1999

The College Board

Advanced Placement Examination

BIOLOGY

SECTION II

Time—1 hour and 30 minutes

Number of questions—4

Percent of total grade—40

Answer all questions. Number your answer as the question is numbered below.

Answers must be in essay form. Outline form is NOT acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write.

1. The rate of photosynthesis may vary with changes that occur in environmental temperature, wavelength of light, and light intensity. Using a photosynthetic organism of your choice, choose only ONE of the three variables (temperature, wavelength of light, or light intensity) and for this variable

   - **design** a scientific experiment to determine the effect of the variable on the rate of photosynthesis for the organism;
   - **explain** how you would measure the rate of photosynthesis in your experiment;
   - **describe** the results you would expect. **Explain** why you would expect these results.

AP® BIOLOGY
1999 SCORING GUIDELINES

Question 1

A. **Experimental Design:** The following experimental characteristics may earn 1 point each. (Max 7 points)

• Score only the **1st** independent variable (temperature, wavelength, intensity) manipulated, and the **1st** factor used by the student to measure photosynthetic rate (O_2, CO_2, etc.). • A 3 point maximum in Section A if the experiment will not work biologically. Examples: using an organism that is not photosynthetic, or using an apparatus that biologically will not measure photosynthesis as designed (i.e. potometer or respirometer). Not intended to mean a technical design flaw.

- State **hypothesis** (clear statement of a hypothesis, identifies it as a hypothesis, uses "If/then" statement
- Specify a **control group** for comparison
- Identify and **hold constant at least one experimental factor** that can affect photosynthetic rate
- **Manipulate the independent variable** (change the temperature, wavelength of light, intensity of light)
- Describe **what is being measured** to determine rate (CO_2 or H_2O consumption, O_2 or carbohydrate production, growth, e^- flow measured with dye reduction, production of an intermediate product, etc.)
- **Quantify** the measurement of the variable (method **&** time frame of measurement)
- **Rate** calculation or definition
- **Verify** results through sample size (>1) or repetition
- Utilize **statistical application** of data (mean, t-test, ANOVA, etc.)
- Design an **exemplary** experiment

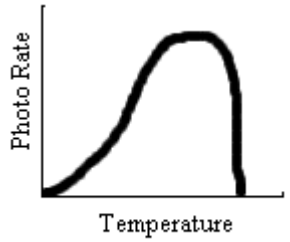
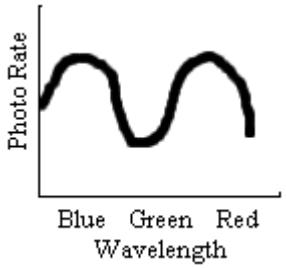
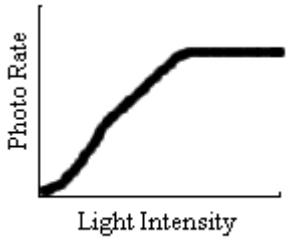
B. **Describe expected experimental results** (Max 2 points)

- Verbal or graphic description of expected experimental results (1 point)

Question 1 (cont.)

- Verbal or graphic description of expected results across the entire range of biological activity (1 point)

- The graphs below represent 2-point graphs, but to earn **any** points, graphs must be accurately labeled

Temperature	Wavelength	Intensity
Rate rises with temperature to an optimum and then falls	An "action spectrum" with highest rates in the blue and red regions of the spectrum	Rate increases steadily to a maximum and levels off
		

C. **Biological explanation of results** (Max 3 points)

Temperature

- Enzyme kinetics or metabolic changes
- Enzyme denatures
- Photorespiration
- Stomatal closing w/high temp, limits CO_2 & lowers rate
- Excessive water loss, less reactant available for reaction
- Elaboration

Question 1 (cont.)

Wavelength

- Absorption/reflection of light by chlorophyll
- Accessory pigments absorbing green light
- Relation between wavelength & energy
- Elaboration

Intensity

- More photons hit photosystems
- More e^- flow in the electron transport system/time
- Plateau caused by limiting factors
- Elaboration

Write in the box the number of the question you are answering on this page as it is designated in the examination.

1

1A

In order to determine the effect of light intensity on the rate of photosynthesis, I would choose an organism such as a photosynthetic algae to experiment with. The algae could be kept in a number of glass vials I could manipulate the light intensity by wrapping the bottles in a variable number of screens, including one vial that is not covered at all and one that is covered completely from light by using aluminum foil. To measure the rate of photosynthesis I would add the dye DPIP to each sample. This dye can be used because as photosynthesis occurs it becomes more and more transparent. I would then be able to measure how much light could penetrate the sample at a given time. I would take measurements about every three minutes while exposing the samples to the same light. I could then use the changes in the transparency of the vials to compare the rates of photosynthesis. I would expect a general increase in the rate of photosynthesis with an increase in light intensity. The sample without any light filters would demonstrate the highest possible rate of photosynthesis while the sample covered in foil should demonstrate no photosynthesis. Since light is a necessary element in photosynthesis the rate at which the reactions occur very much depends of the amount of light that is available to the plant.

(1) manipulate

(1) how measured

(1) Results

3

Write in the box the number of the question you are answering on this page as it is designated in the examination.

1

1A

In order to determine the effect of light intensity on the rate of photosynthesis, I would choose an organism such as a photosynthetic algae to experiment with. The algae could be kept in a number of glass vials. I could manipulate the light intensity by wrapping the bottles in a variable number of screens including one vial that is not covered at all and one that is covered completely from light by using aluminum foil. To measure the rate of photosynthesis I would add the dye DPIP to each sample. This dye can be used because as photosynthesis occurs it becomes more and more transparent. I would then be able to measure how much light could penetrate the sample at a given time. I would take measurements about every three minutes while exposing the samples to the same light. I could then use the changes in the transparency of the samples to compare the rates of photosynthesis. I would expect a general increase in the rate of photosynthesis with an increase in light intensity. The sample without any light filters would demonstrate the highest possible rate of photosynthesis while the sample covered in foil should demonstrate no photosynthesis. Since light is a necessary element in photosynthesis the rate at which the reactions occur very much depends of the amount of light that is available to the plant.

Official Notes from the Reading, Clemson 1999
Reports by Question Leaders

Question 1: Richard Patterson

mean = 3.82
small spread
grades of 2-6 = 83%
grades of 7-10 = 8%

blanks + zeroes = 11%
scores of 4 = 25%

[I gave two tens the whole week.]

Students tended to identify independent variable being manipulated, what measured (height, amt. O_2 produced, etc.), control, and some results

Use of other protocols besides the Lab 4 experiment
Message to teachers: 1. Do the labs, but that's not enough
2. It's important to post-lab and hold kids accountable on tests for lab questions

Note: Lab 4 discusses role of light, which is not what the objectives say.