The Hardy-Weinberg Law of Genetic Equilibrium

When does evolution happen?

There is a lesson to be learned from Alice in Wonderland and looking through the “looking glass”.

Sometimes it is far easier to ask the complementary question:

When does Evolution NOT happen?

G. Hardy and W. Weinberg independently proposed that the frequency of alleles and genotypes in a population will remain constant from generation to generation if the population is stable and in genetic equilibrium.

Five conditions are required in order for a population to remain constant and unchanging. (No evolution).

First of all define Hardy-Weinberg equilibrium:

__________________________________________________

a change in the gene pool is by definition “evolution”. Define “gene pool”:

__________________________________________________

__________________________________________________

The five conditions are required in order for a population to remain at Hardy-Weinberg equilibrium are:

Link

Follow Key Concepts 1 through 6 to answer the following:

Two different scenarios of the effect of earthquakes on a gene pool:

__________________________________________________

An example of random mating:

__________________________________________________

An example of assortive mating:

__________________________________________________

An example of a mutation:

__________________________________________________

An example of isolation:

__________________________________________________

An example of immigration:

__________________________________________________

An example of selection:

__________________________________________________

An example of no selection:

__________________________________________________

Looking at predominant hair color in Stockholm and in Seoul, could one immediately determine which allele is dominant? Yes /No explain

__________________________________________________

What is the Hardy Weinberg equation?

__________________________________________________

Sample Problem 1:

Calculate $q^2$ _____ Find $q$,_______ Find $p$,_______ Find $2pq$,_______

Sample Problem 2:

In a certain population of 1000 fruit flies, 640 have red eyes while the remainder has sepia eyes. The sepia eye trait is recessive to red eyes. How many individuals would you expect to be homozygous for red eye color? ___________
Sample Problem 3:

Phenylketonuria (PKU) is a human metabolic disorder that results in mental retardation if it is untreated in infancy. In the United States, one out of approximately 10,000 babies is born with the disorder. Approximately what percent of the population are heterozygous carriers of the recessive PKU allele? __________

Time out!!! Whoa Nelly! This can be confusing!

Homozygous individuals stricken with PKU never have children. Go back to page 1 and list Hardy-Weinberg Equilibrium condition(s) not being met with the PKU example cited above.

Time out – continued.

Let’s compare two Mugwump populations which inherit coat colour accordingly:

BB is bronze, Bb is speckled (excellent camouflage against lichen) and bb is white.

An isolated population has 10 000 individuals:
3600 Bronze - 4800 Speckled - 1600 White ; for a total of 10 000 in the population

A different isolated population also has 10 000 individuals
3000 Bronze – 6000 Speckled – 1000 White ; again for a total of 10 000 individuals.

First Population:  p = ______________   & q = ____________________
Second Population:  p = ______________   & q = ____________________

One population is in HW equilibrium, while the other population is decidedly NOT in Hardy-Weinberg Equilibrium. Identify which is which.

The first / second population is in Hardy Weinberg Equilibrium (circle one)
The first / second population is NOT in Hardy Weinberg Equilibrium (circle one)

Provide a possible explanation why one population is not in Hardy Weinberg Equilibrium.
________________________________________________________________________________
________________________________________________________________________________

Homozygous recessive sickle cell anaemia is lethal and stricken individuals rarely have children. Yet in some regions of the world, the frequency of the sickle cell allele (q) is increasing over time. Why would that be? Explain.
________________________________________________________________________________
________________________________________________________________________________

In other regions of the world, the frequency of the sickle cell allele (q) is remaining constant over time. Does unchanging p & q constancy indicate Hardy Weinberg Equilibrium has been achieved? Explain. Yes / No
________________________________________________________________________________
________________________________________________________________________________

________________________________________________________________________________
________________________________________________________________________________

Elusive Mugwumps can be very shy.
Here is a very rare photo of a bronze Mugwump.
Allelic Frequency vs. Genotypic Frequency:

If you are told that the frequency of a recessive allele in a population is 10%, what is \( q \) for this population? __________

If you observe a population and find that 16% show the recessive trait, you know the frequency of the \( aa \) genotype. This means you know \( q^2 \). What is \( q \) for this population? _______________

A class of 12 AP biology students gathered the following data:

Initial class frequencies: \( AA \) 3  \( Aa \) 6  \( aa \) 3  Final class frequencies: \( AA \) 2  \( Aa \) 5  \( aa \) 5

1. What are the initial \( p \) and \( q \)?
2. What are the final \( p \) and \( q \)?
3. Is the population in Hardy-Weinberg equilibrium? Explain your response. ______________

Here is a virtual experiment that demonstrates evolution over 200 years during the Industrial Revolution in England: Link

What underlying law of nature has produces this change in numbers? __________________________

500 light colored moths and 500 dark colored moths are released into a polluted forest. After 2 days the moths were recaptured, make a prediction about the number of each type of moth that would be captured. _______________________________________________________________________

Another Tutorial Link before continuing:

Four evolutionary pressures that cause populations to change:

______________________________________________________________________________

Two causes of “Genetic Drift” would be:
the _______________________ Effect & the_____________________ Effect

Natural selection changes allele frequency, and therefore the accumulation of favorable traits, in three ways:

______________________________________________________________________________

Identify the three kinds of graphs:

A _________________ selection
B _________________ selection
C _________________ selection

Explain what could have caused two separate populations in graph 3.
______________________________________________________________________________

Witness yourself how a new species can evolve: Link

Five extraordinary examples of adaptive radiation sharing a common ancestor (click on gallery)
______________________________________________________________________________

Quiz:
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