Molecular Genetics BSCI410 Lectures 19-25. Model Organisms
Homework due **Dec. 2**
The final exam will be given on Monday, **December 13 at 8:00 am**
As usual, we want hard copy.

This homework covers lectures 19-23.
Half of the points on the final exam will come from lectures 19-25.
The other half of the points are comprehensive.
Review material for the earlier sections was provided on earlier homeworks and review sheets.
A complete review sheet for lectures 19-25 will be distributed later.

HOMEWORK QUESTIONS

You have isolated a new recessive **lethal** mutation in *Drosophila*. You tentatively name the mutation (and the gene it's in, unless this mutation turns out to be in previously named gene) *hjm* in honor of the geneticist H.J. Muller, because of the phenotype of the dead embryos, which have an overgrowth of the central nervous system. You have mapped *hjm* to the second chromosome, and wish to refine its map position further. To do this, you use *cinnabar* (*cn*, which has a recessive cinnabar eye color phenotype) and *curved* (*c*, which has the recessive phenotype that the wings are curved). You cross *hjm* / *SM5* females (*SM5* is a balancer chromosome for second chromosome) to *cn c* males, and then mate virgin heterozygous G1 *hjm* / *cn c* females to *cn c* homozygotes. You then examine and test male G2 files that carry a (potentially) recombinant chromosome over the *cn c* tester chromosome. (recomb. / *cn c*)

You first test 100 G2 flies that are homozygous for both *cn* and *c* and find that **none** of those 100 recombinant chromosomes carry the *hjm* mutation. This convinces you that the *hjm* mutation must lie in the region of these markers, so you test only recombinants, working until you collect 100 recombinant males of each of the two reciprocal classes, ignoring thousands of nonrecombinants.

Class of male progeny	number carrying the *hjm* allele
cinnabar eyes, normal wings	85 *hak* chromosomes of 100 tested
wild-type eyes, curved wings	15 *hak* chromosomes of 100 tested

1. (2 points) Examine the Drosophila genetic map (see pg. 141 of Hartwell, Fig. 5.13, or flybase: http://flybase.bio.indiana.edu/) and **estimate the position of *hjm* on the genetic map** (i.e. it's location in map units). For example, *cn* is at 2-57.5).

2. (1 point) Use the information from question 1 to infer an approximate position of your gene (*hjm*) on the **cytological** map (for example, the cytological position of *cn* is 43E16. You will need to visit flybase to correlate the two maps.

3. (2 points) Name one candidate gene that maps in this region. Rationalize why *hjm* might be an allele of that candidate gene.

4. (1 point) Agouti is dominant and non-agouti (black) is recessive. You are using an ES cell line from an Agouti strain for your gene knock-out experiments. The knock-out insertion confers G418-resistance. You inject these ES cells into a different, non-agouti, black strain and obtain a chimeric mouse (the G0 mouse). If you mate this chimeric G0 mouse to a homozygous agouti mouse, what sort of G1 progeny do you expect?
i) half agouti, half black in a Mendelian ratio
ii) ¾ agouti, ¼ black in a Mendelian ratio
iii) all agouti

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5. (1 point) You take one of the agouti G1 progeny from question 4 and mate it to a non-agouti black mouse. You get a litter in which about half of the G2 pups are agouti. Which is true:
a) The agouti mice should all carry the transgene but none of the black mice will.
b) Half of the agouti mice will carry the transgene, as will half of the black mice.
c) None of these mice will carry the transgene.

6. (1 point) You take another of the agouti G1 progeny from question 4 and mate it to a non-agouti black mouse. This time, you get a litter in which all of the G2 pups are agouti. Which is true:
a) All of the pups should carry the transgene.
b) About half of the pups will carry the transgene.
c) None of these mice will carry the transgene.

7. (2 points). In diagramming developmental signaling pathways, the symbol ---| is used to indicate repression; the activity of one gene negatively regulates the activity of the next. For the pathway **A** ---| **B** ---> **C** if A is on, then B will be off (or reduced). If B is on, then C will also be on. You are studying mutations that affect the sensory rays in the male tail development of *C. elegans* and you have defined two genes, *ray-1* and *ray-2*. Loss-of-function mutations in *ray-1* result in males with no sensory rays in the tail. Loss-of-function mutations in *ray-2* result in males with extra rays, more than the normal number. Which of the following regulatory pathways would be consistent with these results?

a) *ray-1* ---> *ray-2* ---> ray formation.
b) *ray-1* ----| *ray-2* ---> ray formation.
c) *ray-1* ---> *ray-2* ----| ray formation.
d) *ray-1* ----| *ray-2* ----| ray formation.
e) *ray-2* ---> *ray-1* ---> ray formation.
f) *ray-2* ----| *ray-1* ---> ray formation.
g) *ray-2* ---> *ray-1* ---| ray formation.
h) *ray-2* ----| *ray-1* ---| ray formation.

8. (2 pts.) In further studies you find that a *ray-1; ray-2* double mutant looks identical to a *ray-2* single mutant (i.e. extra rays are produced). Which of the pathways is most consistent with this result? (Refer to answers a through h in problem 7)

9. (3.5 points) Compare and contrast P elements (used in Drosophila) and T-DNA (used in plants). Compare the list of techniques that each can be used for. Touch on genetic and phenotypic instability, and utility for mosaic analysis.

10. (4.5 points) Answer question 12 in the back of chapter 20 in the book (pp. 752-753).