

Title: Biofuels – Myths vs. Facts

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School: Spring Valley Middle-High School, Wisconsin

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Grade level or Course name: 8th grade Earth Science

Duration: about 7-10 class periods of 45 minutes each

Unit Overview

This unit is intended to compliment a traditional and alternative energy unit in which students have already learned about the production and use fossil fuels, nuclear, wind, solar, hydroelectric, biomass, etc. With ethanol, other biofuels, and energy in general on the news daily and heavily advertised, students need to understand how to “see through” the biases and evaluate the validity of claims. In this unit, students will learn about different types of biofuels, how biofuels are produced, the environmental and economic impacts of biofuels, writing a scientific survey, and educating others about biofuels. The culminating activity of the unit allows students to use their new knowledge and the results of their *What do you know about biofuels?* survey to create a public service messages dispelling commonly-held biofuel myths.

Student Learning Goals

Upon completion of the unit, students will be able to...

Identify types of biofuels and describe how each is produced.

Give examples of the unintended consequences of biofuel production.

Evaluate the benefits and consequences of producing various biofuels.

Measure public knowledge and attitudes about biofuels.

Educate others about biofuels.

Wisconsin Model Academic Standards Addressed [WI Dept. of Public Instruction](#)

By the end of grade eight, students will:

B.8.6 Explain the ways in which scientific knowledge is useful and also limited when applied to social issues

C.8.3 Design and safely conduct investigations* that provide reliable quantitative or qualitative data, as appropriate, to answer their questions

C.8.6 State what they have learned from investigations*, relating their inferences* to scientific knowledge and to data they have collected

C.8.7 Explain* their data and conclusions in ways that allow an audience to understand the questions they selected for investigation* and the answers they have developed

- C.8.8 Use computer software and other technologies to organize, process, and present their data
- C.8.10 Discuss the importance of their results and implications of their work with peers, teachers, and other adults
- E.8.6 Describe through investigations the use of the earth's resources by humans in both past and current cultures, particularly how changes in the resources used for the past 100 years are the basis for efforts to conserve and recycle renewable and non-renewable resources
- H.8.1 Evaluate the scientific evidence used in various media (for example, television, radio, Internet, popular press, and scientific journals) to address a social issue, using criteria of accuracy, logic, bias, relevance of data, and credibility of sources

Lessons / Activities

Day 1: What are biofuels? How are they made?

Materials: *Introduction to Biofuels* PowerPoint Notes, Student Handout *Biofuels Production Flow Chart*

Activities: This unit should be introduced by probing students' prior knowledge about ethanol and biofuels. The following questions could be asked to prompt discussion:

What do you already know about biofuels/ethanol?

Are biofuels/ethanol good for the environment? Compared to what?

Have you seen any commercials or ads for ethanol/biofuels? What were they like?

Alternatively, students could be asked to agree or disagree with statements such as:

I already know a lot about biofuels.

Ethanol is good for the environment.

All ethanol is made from corn because corn is the best material for making ethanol.

There are some negative effects of making and using ethanol.

Biofuels can help "fix" the global warming problem.

(I have students agree or disagree by lining up along the back of my room with one end representing "I totally agree" and the other end being "That's ridiculous!" Then I call on random students and ask them to justify the position they took.)

The teacher will then share the notes and lead a discussion on biodiesel, ethanol, and methanol production. Students will then work to summarize the information on the flow chart activity.

EXTENSION: Students could research and report back on the patterns of biofuels use in the US or world.

Day 2: How does our energy production and use affect species biodiversity?

Materials: *Biofuel Production and Biodiversity – Unintended Consequences* PowerPoint Notes, Student Handout *Ranking Activity: What causes species to go extinct?*

Activities: The teacher will ask the class to brainstorm a few ways in which our energy production and use might cause species to go extinct, at least in a local area if not worldwide. Students should work on the ranking activity in small groups to first identify how each activity

might impact species diversity and then rank the activities with #1 having the biggest/worst effects on biodiversity. The group must negotiate to agree on a ranking and then justify their rankings. Finally, the teacher will lead a class discussion to compare rankings across groups and share notes outlining the actual ranking.

Day 3: How can producing biofuels in the US cause tropical rainforest destruction?

What are the “Pros & Cons” of various biofuels?

Materials: *The “Pros & Cons” of Biofuels PowerPoint Notes*, Student Handouts *Cause & Effect – Ordering and Unintended Consequences Activity* and *The “Pros & Cons” of Biofuels Activity*

Activities: After briefly reviewing the logic of cause and effect if needed, the students should work in small groups to order the events on the activity handout. When all groups are done, the teacher should lead a discussion sharing the proper sequence and explaining “unintended consequences” by sharing the examples in the notes or others. Student groups should brainstorm to add other possible unintended consequences to their sequence of events. (E.g., shortage of corn/beans for food, increase in beef prices, greenhouse gas emissions from deforestation, etc.) The teacher should then share the notes about the pros and cons of biofuels, and students can use the handout as a note-taking guide.

