Name _____

Biology 411 - Developmental Biology
Winter Quarter 2012 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.

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1. (pp. 130-134) How is species-specific fertilization ensured in sea urchins?

Sea urchin sperm have a surface protein called bindin, which is species specific. It binds to a species-specific receptor on the egg cell membrane.

2. (pp. 150- 154) Explain where fertilization would be arrested if a sperm lacked a centriole. Draw the outcome?

The sperm would be able to fuse with the egg. An aster would not form, or move the male pronucleus toward the female pronucleus. Pronuclear fusion would not occur.

3. (p. 154) Provide a plausible reason why zygotes with two male pronuclei or two female pronuclei do not lead to viable progeny.

Methylation of genes can lead to gene inactivation. If genes that are critical for embryonic development are differentially methylated during male and female gametogenesis, a single copy of the critical gene may be present in the zygote. If two male, or two female pronuclei are artificially placed together, the resulting zygote will be missing an active copy certain critical genes.

4. (pp. 352-353) Explain why radial glial cells are considered to be neuronal stem cells.

Radial glial cells are actually neural progenitors. They can replicate by horizontal divisions in the ventricular zone of the neuroepithelium. They can also undergo asymmetric vertical divisions, generating a basal stem cells that continues to reside in the ventricular zone, as well as a intermediate progenitor cells that migrate to the subventricular layer.

5. (p. 361) How could one manipulate the genetics of cavefish to restore formation of eyes?

Downregulating the expression of *shh* would allow the upregulation of *Pax6*, which is necessary for eye rudiment formation.

6. (Chapter 10). A stem cell clinic offers you a chance to grow replacement cartilage for a new nose. Starting with a source of neural crest cells, explain how they would probably grow cartilage cells for your new nose.

Cranial neural crest cells could be exposed to BMP2, BMP4, and BMP7 in culture to induce nasal chondrocytes.

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

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

8. (pp. 406-408) Draw the distribution of retinotectal neurons in a frog in which dominant negative 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.

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. (p. 450) Draw a **dorsal view** **(not a side view)** of a chick embryo in which cervical somites from a donor embryo are transplanted into the thoracic region of a recipient embryo. Explain why.

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

11. (pp. 388-389). Explain what truncus arteriosis is. Explain why a loss of Pax3 would cause this a baby to be born with this condition.

***Pax3* expression is necessary for the specification of cardiac neural crest. Cardiac neural crest cells invade the heart primordium and form a septum that transforms the truncus arteriosis into two vessels, the aorta and the pulmonary artery.**

12. (p. 433) Redraw the cross-sectional view of Fig. 11.22A for the situation that would result if FGF signaling was increased from the myotome. Explain your answer in terms of the concepts shown in Fig. 11.22B.

More cells in the sclerotome would shift to a tendon fate. The syndetome would increase in size.

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13. (pp. 389-390) What is the embryonic origin of the trigeminal nerve? What type of embryonic tissue is this.

The trigeminal nerve is derived from the trigeminal placode. Sensory placodes are derived from cranial placodal ectoderm.

14. What cardiogenic problems would result if the embryonic coelom failed to form?

Failure of the embryonic coelom to form would like prevent the folding of the splanchnopleure, because it would not be mechanically separated from the somatopleure. Without folding of the splanchnopleure, the endocardium and myocardium would not form into their cylindrical shapes.

15. (pp. 441-443) What happens to the cloaca as development proceeds in the human embryo?

The urorectal fold separates the cloaca into two cavities, the urinary bladder and the rectum.

16. (p. 391) What would happen in Fgf8 was overexpressed in r2 neural crest cells?

Fgf8 represses the expression of Hoxa2. Reichhert's cartilage and its derivative would not form. The r2 neural crest cells would become endochrondal bone or dermal bone.

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. (p. 480) Explain why a woman taking a cyclooxygenase inhibitor might have difficulty with labor.

Cyclooxygenase is needed to breakdown arachidonic acid into prostoglandins. Prostoglandins are needed to initiate uterine muscle contraction and labor.

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19. (p. 448 and p. 450) A moropholino to *noggin* is injected into an early stage *miles apart* zebrafish embryo. Two separated heart primordia form in the head region of the embryo. Explain why this phenotype occurred.

Cardiac precursor cells fail to migrate to the midline in *miles apart* zebrafish embryos, resulting in cardia bifida. Noggin normally inhibits BMP expression in the anterior region of the embryo. An absent of Noggin results in a patterning defect, which places the cardiac precursor cells more anterior of their normal location.

20. (pp. 434-435) Describe 2 major developmental differences between the mesonephros and the metanephros in mammals.

The mesonephros is a transient organ rudiment, which largely degenerates during development, whereas the metanephros persists and develops into the kidney.

The mesonephros is a source of hematopoietic stem cells, whereas the metanephros is not.

The mesonephros is formed from the central portion of the nephrogenic cord, whereas the metanephros is formed from the caudal portion of the nephrogenic cord.

21. (p. 474) In figure 12.28, the term "No Wnt" is confusing. Explain why. Redraw this part of the figure to illustrate your point.

Wnt inhibitors would bind secreted Wnt proteins. The word "Wnt" should appear above the first arrow. The red inhibitor arrow should be directed against Wnt.

22. (p. 567) Explain the outcome if a hypostome and a basal disc are co-grafted onto the side of a host hydra

The basal disc contains a source of foot activation. This inhibits the activation of a new head by the hypostome.

23. 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.

24. Eating barbecued foods increases a person's intake of mutagenic chemicals. Even though the food might taste good, explain in molecular terms why eating this type of food might accelerate aging.

Reactive Oxygen Species (ROS) will be generated in BBQ food. Ingestion of these mutagenic compounds lead to DNA damage. Increased mitochondrial DNA damage correlates with a decrease in longevity.

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25. (p. 576) At age 50, would Eng and Chen (the famous (conjoined) Siamese Twins) have methylation like the 3-year-old twins or the 50-year-old twins in Figure 15.36 B? Explain your reasoning.

They would have methylation patterns like the 50-year-old twins. Even though they are conjoined, each cell in their bodies would have undergone random epigenetic drift during aging, resulting in different patterns of gene methylation.