Name _____

Biology 411 - Developmental Biology
Winter Quarter 2013 KEY

Midterm 3

100 Total Points
Open Book

Read the Following Instructions:
* Answer 20 questions (5 points each) out of the available 25 questions
* 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.

---

1. (pp. 377-380) Diagram the dorsolateral migration pathway of neural crest cells if Ephrin expression did not occur in somites.

Migration of neural crest cells would occur on both the anterior and posterior halves of the somites.

2. (pp. 368-370) Some people "go grey" in the second decade of life (i.e. in their 20's), yet they do not lose pigmentation in their scalp. Diagram what you think is happening to their hair follicles. Use Figure 9.42 as a template for your diagram.

Stem cells from the "bulge" migrate to the base of hair shaft. The stem cells differentiate into cells types that secrete the hair or form the hair sheath. However, melanocytes fail to differentiate at the base of the hair shaft. Without melanocytes, the hair shaft is unpigmented, and appears grey in color.

3. (pp. 388-389; pp. 445-454) The heart is considered to be a "mesodermal organ", being derived entirely from mesoderm. Is this concept true? Explain your reasoning. Exclude neurons that innervate the heart from your answer.

Cardiac neural crest cells invade the walls of the truncus arteriosus and proliferate to form a septum that separates the aorta and the pulmonary artery. Neural crest cells are ectodermal.

Name _____KEY_____

4. (pp. 344-350) Draw the location of the sulcus limitans in Figure 9.14(C). Remember when the sulcus limitans forms. Explain the reasoning behind your drawing.

The sulcus limitans would form only on the left side of the neural tube (looking at the figure). The ectopic piece of notochord secretes ventralizing signals that prevent dorsal fates from forming on the right side of the neural tube.

5. (p. 361) How could one manipulate the genetics of a vertebrate embryo with a Rx1 null mutation to restore formation of eyes?

Focally express Pax6 is the presumptive eye field.

6. (p. 391) Consider a child that is born with no jaw, no malleus, and no incus. However, the child does have a stapes, styloid process, and hyoid bone. What type of developmental error probably occurred for this type of birth defect to occur? Explain your reasoning using Figure 10.17.

The specification of non-Hox neural crest cells was probably defective, leading to a loss of that specific lineage and their tissue derivatives.

7. (p. 400) Draw the behavior of a *Drosophila* CNS axon is a *Drosophila* embryo that lacks Robo3. Explain your reasoning. Be sure to diagram the location of the nervous system midline.

Robo3 is not expressed. Therefore, Robo1 is not inhibited. Without Robo1 inhibition, the midline downregulation of chemorepulsion by Slit does not occur. The axon does not cross the midline.

Name _____KEY_____

8. (pp. 334-341) Explain the cellular mechanics of neurulation in the chick embryo? More points will be given for more complete, detailed answers. Use drawings to assist in your answer. Explain when neurulation is complete.

The explanation should contain a discussion about the neural plate, its folding at the median hinge point and the lateral hinge points. The discussion should include fusion of the neural folds. Drawings should illustrate key morphological transformations, and the final configuration of the neural tube underneath the overlying epidermis.

9. (pp. 416-419) Draw the resulting body segments that would result if a **dominant negative** construct of the Eph receptor was electroporated into the presumptive intersomitic furrow of the -1 presumptive somite.

An intersomitic border would be unable to form because the dominant negative Eph receptors would be unable to induce Ephrin ligands in the more anterior presomitic mesoderm cells. These cells would be unable to adopt a posterior identity and form an intersomitic furrow.

10. (pp. 326-330) Skeletal muscle contains a population of stem cells called satellite cells. For a long time, these cells were believed to be unipotent but recent studies have shown that satellite cells might actually be multipotent. Explain (1) why satellite cells are considered as stem cells and (2) the difference between unipotency and multipotency.

A stem cell divides to produce a cell that remains undifferentiated (i.e. its own copy) and a cell that goes down the differentiation pathway. Satellite cells divide to produce more satellite cells as well as muscle progenitor cells. Unipotent stem cells only give rise to one type of cell while multipotent stem cells are able to produce a few different cell types.

Name _____KEY_____

11. What is the difference between chemotropic and chemotrophic? Explain how a chemical agent could be both.

Chemotropic molecules act as guidance cues and promote directed growth while chemotrophic molecules nourish and sustain cells but do not act as guidance cues.

12. (pp. 424-425) What would happen to the somite differentiation if Shh was not secreted from the notochord and floor plate? Explain your reasoning.

The sclerotome would not form. Shh controls the expression of Pax1, which is required for sclerotome formation. Without Shh secretion, primaxial myoblast formation would increase throughout the ventromedial portion of the somite.

