



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	<ul style="list-style-type: none"> • Indicate two membranes <u>with either</u>: <ul style="list-style-type: none"> - infolding of the inner membrane - cristae, or matrix 	<ul style="list-style-type: none"> • cellular or aerobic respiration (Krebs, ETS) • production of ATP • release of chemical energy
Chloroplasts	<ul style="list-style-type: none"> • Indicate two membranes <u>with either</u>: <ul style="list-style-type: none"> - flattened sacs (thylakoids). - flattened stacks (grana). - stroma. 	<ul style="list-style-type: none"> • photosynthesis or description of photosynthesis • production of 3-Carbon molecules (sugars, PGAL, glucose).
Endoplasmic Reticulum (ER)	<ul style="list-style-type: none"> • interconnected membranes, vesicles or sacs • rough ER has attached ribosomes and/or smooth ER without ribosomes 	<ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • synthesis of proteins
Golgi apparatus	<ul style="list-style-type: none"> • series of flattened sacs 	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • vesicle (bag, sac) with enzymes 	<ul style="list-style-type: none"> • digestion or breakdown of molecules waste materials and food with digestive enzymes (e.g., nucleases). • cell lysis • recycling organelles
Peroxisome (glyoxysomes)	<ul style="list-style-type: none"> • vesicle (bag, sac) with enzymes 	<ul style="list-style-type: none"> • breakdown or detoxify free radicals or peroxides
Vacuoles	<ul style="list-style-type: none"> • vesicle (bag, sac) 	<ul style="list-style-type: none"> • water balance • turgidity • storage water, ions, nutrients, or waste
Contractile vacuole	<ul style="list-style-type: none"> • vesicle (bag, sac) 	<ul style="list-style-type: none"> • expulsion of water from cell
Vesicles	<ul style="list-style-type: none"> • sac (bag, sac) 	<ul style="list-style-type: none"> • transporting materials to/from ER, Golgi, or cell membrane
Leucoplast	<ul style="list-style-type: none"> • Indicate two membranes with starch 	<ul style="list-style-type: none"> • storing starch
Chromoplast	<ul style="list-style-type: none"> • Indicate two membranes with pigments 	<ul style="list-style-type: none"> • storing pigments

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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	<ul style="list-style-type: none"> • contains, stores, or transmits genetic information • codes for proteins or traits 	<ul style="list-style-type: none"> • single molecule vs. usually many molecules • circular molecule vs. linear molecule • on avg. smaller number of base pairs (bp) vs. 1,000 times the average number of prokaryote bp • in cell's cytoplasm vs. within nucleus • few/no proteins* vs. histone proteins • no introns * vs. introns <p>*archaeobacteria are an exception</p>
Cell wall	<ul style="list-style-type: none"> • protects • supports • maintains turgidity • maintains shape/ allows adherence 	<ul style="list-style-type: none"> • Peptidoglycans (murein, amino acid, and sugar polymer) vs. Cellulose and/or Chitin
Ribosome	<ul style="list-style-type: none"> • make protein • site of translation 	<ul style="list-style-type: none"> • smaller vs. larger • free in cytoplasm vs. free and attached • simultaneous transcription/translation vs. non-simultaneous • contain different proteins, or RNAs • different antibiotic sensitivity

(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.

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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.

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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)
<ul style="list-style-type: none"> • Movement of water <ul style="list-style-type: none"> - 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 <ul style="list-style-type: none"> - environmentally powered (sun, wind, humidity) - passive on part of plant 	<ul style="list-style-type: none"> - Stomata/guard cells - Spongy mesophyll - Xylem, tubes, tracheids, vessel elements - Any specific root structure (root hairs, Casparian strip) 	<ul style="list-style-type: none"> - Polarity/hydrogen bonding - Cohesion - Adhesion/capillarity - High heat of vaporization (H₂O 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
 - CO₂ in and O₂ and/or H₂O 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)

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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)

<ul style="list-style-type: none"> Alveoli/air sacs <p><u>Description of structures</u></p> <ul style="list-style-type: none"> Grape-like clusters Large surface area in lungs or alveoli Thin-walled Moist lungs or alveoli Proximity to capillaries 	<ul style="list-style-type: none"> Villi/microvilli/plicae <p><u>Description of Structures</u></p> <ul style="list-style-type: none"> Single cell layer Increased surface area Associated with capillaries Villi are finger-like projections Enzymes related to carbohydrate digestion hydrolyze polymers to monomers (amylase, maltase, sucrase, lactase). <ul style="list-style-type: none"> Plicae are folds (of submucosa) Microvilli are hair-like projections (of cells)
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- (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)

<ul style="list-style-type: none"> 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 O₂ molecules bound Cooperative binding (increased affinity as each molecule binds) Small percent dissolved in plasma 4-chambered heart allows separation of oxy/deoxy blood 	<ul style="list-style-type: none"> 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
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- (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)

<ul style="list-style-type: none"> (Simple) diffusion/down a concentration gradient Bohr effect described (↓pH, ↑CO₂ 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 	<ul style="list-style-type: none"> 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
<ul style="list-style-type: none"> Exchange occurs in the capillaries*** <p>*** Can only award this point once, either for glucose OR oxygen</p>	