Blank Lesson Template

Yellow highlight = required component

Subject Area(s) **AP Biology**

Associated Unit **Plants**

Lesson Title **Energy from the Sun**

Lesson Dependency

Time Required **40 Minutes**

Summary

Photosynthesis is one of the most important biological processes for the air we breathe, the food we eat, and the production of raw materials for manufacturing. This lesson connects the energy output of the sun to flora and man-made devices that utilize it.

Engineering Connection

This lesson parallels its associated lesson, "Biomimicry", which is the process of observing natural phenomena and attempting to duplicate it for use by humans. The photosynthetic process occurring in plants has encouraged engineers to pursue highly-efficient solar power systems. The operation of *pin* junctions, diodes and carbon nanotubes will be discussed in association with their use in solar power generation.

Engineering Category = #1

Choose the category that best describes this lesson's amount/depth of engineering content:

1. Relating science and/or math concept(s) to engineering

Keywords

Plants, Photosynthesis, Biomimicry, Photovoltaic Cells, Solar Power

Educational Standards

Science: Texas, science, 2009, The Texas Essential Knowledge and Skills, Chapter 112

2C know scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers.

3B communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials

9B compare the reactants and products of photosynthesis and cellular respiration in terms of energy and matter

Pre-Requisite Knowledge

Learning Objectives

After this lesson, students should be able to:

- **Describe the process of photosynthesis in plants**
- **Explain what solar energy is, as well as pros and cons**
- **Understand the motivation behind carbon nanotubes in photovoltaic cells**

Introduction / Motivation

After learning about photosynthesis, students should be able to understand that radiation from the sun is being absorbed in the chloroplasts (both a and b) in leaf cells. The energy is converted from electromagnetic to chemical energy via a chain of oxidation-reduction reactions in the light-harvesting complexes.

In a similar process, electrical energy can be generated from solar radiation. Semiconductors can be doped (intentional addition of non-matrix elements) to produce layers that are rich in either electrons (negative terminal or *n*-type) or electron holes (positive terminal or *p*-type). When p-type and n-type layers are stacked, the junction between them experiences charge neutralization, thus barring further diffusion without an external influence. When sunlight hits the panel, electrons are excited and overcome the charge barrier, moving into the current carrying wires to the power load. Solar power systems typically include the batteries for storing unused power and inverters to transform the current from direct current (DC) to alternating current (AC). By increasing the efficiency of solar power systems, engineers hope to provide clean, renewable electricity for the ever-growing energy demands.

Lesson Background & Concepts for Teachers

Teachers should review the plant unit of the biology textbook especially the photosynthesis section. Teachers should also be familiar with how solar panels work. More information on solar power and solar cells can be found at:

http://www4.eere.energy.gov/solar/sunshot/resource_center/

A good summary of carbon nanotubes was put together by the Dai research group at Stanford:

http://www.stanford.edu/group/cpima/education/nanotube_lesson.pdf

More information on the use of carbon nanotubes in PVCs can be found at:

http://news.stanford.edu/pr/2011/pr-sorting-out-nanotubes-111611.html

http://spectrum.ieee.org/nanoclast/green-tech/solar/carbon-nanotubebased-thin-film-creates-hybrid-organicsilicon-solar-cells

http://cntsolarcell.com/

Vocabulary / Definitions

Word	Definition
Solar Luminosity	The amount of energy emitted by the sun per unit area per unit time
Photosphere	The outer shell of a light-emitting body
Photosynthesis	The conversion of light energy into chemical energy that is stored in glucose or other organic compounds; occurs in plants, algae, and certain prokaryotes.

	(from Biology, 3rd edition, Neil Campbell)
Chloroplast	An organelle found only in plants and photosynthetic protists that absorbs sunlight and uses it to drive the synthesis of organic compounds from carbon dioxide and water. (from Biology, 3rd edition, Neil Campbell)
Calvin Cycle	The second of two major stages in photosynthesis (following the light reactions), involving atmospheric CO_2 fixation and reduction of the fixed carbon into carbohydrate. (from Biology, 3rd edition, Neil Campbell)
Photovoltaic Cell	An electronic device that converts light energy into electrical energy through the photovoltaic effect (similar to photoelectric effect).
Photoelectric Effect	The emission of electrons from matter as a result of incident light energy.
Semiconductor	A material with electronic energy bands whose separation is greater than conductors (such as copper) but less than insulators (such as glass).
PIN Junction	A boundary between the p-type and n-type doped-semiconductor layers, often utilizing a layer of intrinsic semiconductor as the boundary. Hence P-I-N junction.
Carbon Nanotube	Cylindrical nanostructures of carbon that exhibit valuable mechanical and electrical properties.

Associated Activities

Plant-Like Power Plant

Also can be associated with “Organic Solar Energy and Berries”

Lesson Closure

Assessment

Students will take a short quiz on the subject matter discussed. The first portion will ask the students to describe the pros and cons of solar power. The second portion will ask the students to describe the process of photosynthesis.

Lesson Extension Activities

Additional Multimedia Support

References

Attachments

Other

Redirect URL

Contributors

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Supporting Program

National Science Foundation GK-12 program, University of Houston, Department of Civil and Environmental Engineering