CollegeBoard
Advanced Placement Program

AP® Biology
2006 Scoring Guidelines
Form B

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2006 SCORING GUIDELINES (Form B)

Question 1

Sexual reproduction requires that half of the chromosomes in a zygote come from one parent and the other half from the second parent.

(a) Describe the process by which a germ cell's complement of chromosomes is halved in the formation of the gametes. **(6 points maximum)** One point for each of the following:
- Correct description of meiosis (simply rephrasing the question earns no point)
- Sister chromosomes pair in prophase I
- Spindles move chromosomes pairs to poles in anaphase I
- Two cycles/rounds of division in meiosis
- Sister chromatids separate to poles in anaphase II
- 1 germ cell yields 4 gametes
- DNA replicates in interphase
- No additional replication before meiosis II

(b) Choose **one** organism or group of organism the reproduce **asexually**. Describe the mode of asexual reproduction in that organism and explain the advantages to the organism of asexual reproduction. **(3 points maximum)**
- One point for correct organism or group of organisms that produce asexually
- One point for mode for any of the following (1 point maximum)
  - Plant → cuttings, others possible, e.g., runners
  - Fungi → budding or fission
  - Hydra → budding
  - Bacteria → fission
  - Viruses → uses host machinery
  - Insects/others using parthenogenesis
- One point for advantages for any of the following (1 point maximum)
  - Allows faster reproduction/more efficient
  - Genetic information is identical to parent ("offspring is clone" credited unless already used above)

(c) Choose **one** organism or group of organisms that reproduce **sexually**. Describe the mode of sexual reproduction in that organism and explain the advantages to the organism of sexual reproduction. **(3 points maximum)**
- One point for correct organism or group of organisms that produce sexually
- One point for mode; any of the following acceptable (1 point maximum)
  - Two different parents (male and female)
  - Egg and sperm combine in fertilization
  - Gametes (1n) combine to form zygote (2n), embryo (2n)
  - Fertilization is random
  - Description of fertilization process
- One point for advantages; any of the following acceptable (1 point maximum)
  - Increases genetic diversity/combinations/variations (simply stating "variation" is insufficient, unless linked to genes/genotypes/alleles)
  - Offspring are genetically unique/different from parents
  - Allows individuals/populations to carry recessive lethal

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Question 2

The relationship of structure to function is one of the major themes in biology. For **three** of the following structure/function pairs, describe the structure and then explain how the function is related to the structure.

(a) Enzyme structure/catalysis **(4 points maximum)**

Description (2 points)
- 3-D shape that results from folding of polypeptide chains
- Folding produces a pocket in which substrate may bind
- Levels of protein structure (primary, secondary, tertiary)

Explanation (2 points)
- Complementary 3-D shape of enzyme and substrate are required for proper interaction and catalysis in active site—reduction of activation energy; induced fit
- Allosteric modulation, effect of pH, temperature (or other environmental factors) on enzyme shape
- Elaboration points: competitive/non-competitive inhibition—effect on enzyme action; amino acid side groups in active site interact with substrate to stress bonds in substrate and reduce activation energy of reaction

(b) mRNA structure/protein synthesis **(4 points maximum)**

Description (2 points)
- Linear sequence of RNA nucleotides
- Details: 5' cap; poly-A tail; introns
- Description of origin and/or fate of mRNA (transcription, processing and translation)
- Fine details of RNA nucleotide structure

Explanation (2 points)
- The linear sequence of RNA nucleotides, read as codons (three at a time; contiguous; nonoverlapping)
- specify the sequence of amino acids incorporated in a new protein being constructed at a ribosome
- start codon and/or stop codon roles

(c) Cell membrane structure/signal transduction **(4 points maximum)**

Description (2 points)
- A phospholipid bilayer that incorporates malleable (and, often, mobile) integral or membrane associated proteins
- Membrane-embedded receptor molecules with transmembrane domains

Explanation (2 points)
- Receptor proteins undergo shape changes when proper stimulus is present—signal is communicated through membrane by allosteric shape change
- The altered proteins may then influence other cellular events or states: activation of G-proteins and/or tyrosine-kinase receptor protein auto- and heterophosphorylations leading to cellular response

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Question 2 (continued)

(d) Membrane protein structure/active transport or facilitated diffusion **(4 points maximum)**

Description (2 points)
- Phospholipid bilayer (credited unless already described in c)
- Integral protein in membrane
- Protein's 3-D shape allows it to act as a channel, bind solutes, and/or bind ATP, as necessary

Explanation (2 points)
- Some solutes, like ions and larger hydrophobic molecules cannot cross phospholipid membranes unassisted.
- Integral proteins allow such substances to pass: hydrophilic channel; binding of solute leads to shape change in protein.
- Hydrolysis of ATP causes shape change in protein leading to shuttle of material from one side of membrane to the other.

