CollegeBoard
Advanced Placement Program

AP® Biology
2008 Scoring Guidelines
Form B

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AP® BIOLOGY
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Question 1

1. Measurements of dissolved oxygen (DO) are used to determine primary productivity in bodies of water.

- Explain the relationship of dissolved oxygen to primary productivity.

  Primary productivity **(4 points maximum)**
  - Primary productivity: rate at which autotrophs convert light energy into stored chemical energy
  - Increase in oxygen = increase in primary productivity
  - Rate of carbon compound formation measured indirectly through oxygen production
  - $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
  - Gross productivity\GPP = rate at which primary producer synthesizes O_2
  - Net productivity = GPP – producer respiration
  - Autotrophs produce/consume oxygen; heterotrophs consume oxygen

- How would the predicted levels of DO differ in each of the following pairs of water samples? Provide support for your prediction. Be sure to include a discussion of net productivity and gross productivity in your answer.

  I. Pond water at 25°C vs. pond water at 15°C **(4 points maximum)**
  - Prediction: DO at 15° greater than DO at 25°
  - Why: [saturation DO] 15° greater than [saturation DO] 25°
  - Example **(1 point maximum)**
    - Higher metabolic rate of aquatic organisms at warmer temperature = less available oxygen
    - Fish die in summer ponds/trout live in cold streams
    - Drinks at room temperature hold less dissolved gas than when cold
  - Elaboration of the example

  II. Pond water placed in the dark for 24 hours vs. pond water placed in light for 24 hours **(4 points maximum)**
  - Prediction: DO in light greater than DO in dark
  - Why: photosynthesis ↑ and oxygen ↑
    - Photosynthesis is light dependent
    - Light bottle is the NET productivity
    - Dark bottle uses O_2/respiration

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Question 2

2. Many biological structures are composed of smaller units assembled into more complex structures having functions based on their structural organization.

For THREE of the following complex structures, describe the smaller units, their assembly into the larger structures, and one major function of these larger, organized structures.

For each:

Unit Structure (with description) **1 point**	**Organization/Assembly** **2 points maximum*** **(*1 may be general, second specific to larger structure)**	**Function/Benefit** **1 point maximum**

Structures → Emergent properties **(4 points maximum each, only grade first 3)**

(a) A eukaryotic chromosome

Unit Structure—Organization/Assembly (must demonstrate organization to a chromosome):
- Describe nucleotides (or later structure in the sequence)
  → DNA → nucleosomes* → chromosome
  *around histones (non-DNA)
- Describe levels of folding
  → heterochromatin → condensed chromosome
- Describe DNA (or later structure in the sequence)
  → functional sequences (introns/exons/spacers) → genes → regulatory elements → chromosome

Function/Benefit:
- Package DNA
- Make for efficient cell division
- Juxtaposition of coding elements
- Gene regulation
- Storage/protection of genetic information

(b) A mature angiosperm root

Unit Structure—Organization/Assembly (must demonstrate organization to a functional root):
- Describe organelles (or later structure in the sequence)
  → cells → tissues→ layer → root

Function/Benefit:
- Storage
- Transport H_2O (absorption only via root hairs)
- Symbiotic relationships
- Secondary growth

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Question 2 (continued)

- Anchorage
- Mineral uptake

(c) A colony of bees

Unit Structure—Organization/Assembly (must demonstrate organization to a colony):
- Individual bee (or component later in sequence) (this is usually the unit)
- → organization into castes (workers, drones, queen) → colony
- Elaboration on roles of castes

Function/Benefit:
- Survival of colony—specialization maintains colonial "homeostasis"
- Preservation of genetic makeup through altruism
- Communication for food/enemies
- Role in ecosystem, e.g., pollination

(d) An inner membrane of a mitochondrion

Unit Structure—Organization/Assembly (must demonstrate organization to inner membrane):
- Phospholipids and proteins (or component later in sequence)—describe at least one
- → organization of proteins (specific respiratory molecules together) → folding → membrane
  (cristae must be uniquely mitochondrial)

