

Biology 411 - Developmental Biology Spring Quarter 2013

Midterm 1 Version A

75 Total Points Open Book

Choose **15** out the 20 questions to answer (5 pts each). Only the first 15 questions that are answered will be graded. Cross out answers that you do not wish to be graded. Provide answers using full sentences, unless instructed otherwise.

1. What is the difference between prospective and presumptive in embryology?

Prospective means "capable of becoming" something. Presumptive means, "about to become" something. Usually, these terms are used in discussing the specification or differentiation of tissues.

2. (pg. 52) Explain what is a hemizygous condition. Does an individual with Angelman Syndrome have a hemizygous condition?

A hemizygous condition is where there is only one copy of the allele in the genome. The condition can be denoted as (+/0), where 0 indicates the absence of the allele.

An individual with Angelman Syndrome has a hemizygous condition for all of genes that were lost when the long arm of the maternal autosome, chromosome 15, was lost during gametogenesis.

3. Wild-type *Drosophila* adults usually have red eyes. This phenotype is encoded by the *white-eyed* gene. Explain why developmental biologists refer to the gene as *white-eyed*.

Developmental biologists often name a gene after the mutant phenotype of the gene. In this case, the mutant phenotype is *white-eyed*. The normal version of the gene codes for the wild-type, *red-eyed* phenotype.

4. (pp. 152-153) Explain how addition of soluble ZP3 to sperm blocks their ability to fertilize mouse embryos.

ZP3 binds to the ZP3 receptor in the sperm cell membrane. With its ligand bound, the ZP3 receptor cannot dock with the zona pellucida and thus initiate an acrosomal reaction at the correct location.

5. (pp. 61-62) Is miRNA a gene product? Explain your answer. Where does miRNA act and how does it act?

Yes, miRNA is a transcriptional product of a gene. The pro-miRNA will undergo post-transcriptional modification before becoming active as miRNA in the cytoplasm. miRNA combines with RISC. This complex binds to complementary sequences in mRNA. The targeted mRNA is either blocked from being translated, or the targeted mRNA is targeted for degradation.

6. (pp. 80-82) Draw the resulting chick wing if foot dermis was transplanted underneath the presumptive epidermis of the embryonic wing.

Drawing: The chick's wing has scales and/or claws on it.

7. Pax6 is used in specifying the lens and the pancreas. Pax6 is used to activate the crystallin gene in the lens. If Pax6 is present in developing pancreatic cells, why is the crystallin not expressed in the pancreas?

Pax6 is a transcription factor that acts in combination with other transcription factors to express specific genes. The exact combination of transcription factor (which includes Pax6) to express crystallin is not present in developing pancreatic cells.

8. (p. 26) Draw a Dachshund if it had only one copy of *Fgf4*.

Drawing: a short-haired Dachshund with long legs.

9. Explain the concept of alternative hypotheses. Explain why the construction of alternative hypotheses is useful.

Alternative hypotheses offer different interpretations of cause and effect. A set of alternative hypotheses is useful to construct to promote the discussion and testing of open questions.

10. Explain the concept of gene dosage. Why X inactivation is needed in female mammals to achieve it?

Both male and female animals need comparable numbers of genes in their genome. The Y chromosome contains a relatively small number of genes, compared to the X chromosome. A male has only 1 X chromosome, and therefore only 1 genomic copy of certain alleles, which are present on the X chromosome. Therefore, to obtain similar "dosages" of genes, mammals have evolved the process of X inactivation in females. X inactivation is believed to reduce the number of active X chromosome alleles in the genome, so that gene dosage is comparable between males and females.

11. Explain the difference between a repressor and an insulator protein?

A repressor is a transcription factor that inhibits the activity of an enhancer. An insulator protein binds to a regulatory site, thereby blocking access of transcription factors necessary for transcription of a gene.

12. (pp. 50-52) How many Barr Bodies would be located in each somatic cells of individuals with the following genotypes? Write the number of Barr Bodies to the right of the genotype.

- a. 47, XXY 1
- b. 48, YYXX 1
- c. 48, XYYY 0
- d. 47, XXX 2
- e. 46, XX 1

13. (pg. 79-85) Explain the concept of induction using an example from your text. More points will be awarded for more detailed answers.

Induction is the process by which signals from one embryonic tissue alters the fate of cells in another embryonic tissue. Some examples include epithelial-mesenchymal interactions (Table 3.1).

14. (pp. 125-127) Before fertilization, the oocytes of dogs and foxes are arrested in the prophase of meiosis I. Explain whether these oocytes are primary or secondary oocytes. In addition, explain what is contained in the germinal vesicle.

The oocytes of dogs and foxes that are arrested in the prophase of meiosis I are primary oocytes. The germinal vesicle of these oocytes contains uncondensed chromatin, as well as stabilized mRNAs.

15. (pp. 50-51) Describe a time and place where paternal X inactivation takes place in a female mouse embryo.

Inactivation of the paternal X chromosome takes place in the extra-embryonic trophoblast during embryogenesis.

16. (p. 93) Explain how phosphorylation of beta-catenin affects gene activation.

Phosphorylation of beta-catenin by GSK3 results in the beta-catenin molecule being targeted for degradation. Beta-catenin needs to translocate to the nucleus in order to activate target genes. Thus, phosphorylation of beta-catenin inhibits the expression of genes that are activated by beta-catenin.

17. (p. 82 Figure 3.15) If you cut out the optic cup, what happens? Explain what happens to the expression of Otx2/Pax6/Sox3. Explain why (see p. 81).

Pathway stops at prospective lens ectoderm. A lens placode does not form. Otx2 and Pax6 will be expressed in the prospective lens ectoderm. However, Sox3 is not induced because the prospective lens ectoderm does not receive an inductive signal from the optic vesicle.

18. (pp. 634-635) Explain how DES (diethylstilbestrol) acts as a teratogen.

DES is an estrogen mimic. It interferes with sexual organ development by altering cell fate specification in sex organs and gonads.

19. (p. 123) Diagram the zygote result that would happen if a sperm failed to deliver a centriole to the female gamete during the fertilization period.

The fertilized female gamete would contain a male pronucleus and a female pronucleus. These pronuclei would not migrate towards each other, and thus would probably not fuse.

20. (pg. 145) Describe the process of zygotic nucleus formation in sea urchin, beginning from sperm/egg plasma membrane fusion. Does the zygotic nucleus have a nuclear membrane? Explain.

After sperm/egg plasma membrane fusion, the sperm pronucleus and centriole are inserted into the egg cytoplasm. The single centriole divides twice to form two centrosomes, where the asters develop. Microtubules from the asters attach to the male and female pronucleus and migrate both towards each other. Both pronuclei fuse and form the zygotic nucleus, which has no nuclear membrane until after mitosis is complete.