EDCI 627
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Driving Question

Context of the Unit
Description of learners:

- The majority of learners will be entering their freshman or sophomore year of high school and taking Biology I.
- Students will want to be independent, however they are in one of the beginning level science classes and will need some help along the way. Students are capable of doing things themselves, however often want you to do it for them.
- Students are very concerned about things directly related to them, not necessarily worldly issues. Concerned more about pop-culture.
- Students are beginning to understand abstract concepts, however it is challenging for them.
- Students are concerned about himself or herself, very self-conscious.
- Students are from North Judson (rural), New Prairie (rural), and North Central (suburban/ urban) High Schools.
- Students are in mixed gender classrooms with both females and males.
- Class sizes are between 15 and 35 students in a class and are at small to large sized schools.

Driving Question

What is the driving question that will guide your unit?

- **How can biological methods be effectively used to convert biomass to biofuel to meet our energy needs?**

What makes your question meaningful and authentic to your students?

- The question is meaningful to high school students because they ride in vehicles. Those vehicles predominantly use petroleum based gasoline. If the oil in the world were gone, our students would still want to drive and ride in vehicles. Many students pay for gasoline and have their own jobs. They are interested in where their money goes. Anything related to price of gasoline is engages students into the learning process. Also, some students may know service members who are in the middle east. Learning about the production of fuels from domestic sources will also be of interest to those students as we look for ways that decrease our dependence on foreign oil.

How does it meet the criteria of ill-structuredness, interdisciplinary, and appropriateness?
Criteria:

- Ill-structuredness

There are multiple approaches that students can take to solve this question. Students will be

able to engage into research into different methods of converting organic matter into biofuels (enzymes, inorganic catalysts).

- Interdisciplinary

It is interdisciplinary for a variety of reasons. First, students will be working in groups and communicating about their guided inquiry experiments while investigating enzymes. The oral and written communication requires English skills. Second, mathematics is used in the lab reports related to enzymatic breakdown of cellulose by cellulase. Students will create line graphs showing the breakdown of cellulose over time and under varying conditions.

- Appropriateness

The driving question is appropriate because directly relates to student choices. Students may not go on vacations based on the price of gasoline. They and their parents may have to make sacrifices due to the price of gasoline. As students make daily sacrifices due this driving question concept each day, it is very appropriate.

How does the driving question relate to/integrate with the curriculum?

The driving question relates into the curriculum in the following ways:

- Explores energy types, conversion and loss in reactions and environments.
- Connects to show how humans affect the world around us including population growth, resource depletion, destroying habitats, adding to the carbon footprint, and destroying biodiversity.
- How energy needs a catalyst in order to do work. In biology that specific catalyst is in the form of enzymes.
- Fossil fuels are in limited supplies, therefore we need to find alternative energies including biomass that can be turned into usable energies.

Description of how the driving question is open-ended allowing for different investigative questions.

The driving question allows for different investigative questions because it allows for the students to research and experiment with different enzymes, substrates, and experimental conditions. Students will have the choice to test temperature, pH, concentration, salinity, or some other variable of their choice. Students will be able to create "rules of thumb" through guided inquiry of enzyme catalyzed reactions with biomass. They will also have some choice in their presentation style regarding their final product of the project.

Content and Standards

What specific biomass-biofuels content will be addressed?

Conversion efficiencies between different organic molecules. Students may explore the differences between lignin and cellulose. They may also look into the differences in efficiencies between converting these molecules into more useable biofuels.

Biomass-biofuels content will be addressed by having students explore the conversion of organic matter into useful biofuels. Students will do internet research to discover some of

this information. Students will also conduct guided inquiry experiments over the enzymatic breakdown of cellulose. They will investigate how different variables impact the reaction rate for the enzyme. This will be the guided inquiry portion. Students will design experiments to test the variables of their own choosing. They will then report back to the class the results and evidence for their conclusions.

The following Indiana standards will be addressed in our PBL:
Indiana Biology Standards

SCI.B.1 2010 - Cellular Chemistry

Describe the basic molecular structure and function of the four major categories of organic compounds (carbohydrates, lipids, proteins and nucleic acids) essential to cellular function.(B.1.1)Describe how work done in cells is performed by a variety of organic molecules—especially proteins, whose functions depend on the sequence of their monomers and the consequent shape of the molecule. (B.1.2, B.1.3)

SCI.B.1.1 2010

Describe the structure of the major categories of organic compounds that make up living organisms in terms of their building blocks and the small number of chemical elements (i.e., carbon, hydrogen, nitrogen, oxygen, phosphorous, and sulfur) from which they are composed.

SCI.B.1.2 2010

Understand that the shape of a molecule determines its role in the many different types of cellular processes (e.g., metabolism, homeostasis, growth and development, and heredity) and understand that the majority of these processes involve proteins that act as enzymes.

SCI.B.1.3 2010

Explain and give examples of how the function and differentiation of cells is influenced by their external environment (e.g., temperature, acidity and the concentration of certain molecules) and changes in these conditions may affect how a cell functions.

