Name_____ Date_____ Hour_____

Bioprospecting for Cellulose-Degrading Microbes — Filter Paper Assay Method

Background Reading:

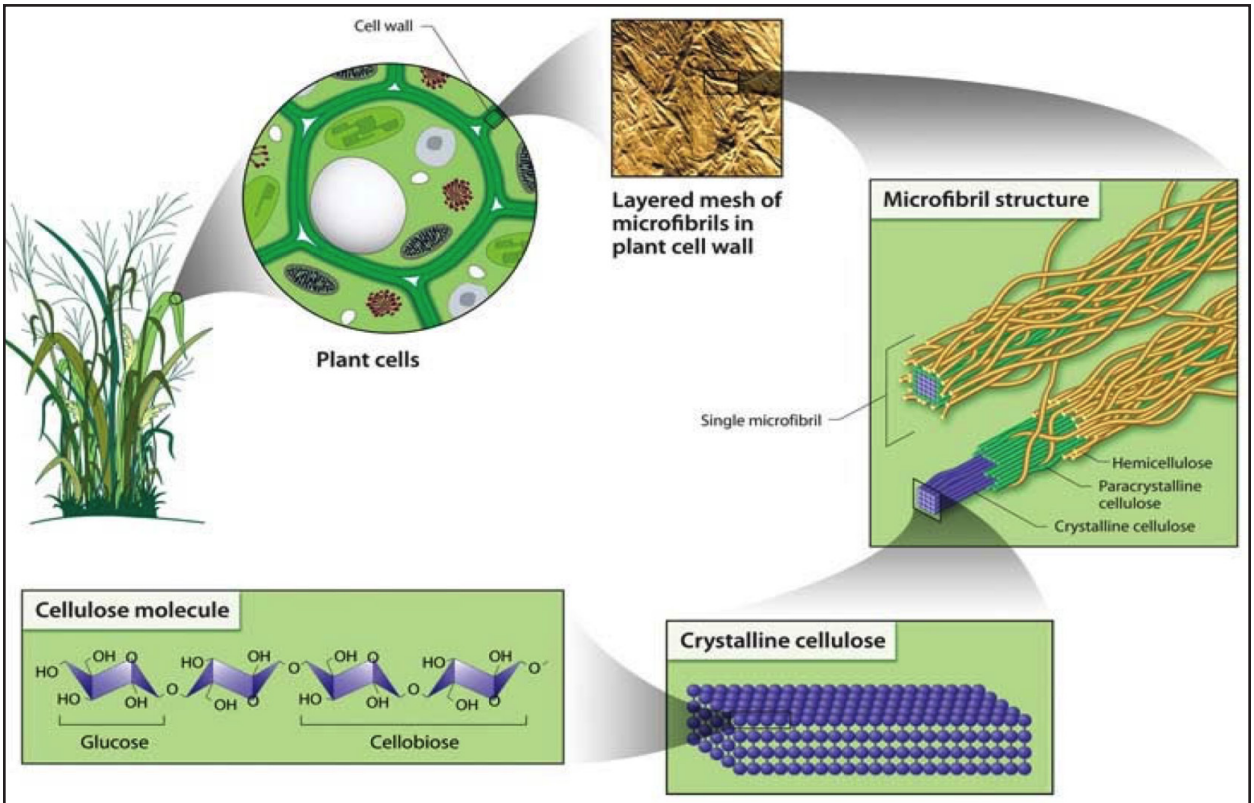

Figure 1: Cellulose, found in plant cell walls, is the most abundant molecule on the planet. Cellulose could represent a huge source of energy if researchers can discover enzymes to break it down into glucose. Source: U.S. Department of Energy, Biofuels Primer, http://genomicscience.energy.gov/biofuels/placemat.shtml

Bioprospecting is the search for diverse organisms that produce or contain genes, enzymes, biochemicals, and other compounds that are of value to humans. Bioprospecting enables scientists to identify useful compounds so that they can be replicated in a lab and used to produce medicines, enzymes, and other useful products.

