AP Biology
1999 Sample Student Responses

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Experimental Design

In order to test the effect of environmental temperature on the rate of photosynthesis, a controlled experiment must be set up. First, a hypothesis: If light intensity is changed, rate of photosynthesis will vary directly. Set up ten vials, each with similar controls of temperature height, wavelength of light, and atmospheric conditions. Each vial should contain an equal amount of chloroplasts, obtained from blended spinach leaves dissolved in a large amount of water. These vials will perform photosynthesis. Each vial will be subjected to a different wattage fluorescent light bulb. The wattages should range by equal intervals from 0 (no light) to 200 watts. These changes in light intensities will be the variable. The use of fluorescent bulbs and the glass walls is to prevent heat generated by the bulbs from skewing results. Each plant vial should be subjected to only the light from its bulb, each bulb set an equal distance from each vial. Each vial will also contain the substance DPIP, initially coloring the vials blue. DPIP will be our measuring device. First, measure the coloration of each vial initially (t = 0) in a spectrometer, then turn on the lights, 5 min. intervals, measure each vial's coloration in the spectrometer. As photosynthesis occurs, excited electrons will cause the DPIP to turn clear. So, if the rate of vial turns clear directly correlates to the photosynthetic rate, in the vial. Graph the rate of photosynthesis for each vial and compare results. The rate should steadily increase as light intensity increases, until leveling.
The leveling off indicates that light has ceased to be a limiting factor as chloroplasts can only work so fast. The experiment should be repeated, and multiple trials at each intensity would give more accurate and reliable results. The graph should look like this:

[Graph showing rate of oxygen uptake vs. light intensity]
The rate of photosynthesis is affected by wavelength of light. To verify this fact an experiment could be done using test tubes of cyanobacteria in H2O. The tubes would be stoppered and a then would be a graduated collection tube to measure the amount of O2 released. All test tubes would be prepared with the same number of bacteria and would be kept at the same temperature. A control tube would be exposed to normal sunlight. The other tubes would only be exposed to a certain wavelength of light. The rate of photosynthesis in each tube would be measured by the amount of O2 produced. I would expect the rates of photosynthesis to be faster in red or blue light because those wavelengths are more readily absorbed by chlorophyll. The rate of photosynthesis, hence the amount of O2 collected would be highest the lowest in green light wavelengths. Chlorophyll does not absorb green light. Therefore photosynthesis would take place at a very slow rate.
This experiment will determine the effect of environmental temperature in algae on the rate of photosynthesis. The first step would be to place all of one kind of algae in a lab. The first one could be placed under ideal conditions at a temperature of 32°F. The second could be placed under the temp. of 50°F & the same ideal conditions. The third could be placed under 70°F (same ideal conditions), & the fourth, 90°F (same ideal conditions). The rate of photosynthesis could be measured by how much O2 each plant gives off. After checking on the plants each day & giving them the same food & nutrients, after a week, it could be determined under which temp. photosynthesis occurred more rapidly. I would not expect the plants at the more extreme temps (30°F & 90°F) to carry out photosynthesis as rapidly as maybe the ones @ a more livable temp. It's hard for organisms to survive @ extreme temp. Just like there are ideal conditions for humans to live in, there are ideal conditions for algae to live in. Transpiration could also help measure the rate of photosynthesis in algae.