GLOSSARY:

Biochemical conversion: Process of making biofuels by using enzymes of bacteria and other micro-organisms to break down biomass.

Biomass: Organic matter, especially plant matter, that can be converted to fuel and is therefore regarded as a potential energy source.

Bioreactor: A large fermentation chamber for growing bacteria or yeast under controlled conditions. Bioreactors are used in the biotechnological production of substances such as pharmaceuticals, antibodies, or vaccines, or for the bioconversion of organic waste.

Cellulose: Complex carbohydrate that is composed of glucose units, forms the main constituent of the cell wall in most plants, and is important in the manufacture of numerous products, such as pharmaceuticals.

Enzymatic engineering: Process of modifying enzymes to produce new metabolites that are more efficient for fuel conversion.

Ethanol: A fuel made from organic matter (plant sugars) in a fermenting process.

Fuel cell: A device that produces electricity by combining a fuel, usually hydrogen, with oxygen. In this reaction, electrons are freed from the hydrogen in the fuel cell by a catalyst, and gain energy from the chemical reaction binding hydrogen and oxygen; this provides a source for electric current. The exhaust of hydrogen fuel cells consists of only water. Fuel cells are currently used in spacecraft and increasingly in ground transportation.

Thermochemical conversion: Process in which heat is the dominant mechanism to convert biomass into another chemical form.

Triacylglycerides: A class of organic compounds that are esters consisting of three fatty acids joined to glycerol. The fatty acids may be the same or may be different. Triglycerides are the chief lipids constituting fats and oils and function to store chemical energy in plants and animals.

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Biofuels from Plants & Algae

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***Advanced* Teachers Guide**

SYNOPSIS:

Organic materials such as plants or animals are renewable energy sources that are converted into biofuels. The two most common biofuels in use today are ethanol and biodiesel. Biofuels are often made from starches, sugars, cellulose, or algae. Algae is being used more commonly as a biofuel because it is becoming easier to harvest and these single celled photosynthetic organisms are known for their rapid growth and high energy content

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CURRICULUM UNITS:

- Biology
- Ecology
- Environmental science
- Physical science
- Physics

CAREER OPPORTUNITIES:

- Biologist
- Botanist
- Chemist
- Civil engineer
- Environmental engineer

PROGRAM OVERVIEW:

Our society has increasing demands for energy and fuel, so scientists are constantly working to increase the reliability and performance of renewable energy technology. A small percentage of renewable energy is created with biofuels. Common examples are ethanol and biodiesel. Ethanol is made from fermenting biomass, such as grasses, wood chips, poplar trees and select agricultural waste.

Fermentation is the breakdown of sugar producing alcohol and carbon dioxide. This is the same process that yeasts and bacteria perform in making bread, beer, wine, and some cultured foods.

Micro-algae are single-cell, photosynthetic organisms known for their rapid growth and high energy content, and are becoming an increasingly viable source in the production of liquid transportation biofuels. Using the sun's energy, these microorganisms combine carbon dioxide with water, creating biomass more efficiently and rapidly than terrestrial plants.

Oil-rich micro-algae strains are capable of producing the feedstock for a number of transportation fuels (biodiesel, "green" diesel, gasoline, and jet fuel) while mitigating the effects of carbon dioxide released from sources such as power plants.

This program investigates new technologies at algae facilites, and explains the processes behind their cutting-edge micro-algae to fuel processes.

ISSUES & CRITICAL THINKING:

1. Nearly 100 years ago, Henry Ford proposed that ethanol become the primary fuel for automobile engines. However, it wasn't until the early 1970s that ethanol began to enter the U.S. fuel supply in quantity. Ask students why ethanol was not in the U.S. fuel supply until the 1970s. Discuss with students what agricultural, political, and technological changes need to happen for biofuels to become more prevalent in today's market.

2. Have students research the process of cultivating algae for biofuels. Discuss difficulties such as lipid extraction and dewatering, or other shocks that can kill an algal system.

3. Discuss environmental pros and cons concerning the manufacture and use of biofuels. Continue the discussion by researching the advantages and disadvantages of harvesting and burning fossil fuels, the production of nuclear fuel, and the storage of its waste. Compare and contrast with the environmental impact of producing an alternative energy technology.

4. Discuss non-food sources for ethanol, such as the use of switchgrass rather than corn.