CollegeBoard AP

# AP® Biology
# 2011 Scoring Guidelines

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# AP® BIOLOGY
# 2011 SCORING GUIDELINES

## Question 1

During an investigation of a freshwater lake, an AP Biology student discovers a previously unknown microscopic organism. Further study shows that the unicellular organism is eukaryotic.

(a) **Identify** FOUR organelles that should be present in the eukaryotic organism and **describe** the function of each organelle.
*(5 points maximum)*

| **Identify organelle (1 point for listing FOUR)** | **Describe corresponding function (1 point for each function)** |
|---|---|
| Nucleus | Contains hereditary information/DNA/chromosomes or is the site of RNA synthesis. |
| Ribosomes | Site of protein synthesis. |
| ER (endoplasmic reticulum) | Internal transport or compartmentalization. |
| Rough ER | Protein synthesis/packaging/transport. |
| Smooth ER | Lipid synthesis or detoxification or transport. |
| Mitochondria | ATP synthesis or aerobic/cellular respiration. |
| Chloroplasts, plastids | Light absorption/photosynthesis/carbohydrate synthesis. |
| Vacuole, vesicles | Storage or transport. |
| Cilia/flagella | Motility. |
| Basal bodies | Support cilia/flagella. |
| Centrioles | Assist chromosome movement in mitosis. |
| Golgi bodies | Protein modification/packaging/transport. |
| Lysosomes | Enzymatic hydrolysis of wastes/metabolites/pathogens. |
| Peroxisomes | Catalase/peroxidase function or detoxification. |

(b) Prokaryotic cells lack membrane-bound organelles found in eukaryotes. However, prokaryotes must perform many of the same functions as eukaryotes. For THREE of the organelles identified in part (a), **explain** how prokaryotic cells carry out the associated functions.
*(3 points maximum)*

| **Eukaryotic organelle** | **Explain how prokaryote carries out function (1 point each)** |
|---|---|
| Nucleus | Hereditary information/DNA/chromosomes or RNA synthesis in cytosol. |
| Ribosomes | Site of protein synthesis. |
| ER (endoplasmic reticulum) | Diffusion of molecules in cytosol. |
| Rough ER | Protein synthesis/transport in cytosol; may be linked to transcription. |
| Smooth ER | Lipid synthesis or detoxification occurs in cytosol. |
| Mitochondria | Other membranes or cytosolic molecules function in ATP synthesis. |
| Chloroplasts | Other membranes or cytosolic molecules function in light absorption/photosynthesis/carbohydrate synthesis. |
| Plastids | Pigments are distributed throughout cytosol or are associated with membranes. |
| Vacuole, vesicles | Inclusion bodies/granules/large molecules in cytosol. |
| Cilia or flagella | Motility via bacterial flagella. |

**Question 1 (continued)**

| | |
|---|---|
| Basal bodies | Other structures support flagella. |
| Centrioles | Enzyme-mediated chromosome movement. |
| Golgi bodies | Protein modification/packaging/transport in cytosol. |
| Lysosomes | Secreted enzymes hydrolyze wastes/metabolites/pathogens. |
| Peroxisomes | Production/secretion of catalase or detoxification. |

(c) According to the endosymbiotic theory, some organelles are believed to have evolved through a symbiotic relationship between eukaryotic and prokaryotic cells. **Describe** THREE observations that support the endosymbiotic theory.
*(4 points maximum)*

