Test Bank
to accompany
Foundations of Neural Development
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Chapter 1: Cell Differentiation and Neural Induction

Multiple Choice

1. The earliest metazoans to have neurons were the
a. sponges.
b. nematodes.
c. echinoderms.
d. cnidarians.
Answer: d
Textbook Reference: 1.1 Metazoans Evolved the Ability to Produce Cells with Very Different Functions, p. 9
Bloom's Level: 1. Remembering

2. The first organisms to have more than one type of cell were the
a. metazoans
b. protozoans
c. vertebrates
d. protostomes
Answer: a
Textbook Reference: 1.1 Metazoans Evolved the Ability to Produce Cells with Very Different Functions, p. 8
Bloom's Level: 1. Remembering

3. The theory that an organism develops by gradually changing to acquire new, more complex structures is called
a. preformation.
b. micrographia.
c. epigenesis.
d. rationalism.
Answer: c
Textbook Reference: 1.2 Preformationism Offered an Easy but Wrong Solution, While Epigenesis Seemed Incomprehensible, p. 10
Bloom's Level: 1. Remembering

4. The modern synthesis of evolution postulated that
a. parents passed along a blend of their traits to their offspring.
b. parents passed along discrete units of inheritance.
c. parents only passed along their dominant traits.
d. a new trait is lost after breeding with "normal" individuals.

Answer: b
Textbook Reference: 1.3 The Rediscovery of Genes Set the Stage for Understanding Development, p. 13
Bloom's Level: 2. Understanding

5. The phenotype of an individual organism or cell refers to the
a. physical characteristics displayed at a particular time.
b. total genetic makeup inherited.
c. physical characteristics that remain stable and unchanged throughout life.
d. stage of development reached once all major organs and body parts are in place.
Answer: a
Textbook Reference: 1.3 The Rediscovery of Genes Set the Stage for Understanding Development, p. 13
Bloom's Level: 2. Understanding

6. Regions of a gene that do not encode for any mRNA are
a. remnants of ancestral genes that are no longer needed.
b. degraded during gene transcription.
c. used to regulate gene expression.
d. no longer existent in vertebrates.
Answer: c
Textbook Reference: 1.4 Gene Expression Directs Cell Differentiation, p. 16
Bloom's Level: 2. Understanding

7. Molecules that regulate gene expression are called
a. promoters.
b. transcription factors.
c. exons.
d. translation factors.
Answer: b
Textbook Reference: 1.4 Gene Expression Directs Cell Differentiation, p. 17
Bloom's Level: 1. Remembering

8. If cells follow their particular fate regardless of what their neighboring cells do, they are said to have _____ specification.
a. conditional
b. mosaic
c. regulatory
d. spontaneous
Answer: b
Textbook Reference: 1.6 Mitotic Lineage Guides Cell Differentiation in Worms, p. 21
Bloom's Level: 1. Remembering

9. How can an organism like *C. elegans*, which follows an invariant pattern of mitosis, develop different cell types in a dividing zygote?
a. The mother deposits different transcription factors in different parts of the egg.

b. The dividing cells communicate with each other to determine their fate.
c. Gravity influences cells differently depending on their position in the zygote.
d. Different cell types cannot arise from an invariant pattern of mitosis.
Answer: a
Textbook Reference: 1.6 Mitotic Lineage Guides Cell Differentiation in Worms, p. 21
Bloom's Level: 3. Applying

10. The first recognizable structure that embryos form is the
a. gastric system.
b. nervous system.
c. epidermis.
d. respiratory system.
Answer: a
Textbook Reference: 1.7 Embryonic Development Begins by Forming Three Distinct Germ Layers, p. 24
Bloom's Level: 1. Remembering

11. From earliest to latest in development, what is the correct order of vertebrate embryological ontogeny?
a. Blastula, neurula, gastrula
b. Neurula, gastrula, blastula
c. Blastula, gastrula, neurula
d. Gastrula, blastula, neurula
Answer: c
Textbook Reference: 1.7 Embryonic Development Begins by Forming Three Distinct Germ Layers, p. 26, 29
Bloom's Level: 3. Applying

12. Which germ layer provides the cellular precursors to the nervous system?
a. Endoderm
b. Mesoderm
c. Ectoderm
d. Neuroderm
Answer: c
Textbook Reference: 1.7 Embryonic Development Begins by Forming Three Distinct Germ Layers, p. 25
Bloom's Level: 1. Remembering