EXTENSION: Instead of giving students notes about the benefits and consequences of each biofuel, they could research the information on the Internet.

Day 4: Biofuels and the Media

Materials: Video clips, commercials, print articles, ads, etc. about ethanol or energy

Activities: The teacher should share media examples about energy sources, especially biofuels, and lead a class discussion on bias and the validity of the information. The teacher should point out that many people get their information from the popular media. How will this affect what people “know” about biofuels? Do they have all the information they need to make wise decisions? What do people really know about biofuels? Students should work in small groups to write 6 survey questions investigating what people know about biofuels. For homework, students should have 2 family members or other adults answer their questions and bring their results to class the next day.

Day 5: What do people know about biofuels? What makes a good survey?

Materials: *Scientific Surveys PowerPoint Notes*

Activities: The students should share their findings from their family surveys through a class discussion. Students should share both the question they asked and the response they received. Are there common misunderstandings or “myths” that were widely shared? Were some questions better at getting useful information from people? The teacher should share the notes about scientific surveys with students, and then lead a class discussion to build a survey measuring what people know about biofuels that will be given to groups of people. (I will use teachers, juniors, and seniors at the high school level.)

Day 6-10: Public Service Message – Biofuels: Myths vs. Facts

Materials: Student Handout *Public Service Message – Biofuels: Myths vs. Facts*

Activities: Once students get the completed surveys, they should analyze and summarize the results in small groups. Preliminary results should be shared through a class discussion. The teacher should introduce the public service message assignment, reviewing the expectations and grading rubric with the class. Students can spend a day or more creating a message that educates the public about biofuels and directly dispels any misconceptions uncovered by their surveys. The format of the message could be anything from brochures and posters to video or radio commercials – it just depends on how much time students can spend on the project, resources available, and teacher preferences.

Student Assessments

Day 1 Each student's *Biofuels Production Flow Chart* should be evaluated for completeness and accuracy.

Day 2 Each group's *What causes species to go extinct?* activity should be evaluated for evidence of thoughtfulness. (E.g., Did students give reasonable justifications for their rankings?)

Day 3 Each group's *Cause & Effect* activity should be evaluated for correct ordering of sequence and thoughtful additions of other possible unintended consequences. Each student's "*Pros & Cons*" of *Biofuels* should be evaluated for accuracy and completeness.

Day 4 & 5 Informal formative assessment can be made during the class discussion.

Day 6-10 Each group's *Public Service Message* should be shared with the class. Each project should be evaluated both by the student group and the teacher using the included grading rubric.

Resources

Class Notes – after Summer 2008 Future Fuels Institute Notes

Introduction to Biofuels (Day 1)

Biofuel Production and Biodiversity – Unintended Consequences (Day 2)

The "Pros & Cons" of Biofuels (Day 3)

Scientific Surveys (Day 5)

Video clips, commercials, print articles, websites, and/or ads about ethanol or energy

(I get mine off the Internet, taping from TV, looking in almost any magazine)

Student Handouts

Biofuels Production Flow Chart (Day 1)

What causes species to go extinct? Ranking Activity (Day 2)

