs) (Note: we're using Goldfish rather than beads..same principles)
4. Population modeling (AP Bio Lab) (note: in red book)