13. (pp. 420-423) Where do epithelial cells and mesenchymal cells in a somite come from?

They originate from the paraxial mesoderm.

14. (pp. 445-449, p. 472) What is the difference between the splanchnopleure and the somatopleure? Do one, both, or neither, give rise to the abdominal wall?

Splanchnopleure consists of the splanchnic (visceral) mesoderm and endoderm, while the somatopleure consists of the somatic (parietal) mesoderm and ectoderm. Only the somatopleure contributes to the abdominal wall. The splanochnopleure contributes to viscera and their connective tissue.

15. (Discussion Section) If the researchers from the Carmona-Fontaine paper inhibited RhoA, what signal would they get from DshGFP during neural crest cell-cell contact? Do the neural crest cells still repel each other? Why?

DshGFP would still express at surface because RhoA is downstream in the PCP pathway. The NC cells would not repel since the PCP pathway was interfered with by the loss of RhoA function.

Name _____KEY_____

16. (p. 391) Describe a mutation that would result in the loss of the hyoid bone and the styloid process?

Either overexpression of Fgf8 (cause no expression of Hoxa2) or loss of Hoxa2 (no formation of Reichert's cartilage).

17. (pp. 466-469) Explain how a bone marrow transplant can be used to treat certain blood cancers?

Chemicals that bind to hematopoietic stem cells are added to a person with blood cancers. The individual is exposed to full body radiation to kill the sensitized blood cells and blood stem cells. Healthy bone marrow is transplanted into the bone marrow of the person. Bone marrow contains hematopoietic stem cells that can regenerate the entire blood system.

18. List two similarities and two differences between placodal ectoderm and neural crest ectoderm. One point will be given for a detailed drawing that illustrates these points.

Similarities: (1) Both ectoderm (2) Both affect nervous system development (3) BMP and Wnt signals are used to specific fates.
Differences: (1) The placodal ectoderm shows focal thickenings of ectoderm while neural crest ectoderm does not. (2) The placodal ectoderm gives rise to anterior structures while neural crest ectoderm migrate and become numerous cell types throughout the body (3) Wnt signals used in placodal and neural crest specification differ in timing.

19. (pg. 446) What does the embryonic coelom become in humans?

The coelom becomes the pleural and peritoneal cavities.

20. (Figure 10.17) Egil Skallagrimsson was a Viking with Paget's Disease, an ossification disorder. Egil's skull was massively thick, and could not be cracked, even with a heavy axe. Using a genetic diagram for bone growth and ossification, suggest mutations that might give rise to abnormal amounts of skull dermal bone. Explain your reasoning.

Any mutations affecting the increase of Cbfa1 that leads towards increased dermal bone formation.

Name _____KEY_____

21. (Chapter 15) What role does methylation play in aging?

Methylated DNA gets accumulated in your genome as you age. If DNA methylation occurs in regulatory element such as promoters and enhancers, it may result in abnormal gene expression. Abnormal gene expression may cause diseases.

22. (pp. 567-568) Explain the outcome if hypostomes from two different Hydra were grafted end to end, i.e. the base of one hypostome is placed in stable contact with the other hypostome.

Only one head would form because the hypostome from the host secretes an inhibitor to only limit one head formation.

23. (pp. 416-419) If presomitic mesoderm cells at the -1 position of a donor were placed at the -1.5 region of a host, where would the cells be located after segmentation? Draw the version(s) and explain why.

They would be located either at the posterior of the somite or on the anterior/posterior of two somites. This is due to the expression of the Lunatic fringe on the posterior end and the imperfections of microsurgery. There would not be any of the cells located at the anterior position alone.

24. (pg. 404) What is a "brainbow", and what is it good for? Explain briefly how to make one.

It is a transgene model good for labeling and tracing individual axons through the embryo. To make one, you would use a transgene encoding multiple fluorescent proteins (four from Livet experiment) upstream of the 3' UTR that have varying Iox recombination sites before each fluorescent protein. With a constitutively active promoter, will use Cre to stimulate random recombination, which will activate one (or many) of the fluorescent proteins, creating numerous color variations to label and trace axons throughout the embryo.

25. (pp. 471-473) Explain why a pharyngeal pouch in a human embryo is not a gill slit? Is a pharyngeal pouch in a fish embryo a gill slit? Explain your reasoning.

Does not function in gas exchange, forms tonsils, thyroid, parathyroid, and thymus gland. No, it is not the gill slit in fish, but the space between contains the pharyngeal clefts, which form the gill slits and the embryo develops into a fish larva.