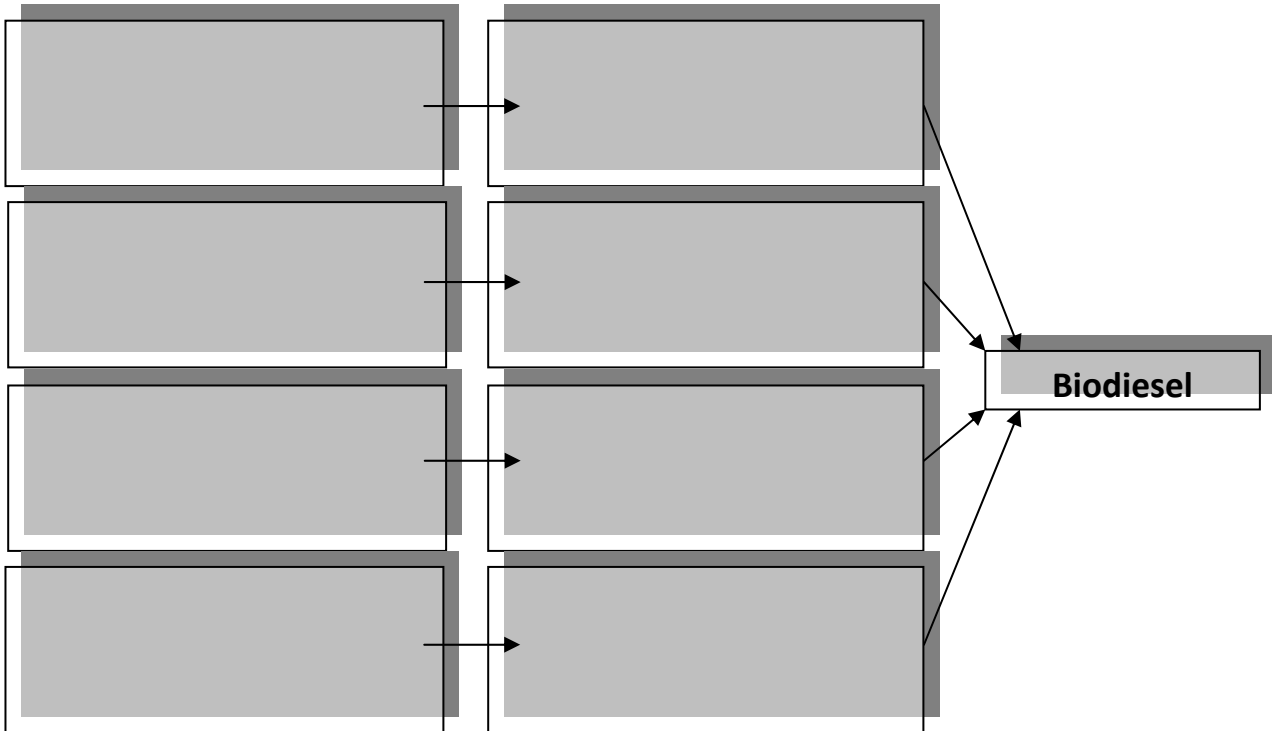
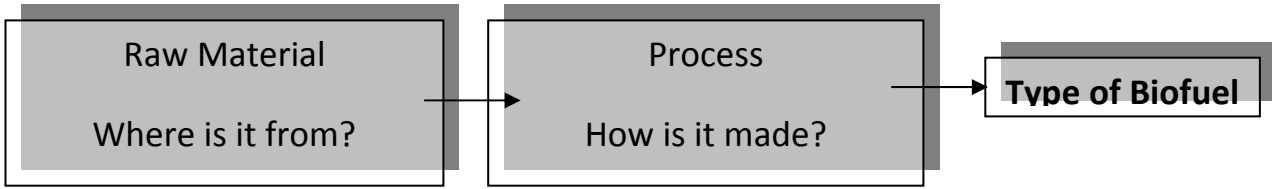
Cause & Effect – Ordering and Unintended Consequences Activity (Day 3)

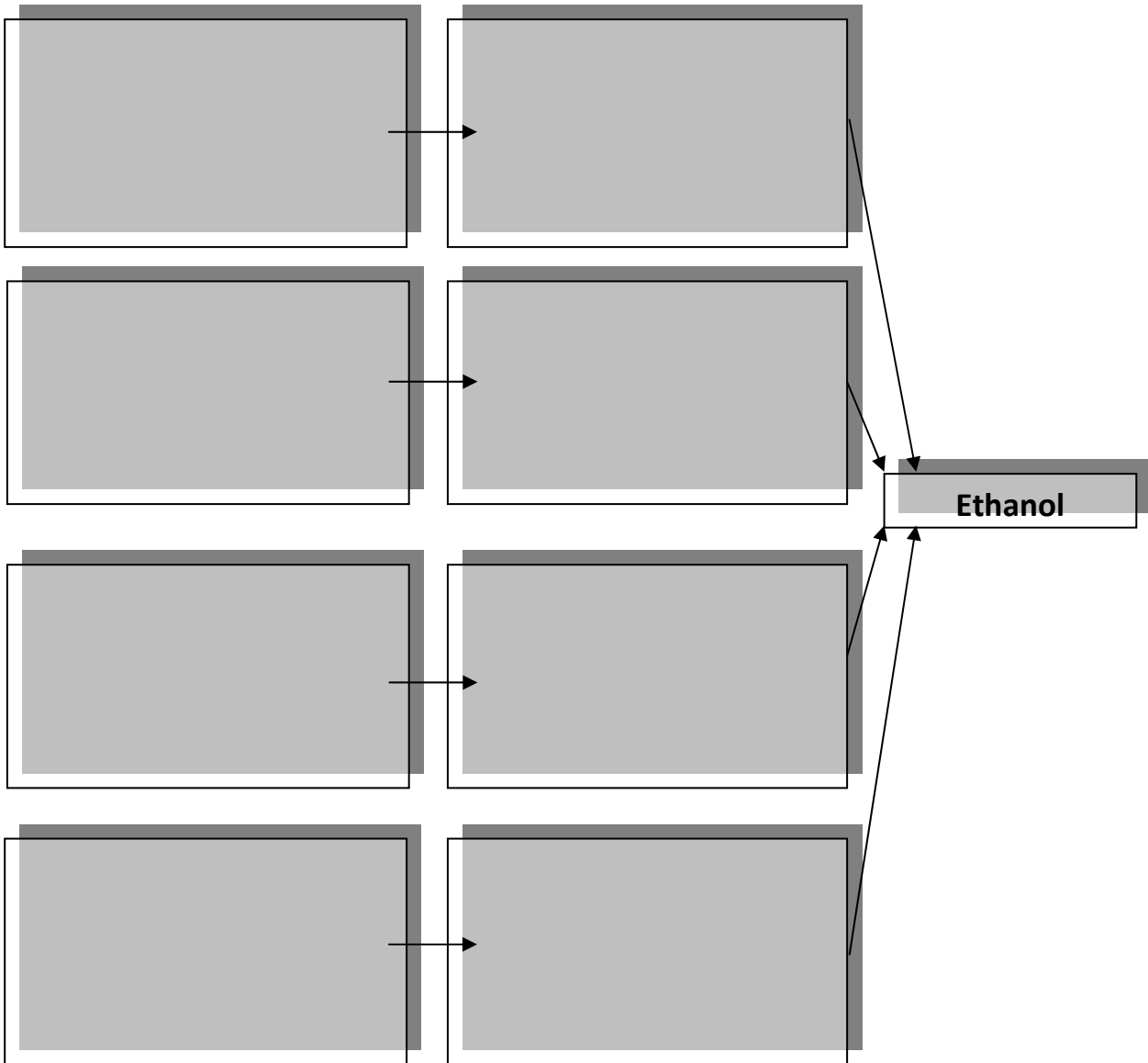
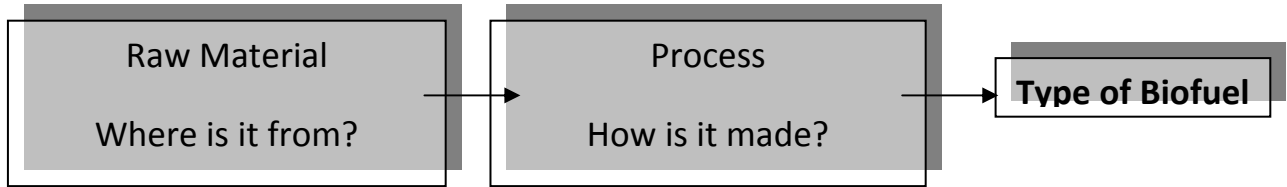
The "Pros & Cons" of Biofuels Activity (Day 3)

