May 21, 2003

Question	**Points**	**Score**
1.	15	_____
2.	18	_____
3.	11	_____
4.	11	_____
5.	11	_____
6.	12	_____
7.	12	_____
8.	24	_____
9.	24	_____
10.	16	_____
11.	14	_____
12.	8	_____
13.	8	_____
14.	16	_____
Total for Final: 200		_____

Number of pages you should have including this one: 14

Question 3 (11 points) Predict the pattern of eve stripe 2 expression directed by a modified stripe 2 enhancer that contains augmented Bicoid binding sites. These sites have a higher binding affinity for the Bicoid gradient than the normal sites. Describe the resulting pattern in embryos with normal Kruppel binding sites and also embryos, lacking the Kruppel repressor.

Question 4 (11 points) Describe the Antp expression pattern in mutant embryos lacking the Polycomb repressor. What happens to the pattern in double mutants that lack both Polycomb and the entire Bithorax gene complex?

Question 5 (11 points) Consider an mRNA that specifies a mutant form of the Toll receptor that is fully activated in the absence of ligand. Describe the consequences of localizing this mRNA in early embryos using the 3' UTR sequence from the oskar mRNA.

Question 6a (6 points). With a signal coming from the notochord, suggest why there might be adjacent domains of gene activity in the ventral region of the neural tube- *nkx2.2* adjacent to the floor plate, and *olig2* in the motor neuron domain, which have a sharp boundary between them?

Question 6b (6 points).Suggest one similarity between this mode of regulation, and that of eve stripe 2 in flies.

Question 7a (4 points) Describe what happens when a growth cone of a neuron encounters a graded distribution of ephrin ligand.

7b (4 points) Fill in the blanks with the relevant molecules that function as guidance cues

	Attractant	repellent
Short range		
Long range		

7c. (4 points) What kind of experiment can show the ability of a substance to act as a long range attractant, for example for commissural axons in the spinal cord?

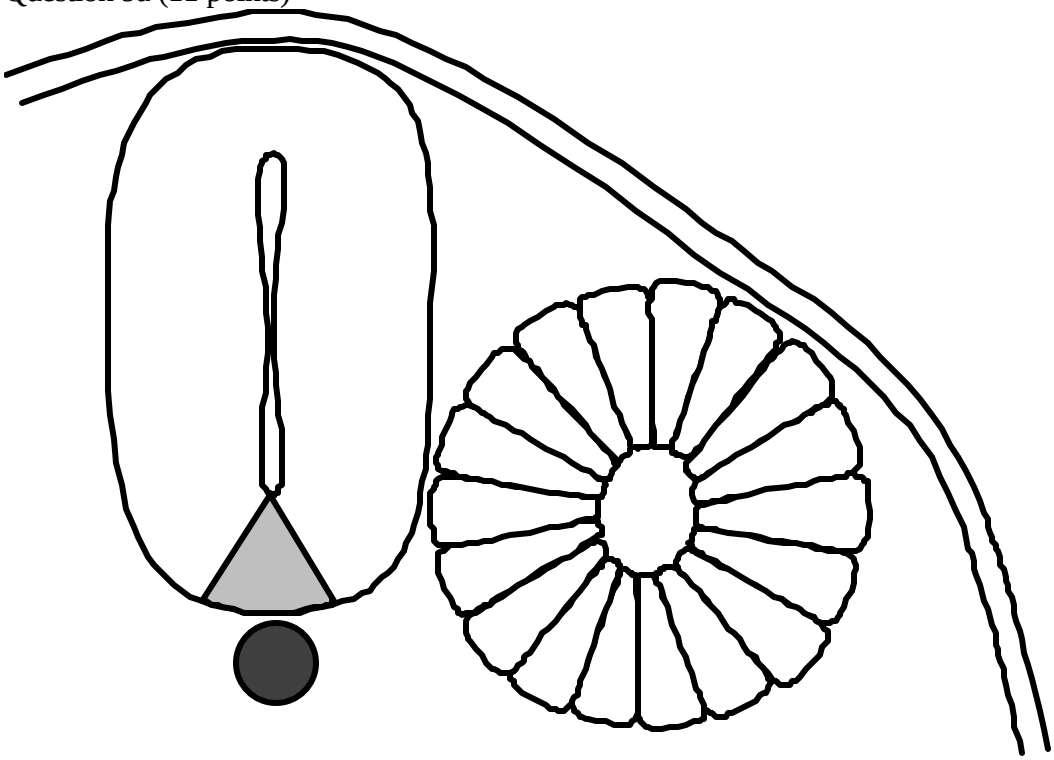
Question 8a. (6 points) Draw a cross section through a Xenopus early tadpole spinal cord. Label the positions of sensory and motor neurons. Also draw a section through a mouse or chicken spinal cord, showing the positions of the sensory and motor neurons.

