CollegeBoard
Advanced Placement Program

AP® Biology
2006 Scoring Guidelines

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Question 1

A major distinction between prokaryotes and eukaryotes is the presence of membrane-bound organelles in eukaryotes.

(a) **Describe** the structure and function of TWO eukaryotic membrane-bound organelles other than the nucleus. **(4 points maximum)**

NOTE: One point is awarded for each bulleted item.

Organelle	Structure—1 point per box, Maximum—2 points	Function—1 point per box, Maximum—2 points
Mitochondria	• Indicate two membranes with either: - infolding of the inner membrane - cristae, or matrix	• cellular or aerobic respiration (Krebs, ETS) • production of ATP • release of chemical energy
Chloroplasts	• Indicate two membranes with either: - flattened sacs (thylakoids). - flattened stacks (grana). - stroma.	• photosynthesis or description of photosynthesis • production of 3-Carbon molecules (sugars, PGAL, glucose).
Endoplasmic Reticulum (ER)	• interconnected membranes, vesicles or sacs • rough ER has attached ribosomes and/or smooth ER without ribosomes	• synthesis of lipids (e.g., steroids) and/or proteins • detoxification of poisons, alcohol • transport • calcium signaling/storage If rough and smooth ER are the two named organelles • synthesis of proteins
Golgi apparatus	• series of flattened sacs	• modification of molecules • packaging molecules • processing molecules • vesicles (sacs) and their contents can be targeted for various locations in the cell and to its exterior
Lysosome	• vesicle (bag, sac) with enzymes	• digestion or breakdown of molecules waste materials and food with digestive enzymes (e.g., nucleases). • cell lysis • recycling organelles
Peroxisome (glyoxysomes)	• vesicle (bag, sac) with enzymes	• breakdown or detoxify free radicals or peroxides
Vacuoles	• vesicle (bag, sac)	• water balance • turgidity • storage water, ions, nutrients, or waste
Contractile vacuole	• vesicle (bag, sac)	• expulsion of water from cell
Vesicles	• sac (bag, sac)	• transporting materials to/from ER, Golgi, or cell membrane
Leucoplast	• Indicate two membranes with starch	• storing starch
Chromoplast	• Indicate two membranes with pigments	• storing pigments

Question 1 (continued)

(b) Prokaryotic and eukaryotic cells have some non-membrane-bound components in common. **Describe** the function of TWO of the following and **discuss** how each differs in prokaryotes and eukaryotes.

- DNA
- Cell wall
- Ribosomes

(4 points maximum)

Component	Function—1 point	Difference between Prokaryotes and Eukaryotes—1 point	
DNA	• contains, stores, or transmits genetic information • codes for proteins or traits	• single molecule • circular molecule • on avg. smaller number of base pairs (bp) • in cell's cytoplasm • few/no proteins* • no introns * *archaebacteria are an exception	vs. usually many molecules vs. linear molecule vs. 1,000 times the average number of prokaryote bp vs. within nucleus vs. histone proteins vs. introns
Cell wall	• protects • supports • maintains turgidity • maintains shape/ allows adherence	• Peptidoglycans (murein, amino acid, and sugar polymer)	vs. Cellulose and/or Chitin
Ribosome	• make protein • site of translation	• smaller • free in cytoplasm • simultaneous transcription/translation • contain different proteins, or RNAs • different antibiotic sensitivity	vs. larger vs. free and attached vs. non-simultaneous

(c) **Explain** the endosymbiotic theory of the origin of eukaryotic cells and **discuss** an example of evidence supporting this theory. **(2 points)**

Explain (1 point):
Prokaryotic cell was engulfed by another cell and formed a (symbiotic) relationship.

Evidence (1 point):
- Mitochondria and/or chloroplast contains own DNA.
- Mitochondria and/or chloroplast contains own ribosomes.
- Mitochondria and/or chloroplast contain double membrane.
- Mitochondria and/or chloroplast divides by binary fission.
- Mitochondria and/or chloroplast have a similar size to prokaryotic cells.

Question 2

According to fossil records and recent published observations, two species of leaf-eating beetles (species A and B) have existed on an isolated island in the Pacific Ocean for over 100,000 years. In 1964 a third species of leaf-eating beetle (species C) was accidentally introduced on the island. The population size of each species has been regularly monitored as shown in the graph above.

(a) **Propose** an explanation for the pattern of population density observed in species C. **[3 points]**
1. Description of curve [1 point]: Type of growth is exponential growth (logarithmic or J-shaped curve acceptable).
2. Explanation must describe the growth using an understanding of [1 point each, 2 points maximum]:
   Lack of limiting factors
   Low competition
   Abundant food
   Low predation
   Ideal environmental conditions (habitat, temperature, moisture, etc.)
   Access to mates

(b) **Describe** the effect that the introduction of beetle species C has had on the population density of species A and species B. **Propose** an explanation for the patterns of population density observed in species A and in species B. **[4 points]**
1. Describe effect [1 point]: Species C has had little or **no effect** on species A; however, as **species C increases, B decreases. Both lines must be addressed for the point.**
2. Explanation for species A or dashed line [1 point]: **No or little competition** (No niche overlap).
3. Explanation for species B or solid line [1 point]: **Competition or Niche overlap**.
4. Identification of the niche **"Competitive Exclusion Principle"** [1 point]: by name or description.

(c) **Predict** the population density of species C in 2014. Provide a biological **explanation** for your prediction. **[2 points]**
1. Prediction [1 point]: The population will **increase, decrease, or stabilize (level off)**.
2. Explanation [1 point]: Tie a correct explanation to the prediction.
   Increase—tie to abundant resources and freedom from competition.
   Decrease—tie to exhaustion of a key resource or density-dependent cause.
   Stabilize or level off—tie to carrying capacity or a limiting resource.