**Describe three observations (1 point each)**

- Mitochondria contain their own DNA.
- Chloroplasts contain their own DNA.
- Mitochondria can self-replicate.
- Chloroplasts can self-replicate.
- Mitochondrial chromosomes are circular.
- Chloroplast chromosomes are circular.
- Mitochondrial chromosomes lack histones.
- Chloroplast chromosomes lack histones.
- Mitochondria contain ribosomes that are similar to bacterial ribosomes.
- Chloroplasts contain ribosomes that are similar to bacterial ribosomes.
- Inner membrane of mitochondria is similar the membrane of prokaryotes.
- Inner membrane of chloroplasts is similar the membrane of prokaryotes.
- Mitochondria can perform transcription and translation.
- Chloroplasts can perform transcription and translation.
- First amino acid in the polypeptides in mitochondria is fMet (N-formylmethionine).
- First amino acid in the polypeptides in chloroplasts is fMet (N-formylmethionine).
- Mitochondria are approximately the size of bacteria.
- Chloroplasts are approximately the size of bacteria.
- Mitochondria use many prokaryote-like enzymes.
- Chloroplasts use many prokaryote-like enzymes.
- Many antibiotics (e.g., rifampicin) interfere specifically with mitochondrial protein synthesis.

**General description of endosymbiotic theory (1 point)**

- Prokaryotic cells have been engulfed by and are living within ancestral/precursor eukaryotes.

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**Question 2**

Organisms utilize a diversity of methods to obtain proper nutrition.

(a) Some organisms digest food intracellularly, while others digest food extracellularly.
*(4 points maximum)*

- **Identify** ONE nonvertebrate organism that digests food intracellularly and **describe** the process.
- **Identify** ONE nonvertebrate organism that digests food extracellularly and **describe** the process.

| | **Organisms include, but are not limited to (1 point each)** | **Identify process (1 point each)** |
|---|---|---|
| Intracellular | Protozoa, sponges, flatworms, Cnidaria | Breakdown/hydrolysis of food inside the cell. |
| Extracellular | Fungi, bacteria, invertebrates with a gut, Cnidaria, carnivorous plants, flatworms | Breakdown/hydrolysis of food in the gastrovascular cavity, gut, or outside of the organism. |

(b) **Describe** TWO structural features of the human stomach and/or small intestine. For each, **explain** how the structure relates to the function.
*(4 points maximum)*

| | **Structural feature** | **Description (1 point each)** | **Explanation of structure/function relationship (1 point each)** |
|---|---|---|---|
| Stomach | Lining | Mucus layer | Protection from acid damage. |
| | Wall | Muscular | Mechanical digestion/churning/movement. |
| | Shape | Saclike | Food reservoir/storage. |
| | | Rugae | Expansion/increase of surface area and secretions. |
| | Sphincter | Muscular ring | One-way movement through the system. |
| Small intestine | Villi | Fingerlike or hairlike | Increases surface area to increase absorption. |
| | Microvilli | Fingerlike or hairlike | Increases surface area to increase absorption. |
| | Duodenum | Tubular passageway | Enzyme-mediated digestion or nutrient absorption. |
| | Length/size | Long or folded | More area and time for absorption. |

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**Question 2 (continued)**

(c) Plants have a variety of mechanisms for obtaining nutrients. **Describe** TWO plant structures and **explain** how each structure is utilized in nutrient uptake.
*(4 points maximum)*

| | **Description of plant structure (1 point each)** | **Explanation of mechanism (1 point each)** |
|---|---|---|
| Root | Branched or fibrous | Increases surface area for absorption. |
| | Taproot | Increases soil penetration to reach deep nutrients. |
| | Nodules | Nitrogen uptake. |
| Root hairs | Hairs, thin extensions | More surface area for water/mineral absorption. |
| Leaf | Stomata/pores/openings in leaf | Carbon dioxide uptake, transpiration drives water/mineral uptake. |
| Trap | Chamber for catching/digesting prey | Breakdown of prey into nutrients absorbed through chamber wall. |

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**Question 3**

Reproduction can be either asexual or sexual.

*Note:* Points must be earned from parts (a), (b), and (c) in order to earn a maximum score of 10.