13. The crease formed by the primitive streak is more pronounced at one end, called the node, which will form the
a. spinal cord.
b. brain and head.
c. vertebral column.
d. epidermis.
Answer: b
Textbook Reference: 1.8 The Vertebrate Nervous System Begins as a Simple Tube, p. 26

Bloom's Level: 1. Remembering

14. The neural tube will give rise to the _____, while the neural crest will give rise to the _____.
a. peripheral nervous system; central nervous system
b. central nervous system; epidermis
c. central nervous system; peripheral nervous system
d. epidermis; central nervous system
Answer: c
Textbook Reference: 1.8 The Vertebrate Nervous System Begins as a Simple Tube, p. 29
Bloom's Level: 2. Understanding

15. What experimental result demonstrates the concept of self-regulation?
a. Killing one cell in a two-cell embryo results in half an embryo.
b. Killing one cell in a developing *C. elegans* results in a worm with one less cell than normal.
c. Scooping out a clump of cells from a blastula results in a neurula with a chunk missing.
d. Surgically removing a chick limb bud causes remaining nearby cells to create a new one.
Answer: d
Textbook Reference: 1.9 Many Embryos, Including All Vertebrates, Display "Self-Regulation," p. 32
Bloom's Level: 3. Applying

16. If you introduce stem cells with a new gene into a mouse blastula, and that mouse grows up to produce pups that also have that transgene, what can you conclude about the fate of those original transgenic stem cells?
a. They were passed directly to the offspring.
b. They did not become incorporated into the parent's genome.
c. They became sperm or eggs.
d. They allowed the mouse to self-fertilize.
Answer: c
Textbook Reference: 1.10 Self-Regulation Seems Incompatible with Mitotic Lineage-Directed Differentiation, p. 33, 34
Bloom's Level: 4. Analyzing

17. The process by which one tissue directs the differentiation of another tissue is called
a. transduction.
b. induction.
c. reduction.
d. retroduction
Answer: b
Textbook Reference: 1.11 Experimental Embryology Revealed Inductive Processes Underlying Self-Regulation, p. 35
Bloom's Level: 1. Remembering

18. If developing cells communicate with one another to induce a particular fate in neighboring cells, the very first cells must receive their instructions of what to become from

a. an organizer.
b. mosaic specification.
c. mitotic linage.
d. conditional specification.
Answer: a
Textbook Reference: 1.12 A Region of the Vertebrate Embryo Seems to “Organize” Development, p. 36
Bloom’s Level: 3. Applying

19. In their search for the organizer signal, the hypothesis the researchers developed after exposing frog embryos to lithium chloride was that lithium chloride may
a. eliminate the organizer.
b. induce another organizer to develop.
c. increase expression of the organizer.
d. decrease expression of the organizer.
Answer: c
Textbook Reference: 1.13 Long Abandoned, the Organizer Was Uncovered Through Molecular Biological Techniques, p. 39
Bloom’s Level: 3. Applying

20. Organizer proteins _____ TGFβ receptor signaling, thus inducing _____ development.
a. activate; epithelial
b. block; neural
c. activate; neural
d. block; epithelial
Answer: b
Textbook Reference: 1.13 Long Abandoned, the Organizer Was Uncovered Through Molecular Biological Techniques, p. 40
Bloom’s Level: 2. Understanding

21. If you were to remove the mesoderm of a developing embryo, you would expect to happen to the embryo?
a. It would develop an abundance of neural cells.
b. It would not develop any skin cells.
c. It would develop an abundance of muscle cells.
d. It would not develop any neural cells.
Answer: d
Textbook Reference: 1.13 Long Abandoned, the Organizer was Uncovered Through Molecular Biological Techniques, p. 40
Bloom’s Level: 3. Applying

22. Which protein, secreted by endodermal cells, induces organizer proteins to start being made?
a. Bone morphogenetic protein
b. Chordin
c. Follistatin
d. β-catenin

Answer: d
Textbook Reference: 1.14 What Organizes the Organizer? p. 42
Bloom's Level: 1. Remembering

23. If you wanted to disrupt blastopore formation on a blastula, you could
a. disrupt the contents of the egg's cytoplasm.
b. disrupt the contents of the blastocoel.
c. scoop out the part of the blastula where the blastopore will form.
d. remove the ectoderm of the blastula.
Answer: a
Textbook Reference: 1.14 What Organizes the Organizer? p. 42
Bloom's Level: 5. Evaluating

