AP® Biology
2012 Scoring Guidelines

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AP® BIOLOGY
2012 SCORING GUIDELINES

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	• 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)	• 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	• Cleavage divisions form a **hollow** ball of cells surrounding a fluid-filled cavity. • Room for germ layers is developed.
Gastrulation	• 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	• Ectoderm / outer germ layer
Digestive system	• Endoderm / inner germ layer (lining) • Mesoderm / middle germ layer (other layers of digestive tract)
Muscle	• Mesoderm / middle germ layer

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	• Patterns of cleavage occur along different planes. • Spiral (diagonal planes in protostomes). • Radial (parallel/perpendicular in deuterostomes).
Determination of cell fate	• Determination of cell fate occurs in different developmental stages. • Early determination in protostomes (determinate). • Late determination in deuterostomes (indeterminate).
Blastopore fate	• Blastopore fate differs. • Mouth forms first; anus forms second in protostomes. • Anus forms first; mouth forms second in deuterostomes.
Coelom formation	• 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)

	Explanation (1 point per box; 2 points maximum)
Unique properties	• Totipotent: can become any type of cell, tissue, organ, or entire organism. • Pluripotent: can become many types of cells, tissues, or organs. • Undifferentiated: has the ability to follow any **differentiation** pathway.
	• Unspecialized: can give rise to **specialized** cell types.
	• 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.

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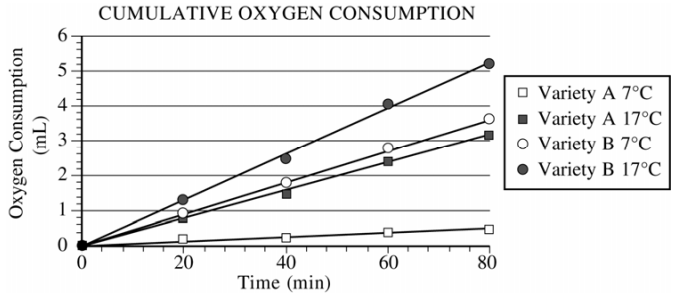
Question 2

An agricultural biologist was evaluating two newly developed varieties of wheat as potential crops. In an experiment, seedlings were germinated on moist paper towels at 20°C for 48 hours. Oxygen consumption of the two-day-old seedlings was measured at different temperatures. The data are shown in the graph below.



(a) **Calculate** the rates of oxygen consumption in mL/min for each variety of wheat at 7°C and at 17°C. **Show** your work (including your setup and calculation).
(3 points maximum)

- **1 point** for using the rate formula (D*y*/D*x*)
- **1 point** for using appropriate data to calculate the slope for at least three treatments
- **1 point** for giving answers in decimal format of mL/min

Note: Setup can choose <u>any</u> pair of points for the rise-over-run calculation of rate. The values used in the calculations can be greater or less than those shown in the examples below. Units of mL/min are implied by the question stem and need not be specifically shown.

Variety A at 7°C	(0.5 – 0 mL)/(80 – 0 min) = 0.0062 mL/min
Variety A at 17°C	(3.2 – 0 mL)/(80 – 0 min) = 0.040 mL/min
Variety B at 7°C	(3.6 – 0 mL)/(80 – 0 min) = 0.045 mL/min
Variety B at 17°C	(5.2 – 0 mL)/(80 – 0 min) = 0.065 mL/min

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Question 2 (continued)

(b) **Explain** the relationship between metabolism and oxygen consumption. **Discuss** the effect of temperature on metabolism for each variety of seedlings.
(4 points maximum)

Explanation of relationship (1 point)

- As metabolism increases, oxygen consumption increases.
  OR,
- As metabolism decreases, oxygen consumption decreases.

Discussion (1 point per bullet; 3 points maximum)
<u>Interpretation of graph</u>

- General statement that increasing temperature increases metabolic rate/oxygen consumption (no specific mention of variety A or B).
  OR,
- Variety A: rate of metabolism/oxygen consumption increases with an increase in temperature.
- Variety B: rate of metabolism/oxygen consumption increases with an increase in temperature.

<u>Comparison of varieties</u>

- Variety B has a higher metabolism/oxygen consumption than variety A at either temperature.
- Variety B has better metabolism/oxygen consumption at lower temperatures than variety A.

<u>Elaboration of temperature</u>

- Kinetic energy increases with temperature.
- Enzyme reaction rates increase with temperature.
- Effects on electron transport chain (ETC)/system.

(c) In a second experiment, variety A seedlings at both temperatures were treated with a chemical that prevents NADH from being oxidized to NAD^+. **Predict** the most likely effect of the chemical on metabolism and oxygen consumption of the treated seedlings. **Explain** your prediction.
(5 points maximum)

Prediction (1 point each; 2 points maximum)

- Metabolism/respiration stops/declines/decreases/slows down.
- Oxygen consumption stops/declines/decreases/slows down.

Explanation (1 point each; 3 points maximum)

- Glycolysis/Krebs cycle/ETC will stop.
- ATP levels will drop/decline/decrease.
- Oxygen cannot accept electrons from ETC.

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Question 3

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.

Information flow in cells can be regulated by various mechanisms.

(a) **Describe** the role of THREE of the following in the regulation of protein synthesis:
- RNA splicing
- repressor proteins
- methylation
- siRNA

(*3 points maximum*)

	Description (1 point per box)
RNA splicing	• Exons spliced together. • Introns removed. • snRNPs/spliceosomes help remove introns.
Repressor proteins	• Inhibit **transcription**. • Inhibit **translation**. • Silence genes. • Inactivate gene expression.
Methylation	• DNA or histone methylation prevents transcription. • Protects against restriction enzymes.
siRNA	• Facilitates degradation of mRNA. • Inhibits translation.

