Guided Reading: Chapter 23

(p.446) **1.** Because Darwin did not know about the work of Gregor Mendel, he could not explain how organisms pass heritable traits to their offspring. In looking at genetic variation, what are *discrete characters*, and what are *quantitative characters*?

Mendel only recognized discrete "either-or" characters/traits, such as purple or white flowers in pea plants, as heritable. Darwin considered the raw material for natural selection to be quantitative characters, those characteristics/traits in a population that vary along a continuum, such as fur length in mammals or the speed with which an animal can flee from a predator.

Genetics Review:

2. What is the ultimate source of new alleles?

The ultimate source of new alleles is MUTATIONS!

3. 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? *(Prior Knowledge)*

(p.244) **(a)** Crossing-Over during prophase-I of meiosis.

(p.243/254) **(b)** Independent assortment during anaphase I and II of meiosis.

(p.255) **(c)** Random Fertilization - union of sperm and egg.

(p.446) **4.** Define each of the following terms:

(a) Population Genetics - Population genetics emphasizes the extensive genetic variation within populations and recognizes the importance of quantitative characters

(b) Population - A population is a localized group of individuals belonging to the same species.

(c) Species - A species is a group of populations whose individuals have the potential to interbreed and produce fertile offspring in nature.

(d) Gene Pool - A gene pool is the total aggregate of genes in a population at any one time and consists of all alleles at all gene loci in all individuals of the population.

(p.447) **5.** The *Hardy-Weinberg principle* is used to describe a population that is ***not*** evolving. What does this principle state?

The Hardy-Weinberg principle states that the frequencies of alleles and genotypes in a population's gene pool remain constant over the generation unless acted upon by agents other than Mendelian segregation and recombination of alleles. Put another way, the shuffling of alleles due to meiosis and random fertilization has no effect on the overall gene pool of population.

(p.449) **6.** If the frequency of alleles in a population remains constant, the population is at *Hardy- Weinberg equilibrium*. There are five conditions for *Hardy-Weinberg equilibrium*. It is very important for you to know these conditions, so enter them neatly into the box below.

Conditions for Hardy-Weinberg Equilibrium

1	Very large population size.
2	No migration (No immigrations and no emigration)
3	No NET mutations.
4	Random mating.
5	No natural selection.

It is **not** very likely that all five of these conditions will occur, is it? Allelic frequencies change. Populations evolve. So this is an attempt to prove what evolution is by proving what it is not. This data can be tested by applying the *Hardy Weinberg equation*. Let's look at how to do this.

Equation for Hardy-Weinberg Equilibrium

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

Where p^2 is equal to the frequency of the homozygous dominant in the population, $2pq$ is equal to the frequency of all the heterozygotes in the population, and q^2 is equal to the frequency of the homozygous recessive in the population.

Consider a gene locus that exists in two allelic forms, *A* and *a*, in a population.

Let p = the frequency of *A*, the dominant allele
and q = the frequency of *a*, the recessive allele.

So,

$p^2 = AA$,
$q^2 = aa$,
$2pq = Aa$

If we know the frequency of one of the alleles, we can calculate the frequency of the other allele:

$p + q = 1$, so
$p = 1 - q$
$q = 1 - p$

7. So, here is a problem to try. Suppose in a plant population that red flowers **(*R*)** are dominant to white flowers **(*r*).** In a population of **500 individuals**, **25%** show the recessive phenotype. How many individuals would you expect to be homozygous dominant and heterozygous for this trait?

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

(1) qq or $q^2 = 0.25$ (2) $p = 1 - q$ (3) $p^2 + 2pq + q^2 = 1$

$q = \sqrt{0.25}$ $p = 1 - 0.5$ $(0.5)^2 + 2(0.5)(0.5) + (0.5)^2 = 1$

$q = 0.5$ $p = 0.5$ $0.25 + 0.50 + 0.25 = 1$

number of homozygous dominant (p2) individuals = 0.25 x 500 = 125

number of heterozygous (2pq) individuals = 0.50 x 500 = 250

8. In a population of plants**, 64%** exhibit the dominant flower color (red), and 36% of the plants have white flowers. What is the frequency of the dominant allele?