Public Service Message – Biofuels: Myths vs. Facts (Day 6)

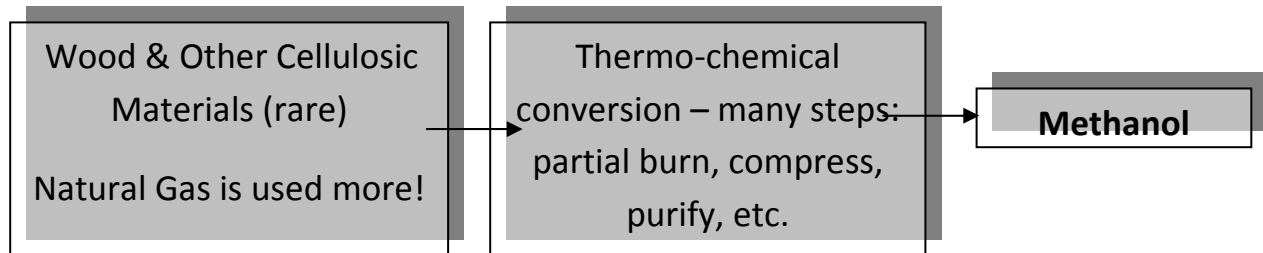
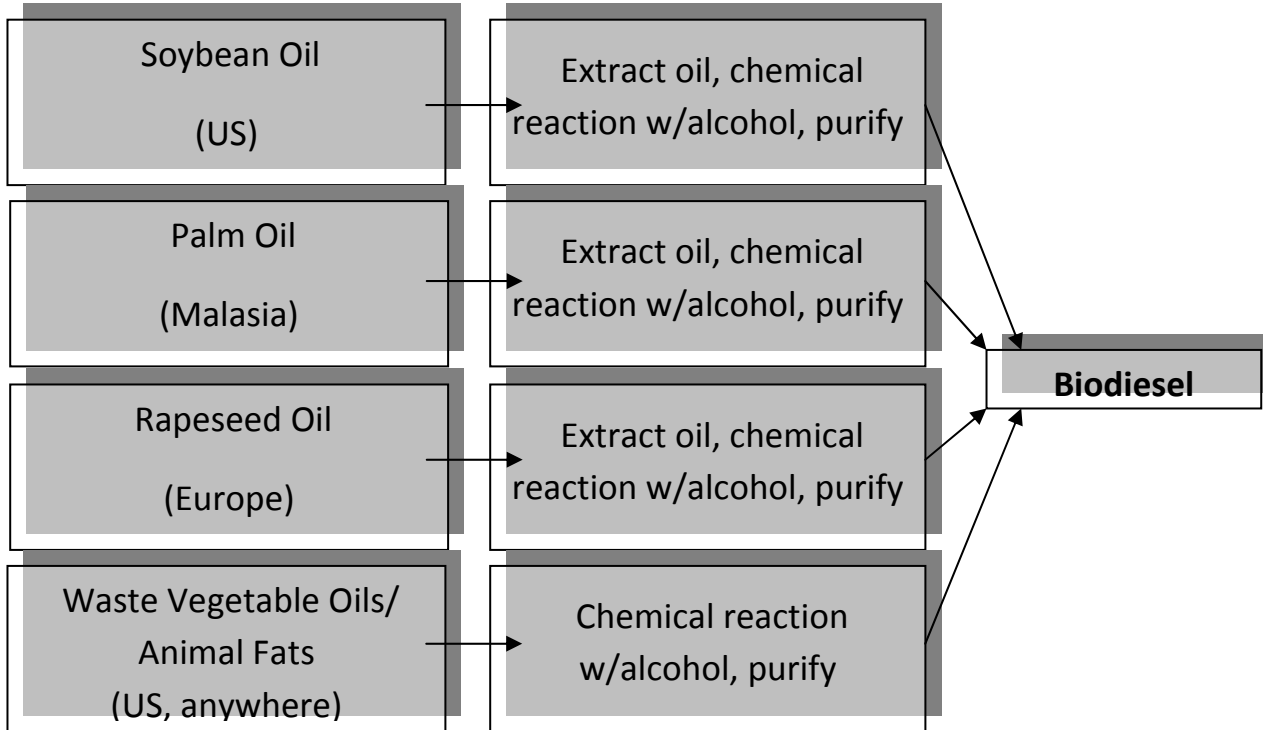
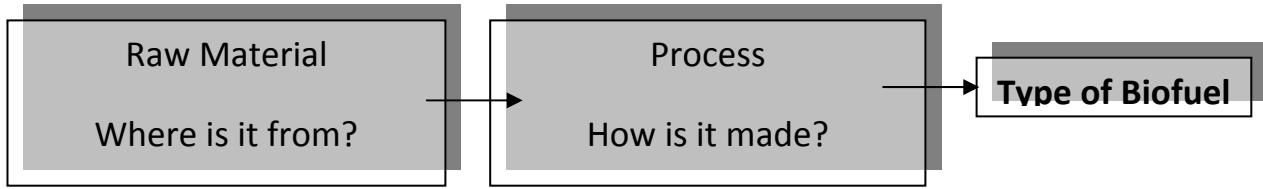
Biofuels Production Flow Chart

