Problem set B

1. A wild-type ry+ (rosy) gene was introduced into a ry mutant using P element-mediated gene transformation, and a strain containing a stable ry+ gene was established.

If a transformed male is mated to an M strain female, would you expect the P element construct used in this experiment to transpose to another site in the genome of the F1?

No, because there is no transposase present.

If a transformed male is mated to an P strain female, would you expect the P element construct used in this experiment to transpose to another site in the genome of the F1?

No, because expression of the P elements and hence transposase in suppressed in the F1.

2. One form of male sterility in corn is maternally transmitted. Plants of a male-sterile line crossed with normal pollen give male-sterile plants. In addition, some lines of corn are known to carry a dominant nuclear restorer gene (Rf) that restores pollen fertility in male-sterile lines.

Research shows that the introduction of restorer genes into male-sterile lines does not alter or affect the maintenance of the cytoplasmic factors for male sterility. What kind of genetic results would lead to such a conclusion?

Rf/+; Male sterile cytoplasm (MSt) self crosses would produce 1/4 male sterile plants.

A male-sterile plant is crossed with pollen from a plant homozygous for Rf. What is the genotype of the F1? The phenotype?

+/+; MSt females x Rf/Rf males would generate all fertile Rf/+; MSt

The F1 plants from part b are used as females in a testcross with pollen from a normal plant. What would be the result of this testcross? Give genotypes and phenotypes, and designate the kind of cytoplasm.
Rf/+; MSt females x +/+ males would generate 1/2 male sterile +/+; MSt males and 1/2 male fertile Rf/+; MSt

The restorer gene already described can be called Rf-1. Another dominant restorer, Rf-2, has been found. Rf-1 and Rf-2 are located on different chromosomes. Either or both of the restorer alleles will give pollen fertility. Using a male-sterile plant as a tester, what would be the result of a cross where the male parent was

Heterozygous at both restorer loci?

MSt females x Rf1/+; Rf2/+ males would produce 1/4 male sterile plants

Homozygous dominant at one restorer locus and homozygous recessive at the other?

MSt females x Rf-1/Rf-1; +/+ males would generate all fertile males.

Heterozygous at one restorer locus and homozygous recessive at the other?

MSt females x Rf-1/+; +/+ males would produce 1/2 fertile males plants.

Heterozygous at one restorer locus and homozygous dominant at the other?

MSt females x RF-1/+; Rf-2/Rf-2 males would produce all fertile male plants.

3. In a screen for P element mutations in the miniature wings gene on X, you cross a male to a female that has a recessive lethal mutation on one X chromosome. The other chromosome is a balancer X chromosome containing an inversion, a recessive miniature wings mutation, a different recessive lethal mutation and the dominant Bar mutation. How would you have generated the male?

Cross P cytotype males to M cytotype females to generate hybrid dysgenic progeny.
What will be the phenotypes most of progeny from the cross to generate new alleles of miniature wings?

The progeny will be females with the Bar phenotype and normal wings.

What is the phenotype and genotype of the animals that you will be screening for?

You will screen for females that have miniature wings. These should contain a new P-element-induced miniature wing mutation derived from the hybrid dysgenic male.

4. The snail Lymnea peregra is a hermaphrodite that can either self or cross breed. In this snail the cytoplasm is transmitted through the egg. You are given true-breeding sinistral (shell spirals left) and true-breeding dextral (shell spirals right) lines, and decide to determine the mode of inheritance of shell asymmetry by crossing the two lines.

<table>
<thead>
<tr>
<th>P1</th>
<th>Dextral egg</th>
<th>Sinistral egg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x Sinistral sperm</td>
<td>x Dextral sperm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F1</th>
<th>all Dex</th>
<th>all Sin</th>
</tr>
</thead>
</table>

| F2(from self) | all Dex     | all Dex      |

Is dextral recessive or dominant? What is the mode of inheritance? What are the genotypes of the F2 progeny.

Dex is dominant. The inheritance is maternal effect. 1/4 D/D, 1/2 D/d, 1/4 d/d.

What phenotypes would you expect to see in the F2 self progeny?

3/4 of the F2 would produce all Dex progeny and 1/4 would produce all Sin progeny.
5. A fly geneticist carries out an enhancer screen and identified several lines that express \textit{lacZ} only in a subset of photoreceptor cells and nowhere else in the fly. The investigator suspects that mutations in these genes will not lead to a lethal phenotype because of the limited expression of the genes, but might impair the ability of the mutant flies to see. One of the P elements is upstream of a gene encodes a rhodopsin-related molecule and \textit{lacZ} is expressed specifically in the photoreceptor cell used to detect UV light. There is a simple assay to test whether flies can detect UV. What would you do to test whether this molecule is required for flies to detect UV?

\textbf{You can cross the enhancer trap line to a strain that expresses transposase. Lines homozygous for the chromosome containing the original enhancer trap are screened by PCR imprecise excision and deletion of the rhodopsin-like gene. These deletion mutants are tested for their ability to detect UV.}

\textbf{Problem set C}

1. You are given five true-breeding hermaphrodite strains of \textit{C. elegans}, each carrying a dumpy mutation, which makes the animals short and fat. All five strains are known to carry single gene mutations. You cross wild-type males with dumpy hermaphrodites of each strain and obtain F1 progeny of the following phenotypes.

\begin{center}
\begin{tabular}{|c|c|c|}
\hline
Dpy strain & F1 progeny & \\
\hline
P & \begin{tabular}{c} wt or Dpy \end{tabular} & \begin{tabular}{c} wt \end{tabular} \\
Q & \begin{tabular}{c} Dpy \end{tabular} & \begin{tabular}{c} Dpy \end{tabular} \\
R & \begin{tabular}{c} wt or Dpy \end{tabular} & \begin{tabular}{c} Dpy \end{tabular} \\
S & \begin{tabular}{c} Roller or Dpy \end{tabular} & \begin{tabular}{c} Roller \end{tabular} \\
\hline
\end{tabular}
\end{center}

\textit{wt}= phenotypically wild-type  \\
\textit{Dpy}=phenotypically dumpy  \\
\textit{Roller}= twisted body that causes animals to roll along their longitudinal axis as they move.

For each cross, what is the phenotype of the self progeny?

i. List the recessive mutation(s)  \\
P, R
ii. List the dominant mutation(s)
   Q, S
iii. List the incompletely dominant mutation(s)
   S
iv. List the mutation(s) that could be sex linked
   Q (R is sex linked)