KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN BIOCHEMISTRY AND BIOTECHNOLOGY

SBC 151: INTRODUCTION TO DEVELOPMENTAL BIOLOGY

DATE: Friday 30th March 2012 **TIME: 8.00a.m – 10.00a.m**

INSTRUCTIONS

SECTON A: Answer All Questions (20 Marks)

1. Which of the following series of events represents the path of vertebrate development?
   - **A.** Formation of blastula, cleavage, neurulation, cell migration, gastrulation, organogenesis, growth
   - **B.** formation of blastula, cleavage, gastrulation, neurulation, cell migration, organogenesis, growth
   - **C.** Cleavage, formation of blastula, gastrulation, neurulation, cell migration, organogenesis, growth
   - **D.** Cleavage, gastrulation, formation of blastula, neurulation, cell migration, organogenesis, growth
2. Which of the following statements about *Drosophila*development is FALSE?
   - **A.** *Drosophila* go through four larval instar stages before undergoing metamorphosis.
   - **B.** During the syncytial blastoderm stage, nuclei line up along the surface of the egg.
   - **C.** Imaginal discs are groups of cells set aside that will give rise to key parts of the adult fly.
   - **D.** Maternal, rather than zygotic, genes govern early *Drosophila* development.

3. *C. elegans* is a powerful developmental model because

A. these nematodes are very small, so it is easy to maintain a large population in a laboratory.

B. the fate of every cell has been mapped.

C. the fate of cells that will become eggs and sperm are predetermined.

D. these nematodes have the same amount of DNA as *Drosophila*.

4. What would happen as a result of a transplantation experiment in a chick embryo in which cells determined to become a forelimb were replaced by some cells determined to become a hindlimb?

A. A hindlimb would form in the region where the forelimb should be.

B. A forelimb would form in the region where the hindlimb should be.

C. Nothing; the forelimb would form normally.

D. Neither a forelimb nor a hindlimb would form because the cells were already determined.

5. The establishment of the anterior-posterior or dorsal-ventral body axes is called:

A. Morphogenesis

B. Differentiation

C. Pattern formation

D. Growth

6. In what way are the homeotic genes of flowering plants similar to those of *Drosophila*and other animals?

A. The homeotic genes of flowers are derived during evolution from the same primordial genes used in animals.

B. The homeotic genes of plants are arranged in a cluster on the chromosome, and are expressed from one end to the other in an anterior-posterior order.

C. Mutations in the homeotic genes of flowers cause transformation of one organ into another.

D. All homeotic genes are transcription factors of the homeobox class.

7. Which of the following, first discovered through mutagenesis studies in *Drosophila*, also function in the development of mammals?

A. the Wnt family

B. homeobox genes

C. hedgehog

D. All of the above

8. Genes control development by

A. containing small preformed body parts and organs that become "expressed" during development

B. directly controlling phenotypes, without intermediates or influence from the environment.

C. containing instructions which describe in detail the final form to be achieved

D. controlling where and when proteins are synthesized

9. In flies, frogs, and chicks, gradients of morphogens determine the future antero-posterior and dorso-ventral axes of the developing embryo. How is the antero-posterior axis determined in *C. elegans*?

A. Sperm entry leads to a reorganization of the cytoskeleton and redistribution of maternally packaged PAR proteins, which in turn determine the antero-posterior axis.

B. Nodal triggers formation of an organizer that will determine the dorsal, and hence the anterior, side of the embryo.

C. Bicoid protein is translated in the anterior of the fertilized egg, leading to a gradient that determines the antero-posterior axis.

D. β-catenin becomes localized to the nucleus in the future anterior cells after fertilization.

10. Which one statement best describes gastrulation in sea urchins?

A. The mouth of the pluteus larva will form from mesomeres on the oral side of the 60-cell embryo

B. Mesenchymal cells originating at the vegetal pole will invaginate first during gastrulation and will form skeletal structures in the pluteus larva.

C. The gut will form from the macromeres at the 16-cell stage.

D. All of the above are true.

11. In which way is the organizer region of the sea urchin similar to that in frogs?

A. The organizer will become the mesoderm.

B. The organizer accumulates β-catenin, which in turn activates the expression of cell-cell signaling molecules.

C. The organizer forms near the dorsal lip of the blastopore

D. The organizer induces the dorso-ventral axis

12. Secretion of Müllerian-inhibiting substance by Sertoli cells

A. causes the Müllerian ducts to develop into the oviducts.

B. causes the testis to produce testosterone

C. causes the Müllerian duct to regress by apoptosis in males.

D. causes the Müllerian ducts to develop into Wolffian ducts.

13. A cell that migrates through the dorsal lip of the blastopore at the very beginning of gastrulation in Xenopus, is likely to end up in the _____ region of the embryo

A. anterior – head region

B. anterior – belly region

C. posterior- spinal cord region

D. posterior- belly region

14. Which of the movements below is critical for the extension of cells along the inside of the embryo during gastrulation?