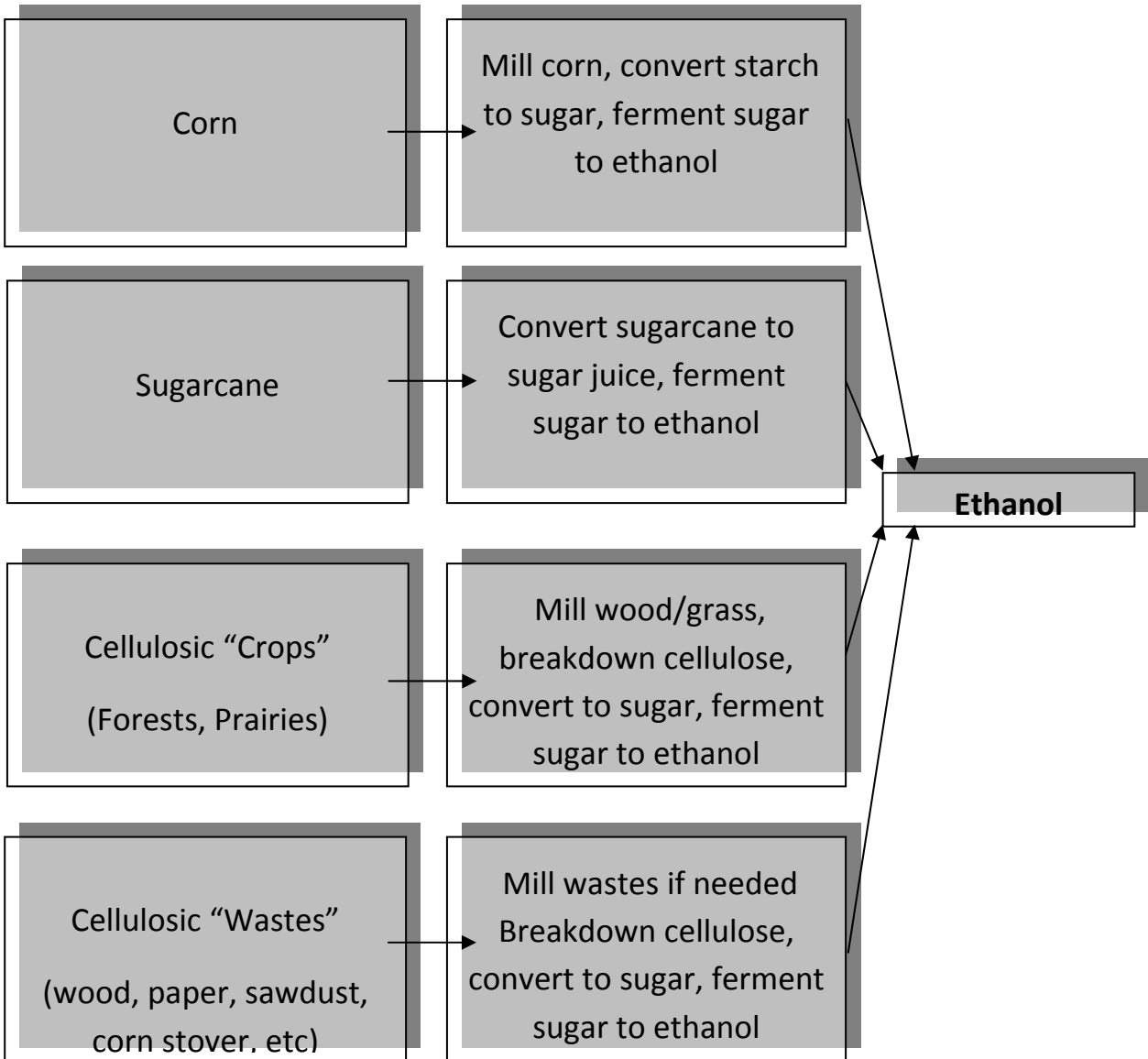
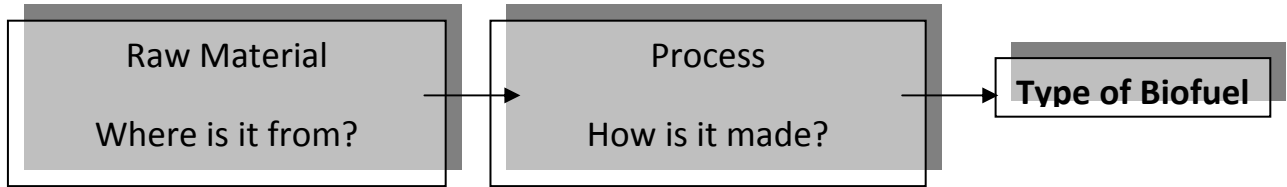
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Biofuels Production Flow Key (Day 1)