Well-known products obtained through bioprospecting include antibiotics, Taxol (a cancer-fighting drug), and aspirin. Bioprospecting is now playing a pivotal role in the research and production of sustainable biofuels. A biofuel is any fuel produced from a biological source; examples include biodiesel and ethanol. Ethanol is made from fermenting plant sugars, such as glucose. Most ethanol is made from sugar cane or corn grain, which is in limited supply. Scientists and engineers are looking for efficient ways to produce ethanol from other plant sources, such as plant cellulose, which could have the potential to produce 30% of U.S. transportation fuel needs.

Cellulose is the rigid, long molecule found in the cell walls of plants. It is made when carbon dioxide is absorbed from the atmosphere during photosynthesis and, as a result, is abundant and renewable. While it is very abundant and can be found in every plant, cellulose does have draw

backs. The biggest problem with cellulose is that it is very hard to break down. In order to be fermented into ethanol, the rigid cellulose must be broken down into a much simpler molecule: glucose. This requires a combination of mechanical grinding and chemical treatments of acids and/or enzymes. The treatment and chemical breakdown (or hydrolysis) of the cellulose molecule is currently the most expensive and difficult step in the process of converting cellulosic biomass into ethanol.

Fortunately, many organisms have evolved in nature to break down cellulose into glucose, which can then be consumed for energy. Examples include the fungi that decompose wood and the micro-organisms in the stomach of the cow that allows it consume cellulosic crops, such as grasses.

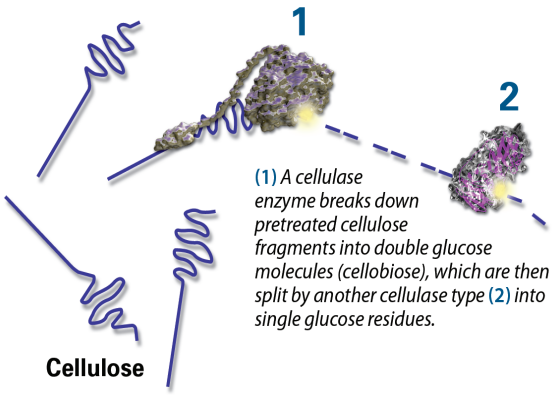

Figure 2: Special enzymes called cellulases break the chemical bonds between the glucose molecules that make up cellulose. Microbes in nature produce cellulase enzymes to help decompose and consume plant biomass.
Source: U.S Department of Energy, Biofuels Primer, http://genomicscience.energy.gov/biofuels/

These fungi and bacteria are able to break down cellulose into glucose because they produce special enzymes called cellulases. The cellulase enzymes break the chemical bonds between the glucose molecules that make up the cellulose strands. Researchers at the Great Lakes Bioenergy Research Center (GLBRC) are bioprospecing for microrganisms in diverse environments that can break down cellulose in hopes of discovering new cellulase enzymes that can improve the efficiency of producing biofuels. For example, scientists have made important discoveries through investigating the cellulase-degrading microbes found in tropical leaf-cutter ant colonies and studying the bacteria in the stomachs of dairy cows.

Pre-Lab Questions:

1. What is the difference between cellulose and cellulase?

2. Why are researchers trying to figure out how to efficiently convert cellulose into ethanol? What are some of the benefits of using cellulose?

3. What are some of the challenges of using cellulose for producing ethanol?

4. What is the purpose of cellulase enzymes for converting cellose into ethanol?

5. If a microbe was discovered that could rapidly break down cellulose, how would this discovery impact the potential use of cellulose as a biofuel?

6. Think of four environmental characteristics that would be suitable for high concentrations of cellulose-degrading microbes and explain how those characteristics would support a large population of this kind of microorganism.

Environmental Characteristic	**Explain how it supports cellulose-degrading micobes**