SCI.B.2.3 2010

Explain that most cells contain mitochondria (the key sites of cellular respiration), where stored chemical energy is converted into useable energy for the cell. Explain that some cells, including many plant cells, contain chloroplasts (the key sites of photosynthesis) where the energy of light is captured for use in chemical work.

SCI.B.2.4 2010

Explain that all cells contain ribosomes (the key sites for protein synthesis), where genetic material is decoded in order to form unique proteins.

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SCI.B.2.5 2010

Explain that cells use proteins to form structures (e.g., cilia, flagella), which allow them to carry out specific functions (e.g., movement, adhesion and absorption).

SCI.B.2.6 2010

Investigate a variety of different cell types and relate the proportion of different organelles within these cells to their functions.

SCI.B.3 2010 - Matter Cycles and Energy Transfer

Describe how the sun's energy is captured and used to construct sugar molecules that can be used as a form of energy or serve as building blocks of organic molecules. (B.3.1, B.3.2, B.3.3) Diagram how matter and energy cycle through an ecosystem. (B.3.4, B.3.5)1

SCI.B.3.1 2010

Describe how some organisms capture the sun's energy through the process of photosynthesis by converting carbon dioxide and water into high-energy compounds and releasing oxygen.

SCI.B.3.2 2010

Describe how most organisms can combine and recombine the elements contained in sugar molecules into a variety of biologically essential compounds by utilizing the energy from cellular respiration.

SCI.B.3.3 2010

Recognize and describe that metabolism consists of all of the biochemical reactions that occur inside cells, which include the production, modification, transport, and exchange of materials that are required for the maintenance of life.

SCI.B.3.4 2010

Describe how matter cycles through an ecosystem by way of food chains and food webs and how organisms convert that matter into a variety of organic molecules to be used in part in their own cellular structures.

SCI.B.3.5 2010

Describe how energy from the sun flows through an ecosystem by way of food chains and food webs and how only a small portion of that energy is used by individual organisms while the majority is lost as heat.

SCI.B.4.1 2010

Explain that the amount of life environments can support is limited by the available energy, water, oxygen and minerals and by the ability of ecosystems to recycle the remains of dead organisms.

SCI.B.4.2 2010

Describe how human activities and natural phenomena can change the flow and of matter and energy in an ecosystem and how those changes impact other species.

SCI.B.5.5 2010

Understand that proteins are responsible for the observable traits of an organism and for most of the functions within an organism.

SCI.B.5.6 2010

Recognize that traits can be structural, physiological or behavioral and can include readily observable characteristics at the organismal level or less recognizable features at the molecular and cellular level.

Technology Standards

TE.HS.2 2006 -

Describe technology as a system with inputs, processes, outputs, impacts, and feedback.

TE.HS.2.J 2006
Analyze and explain impacts / consequences

TE.HS.3 2006 -
Understand the integrated relationship of technology with other academic fields, particularly language arts, math, science, and social studies.

TE.HS.3.C 2006
Understand how technology is related to other school subjects, particularly science and math.

TE.HS.3.D 2006
Apply concepts learned in math, social studies, science, and other classes.
TE.HS.3.E 2006
Be able to use both verbal and written skills to communicate ideas and solutions.

TE.HS.7 2006 -

Develop and refine alternate solutions that address technological needs and opportunities.

TE.HS.7.E 2006
Apply different problem solving processes.

TE.HS.7.F 2006
Participate in brainstorming and develop activities.

TE.HS.7.G 2006
Model potential designs in an efficient manner.

TE.HS.7.H 2006
Create unique solutions to stated issues.

TE.HS.8 2006 -
Evaluate and select appropriate solutions that address technological needs and opportunities.

TE.HS.8.D 2006
Consider human and environmental factors when making decisions.

TE.HS.12 2006 -
Select the appropriate processes needed to produce or operate products, structures, and systems.

TE.HS.12.C 2006
Research and develop fresh solutions to problems or issues.

TE.HS.12.E 2006
Apply a multidisciplinary approach when solving problem.

TE.HS.13 2006 -
Efficiently use appropriate processes to produce communication, construction, manufacturing, transportation, and related devices and systems.

TE.HS.13.D 2006
Prepare media using modern technological devices and systems.

How will the unit ground the content in real life and work beyond school?

- The unit will prepare students for realistic perspectives of energy availability and responsible use for the future.

- The unit will help develop students into educated citizens that have the knowledge to make well informed decisions in the future.
- The unit will allow students to expand their knowledge of available careers and opportunities in the future.

What strategies will you use to keep the students focused on the question?

- We will post the question on a sheet of paper that will be taped on the wall. At the beginning or end of class, we can use discussion and ask students to connect the daily activities to the driving question.
- At the end of an activity, we can use post-it notes that allow students to write down and share how they can relate new information to the driving question.
- We will post a sheet of paper called a parking lot where students can post daily questions or comments that weren't answered in class.