Future Fuels from Forests Teacher Institute
Bio fuels in a Botany Class

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**Subject/Grade:** Botany grades 11-12

**Unit Overview:** The Botany class that this unit is a part of is a trimester long and is an elective science class for juniors and seniors. This unit will be the second unit of the course. It will follow a basic intro unit of an overview of the Plantae Kingdom, taxonomy review, and an overview of the lower plants. The rest of the trimester follows higher plants, including trees.

This unit plan is the intro to our forestry unit and will intro some plant pathology with the wood rot lab that will run longer than this unit. The students will look at the forest as a wildlife resource, economical resource and how to manage it properly for both. Bio fuels will fit into the economical portion mainly. Students will learn different kinds of forests, uses of forests, to measure the biomass of the tree, identify trees, and how forests are used for bio fuels. Students will review fossil fuels from 9th grade within this unit and evaluate bio fuels too. At the end of this unit students will be able to measure and assess a forest plot for biomass and bio fuel possibilities along with some management recommendations. Students will also be able to define what bio fuels are, what plants/trees they are made from, the basic process of ethanol production and connect this to their knowledge of plants, cell walls and plant chemistry. Students will be able to write a persuasive essay that has them pick an opinion about bio fuels or a kind of bio fuel and write with supporting evidence their arguments and counter arguments. This is a school wide school improvement goals of writing in our school as well.

**Sources Consulted:**
2. The Carbon Cycle: Forestry Never Looked So Cool handout from The Forest Foundation, [www.calforestfoundation.org](http://www.calforestfoundation.org) (handout)
3. How a Tree Grows booklet- USDA Forest Service, October 2006 (handout, reading)
5. MEECS Energy Resources Lesson Plans, DEQ, 2005, [www.michigan.gov/deq](http://www.michigan.gov/deq) (classroom activities, readings, homework)
7. Powerpoint: Dr. David Shonnard, Chemical Engineering, MTU, Overview of Bio fuel Sources: Grain & Cellulosic and Bio diesel Ethanol Production and Use in the U.S., MTU Fuels of the Forest Course 2010 (teacher directed discussion/lecture for background information for students)
8. Activity: The Carbon in Trees (MTU Fuels of the Forest Course, Kristin Schmidt presented)
9. Understanding Biomass: Plant Cell Walls Chem. handout (Jessica Wagenmaker, Holton Middle School)

**Learning Objectives**

1. Students will learn what a forest is, how to classify different types of forests and uses of forests. The main uses of forests students will focus on in this unit is habitat for wildlife, maintaining biodiversity, and economic advantages such as bio fuel production.

2. Students will review the carbon cycle from biology and make connections to botany content of plants, trees and photosynthesis. Students will be able to draw and label a carbon cycle. Students will learn the roll of carbon sequestration, reducing their carbon footprint and other ecological advantages to using bio fuels.

3. Students will see the global impact of different fuel forms humans rely upon and learn about bio fuels.
Students will learn pros and cons to bio fuels, especially in a forested area.

4. Students will learn the basic process in producing biomass for bio fuel production and the production process. Students will learn some basic biochemistry in the process including connections to enzyme use.

5. Students will learn the process and demonstrate how to measure tree height, merchantable height, dBH, biomass and other field work measurement techniques for a forest plot.

**State or National Benchmarks Addressed:**

**Biology State Content Expectations (Michigan)** - The content expectation is listed first and a brief explanation of the connection is in parentheses and italics

B3.4C Examine the negative impact of human activities. *(dependence on oil, pros/cons of bio fuels on environment)*

B3.4e Describe the greenhouse effect and list possible causes. *(Carbon Cycle, Carbon Sequestering, Carbon Footprint)*

B3.4e List the possible causes and consequences of global warming. *(reasons for studying bio fuels, carbon cycle)*

B3.2A Identify how energy is stored in an ecosystem. *(carbon cycle, fossil fuels, sunlight, solar, energy)*

B3.4A Describe ecosystem stability. Understand that if a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages of succession that eventually result in a system similar to the original one. *(Forest management over time, oil spill catastrophe and link to fuel dependence)*

B2.2A Explain how carbon can join to other carbon atoms in chains and rings to form large and complex molecules. *(Carbon is in glucose, cellulose in plants and is transformed to CO2)*

B2.2B Recognize the six most common elements in organic molecules (C,H,O,N,P,S)*(Students will see these in the chemicals transformed during the bio fuel process)*

B2.5A Recognize and explain that macromolecules such as lipids contain high energy bonds. *(the high energy molecules in the bio fuels get converted to lower energy molecules of CO2 and H2O during combustion)*

B2.5C Describe how energy is transferred and transformed from the Sun to energy-rich molecules during photosynthesis. *(Carbon Cycle connections, plants in botany used for bio fuels get energy from photosynthesis)*

