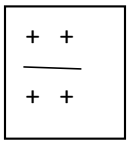
Series 2: Cross Diagrams – Linkage Analysis

There are two alleles for each trait in a diploid organism

In *C. elegans* gene symbols are **ALWAYS *italicized.***

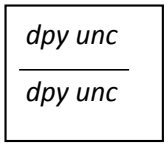
<u>To represent two different genes on the same chromosome:</u>

When both genes are wild-type: + is the wild type or non-mutant form of a gene:



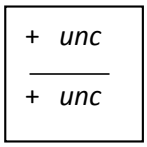
The phenotype of this worm is wild type

When both genes are mutant:

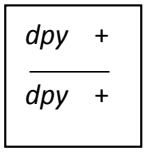


The phenotype of this worm is double mutant Dpy and Unc phenotype.

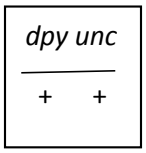
When one gene is wild type and the other mutant:

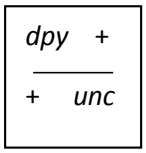


The phenotype of this worm is Unc



The phenotype of this worm is Dpy

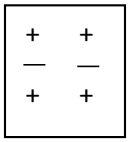




The phenotype of these worms is wild type

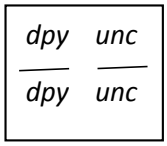
<u>To represent two different genes on different chromosomes:</u>

There is noticeable space between the two chromosomes



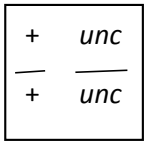
The phenotype of this worm is wild type

When both genes are mutant:

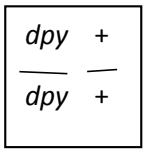


The phenotype of this worm is double mutant Dpy and Unc.

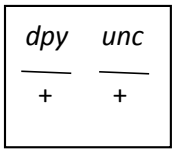
When one gene is wild type and the other mutant:

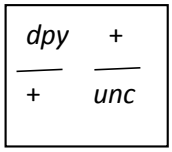


The phenotype of this worm is Unc



The phenotype of this worm is Dpy





The phenotype of these worms is wild type

Mating symbols:

- X – symbolizes mating between two different individuals
- Ⓧ - symbolizes a self cross – when the hermaphrodite worms fertilize their own eggs

NAME: _____

To discover the chromosome on which our mutated gene of interest is located, we will use a set of reference marker genes to perform linkage testing. By completing the following cross diagrams, you will work out your expectations for ratios of progeny when two genes are on the same chromosome (linked) vs. on different chromosomes (unlinked). Your expectations will be different when:

1) The *dpy* gene of interest **IS** on the same chromosome as one of the *unc* markers. We should see linkage in 1 of our 5 strains.

2) The *dpy* gene of interest **IS NOT** on the same chromosome as one of the *unc* markers. We should see this result in 4 of our 5 strains.

Work through the expectations for each cross scenario. You should obtain different expected ratios of progeny dependent on the location of the genes. Show all work and answer all questions for full credit.

The *dpy* gene of interest IS on the same chromosome as one of the *unc* markers.

Cross 1: Dumpy hermaphrodites x wild type males to make heterozygous males. This cross will also allow you to determine if your *dpy* gene is sex-linked.

$\frac{dpy}{dpy}$ X $\frac{+}{+}$ Parental Generation Genotype

_____ _____ List the gametes each parent can produce

_____ Give the genotype of the F1 progeny

_____ Give the phenotype of the F1 progeny

Why must we create heterozygous males?

What phenotype would you see in these F1 progeny if *dpy* was sex linked?

Cross 2: Heterozygous males x *unc* marker strain (linked)

We will now cross the F1 progeny to the *unc* marker strains to determine what our expected progeny will look like if our *dpy* gene and *unc* marker gene are on the **SAME** autosome.

$$\frac{+\ \textit{unc}}{+\ \textit{unc}} \times \frac{\textit{dpy}\ +}{+\ +}$$ Parental Generation Genotype

_____ _____ List the gametes each parent can produce

_____

↓

_____ _____ Give the genotype of the F1 progeny

_____ _____ Give the phenotype of the F1 progeny

We now must self the F1 progeny to determine linkage:

Show the self cross for the F1 worms lacking the *dpy* gene from the cross above:

_____ List the genotype of the worm that does not carry the *dpy* gene

_____ _____ What gametes can this worm make?

_____ _____ _____ What are the genotypes of the progeny from this worm?

_____ _____ What are the phenotype(s) of these progeny?

Can you determine the ratio of each phenotype from this self cross? If YES, give the ratio with corresponding phenotype. If NO, explain why not.

This cross does not tell us anything about the linkage of *dpy* to *unc*. WHY NOT?

If the worms resulting from this cross are uninformative, why did you have to work through this cross?

Show the self cross for the F1 worms CONTAINING the *dpy* gene:

_____ List the genotype of the worm that carries the *dpy* gene

_____ _____ What parental gametes can this worm make?

_____ _____ What recombinant gametes can this worm make?

What are the genotypes of the progeny from this worm? Differentiate among progeny from all parental gametes (most) & rarer genotypes that include one or more recombinant gametes.

What are the phenotype(s) of these progeny? Differentiate those that come from all parental gametes, 1 recombinant gamete and 2 recombinant gametes

Can you determine the ratio of each phenotype from this self cross? If YES, give the ratio with corresponding phenotype. If NO, explain why not. HINT: Do you know how far apart these two genes are on the chromosome?

Why are double mutant *dpy unc/dpy unc* progeny highly unlikely to occur from this cross?

Cross 2: Heterozygous males x *unc* marker strain (un-linked)

We will now cross the F1 progeny to the *unc* marker strains to determine ratios in the progeny if our *dpy* gene and *unc* marker gene are on the **DIFFERENT** chromosomes.

$\frac{+}{+}\ \frac{unc}{unc}$ X $\frac{dpy}{+}\ \frac{+}{+}$ Parental Generation Genotype

_____ _____ List the gametes each parent can produce

_____

_____ _____ Give the genotype of the F1 progeny

_____ _____ Give the phenotype of the F1 progeny

We now must self these worms to determine linkage:

Show the self cross for the worms lacking the *dpy* gene from the cross on the previous page:

_____ List the genotype of the worm that does not carry the *dpy* gene

_____ _____ What gametes can this worm make?

_____ _____ _____ What are the genotypes of the progeny from this worm?

_____ _____ What are the phenotype(s) of these progeny?

Can you determine the ratio of each phenotype from this self cross? If YES, give the ratio with corresponding phenotype. If NO, explain why not.

This cross does not tell us anything about the linkage of *dpy* to *unc*. WHY NOT?

If the worms resulting from this cross are uninformative, why did you have to work through this cross?

Show the self cross for the worms CONTAINING the *dpy* gene:

_____ List the genotype of the worm that carries the *dpy* gene

_____ _____ What gametes can this worm make?

_____ _____

What are the genotypes of the progeny from this worm?

What are the phenotype(s) of these progeny?

Can you determine the ratio of each phenotype from this self cross? If YES, give the ratio with corresponding phenotypes. If NO, explain why not.

What kind of assortment does this represent?