

Name \_\_\_\_\_

**Biology 411 - Developmental Biology  
Winter Quarter 2012**

**Midterm 2 KEY**

**100 Total Points  
Open Book**

**Read the Following Instructions:**

- \* Answer 20 questions out of the available 25 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. In the Essner *et al.* paper that you read for Discussion section, researchers imaged counterclockwise movement of fluid within Kupffer's Vesicle (KV). Consider the following experiment. Take ten zebrafish embryos, and inject a gelatin solution into Kupffer's Vesicle of each embryo. Confirm that fluid movement has stopped. Predict the phenotypes that will be seen in this population of embryos as a result of this manipulation. Explain your reasoning.

**Counterclockwise fluid movement in KV has been correlated with the establishment of right-left asymmetry. Blocking fluid movement would randomize left-right asymmetry in the population. Some of the embryos would have an inverted left-right patterning. Other embryos would have normal left-right patterning. Some embryos would have bilateral gene expression, instead of a distinct left-right asymmetry.**

2. (pp. 220-225) Draw what you believe the phenotype of a *bicoid; ftz* double mutant (i.e. two mutations) *Drosophila* embryo would look like. **Accurately label the parts** of the double mutant embryo and explain your reasoning.

**The embryo would have only abdominal structures that are mirror-symmetric about the embryonic midline. *Bicoid* mutants are mirror-symmetrical about the embryonic midline, and have only an abdominal region with telsons at either end. *Fushi tarazu* (*ftz*) is a odd pair-rule gene. Odd parasegments would be missing.**

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3. (p. 228) Draw the subdivision of tissues (cross-sectional view) in the *Drosophila* embryo if *snail* was mutated to a null phenotype. Remember to consider what the loss of snail activity would have on dorsoventral patterning.

**Twist and Snail are both needed to specific mesoderm. Without Snail activity, neurogenic ectoderm would extend throughout the ventral domain of the embryo.**

4. (p. 170) If *Otx* failed to be activated in micromeres, what would happen to gene expression in VEG2 cells? Explain your reasoning.

***HerC* would not be repressed. Delta protein would not be expressed and secreted. Without Delta, the Notch receptor would not activate non-skeletogenic mesenchyme genes in VEG2 cells.**

5. (pp. 172-177) Draw a sea urchin pluteus larva that failed to undergo convergent extension in the lining of the archenteron during gastrulation.

**A pluteus larva with no mouth or stomach. Only an anus and a posterior gut are present.**

6. (pp. 229-232) Draw the *even-skipped* (*eve*) expression pattern in a *ftz* (*fushi tarazu*) *Drosophila* mutant at the embryonic stage shown in Figure 6.32B.

***eve* will be expressed in all parasegments, since only even parasegments will be specified in the embryo.**

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7. (pp. 314-316) Spina bifida is a common birth defects in humans, occurring in 1 out of 2000 live births. Some researchers have speculated that this birth defect may be related to evolutionary changes in the primate body segments. Which *Hox* genes do you think might be involved in spina bifida? Explain why.

***Hox 9 and 10* paralogues specify lumbar, sacral and coccygeal segments in vertebrates. Mutations in these genes might have a connection to spina bifida.**

8. (pp. 219-223) What would happen if you irradiated the posterior end of a fertilized *Drosophila* embryo with X-rays? Diagram the phenotype and explain your reasoning.

***nanos* mRNA would be destroyed. The resulting embryo would have no posterior structures.**

9. In the first Harry Potter novel/movie, a large three-headed dog named “Fluffy” guarded a hatchway to a secret chamber. Fluffy has the same phenotype as Cerberus, the three-headed dog that guarded the gateway to Hades (Hell) in Greek mythology. Using your knowledge of embryology, how could a three-headed dog actually arise in nature. Diagram your thoughts and explain your reasoning.

**The anterior blastodisc of a dog embryo, which contains the presumptive head rudiment, could split into three portions. A conjoined triplet with three heads would result.**

10. (p. 181) A nucleus from the fertilized egg, produced by a *dd* female snail, is transplanted into an enucleated fertilized snail egg produced by a *DD* female. Draw the resulting cleavage pattern that would result. Diagram the cleavage pattern at the 8-cell stage, looking from the animal pole. Explain your reasoning.