(a) Using a specific example, **describe** how organisms can reproduce asexually.
*(3 points maximum)*

| **Specific examples (include but are not limited to)** | **Describe corresponding reproduction (1 point each)** |
|---|---|
| Bacteria, archaea, protists | Binary fission splits cell into two cells. |
| Yeast, sponges, hydra, jellyfish | Budding by mitosis. |
| Fungi, conidia | Produce haploid spores. |
| Fungi, sponges | Fragments form new individual. |
| Rotifers, nematodes, flatworms, gastropods, insects, crustaceans, fish, amphibians, reptiles, bees, wasps, ants, Komodo dragon | Parthenogenic development of unfertilized eggs. |
| Strawberries | Runners or modified shoots. |
| Irises, bamboo, beach grasses, rushes, sand verbena | Modified shoots/stolons/rhizomes. |
| Potato tubers | Modified shoots with buds/eyes. |
| *Kalanchoe* leaves | Leaves generate new plants. |
| Black locust, pear, apple, cherry, blackberry, aspen | Runners/root sprouts/suckers. |
| Lilies, tulips, onions, daffodils, garlic | Bulbs or corms form modified underground buds. |
| *Crocus*, *Gladiolus*, *Cyclamen*, taro | Short, erect underground stems. |
| Dandelions, blackberries, citrus trees, Kentucky bluegrass | Apomixis produces seeds without pollination. |
| Agricultural crops | Grafting/cutting/cell culture. |

**Discuss** TWO evolutionary advantages of asexual reproduction.
*(2 points)*

- It is successful at low population density.
- It eliminates the energy cost of finding a mate.
- It exploits stable environments.
- It is rapid and efficient.
- It eliminates the energy cost of fertilization/pollination.
- It eliminates the need for pollinators in plants.

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**Question 3 (continued)**

(b) **Identify** THREE ways that sexual reproduction increases genetic variability. For each, **explain** how it increases genetic diversity among the offspring.
*(6 points maximum)*

| **Identification (1 point each; 3 points maximum)** | **Explanation (1 point each; 3 points maximum)** |
|---|---|
| Crossing over or recombination | Generates new combinations of alleles. |
| Independent assortment | Random alignment on metaphase plate during meiosis. |
| Random fertilization | Nonspecific gamete selection. |
| Random mating | Nonspecific mate selection. |
| Diploidy or polyploidy | Harmful recessive mutations may not be expressed. |

(c) **Discuss** TWO prezygotic isolating mechanisms that prevent hybridization between two species. Include in your discussion an example of each mechanism.
*(4 points maximum)*

| **Discussion of isolating mechanism (1 point each) with a reasonable example (1 point each)** | |
|---|---|
| Habitat/ecological isolation | Preferences for living/mating in different habitats/microenvironments. |
| Geographical isolation | Living or mating in different geographic areas with a physical barrier. |
| Mechanical isolation | Structural differences of reproductive organs. |
| Temporal isolation | Different mating time of day or season of year. |
| Behavioral isolation | Different mating rituals between species. |
| Gametic isolation | Molecular incompatibilities between sperm and egg OR Chemical incompatibilities limit sperm viability. |

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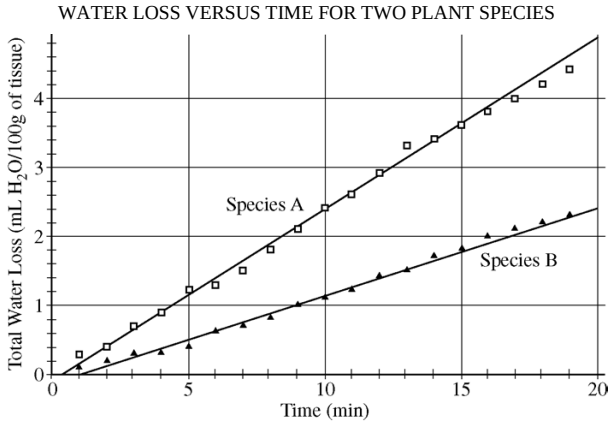
**Question 4**

The regulation of transpiration is an important homeostatic mechanism in plants.

