Bio393: Genetic Analysis **Name:**_____
Problem Set #2
Due on Friday, May 13, 11 AM

Question 1:
A graduate student working on a plant decides to genetically dissect the process of flowering. She knows that flowering is promoted by long daylight hours in this species. When she looks at plants of this species that are flowering, four stages (I to IV) in the process can be morphologically defined. The student decides to do a screen to understand the genetic basis of flowering. She gets 15 mutants with recessive phenotypes that fail to make flowers. Three mutants accumulate at stage I, five mutants accumulate at stage II, and the remaining seven mutants appear to undergo stages I and II normally, but the tissues in the wild type that normally become flowers instead develop into leaves.

Then, the student does all pairwise complementation tests between mutants with similar phenotypes. She finds that the three mutants that accumulate at stage I identify two complementation groups (genes 1 and 2). One of the mutants (mut1) has a cold-sensitive phenotype. This mutant has a mutant phenotype at or below the screen temperature. The other complementation group is made up of two mutations, one of which is temperature-sensitive (mut2). This mutant has a mutant phenotype at or above the screen temperature. The student realizes that she can use these mutations to ask about the order of function of the products of these two genes by reciprocal temperature shifts and do the following experiments.

Using mut1 mut2 double mutants, she grows the double mutant at low temperature until just past the point when step I of the process has occurred in wild-type controls and then shift the individuals to a high temperature to complete development. She finds that all of the plants fail to produce flowers and that the precursor cells accumulate at stage I.

Using mut1 mut2 double mutants, she grows the double mutant at high temperature until just past the point when step I of the process has occurred in wild-type controls and then shift the individuals to a low temperature to complete development. She finds that all of the plants develop normally.

(a) What do these results tell you about the relationship between the steps controlled by genes 1 and 2?

The graduate student also identified a mutant that had flowers in locations where the plant normally grows leaves. This mutant was named “showy”. When crossed to the wild type, all of the offspring have the “showy” phenotype.

(b) What is most likely explanation for the showy phenotype?

(c) Describe two genetic tests that she could do to bolster your suggestion with respect to the nature of the showy phenotype.

Reasoning that she might be able to order the functions of genes 2, 4, and 5 using the “showy” phenotype, the student constructs the following:

Plants that are homozygous for the mutation in gene 4 and heterozygous for “showy”. These plants have the “showy” phenotype.

Plants that are homozygous for the mutation in gene 5 and heterozygous for “showy”. These plants have the phenotype from a mutated gene 5.

(d) What do these results tell you about the order of function of genes 4 and 5?

Question 2:
You are a beginning faculty member and have decided to genetically dissect the process of sex determination in the Mediterranean fruit fly (medfly) *Ceratitis capitata*, reasoning that such knowledge might allow development of control procedures for this invasive crop pest. Also, it might bring you much needed funding and respect.
Fortunately, you met a researcher who already has sex determination mutants but has not studied them. You decide to collaborate.

(a) In case the collaboration goes sour, describe how you would isolate a heat-sensitive mutant that when homozygous causes males to develop as females? This mutation would have no effect on females. Also, remember there are no balancers in medflies.

