

Biology 423L

Sept. 1/2

### Mendelian Genetics using Fast Plants

Report due Sept. 15/16.

**Readings:** Mendelian genetics: Hartwell Chapter 2 pp. 13-27, Chapter 5 pp. 127-130.

FASTPLANTS: Williams et al. (1986) Vol. 232 pp. 1385-1389. PDF available on web site;

FAST PLANTS Growing Instructions booklet, available in lab room. You can find more information at the home page for Wisconsin Fast Plants, <http://www.fastplants.org/>

**Objectives:** 1) To introduce you to higher plants as model organisms for genetics.  
2) To determine if mutations that cause different visible phenotypes (traits) are caused by single genes and to see if those genes are linked or if they are segregating at random according to Mendel's laws.

**Introduction:** We are using plant lines that have been developed to complete their life cycles in a short period of time. These rapid cycling brassica, or FASTPLANTS will complete their life cycle in approximately 8 weeks. These lines were developed at the University of Wisconsin and are widely used in a variety of teaching and research situations. We are going to examine genetic mutations that affect phenotypes in the seedlings of these plants. You will be given examples of the parents of crosses, the F1 generation and the F2 generation. You will be asked to count the number of each phenotype from the F2 generation and then decide what mutations are segregating which alleles are dominant and which are recessive.

**Materials and methods:** The cultivation procedures are not difficult but rather specific for optimal growth. They will be discussed in the lab.

#### Plants

1. *wild type*
2. *anthocyaninless*,
3. *yellowgreen*
4. *variegated*

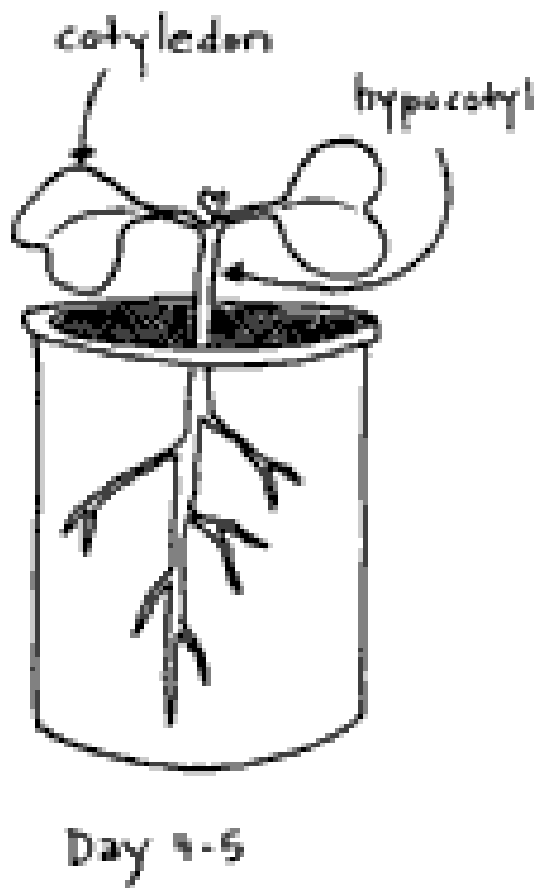
F1 of 2X3  
F1 of 3X2  
F1 of 1X4  
F1 of 4X1

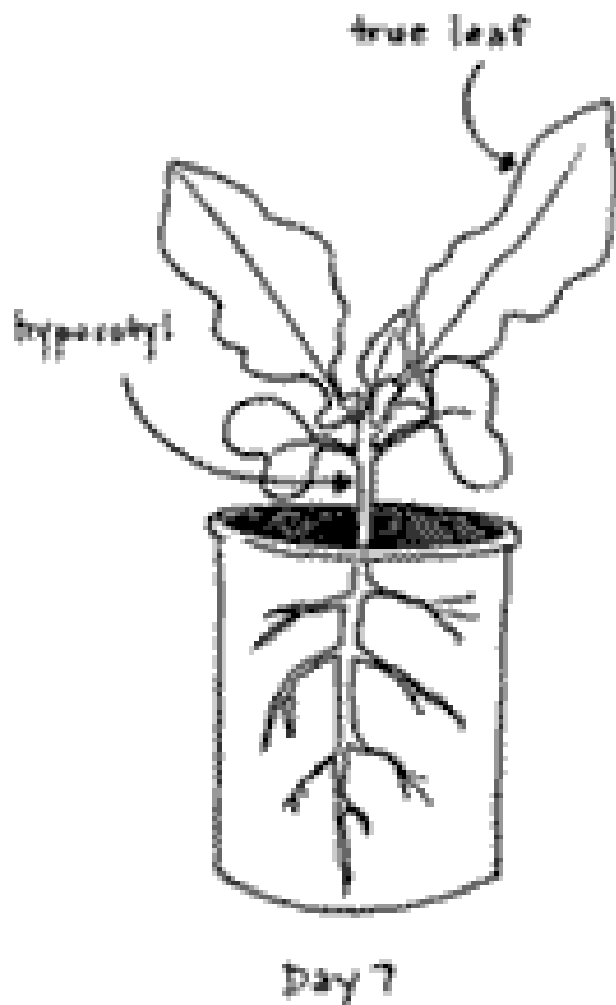
F2 of *yellow green* by *anthocyaninless*: 1/2 flat per group. (F1 of 2X3 selfed)  
 F2 of 1X4 F1 selfed  
 F2 of 4X1 F1 selfed

