Bio 10: Chapter 10.4- Cell Differentiation

Lesson Objectives

- Describe the process of differentiation
- Define stem cells and explain their importance.
- Identify the possible benefits and issues relating to stem cell research.

Lesson Summary

**From One Cell to Many** Multicellular organisms produced via sexual reproduction begin life as a single cell.

- Early cell divisions lead to the formation of an embryo.
- Then, individual cells become specialized in both form and function through the process of differentiation.
- Once cells of a certain type, such as nerve cells or muscle cells, have formed, the cells cannot develop into a different type of cell.

**Stem Cells and Development** During an organism’s development, some cells differentiate to become a wide variety of body cells.

- A fertilized egg and the first few cells in an embryo are able to form any kind of cell and tissue. Such a cell is termed totipotent.
- A blastocyst is an embryonic stage that consists of a hollow ball of cells. These cells are able to become any type of body cell. Such cells are termed pluripotent.
- Unspecialized cells that can develop into differentiated cells are called stem cells. Stem cells are found in embryos and in adults.
  - Embryonic stem cells are the pluripotent cells of an early embryo.
  - Adult stem cells are multipotent, which means they can produce many, but not all, types of differentiated cells.

**Frontiers in Stem Cell Research** Scientists want to learn about the signals that tell a cell to become either specialized or multipotent.

- Potential benefits of stem cell research include the repair or replacement of damaged cells and tissues.
- Research with human stem cells is controversial because it involves ethical issues of life and death.

**From One Cell to Many**

For Questions 1–4, complete each statement by writing the correct word or words.

1. Humans, pets, and petunias all pass through an early stage of development called a(n) ____________.

2. Cells become ____________ through the process of differentiation.
3. Scientists have mapped the outcome of every ___________ that leads to differentiation in the development of the microscopic worm *C. elegans*.

4. Most cells in the adult body are no longer capable of ________________.

**Stem Cells and Development**

*For Questions 5–7, write the letter of the correct answer on the line at the left.*

_____ 5. Which is an example of a totipotent cell?
   - A. blastocyst
   - B. bone cell
   - C. fertilized egg
   - D. lymphocyte

_____ 6. Cells that are pluripotent are unable to develop into the tissue that
   - A. forms the skin.
   - B. lines the digestive tract.
   - C. produces blood cells.
   - D. surrounds an embryo.

_____ 7. Adult stem cells are best described as
   - A. multipotent.
   - B. pluripotent.
   - C. totipotent.
   - D. unable to differentiate.

8. Complete the concept map by identifying some of the types of cells that embryonic stem cells give rise to. Then explain how stem cells are like the stem of a plant.

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Embryonic Stem Cells

can become

[Blank boxes for types of cells]

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Frontiers in Stem Cell Research

For Questions 9–11, write the letter of the correct answer on the line at the left.

9. Which is not a new, potential benefit of stem cell research?
   A. growing new skin cells to repair a cut
   B. replacing heart cells damaged by heart attacks
   C. repairing breaks between nerve cells in spinal injuries
   D. preventing suffering and death caused by cellular damage

10. What is the main reason that embryonic stem cell research is considered ethically controversial?
    A. embryos contain totipotent cells
    B. embryos are the result of sexual reproduction
    C. embryos from many different organisms are used
    D. embryos are destroyed in the process

11. What is one new technology that could make stem cell research less controversial?
    A. implanting skin cells instead of stem cells in damaged tissue
    B. developing the ability to switch on the genes that make an adult cell pluripotent
    C. replacing stem cells with cancer cells
    D. using the Internet to get more people to accept stem cell research

Apply the Big idea

12. Many plants such as orchids are grown by a technique called tissue culture. Small pieces of plant tissue from a leaf, stem, or root of a mature plant are placed in a medium that contains the proper nutrients. The cells first form a mass of undifferentiated cells, from which tiny roots, stems, and leaves eventually grow. How do the plant cells placed in a medium for tissue culture change in terms of their degree of specialization? What types of animal cells are most similar to the undifferentiated plant cells in a tissue culture? Explain your answer.