A. Epiboly

B. convergent extension

C. regression

D. ingression

15. Human identical twins are formed when the dividing fertilized egg splits in half, before the 32-cell stage. Each new embryo contains half the number of cells that the original embryo contained, and yet develops normally. This is possible in humans because:

A. you only need half the cells you are born with; the rest die by apoptosis anyway

B. the cells that end up in each half-embryo have different content initially, but are reprogrammed to start development over when separated

C. the remaining cells are all equivalent and can signal to each other to make up for the missing cells

D. the cells from one embryo signal to the other adjacent embryo to make up for any deficiencies in each half-embryo

16. Developmentally important proteins in the early cleavage-stage embryo in *C. elegans* and *Xenopus*) are

A. all synthesized in the oocyte from transcripts made during oogenesis

B. partly synthesized in the oocyte and partly after fertilization from transcripts made during oogenesis.

C. partly synthesized in the oocyte from transcripts made during oogenesis, and partly after fertilization from transcripts made after fertilization from the embryo's genome.

D. mostly synthesized in the early cleavage stage cells from transcripts made after fertilization from the embyro's genome.

17. In flies, frogs, and chicks, gradients of morphogens determine the future antero-posterior and dorso-ventral axes of the developing embryo. How is the anterior-posterior axis determined in *C. elegans*?

A. Nodal triggers formation of an organizer that will determine the dorsal, and hence the anterior, side of the embryo.

B. Bicoid protein is translated in the anterior of the fertilized egg, leading to a gradient that determines the antero-posterior axis.

C. Sperm entry leads to a reorganization of the cytoskeleton and redistribution of maternally packaged PAR proteins, which in turn determine the antero-posterior axis.

D. β-catenin becomes localized to the nucleus in the future anterior cells after fertilization.

18. In two successive embryonic cleavages, which factor among the following can determine spindle orientation in the second cleavage relative to the first cleavage?

A. Whether the first cleavage was meroblastic or holoblastic.

B. Whether the two blastomeres resulting from the first cleavage are unequal in size.

C. The failure of cortical microtubules to pull on the spindle poles to change spindle orientation prior to the second cleavage.

D. The plane in which the duplicated centrosomes migrate around the envelopes of the nuclei that form following the first cleavage.

19. In mammals, dosage compensation is carried out by

A. inactivating one X chromosome in males by condensation as heterochromatin.

B. inactivating one X chromosome in females by condensation as heterochromatin.

C. increasing the transcription of the X in males.

D. decreasing the transcription of the X in males.

20. In what way, if any, does the chromosomal determination of sex differ in *Drosophila* and humans?

A. In humans, it is the presence of only one X chromosome that triggers male development, and two X chromosomes trigger female development, just as occurs in *Drosophila*

B. In human males, a single Y chromosome is present in the absence of an X chromosome, while in *Drosophila*, a single X chromosome is present in the absence of a Y chromosome.

C. In humans, the Y chromosome determines maleness, but in *Drosophila*, the ratio of X chromosomes to autosomes determines maleness or femaleness.

D. There is no fundamental difference: in both organisms, the Y chromosome determines maleness.

SECTON B: Answer All Questions (30 Marks)

1. **a)** Early mammalian development has for long been hard to study. Explain **(1 Mark)**

b) Outline the key processes of embryonic development **(3 Marks)**

c) Distinguish between apoptosis and necrosis **(1 Mark)**

2. Discuss variations in life cycle of flowering plants **(5 Marks)**

3. Explain the genetic basis of sex determination in animals **(5 Marks)**

4. Developmental biology is a great field for scientists who want to integrate different levels of biology. Explain **(5 Marks)**

5. **a)** Imagine that gastrulation is blocked in a *Xenopus* embryo. Predict the consequence for the embryo **(2 Marks)**

b) In experiments on *Xenopus* cleavage, you treat 1-cell embryos with a drug that completely blocks RNA polymerase II, which is required for all mRNA synthesis. Explain briefly if and how you would expect this treatment to affect the processes of cleavage and gastrualtion **(2 Marks)**

c) Explain why sexual reproduction confers reproductive advantage to most animal species **(1 Mark)**

6. a) Define the followings as used in developmental biology **(½ Mark each)**

i. Cleavage
ii. Embryology
iii. Involution
iv. Morula

b) Imagine you could take a just-fertilized *C. elegans* embryo (1-cell stage) and dictate the plane of its first division so that it was perpendicular to the normal plane of division (cleavage furrow is horizontally placed rather than vertically). Predict the consequences of this change on the development of the embryo. **(3 Marks)**

SECTON C: Answer any Two Questions (20 Marks)

1. Discuss the model organisms used in developmental studies **(10 Marks)**
2. Discuss establishment of Anterior-Posterior axis in animals **(10 Marks)**
3. Discuss the cellular and molecular basis of morphogenesis **(10 Marks)**