What causes species to go extinct? Ranking Activity

Names:

With your group, discuss and record how each listed activity might cause species loss and then rank the activities as #1 being the most harmful to biodiversity and #11 being the least. You must come to agreement with your group on your rankings. Explain why you ranked each one as you did.

Human Activity	How it endangers species	Ranking	Justification: Why so high/low?
Agriculture			
Commercial Development of Land (Buildings)			
Water Development (Dams, pumping water, draining wetlands, etc.)			
Outdoor Recreation (Boating, off-road vehicles, fishing/hunting)			
Livestock Grazing			
Pollution (all types)			
Infrastructure Development (Building roads, bridges, pipelines, etc.)			
Suppressing forest fires, even natural ones caused by lightning, drought, etc.			
All Logging Activities			
All Mining Activities, including minerals, fossil fuels, etc			
Military Activities			

After you compare your group rankings to the actual ones, answer the following questions.

1. What was the most surprising part of the actual rankings? Why?

2. How did your group ranking compare to the actual ranking? Why were you accurate and/or wrong about specific activities?

3. Consider the top two activities on the actual ranking. Other than reducing biodiversity, what do they have in common? What makes them so likely to cause a loss in biodiversity?

What causes species to go extinct? Ranking Activity KEY (Day 2)

With your group, discuss and record how each listed activity might cause species loss. As a group, rank the activities with #1 being the most harmful to biodiversity and #11 being the least. You must come to agreement on your rankings. Then explain why you ranked each one as high or low as you did.

Human Activity	How it endangers species	Ranking	Justification: Why so high/low?
Agriculture	Habitat loss/alteration	1	Scale – so much natural environment is replaced by agricultural lands
Commercial Development of Land (Buildings)	Habitat loss	2	Near total replacement of natural environment by asphalt, concrete, steel, etc
Water Development (Dams, pumping water, draining wetlands, etc.)	Habitat loss/alteration	3	Scale – so much of the natural water cycle is controlled for human convenience/use
Outdoor Recreation (Boating, off-road vehicles, fishing/hunting)	Habitat loss, collisions, direct removal of species	4	Scale & intensity of use
Livestock Grazing	Habitat loss/alteration/fragmentation	5	Scale – so much natural environment is degraded by overgrazing
Pollution (all types)	Poisoning affecting health and reproduction	6	
Infrastructure Development (Building roads, bridges, pipelines, etc.)	Habitat loss/alteration/fragmentation	7	
Suppressing forest fires, even natural ones caused by lightning, drought, etc.	Many forests NEED regular small fires to reproduce, preventing all fires causes huge fuel buildup → big fires	8	
All Logging Activities	Habitat loss/alteration/fragmentation, soil erosion	9	
All Mining Activities, including minerals, fossil fuels, etc	Habitat loss/alteration poisonous wastes, water drawdowns	10	
Military Activities	Habitat loss, poisonous wastes	11	

After you compare your group rankings to the actual ones, answer the following questions.

1. What was the most surprising part of the actual rankings? Why?

____ answers will vary _____

2. How did your group ranking compare to the actual ranking? Why were you accurate and/or wrong about specific activities?

