AP® BIOLOGY
2004 SCORING GUIDELINES

Question 3

(a) On the axes provided, **construct** and **label** a graph showing the results for the three samples.
(1point each; 3-point maximum)

- Orientation of axes is correct: x-axis is time/minutes, y-axis is light transmittance/%
- Data are plotted correctly (one misplaced data point is permissible)
- Graph is accurate: must include proper scaling and correct labels and units of measurement and key

(b) Identify and explain the control or controls for this experiment.
(1 point each; 3-point maximum)

- Sample 1 is the control
- Sample 1 is in the light and has permissive temperature/functional structures (membranes, proteins, enzymes, etc.)
- Control is the basis for comparison to treatment effects (can award even if wrong sample was identified as the experimental control)
- Reliability of data/design: identical procedures, reagents, measurements, adequate sample size (must identify at least two)

(b) **Discuss** how electrons are generated in photosynthesis and why the three samples gave different transmittance results.
(1 point each; 6-point maximum)

- Chlorophyll (photosystem, reaction- or photo- center; "chloroplast" alone is not sufficient) is the link between light (photons) and the generation of electrons
- Water is the source of electrons (photolysis, oxidation, splitting)
- Electron generation, not simply photosynthesis, is proportional to DPIP reduction light transmittance
- Decreasing light availability decreases the quantity of electrons that will be generated, and/or vice versa
- Boiling disrupts functional structures (membranes, denaturation of proteins/enzymes, etc.; "chloroplast" alone is not sufficient)

Elaboration (1 point only)
photosystem II and/or I/Z-scheme
data analysis

2006B FRQ Enzyme/Protein/Cell Membrane Structure and Function Rubric

(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

(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 8

A research team has genetically engineered a strain of fruit flies to eliminate errors during DNA replication. The team claims that this will eliminate genetic variation in the engineered flies. A second research team claims that eliminating errors during DNA replication will not entirely eliminate genetic variation in the engineered flies. (**3 points maximum**)

(a) **Provide** ONE piece of evidence that would indicate new genetic variation has occurred in the engineered flies. (**1 point**; LO 1.10)

Piece of evidence

- New phenotypes
- Different DNA sequence
- New genotypes
- Chromosomal differences
- Different mRNA sequence
- Protein with different amino acid sequence

(b) **Describe** ONE mechanism that could lead to genetic variation in the engineered strain of flies. (**1 point**; LO 3.28)

Describe mechanism

- Sexual reproduction produces offspring with new combinations of alleles/traits
- Meiosis produces new combinations of alleles/traits
- Crossing over produces new combinations of alleles/traits
- Independent assortment produces new combinations of alleles/traits
- Random fertilization produces new combinations of alleles/traits
- Immigration/gene flow introduces new alleles/gene sequences
- Viral infection inserts DNA into genome
- Nondisjunction causes anomaly in chromosome number
- Chromosomal rearrangements (e.g., large deletions, duplications, translocations, inversions, transposons, etc.) inactivate genes or result in multiple copies of genes
- Radiation or chemicals or mutagens induce mutations/changes in DNA

(c) **Describe** how genetic variation in a population contributes to the process of evolution in the population. (**1 point**; LO 1.25)

Description

- Genetic variation is the basis of phenotypic variation that can be acted upon by natural selection
- Without genetic variation, there is no phenotypic variation on which natural selection can act