Problem Set

Background: Around 1300 a European(s) was born with the delta-32 mutation. That mutation, which was a deletion of thirty-two nucleotides from the CCR5 gene, resulted in a lack of CCR5 protein on the affected individuals white blood cells. Ironically, the absence of this receptor protein prevented Yersinas pestis, the bacteria which causes bubonic plague, from infecting lymphocytes (white blood cells). Over the next four hundred years, many plague epidemics swept through Europe killing millions of people. In that era of the Black Death, individuals with the mutant CCR5 gene were more likely to survive and reproduce than individuals with the wild-type “normal” CCR5 gene. Thus, many of today’s descendants of those Europeans have the CCR5 gene.

If you inherited a wild-type CCR5 gene from both parents, geneticists would call you “homozygous wild-type.” If you inherited a mutant, delta-32 CCR5 gene from both parents, geneticists would call you “homozygous mutant.” If you inherited a mutant, delta-32 CCR5 gene from one parent and a wild-type CCR5 gene from your other parent, geneticists would call you “heterozygous.”

Mathematically we can interpret the frequency of wild-type and mutant genes in a population using P to represent the frequency of a wild-type gene and Q to represent the frequency of a mutant gene. In the case of CCR5, the frequency of normal CCR5 = P and the frequency of delta-32 CCR5 = Q.

Questions:

1) If 1% of Americans possess the mutant, delta-32 CCR5 gene, what is the P and Q for the population?

2) If 4% of the descendants of the people who lived in Eem (village in Northern England) are totally immune to HIV,
   a. What percentage would be totally resistant to plague?
   b. What percentage would have no protection against HIV or plague?
   c. What would P and Q be for the population.

3) If 285,000,000 of the 300,000,000 Americans do not have the delta-32 mutation in their genome.
   a. How many Americans would you predict to be immune to HIV?
   b. How many Americans would you predict to be carriers of delta-32?