____ answers will vary _____

4. Consider the top two activities on the actual ranking. What do they have in common, other than reducing biodiversity? What makes them so likely to cause a loss in biodiversity?

____ Habitat loss – the natural environment is replaced with a human one. _____

How can ethanol made from corn grown in the US cause rainforest destruction in Brazil?

Cut out the cards below. In your group, arrange the cards in sequence. The action or condition on the first card should cause the situation on the second card, which should in turn cause the occurrence on the third card, and so on. When the group agrees with the sequence, number the cards from 1 to 8 and complete the attached activities.

Once you have laid out your sequence of ordered cards, check your work with your teacher. Does each card cause the next? Is each card the effect of the previous one? Tape or glue the cards down on a large piece of paper and draw arrows to make the diagram into a flow chart.

Ethanol producers need more of the corn supply.

Brazilian soybean farmers expand their soybean cropping operations onto cattle pastures.

There is a shortage of soybeans in the world market.

US soybean farmers switch to growing corn because they can make more money due to high corn prices.

Displaced Brazilian cattle ranchers clear the rainforest to make new cattle pastures.
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In an effort to be “green” and energy independent, the US government mandates/ requires ethanol use.

Corn prices increase due to higher demand.

Soybean prices increase due to a small supply of soybeans.

Cause & Effect – Ordering and Unintended Consequences Activity Name:

Consider the sequence of events. Did the U.S. government and farmers mean for their choices to result in rainforest destruction? Probably not, but with careful consideration they might have been able to predict this logical string of events. These types of outcomes that were not meant to occur as a result of our actions are called *unintended consequences*. Many people believe that unintended consequences can never be avoided because a single “cause” always has many “effects”. Sometimes we can predict all the unintended consequences, and sometimes we cannot. Sometimes unintended consequences create all new problems.

Look at your flow chart, and think of other unintended consequences that could occur, either branching off at any point or at the end. (Hints: When there is a shortage of something, think about what else that material is used for. What else could be affected by high prices? What effects might result from rainforest destruction?) Draw arrows and boxes to add in at least two more possible unintended consequences that are likely to occur.

1. In the chain of events on your diagram, people were making choices. For example, when soybean farmers switch to growing corn, they made a choice to try to make more money. Is it reasonable to expect each farmer to think about the far-reaching possible unintended consequences of their decisions? In other words, should US farmers be blamed for the rainforest destruction that was the result of their decisions? Why or why not?

2. Who should be in charge of trying to predict unintended consequences and held responsible for the results on your diagram? Why?

3. One of the reasons for using ethanol in vehicles rather than fossil fuels is to reduce net carbon dioxide emissions that contribute to global warming. When ethanol is made from corn, is it likely to help solve the global warming problem or likely to make it worse? Explain.

The “Pros & Cons” of Biofuels Note-Taking Guide

Name:

Type of Biofuel and source	Net Energy Gain (energy in fuel / energy used making it)	Impacts on Species Biodiversity	Impacts on Food Supply & Prices	Impacts on Greenhouse Gasses
Biodiesel from soybeans				
Biodiesel from waste fry oil				
Biodiesel from tropical palm oil				
Ethanol from corn crops				
Ethanol from sugar cane or beets				
Ethanol from woody/ cellulosic waste				
Ethanol from <i>cropped</i> switchgrass				
Ethanol from <i>natural</i> prairies				
Ethanol from forest crops				

1. Considering the pros and cons of various biofuels, which are the best? Why?

2. Considering biofuels above, which are currently the most widely used in the US? Why?

How can ethanol made from corn grown in the US cause rainforest destruction in Brazil?

KEY (Day 3)

Cut out the cards below. In your group, arrange the cards in sequence. The action or condition on the first card should cause the situation on the second card, which should in turn cause the occurrence on the third card, and so on. When the group agrees with the sequence, number the cards from 1 to 8 and complete the attached activities.

Once you have laid out your sequence of ordered cards, check your work with your teacher. Does each card cause the next? Is each card the effect of the previous one? Tape or glue the cards down on a large piece of paper and draw arrows to make the diagram into a flow chart.

#2

Ethanol producers need more of the corn supply.

#7

Brazilian soybean farmers expand their soybean cropping operations onto cattle pastures.

#5

There is a shortage of soybeans in the world market.

#4

US soybean farmers switch to growing corn because they can make more money due to high corn prices.

#8

Displaced Brazilian cattle ranchers clear the rainforest to make new cattle pastures.
: (

#1

In an effort to be "green" and energy independent, the US government mandates/ requires ethanol use.

#3

Corn prices increase due to higher demand.

#6

Soybean prices increase due to a small supply of soybeans.