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Question 3

While studying transpiration, a scientist used a dendrometer to record the small daily changes in the diameter of a tree trunk at two different heights (2 meters and 3 meters) above the ground at the same time. The diameter decreased in the daytime. This decrease happened first at the higher location. Discuss the following in relation to water movement in plants.

(a) Identify how **two** different environmental factors could be involved in the daily fluctuations shown above. (**4 points maximum**; 2 points for each factor correctly associated with a mechanism)

Factor	How
Humidity	Humidity down ➔ Transpiration up ➔ Decreases diameter Humidity up ➔ Transpiration down ➔ Increases diameter
Sunlight	Sunlight up ➔ Transpiration up (stoma open) ➔ Decreases diameter Sunlight down ➔ Transpiration down (stoma close) ➔ Increases diameter
Temperature	Temperature up ➔ Transpiration up ➔ Decreases diameter Temperature down ➔ Transpiration down ➔ Increases diameter
Wind	Wind up ➔ Transpiration up ➔ Decreases diameter Wind down ➔ Transpiration down ➔ Increases diameter
Ground water	Transpiration removes water faster than roots pick it up ➔ Decreases diameter

(b) Discuss the mechanisms involved in the uptake and transport of water by vascular plants. **(4 points maximum)**

Uptake (2 points maximum)	Transport (2 points maximum)
• Root hairs or mycorrhizae increase surface area • Osmotic adjustment in roots, water flows in due to gradient • Aquaporin moves water in • Water potential moves water in	• Transpiration pull when water exits leaves • Creates negative pressure (tension) • Cohesion of water in xylem/column of water • Adhesion of water in xylem/column of water

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Question 3 (continued)

(c) Discuss the role of water in the normal functioning of plants (**4 points maximum**; 2 points for each role correctly associated with a function, 1 point for function alone)

Role (2 points maximum)	Function (2 points maximum)
• Photosynthesis (photolysis) • Transport • Structure • Solvent • Reproduction • Change in guard cells • Growth	• e- in electron transport, H+ in ATP synthesis • movement of nutrients and ions • Turgor (vacuole)/support • Media of chemical reactions • Mosses/ferns fertilization by sperm • Water intake increases turgor ➔ guard cells open • Needed for cell elongation

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Question 4

In many ways, all organisms in a food web can be said to be solar-powered. The producer level of the food web is responsible for the transformation of the solar energy into a form that can be used by other living organisms.

(a) Discuss the role of green plants in transforming the Sun's energy into a form that can ultimately be used by heterotrophs. **(6 points maximum)**

Required (Student cannot earn the maximum of 6 points without earning these 3 points)

- Energy transformation (photosynthesis -> chemical energy/glucose/G3P/ PGAL/starch/carbohydrate/chemical bonds)
- Chlorophyll or chloroplast required ("green pigment" not credited)
- Function of chlorophyll—light/energy capture concept

Parts of photosynthesis (in context or with explanation) (3 points maximum)

- Photolysis (splitting of water)—oxygen and/or electrons released
- Chemiosmosis (or explanation)
- ATP production
- NADPH production/reduction
- Photosystems II and I in correct order
- Calvin Cycle
- CO_2 fixation
- Products of light-dependent reactions used in light-independent (dark) reactions

(b) Discuss the flow of energy from producers through top carnivores in a food web in terms of the laws of thermodynamics. **(6 points maximum)**

Required (Student cannot earn the maximum of 6 points without earning these 2 points)

- Statement/definition of 1st Law of Thermodynamics
- Statement/definition of 2nd Law of Thermodynamics (definitions must be correct, but students are not penalized for misnumbering the laws)

Concepts of energy flow (in context or with explanation) (4 points maximum)

- 10 percent rule/Not all energy transferred to next level/Very little energy transferred to next level/energy lost at each level
- Explanation of energy loss (e.g., used in metabolism, locomotion, etc.)
- Lost energy as heat/entropy/2nd law illustrated as heat loss or inefficiency
- Energy pyramid (explained)
- More energy at producer level than at consumer levels
- Scarcity of energy at higher trophic levels
- Limited number of consumer levels
- Very few top carnivores
- 1st law illustrated as conversion of solar energy to chemical energy or as conversion of chemical energy to chemical energy (e.g., Glucose to ATP)

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