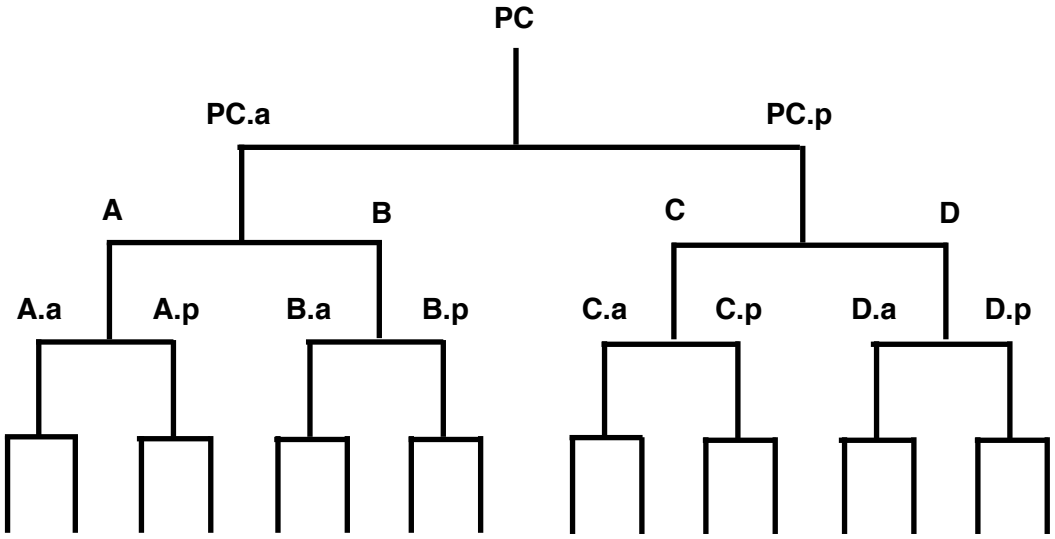
You collaborator has three mutants (fem, del1, and del2) that all causes males to develop as females. You would like to know if they have mutations in the same gene. fem is temperature-sensitive; del1 is cold-sensitive; and del2 has a recessive phenotype that is not cold or temperature-sensitive.

(b) If del1 and del2 have mutations in the same gene and fem complements both del1 and del2, describe the conditions under which you would do the complementation tests and the results that would be expected.

Another mutant called Ix has a dominant phenotype that causes males to develop as intersexes (a mix of male and female).

(c) Using the mutagen EMS, how can you determine if the mutated locus is haploinsufficient or a gain-of-function?

Question 3:
You are studying a relative of *C. elegans* named *C. horvitzii*. Just like Bob Horvitz and John Sultan, you want to generate a lineage map of the organism from the zygote the the adult animal. Below is the lineage you have constructed so far.



You need to place cells 1-16 on the lineage. Using ablation to generate the following data:

Ablated cell	Cells that are present
PC.a	2, 4, and 9-14
A	2, 4, 5, 6, and 9-16
A.a	2, and 4-16
B.p	1,2,3,4,7,8, and 9-16
D	1,3,4,5,6,7,8,9,10,13,15,and 16
D.p	1,3,4,5,6,7,8,9,10, and 12-16
C.p	1-8, 10, 11, 12, 14-16

(a) Label the lineage above with cells 1-16.

You have several lineage defective mutants that fail to form certain cells and their direct descendants. Using these mutants, you attempt to discern which cells are needed for the development of particular components of the adult body.

In mutants for lineages A, B, C, and D.a, you always see the tail formed correctly. Mutants for lineage D never have a proper tail.

In mutants for lineages A.p, B, and PC.p, you always see a proper vulva. However, mutants for lineages A and PC.a never have a proper vulva.

In mutants for lineages A, B.p, C.a, and D, you always see proper formation of the gonad. However, mutants for lineages B and C do not have gonads.

(b) Which cells are responsible for tail, vulva, and gonad formation?

Question 4:
You are interested in the development of a set of cells that make the opening of the secretory duct to the intestine of *Drosophila*. Fourteen cells are arranged in two rings with seven cells in each ring. The cells of the first ring are numbered 1-7 and the second ring 8-14. To investigate the developmental origin of these cells, you induce mitotic recombination in flies heterozygous for a somatic cell marker that you can score. The time at which you induce mitotic recombination is prior to when all 14 cells are formed. When you score for clones homozygous for your somatic cell marker in a large number of flies, you observe the following numbers and patterns of clones:

Cells expressing somatic marker	Number of cases
1,3,5,10	7
8,14	10
2,7,8,9,13,14	4
1,3,4,5,6,10,11,12	4
4,6,11,12	6
8,9,13,14	7
9,13	12
1,10	11
4,11	13
6,12	12
3,5	12
2,7	14
All	2

Say as much as you can about the developmental relationships of the cells that makeup this duct.