Name _____KEY_____

Biology 411 - Developmental Biology
Spring Quarter 2013

Midterm 3

75 Total Points
Open Book

15 questions - 5 pts each
Provide answers using full sentences, unless instructed otherwise.

1. (p. 348) Explain the difference in outcome between a horizontal cell division versus a vertical cell division of a vertebrate neuroepithelial cell.

A horizontal cell division in the neuroepithelium reduces in two daughters cells that remain neural stem cells. A vertical division results in the generation of a neural stem cell that remains attached to the luminal surface of the neuroepithelium, as well as a daughter cell that migrates and differentiates.

2. (pp. 375-377) If a mouse lacked pigmentation on its abdomen, as well as gut motility, what defect probably occurred during embryogenesis? Explain the reasoning of your answer for full credit.

Lack of neural crest cell specification probably occurred in this region of the body. Lack of pigmentation would be likely caused by a lack of melanocytes (derivatives of neural crest cells). Lack of gut motility would likely be caused by a lack of enteric neurons (also neural crest derivatives).

3. (pp. 391-392) What would happen to a group of R2 neural crest cells if they were transported from a donor embryo into the R4 region of the dorsal neural tube of a recipient embryo? Explain why this would occur?

The R2 neural crest cells would become exposed to RA (retinoic acid) and be stimulated to expressed *Hox2a*. This would shift the fate of the R2 neural crest cells to form Reichart's cartilage and its derivatives.

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4. (p. 394) Draw the probable innervation pattern of the muscles at the anatomical level of the hindlimb in a *Lhx3* knockout mouse.

Innervation of axial muscle would not occur. Instead, neurons from the medial motor column would probably innervate dorsal and ventral limb muscle.

5. (pp. 407-408) Draw the distribution of retinotectal neurons in a frog in which dominant-negative (i.e. inactive) Eph receptors are selectively expressed in a nasal-temporal gradient in the retinotectal neurons.

The neurons would be disorganized on the surface of the tectum because they would be unable to properly read and/or transduce signals from the distribution of Ephrins on the tectal neuronal membranes.

6. (p. 417) Draw the resulting body segments that would result if a dominant-negative construct of the Notch receptor was electroporated into the presumptive intersomitic furrow of the -1 presumptive somite.

The intersomitic furrow would not form because a functional Notch receptor is needed to activate *Mesp2* and activate *Hairy1*. Without expression of these two genes, neighboring

cells in a presumptive intersomitic furrow region cannot express the correct pattern of Ephrin and Eph receptor to pattern and form an intersomitic furrow.

7. Draw a dorsal view of a chick embryo in which cervical somites from a donor embryo are transplanted into the thoracic region of a recipient embryo.

The trunk will form cervical vertebrae that lack ribs. This is because the somites retain their anterior-posterior identity after transplantation.

8. (p. 433) Redraw the cross-sectional view of Fig. 11.22A for the situation that would result if Shh signaling were suppressed. Explain your answer in terms of the concepts shown in Fig. 11.22B.

No cartilage would form. All of the cells in the sclerotome would probably shift to tendon fate.

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9. (p. 400) Explain in words why Slit mutants have an aggregation of neurons at the embryonic midline? Diagram how a neuron would navigate in a Slit mutant.

Slit mutants do not have functional Slit proteins to repel neurons from the midline. Neurons would be free to move towards the embryonic midline, and form a solid tract of neurons at that location.

10. (p. 337) What would happen to chick neurulation if dorsolateral hinge points failed to form? Draw the result.

The neuroepithelium would remain bent in a V-shaped configuration. The neural folds would not come into contact, and neurulation could not be completed.

11. (pp. 448-449) Describe the role that endoderm plays in heart formation.

Endoderm differentiation is needed to promote the migration of cardiac cell precursors from the lateral edges of the gut tube to the embryonic midline. The endoderm also is needed to promote cell division and cell fate specification of cardiac cell precursors.

12. (pp. 334-341) What is the difference between primary and secondary neurulation?

A neural tube is formed by a folding the neural plate in primary neurulation. In secondary neurulation, a neural tube is formed by cavitation of a solid neural rod.

13. (p. 345) What is the likely concentrations of Shh in the area of the secondary floor plate in Figure 9.14?

4 nM or above

14. (pp. 478-480) What problems of gestation would occur if fetal lungs failed to mature? Explain your reasoning in molecular terms.

Surfactant Protein A would not be produced in immature fetal lungs. With Surfactant Protein A, labor (i.e. uterine contraction) would not be initiated.

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15. (pp. 566-570) What would happen if *shinguard* was over-expressed throughout a hydra. Explain your answer in molecular terms.

No new bodies would be able to bud in the affected hydra. The over-expression of *shinguard* would block *wnt* expression from establishing a new hypostome.

16. (p. 421) Why does vitamin A induce an entire new limb from the stump of a regenerating salamander limb?

Vitamin A stimulates the expression of certain *Hoxa* genes in the blastema of regenerating limbs. Normally vitamin A is synthesized in the wound epidermis. Extra vitamin A stimulates *Hoxa* genes characteristic of more proximal cell fates. Thus, an entire new limb is formed from the stump, instead of just more distal parts from the site of amputation.

17. (p. 474) Explain the importance of Hox genes in patterning the mammalian gut. How do mesenchyme cells play a role in this?

Hox genes are involved in specifying the anterior-posterior sections of the gut into different organs. Mesenchyme cells secrete signaling molecules, such as BMPs, and Wnt inhibitors, that influence the expression of Hox genes.

18. (p. 431) Explain the concept of resegmentation.

Segmentation generates repeating blocks of sclerotome. Each sclerotome splits into a rostral and caudal segment. Spinal neurons grow through these split blocks of sclerotome. The rostral portion of one segment combines with the caudal portion of an adjacent segment to form a new vertebral rudiment. Through this process, a vertebral rudiment is produced by a "resegmentation" of adjacent sclerotomal segments.

19. (pp. 418-419) Explain how the clock and wavefront model for somitogenesis works. Use your own words. More points will be awarded for more detailed answers on how individual somites segregate from the presomitic mesoderm.

Your narrative should include a discussion of cyclic gene expression, Notch activation, Eph-ephrin interactions.

20. (pp. 572-573) What would happen to cells in a *C. elegans* larvae, if the promoter to the DAF-2 insulin receptor became methylated.

This would result in the disinhibition (i.e. activation) of DAF-16, resulting in the activation of DNA repair enzymes. This state is known as the dauer larva stage in *C. elegans*.