Photosynthetic Process Model

Engineering Solution

Green plants produce their own food through the process of photosynthesis. The process starts when the energy from the Sun, in the form of sunlight, hits the leaf of a plant, and then the chloroplast with the chlorophyll inside uses that energy to combine carbon dioxide (CO_2) and water (H_2O). The molecular reactions create glucose (sugar) and oxygen (O_2).

The Challenge

Design a labeled, three-dimensional model of the photosynthetic process. You must have objects to represent the energy that starts the process, the reactants and products of the process, as well as the leaf and organelle that allow the process to occur. You should also have labeled arrows to indicate the energy and matter flow of photosynthesis.

Criteria and Constraints

Must be a 3-D, free-standing model of the photosynthetic process.
Your model must be no more than 12 square inches.
You may not spend more than $10 on your model.
You must clearly and accurately show the energy, the reactants and products, the leaf and organelle involved in the process, as well as labeled arrows to indicate the energy and matter flow of photosynthesis.
An illustrated (drawing) prototype of your model must accompany your project.

Procedures

Get in groups of four. Use your lab journal to record all of your steps and observations.

A. What is the problem? (State the problem in your own words.)

B. Explore and research the problem.
   1. List what you know and what you need to know.
   2. Do a web search about the photosynthetic process and about photosynthesis energy and matter flow.

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C. Brainstorm and design a solution to the problem.
   1. Draw two prototypes of your model and all its parts. (Use criteria to help you.)
   2. Choose which prototype to make. (Use argumentation and discourse within your group to decide this.)
   3. Identify what materials you will use.
      a. You may need to brainstorm with other people on other teams to share ideas.
      b. Gather the necessary materials to make your model. (Either purchase these items or bring recycled items from home or school.)

D. Build, test, and analyze your solution.
   1. How will you construct your model?
   2. What formulas and calculations will you use to mathematically construct this model?
   3. Analyze how the structures are related to the energy and matter flow in photosynthesis.

E. Improve or redesign and retest the solution.
   1. Are the assembly procedures easy to follow so that others could complete this model?
   2. What errors could have been made during the collection of research data, and how can you improve this data-gathering technique?
   3. Were you able to create a model of the photosynthetic process that meets all of the criteria? If not, what changes do you need to make to your model?

F. Present and share your solution (model).
   1. Decide how you will share your solution with the teacher or class.
   2. Discuss who will talk about what you discovered.
   3. Conclude with a class discussion.

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Rubric for an Engineering Design Challenge

Points Awarded	Expert (4)	Competent (3)	Beginner (2)	Novice (1)
Identification of the Problem and Constraints	Clearly defines the problem in real-world context and identifies the constraints for a viable solution.	Defines the problem and the constraints within the context presented.	Identifies the problem but does not address the constraints.	Problem is not clearly identified and/or few constraints are addressed.
Solution, Prototype or Plan	The solution to the problem is well-outlined and clearly addresses each of the constraints listed. The solution is viable within a real-world context. Alternative solutions are also offered.	The solution to the problem is outlined with some areas not clearly addressed. Some constraints are not addressed. The solution is limited to the context of the problem.	The solution to the problem is outlined with some key pieces missing. Some constraints are not addressed.	The solution is not probable and/or many of the constraints are not addressed.
21st Century Skill: Collaboration	Steps in to help the team when another member is absent. Encourages others to share ideas, helps to make them clear, and connects them to the team's work. Notices if a team member does not understand something and takes action to help.	Helps the team solve problems, manage conflicts, and stay focused and organized. Shares ideas that help the team improve its work. Gives useful feedback (specific and supportive) to others so they can improve their work. Offers to help others do their work if they need it.	Cooperates with the team but does not actively help it. Makes some effort to share ideas with the team. Sometimes gives useful feedback to others. Sometimes offers to help others.	Does not help the team solve problems; may cause problems. Does not share ideas with other team members. Does not give useful feedback to others. Does not offer to help others.
Scientific Content and Scientific and Engineering Design Practices	The solution uses accurate scientific reasoning. The information given is research based and cites resources. The solution proposed uses the EDP or is based on a Fair Test.	The solution uses scientific reasoning. Some of the information given is research based and some resources are cited. The solution proposed is based on a Fair Test or EDP.	The solution offered is based on scientific knowledge. Some resources are cited.	The solution is not based on scientific principles and/or there are no resources used.