

2012 AP[®] BIOLOGY FREE-RESPONSE QUESTIONS

BIOLOGY

SECTION II

Time—1 hour and 30 minutes

Directions: Answer all questions.

Answers must be in essay form. Outline form is not acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write. Write all your answers on the pages following the questions in this booklet.

1. The ability to reproduce is a characteristic of life.
 - (a) **Describe** the process of embryological development in a typical vertebrate embryo, beginning with a fertilized egg and ending with the development of three tissue layers.
 - (b) **Identify** the developmental origin of TWO of the following tissues in vertebrates:
 - central nervous system
 - digestive system
 - muscle
 - (c) **Identify** and **explain** THREE differences between the embryological development of protostomes and the embryological development of deuterostomes.
 - (d) **Explain** TWO unique properties of human embryonic stem cells that distinguish them from other human cell types. **Describe** a current medical application of human stem cell research.

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Question 1

Note: At least 1 point must be earned from each of parts (a), (b), (c), and (d) in order to earn a maximum score of 10.

The ability to reproduce is a characteristic of life.

- (a) **Describe** the process of embryological development in a typical vertebrate embryo, beginning with a fertilized egg and ending with the development of three tissue layers.
(4 points maximum)

Embryological process	Description of embryological process (1 point per box)
Fertilization	<ul style="list-style-type: none"> • Egg is fertilized by sperm. • Zygote is formed. • Polyspermy is blocked. • Diploid number of chromosomes is restored. • Nuclei of egg and sperm fuse. • Sex of offspring is determined. • Polarity is determined.
Cleavage (can occur in other stages)	<ul style="list-style-type: none"> • Rapid cell divisions. • Cell divisions without cell growth. • Cleavage divisions form a small, solid ball of cells (morula). • Rapid DNA replications and mitotic divisions occur. • Cells get smaller in early cleavage with each division.
Blastulation	<ul style="list-style-type: none"> • Cleavage divisions form a hollow ball of cells surrounding a fluid-filled cavity. • Room for germ layers is developed.
Gastrulation	<ul style="list-style-type: none"> • Germ cell layers (ectoderm, endoderm, and mesoderm) are established. • Opening called a blastopore forms. • Cells near the surface of the blastula reorganize and move to an interior location. • Primitive digestive gut (archenteron) forms.

- (b) **Identify** the developmental origin of TWO of the following tissues in vertebrates:
- central nervous system
 - digestive system
 - muscle
- (2 points maximum)

Tissue	Identification of developmental origin (1 point per box)
Central nervous system	<ul style="list-style-type: none"> • Ectoderm / outer germ layer
Digestive system	<ul style="list-style-type: none"> • Endoderm / inner germ layer (lining) • Mesoderm / middle germ layer (other layers of digestive tract)
Muscle	<ul style="list-style-type: none"> • Mesoderm / middle germ layer

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Question 1 (continued)

- (c) **Identify** and **explain** THREE differences between the embryological development of protostomes and the embryological development of deuterostomes.
(3 points maximum)

Developmental differences: protostomes vs. deuterostomes	Explanation (1 point per box)
Pattern of cleavage	<ul style="list-style-type: none"> • Patterns of cleavage occur along different planes. • Spiral (diagonal planes in protostomes). • Radial (parallel/perpendicular in deuterostomes).
Determination of cell fate	<ul style="list-style-type: none"> • Determination of cell fate occurs in different developmental stages. • Early determination in protostomes (determinate). • Late determination in deuterostomes (indeterminate).
Blastopore fate	<ul style="list-style-type: none"> • Blastopore fate differs. • Mouth forms first; anus forms second in protostomes. • Anus forms first; mouth forms second in deuterostomes.
Coelom formation	<ul style="list-style-type: none"> • Coelom formation from mesoderm occurs by different processes. • Coelom forms from splitting of mesoderm in protostomes. • Coelom forms from outpocketing of mesoderm in deuterostomes.

- (d) **Explain** TWO unique properties of human embryonic stem cells that distinguish them from other human cell types. **Describe** a current medical application of human stem cell research.
(3 points maximum)

Unique properties	Explanation (1 point per box; 2 points maximum)
	<ul style="list-style-type: none"> • Totipotent: can become any type of cell, tissue, organ, or entire organism.
	<ul style="list-style-type: none"> • Pluripotent: can become many types of cells, tissues, or organs.
	<ul style="list-style-type: none"> • Undifferentiated: has the ability to follow any differentiation pathway.
	<ul style="list-style-type: none"> • Unspecialized: can give rise to specialized cell types.
	<ul style="list-style-type: none"> • Infinite reproduction: no restriction on cell types.

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Question 1 (continued)

Description of a current medical application (1 point maximum)

Acceptable responses include, but are not limited to, the following:

- Repair of brain and spinal tissues.
- Treatment of diseases such as leukemia, stroke, Alzheimer's, Parkinson's, diabetes, cystic fibrosis.
- Therapeutic cloning of human cells, tissues, and certain organs (e.g., bone, cartilage, muscle).
- Reprogramming of diseased cells.
- Testing of new drugs.
- Storage of umbilical cord stem cells.