24. In insects, the expression of _____ is the first step ectodermal cells must take on the path to becoming neural cells.
a. *noggin*
b. achaete-scute complex
c. *Notch*
d. *chordin*
Answer: b
Textbook Reference: 1.15 In Insects, Epidermal Cells Compete to Become Neuroblasts, p. 44
Bloom's Level: 2. Understanding

25. When Delta and Notch bind together, a Notch fragment joins with _____ to create a transcription factor that _____ proneural gene expression.
a. protease; inhibits
b. enhancer of split; enhances
c. protease; enhances
d. enhancer of split; inhibits
Answer: d
Textbook Reference: 1.15 In Insects, Epidermal Cells Compete to Become Neuroblasts, p. 47
Bloom's Level: 2. Understanding

Short Answer

26. Describe the difference between cellular differentiation and ontogeny.
Answer: Cellular differentiation is the process by which cells specialize and become different from one another. Ontogeny is the process by which a whole organism develops and grows old.
Textbook Reference: 1.2 Preformationism Offered an Easy but Wrong Solution, While Epigenesis Seemed Incomprehensible, p. 11
Bloom's Level: 2. Understanding

27. Researchers implanted the nucleus of an albino frog's skin cell into an enucleated egg from a pigmented frog, and a whole albino frog developed. What did this tell us about how genes direct cellular differentiation, and how might transcription factors play a role in this?

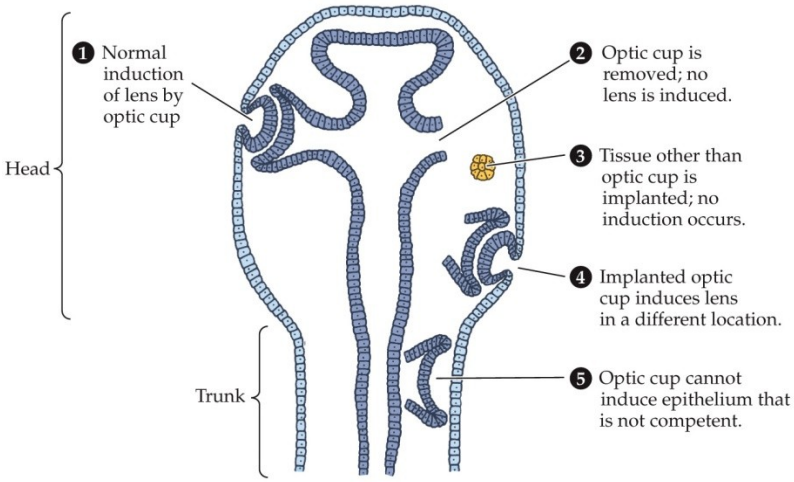
Answer: All cells retain all genes that are needed to make any type of cell (i.e., cells don't discard unneeded genes). The egg's cytoplasm contained the transcription factors needed to influence the gene expression to make a whole frog.
Textbook Reference: 1.4 Gene Expression Directs Cell Differentiation, p. 14, 17
Bloom's Level: 4. Analyzing

28. List three characteristics of *C. elegans* that make it particularly useful for studying genetic mutations.
Answer: Mutations can be readily induced in *C. elegans*; they generate very quickly; their transparency allows for watching development; and they can self-fertilize, which means mutations that might impair an individuals' ability to mate can be studied.
Textbook Reference: 1.5 Scientists Domesticated a Simple Worm to Address the Questions of Cell Differentiation, p. 19
Bloom's Level: 2. Understanding

29. One of the earliest experimental embryology experiments was conducted by Wilhelm Roux, who used a hot needle to kill one of the cells in an amphibian embryo at the two-cell stage. In the experiment, the remaining living cell formed only half of an embryo. However, later vertebrate experiments showed that by completely separating cells in early embryos, each can make complete individuals. What could explain the discrepancy in these experiments?
Answer: The dead cell in Roux's experiment may have affected the development of its neighboring cell, whereas in later experiments, the cells were completely separated from one another so they "sensed" that their neighbor was missing and changed their fate to replace it.
Textbook Reference: 1.9 Many Embryos, Including All Vertebrates, Display "Self-Regulation," p. 30
Bloom's Level: 5. Evaluating