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**The spiral cleavage pattern is determined by maternal determinants, which are lacking in the egg produced by the *dd* female. The cleavage pattern is clockwise looking from the animal pole at the 8-cell stage.**

11. (pp. 213-214) If an extracellular protease inhibitor was added to the perivitelline space, what would happen to patterning in the *Drosophila* embryo? Predict the resulting phenotype.

**The cascade of extracellular proteases would be inhibited. Dorsal would not be able to translocate into the nucleus. The embryo would be dorsalized.**

12. (pp. 312-317) Development occurs more rapidly in the anterior end of the mammalian embryo, compared to the posterior end of the embryo. Why does this occur?

**Retinoic acid, Fgf, and Wnt gradients are established during embryonic axis formation. These gradients regulate the expression of Hox genes, which specify the identity of body regions.**

13. (p. 212) Is *torpedo* a maternal effect gene? Explain your reasoning.

**Yes, *torpedo* is a maternal effect gene, even though it is expressed in follicle cells. The defect is encoded by a maternal gene, not a zygotic gene.**

14. What is the purpose of a F2 mutagenesis screen?

**The F2 is used to isolate recessive alleles that alter early development, following a saturation mutagenesis of the model organism. Heterozygous individuals that carry the recessive alleles are identified. Crosses between these individuals are used to generate homozygous phenotypes that are of interest.**

15. Why are organizer genes probably conserved across many types of vertebrate embryos, even though their mode of gastrulation can be radically different?

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**Organizer genes are probably conserved for patterning and cell fate specification. Setting up a dorsal-ventral axis is a critical step of embryogenesis. Specifying dorsoventral cell fate is probably more constrained by natural selection than the cellular mechanics of gastrulation.**

16. (pp. 204-206) What would happen to gastrulation if *Smaug* was overexpressed in the *Drosophila* embryo?

***Smaug* overexpression would cause the mid-blastula transition to occur earlier. Zygotic genes would turn on earlier. If initiated, gastrulation would occur earlier with fewer cells in the blastoderm.**

17. A zebrafish mutant named *floating head* lacks a notochord. Explain why the researchers chose the name *floating head* for the gene involved.

**Genes are often named after the mutant phenotype. In this case, mutation of *floating head* leads to the absence of a notochord, which in turn, leads to the lack of an extended body (the body crunches up). The head of the embryo appears to be floating in the water.**

18. It is thought that King Tut of Egypt was born to consanguineous parents? Explain why King Tut may have had several major birth defects.

**Progeny from consanguineous unions have increased risk of having deleterious, homozygous, recessive alleles. This condition can lead to one or more severe birth defects.**

19. What cellular process drives convergent extension in the amphibian notochord?

**Mediolateral cell intercalation.**

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20. (p. 269) Draw the resulting frog larvae that would result if BMP signaling, but NOT Wnt signaling, was inhibited in the anterior region of the embryo. Explain your reasoning.

**The embryo would have a normal tail. Trunk and spinal cord would extend to the anterior tip of the embryo. The embryo would have no head.**

21. (p. 196) If P-granules were overexpressed in the *C. elegans* embryo, what would happen to the embryo?

**All cells would become germ cells.**

22. (p. 302) What would happen to the early mouse blastocyst if *Oct4* expression was knocked down with morpholinos?

**The morula would form only trophoblast tissue. No inner cell mass cells would form.**

23. (pp. 290) Figure 8.3. Draw the distribution of mesodermal tissues in the chick embryo, if convergence and extension failed to occur during gastrulation.

**The notochord will fail to elongate. It will remain aggregated at the dorsal lip of the primitive streak.**

24. (p. 314, glossary) Why are certain *Hox* genes considered to be “paralogues”?

**Paralog genes are members of a gene family, which was derived (by duplication) from a single gene in an ancestor.**

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25. (p. 254- 261) Cells are removed from the animal cap of an amphibian blastula. What chemicals or inhibitors could you add to the culture medium to induce the clump of cells to become mesodermal cells normally found in a “Bauchstück”? Remember that the “Bauchstück” contains both ventral endoderm and ventral mesoderm.

**Animal cap cells need to be treated with Veg1 and Veg2 signals to induce presumptive mesoderm. BMP molecules are needed to induce ventral mesoderm.**