8b. (6 points) If you take a piece of intermediate neural plate from a chick embryo and put it in culture it forms neither sensory nor motor neurons. Suggest two kinds of manipulations that will induce motor neurons.

8c (6 points) What two kinds of manipulations will induce floor plate?

8d. (6 points) Give examples of two kinds of manipulations that will induce sensory neurons.

Question 9a (11 points)



Draw arrows on the schematic figure of a chick embryo above to indicate the tissues, or parts of tissues that pattern the somite
Label the arrows with the following (letters only is OK)
a *noggin*
b *sonic hedgehog*
c *BMP*
d *Wnt*
You should draw in any obviously missing structures that are involved in the somite patterning

Label the following on the diagram (use the letter, not the full name, 1 point each)
e prospective sclerotome
f. prospective dermamyotome
g. notochord
h. surface ectoderm

Question 9b (13 points)As the somite matures, some of the cells change their properties and their fates.
Draw a cross section through the trunk of a later stage chick embryo, and indicate regions that
a. have undergone epithelial to mesenchymal transition
b. start to migrate into the limbs
c. will form the vertebral body
d. will form the connective tissue of the skin
e. will form the pigment cells of the adult
f. will form the mesonephros
g. contains precursors of muscles of the back

Provide alternative names for
b.

c.

d.

e.

f.

g.

Question 10. (16 points)
XX Embryonic stem cells from a black mouse are injected into an XY mouse blastocyst from a line of brown mice.
Predict what color the mouse will be

What sex will the mouse develop into?

Would the mouse develop germ cells derived from the ES cells? Why?

Discuss the sex of the following animals; justify your answer.
XXY Drosophila
XXY Mouse

Question 11. (14 points) To analyze neurogenesis, you decide to exploit observations that you can prevent synthesis of Notch RNA in Xenopus embryos, by using morpholino oligonucleotides directed at the Notch mRNAs. You decide to analyze embryos that are mosaic within the neural plate for the Notch depleted cells.

If you want to avoid complications from Notch depletion in other regions of the embryo, how would you generate mosaic embryos? How would you mark the cells that are depleted?

After doing a successful injection, and achieving a nice salt-and-pepper distribution of depleted cells in the neural plate, you examine the neural plate for differentiation of neurons.
Focusing on regions that normally differentiate early, what would you predict would be the pattern of differentiation in the depleted and non-depleted cells?

Question 12. (8 points) An experimental manipulation in the chick limb bud resulted in the following digit pattern: 2,2,3,4. Explain what this manipulation could have been and justify the observed result.

Question 13. (8 points) Why do the dorsal root ganglia form as aggregations over the anterior part of each somite?

Question 14a. (4 points) Give an example of a similarity between loss of the Mullerian duct in male mammals, and sculpting of the spaces between the digits of the limb.

Question 14b (6 points)Give an example of a similarity in the signaling pathways used in loss of Mullerian duct and sculpting of interdigital spaces.

Question 14c (6 points) For one of these molecular signals, provide six examples of other developmental contexts where it is used.