Function/Benefit:
- Impermeable to H+ forming gradient
- Proximity of Kreb's Cycle to the membrane
- Electron transport

(e) An enzyme

Unit Structure—Organization/Assembly (must demonstrate organization to enzyme):
- Amino acid (or component later in the sequence) described
- → polypep (1° structure, etc.) → protein + modification
- Uniquely enzymatic modifications: cofactor/coenzyme/prosthetic group/allosteric modulators

Function/Benefit:
- R-group interactions forming active site
- Lowers activation energy
- Increases reaction rate (cannot simply say "catalyzes reactions")

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Question 3

3. Evolution is one of the unifying themes of biology. Evolution involves change in the frequencies of alleles in a population. For a particular genetic locus in a population, the frequency of the recessive allele (*a*) is 0.4 and the frequency of the dominant allele (*A*) is 0.6.

   (a) What is the frequency of each genotype (*AA, Aa, aa*) in this population? What is the frequency of the dominant phenotype?

   Calculations **(4 points maximum)**
   - Frequency *AA* = .36
   - Frequency *Aa* = .48
   - Frequency *aa* = .16
   - Frequency dominant phenotype = .84

   (Correct equation needed for credit if one of calculated numbers is wrong.)

   (b) How can the Hardy-Weinberg principle of genetic equilibrium be used to determine whether this population is evolving?

   Evolving population **(2 points maximum)**
   - Allelic frequency changes or five conditions that do not change if population is not evolving
   - Means of measurement/detection

   (c) Identify a particular environmental change and describe how it might alter allelic frequencies in this population.

   Explain which condition of the Hardy-Weinberg principle would not be met. **(4 points maximum)**
   - Environmental change identified **(1 point)** (first one scored)
   - Explanation of how allelic frequency changed **(1–2 points)**
   - Which Hardy-Weinberg condition not met **(1 point)**

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Question 4

4. Scientists use the concept of homology in identifying evolutionary relationships among organisms. Features shared by two groups of organisms are said to be homologous if the similarities reflect shared ancestry. Homology is found in comparisons of structural, molecular, biochemical, developmental, physiological, and behavioral characteristics of organisms. Select THREE of the following hypotheses and explain TWO examples of homology that support each hypothesis.

First 3 only (4 points maximum each)

(a) Chloroplasts are related to photosynthetic prokaryotes.

(Identify two: 1 point identification, 1 point explanation for each)
- DNA circular/nonhistonal
- Photosynthesis process the same
- Ribosomes/size and organization
- Endosymbiotic origin of chloroplasts
- Chlorophyll
- Binary fission for reproduction

(b) Spiders and insects are closely related.

(Identify two: 1 point identification, 1 point explanation for each)
- Exoskeleton
- Jointed appendages
- Tracheal tubes
- Chitin
- Open circulation
- Simple eyes (omatidia)
- Segmented body
- Ventral NS—paired nerve cord and segmental ganglia
- Malpighian tubules—excretory

(c) Echinoderms (sea stars and their relatives) are closely related to the chordates (the phylum that includes vertebrates).

(Identify two: 1 point identification, 1 point explanation for each)
- Deuterostome difference (blastopore forms anus)
- Cleavage pattern (radial) and gastrula structures similar
- DNA sequencing
- Coelomates—body cavity
- Bilateral larvae
- Indeterminant development

(d) Reptiles and birds are closely related.

(Identify two: 1 point identification, 1 point explanation for each)
- Embryology
- Amniotic/cleidoic egg (not just "egg")
- Dinosaur/ skeletal structure
- Scales or scales → feathers
- Similar brain structures
- Uric acid

(e) Humans and chimpanzees are closely related primates.

(Identify two: 1 point identification, 1 point explanation for each)
- DNA sequencing
- Thumbs (not just "hands")
- Brain structure
- Tool making/culture—other specific behaviors
- Chromosome banding pattern
- Protein structural similarity/ conservation—e.g., cytochrome c
- Skeletal similarities—e.g., no external tail, stereoscopic vision

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