(a) Under controlled conditions, a transpiration experiment was conducted using two plant species. The data collected are shown in the figure below. Using the data from the experiment, **calculate** the rate of transpiration for species A and species B between the times of 5 and 15 minutes (show your work). **Summarize** the difference between the two transpiration rates.
*(3 points maximum)*




- Calculate transpiration rates, with units *(1 point each; 2 points maximum)*.
- Correct setups with incorrect results *(1 point maximum)*.

**Species A**
*(1 point)*

$\frac{3.6 \text{ mL } H_2O - 1.2 \text{ mL } H_2O}{15 \text{ minutes} - 5 \text{ minutes}} = 0.24 \text{ mL } H_2O/100g/\text{min } (\pm 0.02)$

**OR**

$\frac{3.6 - 1.2}{15 - 5} = 0.24 \text{ mL } H_2O/100g/\text{min } (\pm 0.02)$

**OR** equivalent

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**Question 4 (continued)**

**Species B**
*(1 point)*

$\frac{1.8 \text{ mL } H_2O - 0.4 \text{ mL } H_2O}{15 \text{ minutes} - 5 \text{ minutes}} = 0.14 \text{ mL } H_2O/100g/\text{min } (\pm 0.02)$

**OR**

$\frac{1.8 - 0.4}{15 - 5} = 0.14 \text{ mL } H_2O/100g/\text{min } (\pm 0.02)$

**OR** equivalent

**Summarize the difference between the rates** *(1 point).*

- Species A is losing water or transpiring faster than species B.

(b) **Identify** and **explain** THREE different structural or physiological adaptations that could account for the different transpiration rates of species A and B.
*(6 points maximum)*

| **Identify adaptation (1 point each; 3 points maximum)** | **Explain effect and specify directionality (1 point each; 3 points maximum)** |
|---|---|
| Cuticle | Thicker cuticle decreases transpiration. |
| Stomata number | Increased number increases transpiration. |
| Stomata location | Underside location decreases transpiration. |
| Stomata size | Larger stomata increase transpiration. |
| Surface area of leaves | Increased surface area increases transpiration. |
| Root size or structure | Affects rate of water absorption, amount of water lost. |
| Root hairs | Increased number increases transpiration. |
| Leaf hairs | Presence decreases transpiration. |
| Stomatal crypts or recessed pits | Presence decreases transpiration. |
| $C_3$ photosynthesis | Requires more water than $C_4$. |
| $C_4$ photosynthesis: $CO_2$ concentrated as 4-carbon acid | Requires less water than $C_3$. |
| CAM photosynthesis: stomata open at night | Reduced water loss during day. |
| Abscissic acid | Closes the stomata, slows transpiration. |
| Guard cell regulation | Turgidity opens stomata, increasing transpiration. |

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**Question 4 (continued)**

(c) Water potential ($\Psi$) is described by the following formulas.

$$\Psi = \Psi_p + \Psi_s$$

$$\Psi = -iCRT$$

**Discuss** the variables in both formulas and how they affect water potential.
*(4 points maximum)*

| **Variables in $\Psi = \Psi_p + \Psi_s$** | | **Discussion of effect on water potential (1 point each; 2 points maximum)** |
|---|---|---|
| $\Psi_p$ | Pressure potential | Water will move from the area of high pressure to the area of low pressure. |
| $\Psi_s$ | Solute potential | Water will move from the area of high solute potential (low solute concentration) to the area of lower solute potential (higher solute concentration). |

| | **Variables in $\Psi = -iCRT$** | **Discussion of effect on water potential (1 point each; 2 points maximum)** |
|---|---|---|
| i | Ionization constant | Greater ionization decreases water potential/increases water movement, OR<br>Decrease in ionization increases water potential/decreases water movement. |
| C | Concentration | Increase in concentration decreases water potential/increases water movement, OR<br>Decrease in concentration increases water potential/decreases water movement. |
| R | Pressure constant | No change in water potential/movement. |
| T | Temperature | Increase in temperature decreases water potential/increases water movement, OR<br>Decrease in temperature increases water potential/decreases water movement. |

- Discussion stating that the formula allows osmotic potential or water movement to be calculated or predicted *(1 point).*

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