(There are a couple of twists in this problem, so read and think carefully.)

p = red
q = white

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

(1) qq or $q^2 = 0.36$ (2) $p = 1 - q$

$q = \sqrt{0.36}$ $p = 1 - 0.6$

$q = 0.6$ $p = 0.4$

(p.450) **9.** Define **microevolution**.

Microevolution is the generation-to-generation in a population's frequencies of alleles.

(p.450) **10.** What are the 2 main causes of microevolution.

(a) Genetic Drift **(b)** Natural Selection

(p.450) **11.** Define **genetic drift**. (*Amoeba Sisters Animation*)

Genetic drift is the change in a population's allele frequencies due to chance.

(p.450) **12.** List, and briefly describe the two situations that can shrink a population down to a small enough size for genetic drift to have a large effect. *(Animation)*

(a) Bottleneck Effect - the drastic reduction in population size (due to disasters such as earthquakes, floods, droughts and fires) leading to genetic drift having an effect.

(b) Founder Effect - when genetic drift resulting when a few individuals from a larger population colonize an isolated island, lake or some other new habitat.

(PBS Video) *(HHMI Video)*

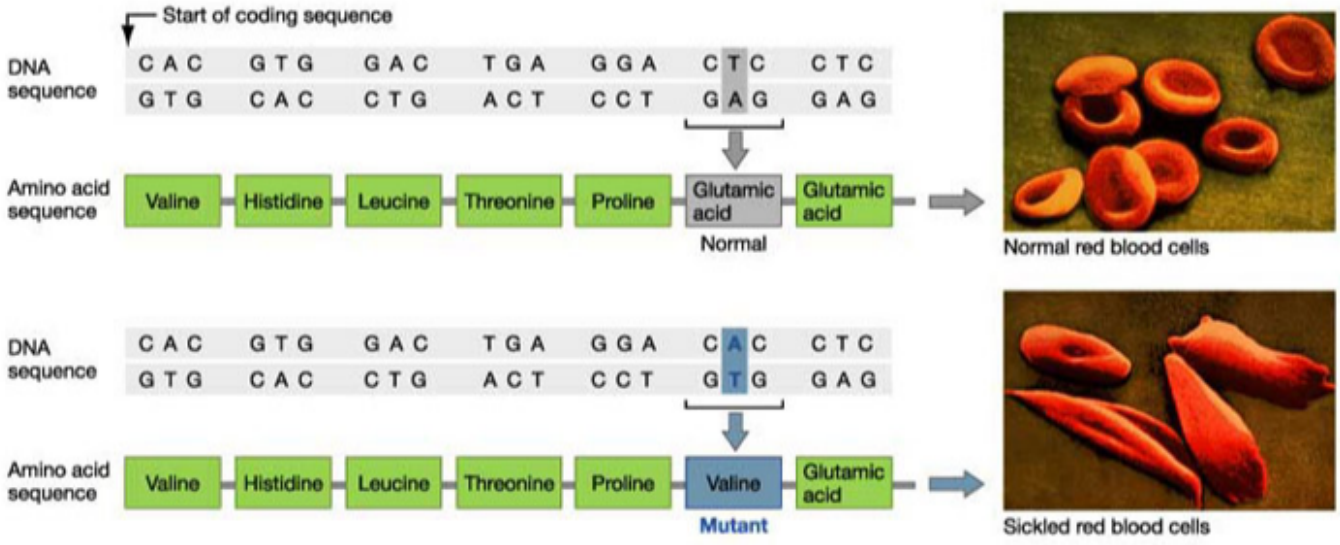
(p.456) **13.** Discuss what is meant by ***heterozygote advantage***, and use sickle-cell anemia as an example.

Heterozygous advantage is when individualsheterozygous for a particular trait have a greater survivorship and reproductive success than any other genotype, maintaining that genotype throughout the population.

(See diagram below to review the Sickle Cell mutation)

(p.457) **14.** In evolutionary terms, ***fitness*** refers only to the ability to leave offspring and contribute to the gene pool of the next generation. It may have nothing to do with being big, or strong, or aggressive. Define ***relative fitness*.**

Relative Fitness is the contribution of a genotype to the next generation compared to the contribution of alternative genotypes for the same locus.



The change in amino acid sequence causes hemoglobin molecules to crystallize when oxygen levels in the blood are low. As a result, red blood cells sickle and get stuck in small blood vessels.