

Explore An Issue: Biofuel Brouhaha

Teacher Resource

This activity will assist in meeting the following Prescribed Learning Outcomes in the British Columbia Integrated Resource Package (2006) for **Biology 11/12**:

- A3 Interpret data from a variety of text and visual sources
- B4 Analyse the structure and function of biological molecules in living systems (carbohydrates)
- B11 Analyse the roles of enzymes in biochemical reactions

In addition, this activity will assist in meeting the following Prescribed Learning Outcomes in the British Columbia Integrated Resource Package (2008) for **Sustainable Resources 11**:

- C1 Analyse the environmental, social, and economic significance of forestry and related industries at the local, provincial, and global levels
- C6 Analyse challenges and opportunities faced by forest industries in BC
- D1 Analyse the environmental, social, and economic impacts of acquiring mineral resources, and hydrocarbons from fossil fuels, at the local, provincial, and global levels
- D3 Assess current practices related to the sustainable management of hydrocarbon and mineral resources in BC
- E3 Investigate current practices related to the management of sustainable energy resources
- E5 Analyse challenges and opportunities faced by energy industries in BC

Background information

This activity is designed to introduce students to the controversies surrounding biofuel generation and some of the possible solutions to current biofuel generation. Before beginning the activity, a short review of carbohydrate chemistry and the fermentation of glucose to produce ethanol will be given. Students will view a short video clip portraying the oil sands in Alberta, read a short article supporting one viewpoint, write a response to a prompt, and then partner with a peer who has information on the opposing viewpoint. The students will then discuss the information given and write a second, updated response to the prompt. The prompt given to students is: *Biofuels are the solution to future energy needs.*

Set up & Delivery

Last Update: April, 2020

1. Before the class activity, photocopy and cut out each of the information card sheets so that each student will receive one card, and there are approximately equal numbers of 'brown' and 'green' cards. This activity will run more smoothly if the green cards are copied onto green paper, and the brown cards are copied onto brown (or tan) paper. For durability, teachers may consider having the cards laminated.
2. As students arrive to class, have them select either a green card or a brown card.
3. Introduce the topic of fermentation (https://www.youtube.com/watch?v=6-D1oes63_U). The video linked here may be good background information for teachers, or shown to students as an example of how sugars are fermented in biological systems. Students may have an understanding of the role of yeast in the production of foods such as bread, beer, or wine. Draw the students' attention to the diagram on their worksheets and have students summarize what is happening in this metabolic pathway. Students should understand that the diagram is illustrating fermentation of glucose to form ethanol. The mechanism by which this occurs is through *enzymatic action* on the molecules. Ask students if they have ever heard of biofuels, and what they think biofuels are. Explain that today's class will explore the issues and controversies surrounding biofuels as well as traditional fossil fuel extraction methods.
4. Begin playing the video: RMR: Rick in Oil Sands (<https://www.youtube.com/watch?v=HNSbiNxxITQ>). This is a segment of the Rick Mercer Report. Rick is touring the oil sands in northern Alberta. This segment is not provided to give students scientific information, rather to show them what the oil sands look like and the scope of the industry.
5. Once the video is complete, give students an opportunity to discuss what they saw, the size of equipment and operations, and what they think the environmental impact of this industry is. Ask students if they have heard of biofuels as an alternative to fossil fuel extraction.
6. Highlight some of the local research being done to develop this emerging technology. Carbohydrate enzymology is being worked out at both the Withers Lab and the Brumer Lab at the [Michael Smith Laboratories](#) at UBC. Have students read the introductions at these websites, or display the webpages in the classroom for the entire group of students.
7. Next, display the writing prompt for the activity and have students copy it into their worksheet. Direct the students' attention to the card they have. Have the students read their own card and then respond to the prompt as either a supporter or opponent of the statement: Biofuels are the solution to future energy needs.
8. At this point, students may be quite adamant that their position is 'correct'.
 - a. If enrichment in this activity is desired, direct student attention to the [National Geographic article on biofuels](#). Once students have read through this article, have them find a peer with the alternate card colour and read that card.