(d) **Explain** why invasive species are often successful in colonizing new habitats. **[2 points—from either or both areas below]**
1. They have **lost a controlling population factor** from their original habitat: predator, pathogen, or parasite.
2. They **have a novel evolutionary advantage** brought to the island from their original habitat: an aspect that provides an advantage—a chemical defense, flight advantage, novel enzyme, etc.

Question 3

The movement of water through vascular plants is important to their survival.

(a) **Explain** the mechanism of water movement through vascular plants during transpiration. Include a discussion of how the anatomy of vascular plants and the properties of water contribute to this process. **(7 points maximum)**

***** Each dash = 1 point

Mechanism (in correct context)	**Anatomy** (related to how anatomy contributes to transpiration)	**Water Properties** (related to how property contributes to transpiration)
• Movement of water - water evaporates or leaves the plant - transpiration pull **OR** cohesion-adhesion tension theory - continuous column of water - capillarity - root pressure - ψ (water potential differences) - osmosis/diffusion/tonicity • Energy driving transpiration - environmentally powered (sun, wind, humidity) - passive on part of plant	- Stomata/guard cells - Spongy mesophyll - Xylem, tubes, tracheids, vessel elements - Any specific root structure (root hairs, Casparian strip)	- Polarity/hydrogen bonding - Cohesion - Adhesion/capillarity - High heat of vaporization (H_2O vapor exiting leaf)

* Each dash = 1 point

(b) **Explain** how gas exchange affects transpiration. **(2 points maximum)**

- Stomata
  - Open stomata → increased transpiration
    OR
  - Closed stomata → decreased transpiration
- Gas identification
  - CO_2 in and O_2 and/or H_2O out of the plant
    (gas exchange must be in correct direction)
- Consequence of gas exchange
  - tradeoff of more gas exchange (for more photosynthesis) resulting in more transpiration (and possible dehydration, wilting, flaccidity)
- Environmental factors such as:
  - humidity
  - air movement
  - evaporative cooling
  - wind stress
  - intense light/heat (factor must be tied to effect on transpiration)

Question 3 (continued)

* Each dash = 1 point

(c) **Describe** TWO adaptations that affect the rate of transpiration in desert plants. **(2 points maximum)**

- Reduced surface area
  - small leaves
  - loss of leaves/other parts
- Leaf modifications
  - thick cuticle (not just "waxy")
  - thicker epidermis
  - reflective surfaces
  - epidermal hairs "trap" water vapor
  - leaf wilting/curling
  - leaf orientation
- Stem modifications
  - thick cuticle (not just "waxy")
  - thicker epidermis
  - have stomata
- Stomata
  - concentrated on lower/shady surface
  - in pits, furrows, depressions
  - fewer stomata
- Metabolism
  - stomata open at night (CAM plants)
  - stomata closed when arid/not open as long (C_4 plants) (no points for photorespiration)
  - hydraulic lift
- Water storage/uptake
  - in fleshy stems
  - roots (large, shallow system for maximum water capture; deep taproots, etc.)
- Dormancy

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Question 4

The evolution of circulatory systems allowed larger and more-complex animals to arise.

(a) **Describe** the respiratory and digestive systems' specialized structures that facilitate the movement of oxygen and glucose into the circulatory system of mammals. **(4 points maximum)**

Oxygen Uptake (2 points maximum)	**Glucose Uptake** (2 points maximum)
• Alveoli/air sacs Description of structures • Grape-like clusters • Large surface area in lungs or alveoli • Thin-walled • Moist lungs or alveoli • Proximity to capillaries	• Villi/microvilli/plicae Description of Structures • Single cell layer • Increased surface area • Associated with capillaries • Villi are finger-like projections • Plicae are folds (of submucosa) • Microvilli are hair-like projections (of cells) • Enzymes related to carbohydrate digestion hydrolyze polymers to monomers (amylase, maltase, sucrase, lactase).

(b) **Explain** how oxygen and glucose are transported within the circulatory system of mammals. **(4 points maximum)**

Oxygen Transport (3 points maximum)	**Glucose Transport** (1 point maximum)
• RBC *or* Hemoglobin (oxyhemoglobin) attachment to oxygen • Description of structure of RBC (biconcave, no nucleus or mitochondria) as related to oxygen transport **OR** Description of hemoglobin, e.g., iron, quaternary structure, number of O_2 molecules bound • Cooperative binding (increased affinity as each molecule binds) • Small percent dissolved in plasma • 4-chambered heart allows separation of oxy/deoxy blood	• Dissolved in blood or carried in plasma (NOT merely "carried in blood") • Explanation of small percent attached to Hb or other proteins, e.g., glycoproteins

(c) **Explain** the transfer of oxygen and glucose from the blood and into the active cells of mammals. **(4 points maximum)**

Oxygen Transfer (2 points maximum)	**Glucose Transfer** (2 points maximum)
• (Simple) diffusion/down a concentration gradient • Bohr effect described (↓pH, ↑CO_2 causes dissociation) • Pathway—hemoglobin, plasma, leaky capillary, interstitial fluid, cell membrane • Description of membrane permeability, e.g., phospholipid bilayer and small molecules, polarity • Binding to myoglobin increases movement into muscle	• Facilitated diffusion/definition (to say diffusion alone is not enough) • Down a concentration gradient • Membrane transporter required for polar/large molecules, polarity • Arterial pressure in capillaries • Pathway as described for oxygen, plus transporter • Insulin increases glucose uptake by cells
• Exchange occurs in the capillaries***	
*** Can only award this point once, either for glucose OR oxygen	