Blank Lesson Template

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:


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


http://cntsolarcell.com/

Vocabulary / Definitions

<table>
<thead>
<tr>
<th>Word</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Solar Luminosity</td>
<td>The amount of energy emitted by the sun per unit area per unit time</td>
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<tr>
<td>Photosphere</td>
<td>The outer shell of a light-emitting body</td>
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<tr>
<td>Photosynthesis</td>
<td>The conversion of light energy into chemical energy that is stored in glucose or other organic compounds; occurs in plants, algae, and certain prokaryotes.</td>
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<tr>
<td>Term</td>
<td>Description</td>
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<tr>
<td>Chloroplast</td>
<td>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)</td>
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<tr>
<td>Calvin Cycle</td>
<td>The second of two major stages in photosynthesis (following the light reactions), involving atmospheric CO₂ fixation and reduction of the fixed carbon into carbohydrate. (from Biology, 3rd edition, Neil Campbell)</td>
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<td>Photovoltaic Cell</td>
<td>An electronic device that converts light energy into electrical energy through the photovoltaic effect (similar to photoelectric effect).</td>
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<td>Photoelectric Effect</td>
<td>The emission of electrons from matter as a result of incident light energy.</td>
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<td>Semiconductor</td>
<td>A material with electronic energy bands whose separation is greater than conductors (such as copper) but less than insulators (such as glass).</td>
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<td>PIN Junction</td>
<td>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.</td>
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<tr>
<td>Carbon Nanotube</td>
<td>Cylindrical nanostructures of carbon that exhibit valuable mechanical and electrical properties.</td>
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**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
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