

2004 AP® BIOLOGY FREE-RESPONSE QUESTIONS

3. A controlled experiment was conducted to analyze the effects of darkness and boiling on the photosynthetic rate of incubated chloroplast suspensions. The dye reduction technique was used. Each chloroplast suspension was mixed with DPIP, an electron acceptor that changes from blue to clear when it is reduced. Each sample was placed individually in a spectrophotometer and the percent transmittance was recorded. The three samples used were prepared as follows.

- Sample 1 – chloroplast suspension + DPIP
- Sample 2 – chloroplast suspension surrounded by foil wrap to provide a dark environment + DPIP
- Sample 3 – chloroplast suspension that has been boiled + DPIP

Percent Transmittance in Three Samples

Time (min)	Light, Unboiled % Transmittance	Dark, Unboiled % Transmittance	Light, Boiled % Transmittance
	Sample 1	Sample 2	Sample 3
0	28.8	29.2	28.8
5	48.7	30.1	29.2
10	57.8	31.2	29.4
15	62.5	32.4	28.7
20	66.7	31.8	28.5

- (a) On the axes provided, **construct** and **label** a graph showing the results for the three samples.
- (b) **Identify** and **explain** the control or controls for this experiment.
- (c) The differences in the curves of the graphed data indicate that there were differences in the number of electrons produced in the three samples during the experiment. **Discuss** how electrons are generated in photosynthesis and why the three samples gave different transmittance results.

**AP[®] BIOLOGY
2004 SCORING GUIDELINES**

Question 3

(a) On the axes provided, **construct** and **label** a graph showing the results for the three samples.

(1 point 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