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Biology 411 - Developmental Biology
Spring Quarter 2013

Midterm 2 KEY Version A

75 Total Points
Open Book

Read the Following Instructions:

Answer 15 questions out of the available 20 questions - (5 pts each)

Cross out answered questions that you do not want graded. We will grade the first 20 answered questions that are not marked out.

Provide answers using **full sentences**, unless instructed otherwise.

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1. (p. 168-170) Why do micromeres induce a second archenteron when they are transplanted into the animal pole of a sea urchin embryo?

Micromeres secrete inductive signals that induce neighboring animal pole cells to become vegetal plate endoderm. Vegetal plate endoderm can then undergo invagination to form a second archenteron.

2. (p. 223) Why does the mRNA spatial pattern for *bicoid* differ from the protein pattern for the Bicoid protein?

bicoid mRNA is anchored to cytoplasmic elements in the anterior region of the embryo. Bicoid protein is free to diffuse through the cytoplasm.

3. (p. 234) Draw a *Drosophila* adult in which all three bithorax genes have been silenced in the head region.

A wild-type adult is the correct answer. Genes of the Bithorax complex are normally expressed in the abdominal region.

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4. (p. 170) What would happen to Veg2 cells in a sea urchin if micromeres failed to express the Delta ligand? Explain your reasoning.

The Veg2 cells would fail to produce non-skeletogenic mesenchyme genes.

5. Explain how the products of maternal effect genes can influence early development.

The products of maternal effect genes (also known as cytoplasmic polarity genes), mRNA and proteins, can become localized in certain parts of the developing embryo. These gene products, which are present at fertilization, can trigger early differential gene expression, leading to specification of cell fate and/or embryonic polarity.

6. (pp. 179-181) Explain how a maternal effect gene product determines shell coiling direction in the snail *Lymnea*.

The spiral coiling of the shell is determined by localization of maternal determinants in the 4d blastomere. Progeny of the 4d blastomere form a gland that is involved in the secretion of the spiraling shell. The spatial location of the 4d blastomere, and its cellular progeny, determines whether the snail's shell will coil left, or coil right.

7. (pp. 213-214) Consider a mutant *Drosophila* embryo where Gurken is secreted by follicle cells in a mutant embryo. Predict the resulting phenotype of the embryo, and explain your reasoning.

Gurken would activate the Torpedo receptor everywhere in the embryo. This would lead to dorsalized fate everywhere in the blastoderm.

8. (pp. 245-249) Describe a role for invagination during early amphibian gastrulation.

Bottle cells form by the process of invagination.

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9. (p. 292-294) What role does Koller's Sickle play in chick development?

Koller's Sickle is the equivalent of the Nieuwkoop Center in the amphibian embryo. It induces organizer gene activity.

10. (p. 196) What role(s) do P granules play in *C. elegans* development?

P granules become localized in cells that are destined to become the germ line. P granules activate genes involved in the specification of germ cells.

11. (p. 299) Figure 8.14. Draw the expression pattern of Nodal if the activity of both Activin and Fgf8 were suppressed in the chick embryo, during the primitive streak stage. Explain the reasoning for your drawing.

Nodal would be expressed on both the left and ride sides of the embryo, extending from the head to the mid-trunk.

12. (p. 177) What is the archenteron in a sea urchin embryo? Explain how convergence and extension is involved in the formation of the archenteron.

The archenteron is the gut cavity of the sea urchin embryo. However, many embryologists also refer to the cellular lining of the archenteron as the "archenteron." Cell intercalation within the invaginating vegetal plate drives convergence and extension of the archenteron.

13. (p. 191) Draw the resulting tissues in Figure 5.39 if Macho was mutated to a null phenotype.

Endoderm, nerve cord, and notochord. No muscle, no mesenchyme

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14. (p. 302) Draw the mouse embryo that would result if *Nanog* was inactivated in the early mouse embryo? Describe the differences from the wild type phenotype that would occur.

The morula would form inner cell mass cells, with a hypoblast. However, the ICM cells would not form an epiblast or embryonic stem cells.

15. (p. 269) Explain why injection of *cerberus* mRNA into a single D4 blastomere of a 32-cell Xenopus embryo induces a secondary head.

Cerberus protein inhibits both BMP and Wnt signaling. These conditions favor induction of a head rudiment.

16. (pp. 316-317) Define homeosis, and explain it using molecular terms and concepts.

Homeosis is the transformation of one body part into another. This involves a change in the specification of "identity" for the body part. Homeotic genes play a major role in specifying body part identity. Homeotic genes encode transcription factors that activate specific sets of genes. These genes contain a conserved DNA sequence called the homeodomain.

17. (p. 253) Explain the significance of the experiment illustrated in Figure 7.14.

This experiment illustrates that a nucleus at the 16-cell stage remains totipotent.

18. (p. 207) What is role of the germ band in *Drosophila* development?

The germ band forms body segments.

19. What is *in situ* hybridization? What is it used for in developmental biology?

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***In situ* hybridization is a method for imaging the location of specific mRNAs. It is used in embryology to identify the expression patterns of specific genes in developing tissues.**

20. (p. 309) Digram how a mammalian conjoined twin forms.

Illustrate the partial splitting of a blastodisc.