Hardy-Weinberg Practice Problems

The Hardy-Weinberg formulas allow scientists to determine whether evolution has occurred. Any changes in the gene frequencies in the population over time can be detected. The law essentially states that if no evolution is occurring, then equilibrium of allele frequencies will remain in effect in each succeeding generation of sexually reproducing individuals. In order for equilibrium to remain in effect (i.e. that no evolution is occurring) then the following five conditions must be met:

1. No mutations must occur so that new alleles do not enter the population.
2. No gene flow can occur (i.e. no migration of individuals into, or out of, the population).
3. Random mating must occur (i.e. individuals must pair by chance)
4. The population must be large so that no genetic drift (random chance) can cause the allele frequencies to change.
5. No natural selection can occur so that certain alleles are not selected for, or against.

Obviously, the Hardy-Weinberg equilibrium cannot exist in real life. Some or all of these types of forces all act on living populations at various times and evolution at some level occurs in all living organisms. The Hardy-Weinberg formulas allow us to detect some allele frequencies that change from generation to generation, thus allowing a simplified method of determining that evolution is occurring. There are two formulas that must be memorized:

Remember the basic formulas:

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

p = frequency of the dominant allele in the population
q = frequency of the recessive allele in the population
p^2 = percentage of homozygous dominant individuals
q^2 = percentage of homozygous recessive individuals
2pq = percentage of heterozygous individuals

1. You have sampled a population in which you know that the percentage of the homozygous recessive genotype (a) is 36%. Using that 36%, calculate the following:

   a. The frequency of the "aa" genotype.
   b. The frequency of the "a" allele.
   c. The frequency of the "A" allele.
   d. The frequencies of the genotypes "AA" and "Aa."
   e. The frequencies of the two possible phenotypes if "A" is completely dominant over "a."

2. Sickle-cell anemia is an interesting genetic disease. Normal homozygous individuals (SS) have normal blood cells that are easily infected with the malarial parasite. Thus, many of these individuals become very ill from the parasite and many die. Individuals homozygous for the sickle-cell trait (ss) have red blood cells that readily collapse when deoxygenated. Although malaria cannot grow in these red blood cells, individuals often die because of the genetic defect. However, individuals with the heterozygous condition (Ss) have some sickling of red blood cells, but generally not enough to cause mortality. In addition, malaria cannot survive well within these "partially defective" red blood cells. Thus, heterozygotes tend to survive better than either of the homozygous conditions. If 9% of an African population is born with a severe form of sickle-cell anemia (ss), what percentage of the population will be more resistant to malaria because they are heterozygous (Ss) for the sickle-cell gene?

3. In humans, the ability to taste the chemical phenylthiocarbamide (PTC) is inherited as a dominant characteristic. Suppose you found out that 360 out of 1000 college students could not taste PTC.
What is the frequency of the gene for tasting PTC: (p =?)
How many students (out of 1000) would be heterozygous for tasting?