Last Update: April, 2020

- b. If the teacher prefers not to read the additional article, continue with the rest of the activity by having students find a peer with the alternate card colour, exchange cards and read that information.
9. Finally, have students add to or modify their original response to the prompt. These may be collected as an assignment. There is no one 'right' answer to this discussion. This activity is designed to encourage students to question the sustainability of fossil fuels, and the possibility of developing biofuels as an alternative. Both sides to the debate have valid points to consider.
10. At the end of the activity, invite contributions from students about the biofuel debate, whether their opinions have changed, and what they think the future of energy generation is.
11. Students should be aware that the information they've read today is just the tip of the iceberg as far as the biofuel debate goes and they should not jump to any immediate conclusions. An interesting case study for further extension is the [Brazilian biofuel story](#). Another link [here](#).

Resources

There are many websites dedicated to biofuel information. The material for this teaching activity is located on the following websites:

- 10 Disadvantages of Biofuels: <http://auto.howstuffworks.com/fuel-efficiency/biofuels/10-disadvantages-of-biofuels.htm>
- What are Biofuels: <http://www.conserve-energy-future.com/advantages-and-disadvantages-of-biofuels.php>

Included below is a chart illustrating one option for harnessing solar energy; there are several other options for utilizing the energy in biological materials. There are several methods to obtain energy from biomass; the focus in this activity is on obtaining energy from plant waste. Agricultural and industrial wastes are also possibilities for the production of ethanol. In particular, efforts are being made to make the fermentation of cellulosic fibres more efficient and feasible for biofuel generation. BC's forest industry provides abundant opportunity for the use of wood chips and sawdust as fuel.

Solar Energy → Photosynthesis → Plant Products → Biomass → Aqueous Processes → Fermentation → Ethanol

Last Update: April, 2020

Biofuels are expensive to produce and require a very large initial capital investment for machinery. Infrastructure needs to be in place for biofuel production, transportation, and use and there is currently little support for this.

Biofuels are expensive to produce and require a very large initial capital investment for machinery. Infrastructure needs to be in place for biofuel production, transportation, and use and there is currently little support for this.

Huge amounts of water and fertilizer are needed to ensure vigorous crops to harvest. This puts a strain on local water supplies and fertilizers could contaminate land and ground water with run-off.

Huge amounts of water and fertilizer are needed to ensure vigorous crops to harvest. This puts a strain on local water supplies and fertilizers could contaminate land and ground water with run-off.

Biofuels use up crops that could be used to feed many people, especially those in the developing world. Remaining crops will be more expensive due to higher demand and some countries may begin to cut forested land to grow biofuels on.

Biofuels use up crops that could be used to feed many people, especially those in the developing world. Remaining crops will be more expensive due to higher demand and some countries may begin to cut forested land to grow biofuels on.

The carbon footprint to create biofuels may not make it worthwhile. Costs of machinery for cultivating, harvesting and transporting crops are still very high in carbon emissions. Often, plant material needs to be trucked a very long distance to be processed.

The carbon footprint to create biofuels may not make it worthwhile. Costs of machinery for cultivating, harvesting and transporting crops are still very high in carbon emissions. Often, plant material needs to be trucked a very long distance to be processed.

Biofuels produce fewer emissions, resulting in less greenhouse gas, and yet perform very well in current engine designs. With increased production they may also become cheaper than fossil fuels.

Biofuels produce fewer emissions, resulting in less greenhouse gas, and yet perform very well in current engine designs. With increased production they may also become cheaper than fossil fuels.

Biofuels come from renewable sources such as wood fibres, corn, soybeans, and grasses. Plant crops are easy to grow and quick to mature (unlike fossil fuels), so biofuels are very efficient.

Biofuels come from renewable sources such as wood fibres, corn, soybeans, and grasses. Plant crops are easy to grow and quick to mature (unlike fossil fuels), so biofuels are very efficient.

Second generation biofuels use sources that are not potential food crops for human consumption. These options include wood chips from BC sawmills, grasses that grow in marginal areas, and willow fibres. In many cases, arable land is not used.

Second generation biofuels use sources that are not potential food crops for human consumption. These options include wood chips from BC sawmills, grasses that grow in marginal areas, and willow fibres. In many cases, arable land is not used.

Most countries could produce their own biofuels, even if they do not have a fossil fuel source. This would lead to greater economic independence and security with decreased reliance on global market supplies.

Most countries could produce their own biofuels, even if they do not have a fossil fuel source. This would lead to greater economic independence and security with decreased reliance on global market supplies.