Figure 1. Diagram of Fast Plant seedlings: Day 4



*Wild type* and *anthocyaninless* differ in the trait of purple color in the hypocotyl





You will be given small pots with seedlings.

The parental lines will be marked with a stake with P#

The first generation resulting from crossing parents will be marked with F1 #X#

The second generation called the F2 generation is made by mating 2 F1 plants together. These will be labeled F2 #X#.

Examine the seedlings in your pots.

Compare the phenotypes (appearance) of the F1 plants to the appropriate parental lines.

**For the F2 2X3 seedlings. Describe the phenotypes of the parental lines,** describe the phenotype of the F1 seedlings of the 2X3 cross and the 3X2 F1 seedlings. Make a table. On the left side, list the 4 phenotypes you might expect to see in the F2 generation of the 2X3 cross. Use the heading phenotypes. The second column should have the number of F2 plants with each phenotype. Record the number of seedlings with each phenotype in your pot. The last row will have the total number of seedlings counted from your F2 pot.

Not all traits are inherited in a Mendelian fashion. We will set up several examples in which different parents were crossed together. According to Mendel's laws the F1 plants should have the same phenotype no matter which parent had the variant allele and which was wild type. Check the parents and F1 progeny in the demonstration flats. Do you see any unusual patterns of inheritance?

### Report:

**Abstract:** In three sentences, describe the questions addressed in the lab exercise, the methods used and the conclusions you can draw from the results.

**Introduction:** Define both of Mendel's laws.

Define a gene.

Define a locus.

Define an allele

Describe the genetic convention for the order of the numbers in the crosses ie. which parent was the female in each of the crosses we examined?

Remember that gene names are written in italics. Dominant alleles start with a capital letter and recessive alleles start with a small letter.

**Results section:** Make the table requested above.

Predict the number of genes with different alleles in the parent genotypes.

Is there more than one genetic difference comparing parent 2 and parent 3?

Explain how you can tell the difference by looking at the F2 population.

Do the test described below to determine if the alleles of the variant genes from parent 2 and parent 3 are segregating independently in your F2 population.

Predict the genotypes of the parents. Only consider the variant traits we can observe in the seedlings.

Make a Punnet square to calculate the different genotypes that should be segregating in your F2 population. If Mendel's laws apply to the traits we are considering, it should not matter which parent line is the male and which is the female in your punnet square.

Decide which allele is dominant for each gene. To do this, look at the demonstration F1 crosses and see the phenotype when you have two different alleles from each parent for a trait of interest.

Eg for F2 population made after crossing two parents that differ in their alleles at a single gene (locus) You may have alleles at more than one locus segregating in the crosses we look at this week.

Parents: AA X aa

F1 generation: All plants are Aa

Example punnet square for two alleles at one locus, F2 generation:

Punnet Square	Female A	Female a
Male A	AA	Aa
Male a	Aa	aa

Then using the genotypes you have predicted for the F2 population in your Punnet square, predict the proportion of each phenotype you would expect to see.

Compare your observations to your predictions.

The null hypothesis is alleles for your traits are segregating according to your prediction.

Calculate the number of plants of each phenotype you would expect given the total number of plants you examined. Use a Chi-square test to determine if your observations match your model. You can find a description of the Chi-square test and a Chi-square table in Hartwell et al ed. 3 or in most Genetics text books. (You should also be able to find a description online)

Chi-square test:  $\sum \frac{(\# \text{ expected} - \# \text{ observed})^2}{\# \text{ expected}}$

for each phenotype you can distinguish. Use the actual numbers of plants you counted, not the proportions.

What degrees of freedom apply in this case?

Look up a Chi-square table to see if you can accept or reject the null hypothesis.

**Discussion:** Did your observations for the F2 population from the 2X3 cross match your predictions? What variables could make the observations stray from your predicted numbers even if the assumption of independent Mendelian segregation of alleles for the traits of interest was correct?

Non-mendelian inheritance. Did you see any examples of non-mendelian inheritance in the demonstration of F1 plants?

How were those plants different from your expectations based on Mendel's laws?

Can you explain why the genetic mutation involved is not inherited according to Mendel's laws? You can go to the fastplants web site and learn about the variegated mutation. Be sure to quote your sources, ie. make a citation telling us where you found the information you are presenting.