1. Define and describe the difference between a. An allele an a gene, and b. a genotype and a gamete.

   a. A **gene** is a vague term which is used to describe a unit of inheritance transmitted from parent to offspring. The term **gene** is often used interchangeably with the both **locus** and **allele**. An **allele** differs from a **gene** in that the term **allele** refers to the particular form of a **gene**. A **locus** is a term which is used to describe the physical location on a chromosome where the **gene** resides. For example, in class tutorial we have been frequently discussing a situation in which there are two **alleles** at a particular **locus**. Frequently we have demarcated this **gene** using the letter 'A', with an uppercase 'A' used to denote one **allele** and a lowercase 'a' used to denote the other **allele**. In the situation were there are more than two alleles at a particular **locus** (or more than two **alleles** for a particular **gene**), the different **alleles** are often denoted by a letter or letters with a subscript of a number or other letters. For example at the 'A' **locus** with five alleles, we might denote the different alleles as A_1, A_2, A_3, A_4, and A_5. In question 1 from the first weeks required problem set, there were two **alleles** at the PGI-2 **locus**, and they were denoted as PGI-2_A and PGI-2_a.

   b. A **genotype** is a complete description of all of the **alleles** that an **individual** or **individuals** has/have at one or more **loci**. If an individual is **diploid** then an their **genotype** will always have an even number of **alleles** listed regardless of the number of **loci.** For example, a diploid individual might have the $\mathbf{A_1A_3}$ at the locus- but their genotype at the A and B loci might be $\mathbf{A_1A_3\ B_2B_5}$. A gamete on the other hand is **haploid** and therefore will only **one** copy of each **gene** or a single **allele** at each **locus**. An individual with the **genotype** $\mathbf{A_1A_3\ B_2B_5}$ could produce the following **gametes**: A_1B_2, A_1B_5, A_3B_2, A_3B_5.

2.

   a. $P_B = 0.523952$, $P_b = 0.476048$.

   b. $N_{BB} = 45.8458$, $N_{Bb} = 83.3084$, $N_{bb} = 37.8458$. Comparing these numbers to the starting numbers of genotypes it would appear that the population is NOT in Hardy-Weinburg equilibrium. Calculating the chi-square value for this yields 28.323. Comparing this value to a table of critical chi-square values with two degree's of freedom (available at http://www.ento.vt.edu/~sharov/PopEcol/tables/chisq.html) we can see that these numbers differ significantly from our expectations of H.W.E.

3. a

a. $P_{C1} = 0.537594$, $P_{C2} = 0.327068$, $P_{C3} = 0.135338$

b.

	C1 C1	C1 C2	C1 C3	C2 C2	C2 C3	C3 C3	Total
Observed	43	39	18	24	0	9	133
Expected	38.438	46.7707	19.3534	14.2274	11.7744	2.4361	133
Chi-Sq	0.541	1.29106	0.0946	6.7126	11.7744	17.686	38.1002

The Chi-Square value is greater than the critical value of the Chi-Square distribution with 5 degrees of freedom. Therefore the population is not in Hardy Weinburg Equilibrium.

4. $P_{A1} = 0.4$, $P_{A2} = 0.6$, $P_{B1} = 0.5$, $P_{B2} = 0.5$. $P_{A1B1} = P_{A1}P_{B1} + D$. $P_{A1B1}=0.3$. $P_{A1}P_{B1}=0.4*0.5=0.2$ $D = P_{A1B1} - P_{A1}P_{B1} = 0.3-0.2 = 0.1$. $P_{A2B1} = P_{A2}P_{B1}-D$. $P_{A2} P_{B1} = 0.6*0.5=0.3$. $D=P_{A2}P_{B1}-P_{A2}P_{B1} =0.3-0.2=0.1$. Therefore D=0.1.

5.

a. Without linkage

P	A1	A2	A3
B1	0.02	0.035	0.045
B2	0.08	0.14	0.18
B3	0.1	0.175	0.225

b. With D=0.3. $D_{ABSOLUTEMAX}$ <= 0.25. You can calculate what D_{MAX} is by noting that it will be less than or equal to the smallest value of all of the gamete frequencies. For the above question that is 0.02.