30. Why is the *C. elegans* strategy of development referred to as the "European plan" and the vertebrate strategy of development referred to as the "American plan?" Name the two animal development strategies referred to by each, and explain why each is akin to "European" or "American" ideals.
Answer: *C. elegans* uses mosaic cell differentiation to determine cell fate, which is akin to the traditional European "who is your ancestor?" method of determining an individuals' social and economic status. Vertebrates use conditional specification (or cell-cell interaction) to determine cell fate, which is akin to the American "who is your neighbor?" idea that you can take on any role in society if you are in the right environment.
Textbook Reference: 1.10 Self-Regulation Seems Incompatible with Mitotic Lineage-Directed Differentiation, p. 33
Bloom's Level: 4. Analyzing

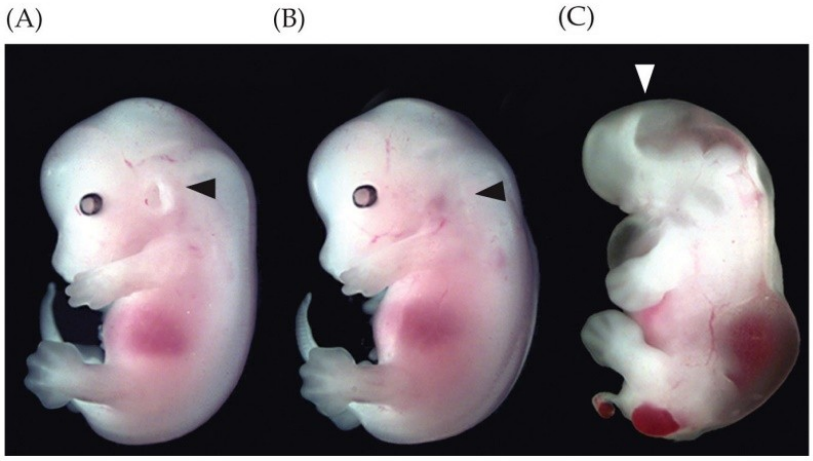
31. Refer to the figure.



If the optic cup normally induces the overlying epithelium to differentiate into a lens and cornea, why might it not be able to induce the trunk epithelium to do the same?
Answer: Not all epithelium is competent to respond to the optic cup—there is something different about the head epithelium and trunk epithelium.
Textbook Reference: 1.11 Experimental Embryology Revealed Inductive Processes Underlying Self-Regulation, p. 35
Bloom's Level: 5. Evaluating

32. Transplanting the dorsal lip of the blastopore of one newt blastula onto another part of a differently pigmented newt blastula results in what kind of newt with what kind of pigment? What does this tell us about the dorsal lip of the blastopore?
Answer: A second newt with its own head and central nervous system will develop, and it will be mostly pigmented like the host newt that received the transplant. This indicates that the dorsal lip of the blastopore induced the host cells to form a second individual.
Textbook Reference: 1.12 A Region of the Vertebrate Embryo Seems to "Organize" Development, p. 37
Bloom's Level: 3. Applying

33. Refer to the figure.



A normal wild-type mouse is shown in (A), a mutant mouse with an arrow pointing to its missing ear is shown in (B), and a mutant mouse with an arrow pointing to a missing brain is shown in (C). What specific mutations might (B) and (C) have?
Answer: (B) has a *noggin* knockout mutation and (C) has *noggin* and *chordin* knockout mutations.
Textbook Reference: 1.13 Long Abandoned, the Organizer was Uncovered Through Molecular Biological Techniques, p. 40
Bloom's Level: 4. Analyzing

34. What is an advantage of having many inductive steps (e.g., an organizer to organize another organizer) in an embryo?
Answer: If any part of an embryo is removed or damaged, there is still a good chance the embryo develop into a complete individual because the embryo will self-regulate to compensate for the loss (i.e., it increases chances of survival).
Textbook Reference: 1.14 What Organizes the Organizer? p. 42
Bloom's Level: 5. Evaluating

35. In the Achaete-scute complex, all cells in the ectodermal rosette begin by expressing AS-C, but only one ends up expressing AS-C. What does this suggest about how the cells in each rosette determine which will become the neuroblast? How was this suggestion confirmed experimentally?
Answer: These results suggest there is some competition going on between cells in each rosette to determine which will take on the neuroblast fate (i.e., lateral inhibition). This suggestion was confirmed experimentally when scientists killed a rosette cell that was in the process of delaminating, and observed that another cell subsequently began to delaminate.
Textbook Reference: 1.15 In Insects, Epidermal Cells Compete to Become Neuroblasts, p. 46
Bloom's Level: 4. Analyzing