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Question 3 (continued)

(b) Information flow can be altered by mutation. **Describe** THREE different types of mutations and their effect on protein synthesis.
(4 points maximum)

Type of mutation (not limited to the following)	**Description (1 point per box)**	**Effect (1 point per box)**
Silent	Nucleotide change.	No change in amino acid/protein sequence.
Missense/substitution	Nucleotide change causes new codon.	Different amino acid/protein sequence.
Nonsense/substitution	Nucleotide change causes stop codon.	Protein not formed OR truncated protein.
Frameshift (insertion/deletion)	Nucleotide insertion/deletion alters reading frame after mutation.	Changes amino acid/protein sequence OR nonfunctional protein OR no protein.
Regulatory region	Nucleotide insertion/deletion/substitution.	Alters gene expression OR alters splice site.
Translocation	Chromosome segment moves to different site.	Alters gene expression.
Nondisjunction	Chromosomes fail to separate.	
Duplication	Chromosome segment doubles.	
Deletion	Chromosome segment is removed.	
Inversion	Chromosome segment is reversed.	
Transposition	Chromosome segment moves to a different site.	

(c) **Identify** TWO environmental factors that increase the mutation rate in an organism, and **discuss** their effect on the genome of the organism.
(4 points maximum)

Environmental factor (not limited to the following) (1 point each; 2 points maximum)	**Discussion (1 point each; 2 points maximum)**
• UV light	• T-T/thymine dimers.

• Carcinogens
  ○ Cigarette smoke
  ○ Asbestos
  ○ Radon gas
• Radiation
  ○ X-rays
  ○ Gamma rays/cosmic rays
• Chemical mutagens
  ○ Nitrites
  ○ EtBr
  ○ Aflatoxin
  ○ Pollution
	• DNA is altered/damaged (e.g., deamination, depurination, double strand breaks).

• Viruses	• Disrupt gene sequence.

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Question 3 (continued)

(d) Epigenetics is the study of heritable changes in the phenotype caused by mechanisms other than changes in the DNA sequence. **Describe** ONE example of epigenetic inheritance.
(1 point maximum)

Description of an epigenetic example (1 point maximum)

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

- DNA or histone modifications
- Inactivated X chromosomes (Barr bodies, calico cats)
- Heterochromatin
- Tumor suppressor genes (inactivation of *p53*)
- Cellular aging
- Environmental/in utero influences
- Maternal diet
- Agouti mice
- Heavy metals
- Famine study
- Pollution
- Twin studies (e.g., identical twin variations)
- Stress-induced alterations (e.g., post-traumatic stress disorder)
- Genomic imprinting (e.g., Prader-Willi syndrome, Angelman syndrome)

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Question 4

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

The element carbon is contained in all organic compounds.

(a) **Discuss** the role of photosynthesis and cellular respiration in carbon cycling in the biosphere.
(2 points maximum)

	Discussion (1 point per box)
Photosynthesis	• Removes CO_2 from the atmosphere. • Reduces (or uses) CO_2. • Fixes carbon into organic molecules (sugars).
Cellular respiration	• Metabolizes (oxidizes, catabolizes) organic molecules (sugars). • Returns CO_2 to the atmosphere. • Releases CO_2.

(b) For THREE of the following, **predict** and **explain** the effect on the carbon cycle if:

- decomposers were absent
- deforestation occurred
- volcanic dust accumulated in the atmosphere
- the average ocean temperature increased

(6 points maximum)

	Prediction (1 point per box; 3 points maximum)	**Explanation (1 point per box; 3 points maximum)**
Decomposers absent	• Less CO_2 in atmosphere. • More carbon stored in dead organisms.	• CO_2 is not released. • Organic material is not degraded.
Deforestation	• More CO_2 in atmosphere. • Fewer carbon compounds in organisms.	• Decreased photosynthesis.
Volcanic dust in atmosphere	• More CO_2 in atmosphere. • Fewer carbon compounds in organisms.	• Less solar radiation causes less photosynthesis.
Average ocean temperature increased	• More CO_2 in atmosphere. • Less CO_2 in ocean.	• Increased decomposition/rate of respiration. • Decreased CO_2 solubility (less photosynthesis).
	• Less CO_2 in atmosphere.	• Increased photosynthesis (e.g., algae blooms). • Decreased O_2 solubility, resulting in decreased respiration.
	• No net change in CO_2 reservoirs.	• Increased photosynthesis **AND** respiration.

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Question 4 (continued)

(c) **Explain** how increased CO_2 in the atmosphere results in greater acidification of oceans and **describe** the effect on marine organisms. **Include** in your discussion TWO examples of how human activity can increase atmospheric CO_2.
(4 points maximum)

Explanation (1 point)	• CO_2 dissolves, forming an acid (carbonic acid); the release of H^+ ions decreases pH. ($CO_2 + H_2O \rightleftarrows H_2CO_3 \rightleftarrows H^+ + HCO_3^-$)
Effect (1 point)	• Decreases ability to make corals/shells/exoskeletons. • Decreases availability of CO_3^{2-} for formation of $CaCO_3$ because more H^+ combines with CO_3^{2-}. • Decreases efficiency of enzymes in suboptimal pH.
Examples (1 point each; 2 points maximum)	• Combustion of gasoline/diesel. • Combustion of coal. • Combustion of natural gas. } **OR** Combustion of fossil fuels. • Combustion of wood. • Combustion/decomposition of wastes. • Deforestation reduces photosynthesis.

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