Cause & Effect – Ordering and Unintended Consequences Activity KEY (Day 3)

Consider the sequence of events. Did the U.S. government and farmers mean for their choices to result in rainforest destruction? Probably not, but with careful consideration they might have been able to predict this logical string of events. These types of outcomes that were not meant to occur as a result of our actions are called *unintended consequences*. Many people believe that unintended consequences can never be avoided because a single “cause” always has many “effects”. Sometimes we can predict all the unintended consequences, and sometimes we cannot. Sometimes unintended consequences create all new problems.

Look at your flow chart, and think of other unintended consequences that could occur, either branching off at any point or at the end. (Hints: When there is a shortage of something, think about what else that material is used for. What else could be affected by high prices? What effects might result from rainforest destruction?) Draw arrows and boxes to add in at least two more possible unintended consequences that are likely to occur.

1. In the chain of events on your diagram, people were making choices. For example, when soybean farmers switch to growing corn, they made a choice to try to make more money. Is it reasonable to expect each farmer to think about the far-reaching possible unintended consequences of their decisions? In other words, should US farmers be blamed for the rainforest destruction that was the result of their decisions? Why or why not?

___ answers will vary _____

2. Who should be in charge of trying to predict unintended consequences and held responsible for the results on your diagram? Why?

___ answers will vary _____

3. One of the reasons for using ethanol in vehicles rather than fossil fuels is to reduce net carbon dioxide emissions that contribute to global warming. When ethanol is made from corn, is it likely to help solve the global warming problem or likely to make it worse? Explain.

___ Large amounts of corn produced with intensive agriculture are likely to create more greenhouse ___ gasses, adding to the global warming problem. The loss of rainforest and other natural biomass ___ is worse than the benefit provided by corn ethanol. _____

The “Pros & Cons” of Biofuels Note-Taking Guide

KEY (Day 3)

Type of Biofuel and source	Net Energy Gain (energy in fuel / energy used making it)	Impacts on Species Biodiversity	Impacts on Food Supply & Prices	Impacts on Greenhouse Gasses
Biodiesel from soybeans	0% - 320% gain intensive agriculture uses a lot of energy	large habitat losses due to land converted to intensive agriculture crops	potentially lowers supply and raises price of soy-based foods	potentially doubles release of greenhouse gasses
Biodiesel from waste fry oil	??? no studies with data could be found	No direct effect	No direct effect	80% reduction – could reduce warming by replacing fossil fuels
Biodiesel from tropical palm oil	~70% gain	large habitat losses due to land converted to intensive agriculture crops	No direct effect	potentially doubles release of greenhouse gasses
Ethanol from corn crops	~30% gain intensive agri. uses a lot of energy, eg. tractor fuel	large habitat losses due to land converted to intensive agriculture crops	potentially lowers supply and raises price of corn-based foods	12% reduction, unless natural land → farms, then adds to warming
Ethanol from sugar cane or beets	~350% gain intensive agriculture, but more concentrated E	large habitat losses due to land converted to intensive agriculture crops	potentially lowers supply and raises price of sugar	55% reduction, unless natural land → farms, then adds to warming
Ethanol from woody/cellulosic waste	~260% gain, varies depending on waste type/location	No direct effect	No direct effect	80% reduction – could reduce warming by replacing fossil fuels
Ethanol from <i>cropped</i> switchgrass	~540% gain low agricultural inputs	large habitat losses due to land converted to intensive agriculture crops	No direct effect	60% reduction, unless natural land → farms
Ethanol from <i>natural</i> prairies	~540% gain low agricultural inputs	minor habitat alteration due to harvesting practices	No direct effect	90% reduction – could reduce warming by replacing fossil fuels
Ethanol from forest crops	~540% gain low agricultural inputs	minor habitat alteration due to harvesting practices	No direct effect	60% reduction – could reduce warming by replacing fossil fuels

1. Considering the pros and cons of various biofuels, which are the best? Why?

Fuels made from wastes are best because they turn a waste problem into a useful product.

Ethanol from “natural” prairie harvests could be ok also – small ag input, good habitat & net energy.

2. Considering biofuels above, which are currently the most widely used in the US? Why?

___ Ethanol from corn is most common due to supportive government policies. _____

Public Service Message – Biofuels: Myths vs. Facts

Names:

The Challenge

Your team is to develop a public service message to educate people on the truth about biofuels. Your message may take any format(s) you wish. You may create posters, displays, brochures, TV or radio commercials, or any other media form that could effectively educate the public about biofuels. Your message should directly address any misconceptions that were discovered through your survey results and work to correct them.

Grading Rubric

Use the following rubric to develop your message, and when you are done, evaluate your own work in the space provided. Your teacher will also evaluate your work below.

	Total Points Possible	Group Self Evaluation	Teacher Evaluation
Accuracy of Information <i>Your message should demonstrate that you understand the biofuel issues discussed in class.</i>	25		
Survey Results Addressed <i>Your message should directly correct any weaknesses or misconceptions discovered in your survey.</i>	10		
Creative Approach <i>Your format should get and hold people’s attention with an unique, interesting message.</i>	10		
Neat & Organized Presentation <i>Your message should be clear, neat, easy to follow and understand.</i>	5		

TOTAL 50 _____ _____