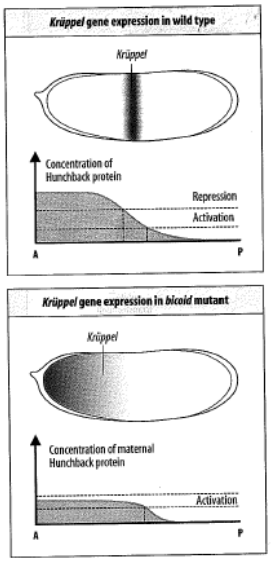
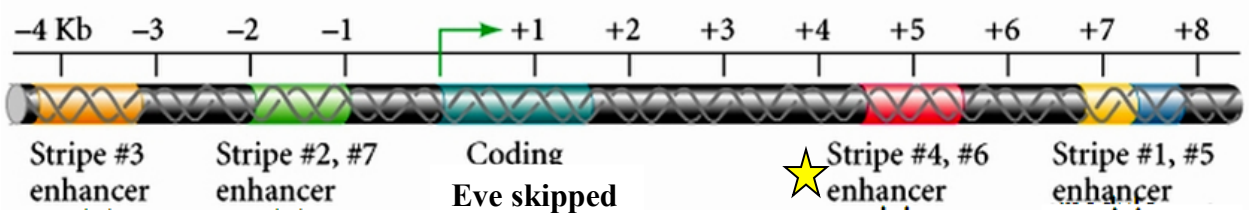
Problem Set 8

1. (1) The gap gene Kruppel is expressed in a band of cells just anterior to the middle of the embryo. Its expression is inhibited by high levels of Hunchback, and also by another gap gene called Knirps, which is expressed just posterior to Kruppel's normal domain of expression (see figure 9.28 in your book). In an embryo from a bicoid -/- mother, (ie, no bicoid), the domain of expression of Kruppel is altered as shown below. Explain what is responsible for this shift in expression. Be sure to consider both maternal and embryonic transcripts.



Use the diagram below to answer questions 2-5



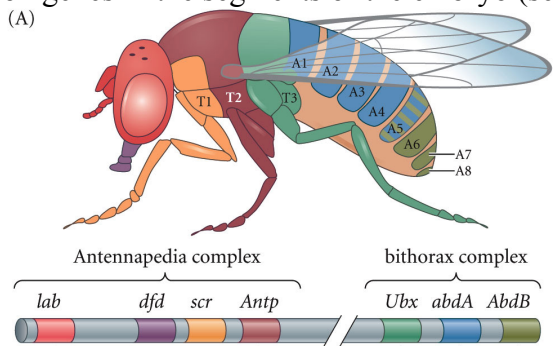
You generate a transgenic Drosophila that contains the enhancer module starred above hooked to the lacZ gene. "Stripes" refer to the parasegments that contain eve expression (every other parasegment, so stripe 1 = parasegment 1; stripe 2= parasegment 3, etc).

2. (.5) If you look at these embryos, stained for lacZ, where will you see lacZ product? In parasegments:
   a.1, 3,5,7,9,11,13 b. 2,4,6,8,10,12,14 c. 4 and 6 d. 5 and 9 e. 7 and 11
3. (.5) If you use in situ hybridization to look at the mRNA expression pattern of *eve* in this transgenic animal, what will it look like?
   a. Only present in the parasegments where the transgene is active
   b. Normal pattern of eve expression
   c. No eve expression
4. (.5) Explain what the result in 2) demonstrates about the different enhancer modules for *eve.*

5. (1) If you look at the expression pattern of *even-skipped (eve)* in the fly embryo, it is expressed in every other parasegment (ie, 1,3,5,7, etc). If you look at the expression pattern of the gap gene knirps, it is expressed in parasegments 6-10. In a *knirps* loss of function mutant embryo, if you visualize with in situ hybridization the pattern of eve expression, you see expression in segments 1,3,5,6,7,8,9,10,11,13. What can you conclude about the normal role of *knirps* with respect to regulation of eve expression?

6. (1) A loss of function mutation in any pair rule gene results in an embryo with half the number of segments as a normal embryo (7 rather than 14). If there were a mutation in a regulatory element of a pair rule gene, what would you expect the mutant animal to look like with respect to its segments?

The diagram below shows the Drosophila complex of Hox genes on chromosome 3, and the expression of these Hox genes in the segments of the embryo (segments T1-A8).



Hox gene	. . .	Scr	Antp	Ubx	AbdA	AbdB
Expressed in:		T1	T2	T3	A1-A5	A6-A8
		Antennapedia complex		Bithorax complex		

There are normally 14 segments in a Drosophila larva. The most anterior 3 make up the head. Then there are 3 thoracic segments (T1-T3), followed by 8 abdominal segments. Since the A1-5 segments have the same Hox gene expression and A6-8 have the same, we can represent a normal embryo with 5 different kinds of segments: T1 T2 T3 A1-5 A6-8.

7. (.5) You have isolated a loss of function mutant in Antp. What do you predict would be the phenotype in terms of segment identities?

a) T1 T1 T1 T1 T1
b) T1 T1 T2 T2 T2
c) T1 T1 T3 A1-5 A6-8
d) T2 T2 T3 A1-5 A6-8

8. (.5) A homeotic mutant fly exhibits a transformation in which the A1-5 segments have taken on the characteristics of the A6-8 segment. What type of transformation has the altered segment undergone?

a) Anterior to posterior
b) Posterior to anterior

9. (.5) What type of mutation in a Hox gene is likely to have caused this transformation in question 10?

a) dominant *gf*
b) recessive *lf*
c) could be either

10. (1) A homeotic mutant fly exhibits a transformation in which two adjacent body segments have wings (ie, the fly has 4 wings). Select all choices below that could result in this phenotype.

a. Ubx loss of function
b. Ubx gain of function
c. Ant loss of function
d. Ant gain of function
e. AbdA loss of function
f. AbdA gain of function

11. (1) Explain what the mutation(s) you selected in question 10 would look like at the DNA level in order to get the phenotype of a fly with 4 wings.

12. (1) Accutane is a prescription medication used to treat severe acne. Accutane is a member of a family of drugs called retinoids, which are related to vitamin A. When taken during pregnancy, Accutane and other retinoids can cause very serious birth defects in humans. If an embryo is exposed to the drug during the development of the brain, spinal cord and vertebrae, there are defects in these structures. What would you predict the defects to be (make a general statement about the defects), and explain why this is the consequence of this drug.

13. (1) In vertebrates, somites (from which muscles, vertebrae and ribs develop), can fail to undergo the segmentation process appropriately, but the individual cells can still differentiate into their correct identity. Briefly explain why this is true.