B2.5f Relate plant structures and functions to process of photosynthesis and respiration. *(Carbon Cycle connections)*

B3.1A Describe how organisms acquire energy directly or indirectly from sunlight. *(photosynthesis, energy sources, fossil fuel connections)*

B3.1B Illustrate and describe the energy conversions that occur during photosynthesis and respiration. *(Carbon Cycle)*
B3.1D Explain how living organisms gain and use mass through the processes of photosynthesis and respiration. (Biomass used for bio fuels)

ELA (English-Language Arts) Content Expectations- Connections Students will write daily in journals and read several articles throughout this unit. They will also write a persuasive essay at the end about bio fuels. The following ELA content expectations address these skills and outcomes.

1.1 Understand and practice writing as a recursive process. Daily writing by responding to quick writes. 1.2 Use writing, speaking, and visual expression for personal understanding and growth. 1.3 Communicate in speech, writing, and multimedia using content, form, voice, and style appropriate to the audience and purpose. 1.4 Develop and use the tools and practices of inquiry and research-generating, exploring, and refining important questions; creating a hypothesis or thesis; gathering and studying evidence; drawing conclusions; and composing a report. 1.5 Produce a variety of written, spoken, multi-genre, and multimedia works, making conscious choices about language, form, style, and/or visual representation for each work. 1.6 Students will produce a persuasive essay with at least three pieces of evidence supporting their thesis and one counter argument. (rubric attached)

Lesson Plans of Classroom or Field Activities:

Day 1: Introduction to our forest area, definitions of forest, kinds of forests, uses of forests

1. Students take clipboards out to our local wooded area and make observations about living, non-living materials they see, questions they have, sketches. (20 min)

2. Journal questions when they return to both pre-assess and to set the stage for discussion: After students do the journal questions individually, go over them in discussion. (10-15 min)

1. What is a forest? 2. Is our wetland area a forest, why or why not? 3. What are forests used for? (list at least 5) 4. What kind of forest make up most of Michigan?

3. Journal questions discussion leads to World Forest Tour cards from Project Learning Tree Forests of the World book, pages 24-30. (take pictures off and have students classify them, have different groups do different cards, maybe 2 from each category and then do some sharing at the end) Students will also view posters of forests of the world (PLT- Global Ecological Zones- Mapping the World's Forests) with countries labeled to make connections to the cards and to see what kind of forest we have in Michigan. (discovery on their own) (20 min)

4. Intro homework and get started if time- The Forest Planet reading (PLT pages 15-22) Students read, highlight words they do not know, make notes in the margins connecting things they do recognize or have heard before. Due tomorrow. (5 min)

Day 2: Review homework, Carbon Sequestering links to Carbon Cycle Review, Intro terms for unit

1. Journal questions to start: List uses of forests from reading, Have students draw a simple carbon cycle (review from biology and connects to the article from homework) (20 min)

2. Teacher presents idea to students: Imagine you are a homeowner with 20 acres of forested land you inherited. How would you use this land? (We will use our school forested area as an example. Show students visual of acres, show school property and our forested area for them to get an idea- use GIS images in small groups with questions to guide them on the school area, finding an acre, kind of forest we have here. Then brainstorm possible uses of the land or management ideas (20 min)
3. We need to learn about our forest area before we can make good decisions- Intro to Forest Unit. Intro terms and measurement techniques. We will start with some basic tree identification and discussion of types of wood such as softwoods and hardwoods. Go over basic trees found in our area, practice leaf ID in lab with samples and we will ID our trees and map out our areas when we are outside later. (20 min)

4. Make Tree ID flashcards for homework. (picture one one side, name on another- web search pictures)

Day 3: Continue Tree ID practice, set up wood rot lab **As part of studying our forest, forest pathology and disease is a part and will be addressed in the next unit. We will set-up a wood rot lab developed at MTU that will run 6-8 weeks.

1. Students meet in groups to practice more leaf ID of trees (10 min)

2. Students read/overview “How a Tree Grows” USDA handout Show how most of the wood comes from the layers of xylem within the tree. What part protects the tree from diseases? (bark) Discuss components of bark. What types of pathogens cause disease in trees (lead to fungus) (15 min)

3. Intro Wood Rot lab and set up basic portions. Review sterile techniques. Lab from Micologia Aplicada International 13(1) pp 41-44 (35 min) Set up fungus inoculation and let go for 6-8 week.

Day 4: Continue Forest unit- Go back to uses of forest- more ID and measurements

1. Using journal questions from 2 days ago, students will want to see how to make money from their plot which will lead to basic measurements. It also helps to take a basic inventory. Show students how to measure a tree height, dBH, canopy coverage of an area, merchantable height, biomass, etc. (20 min)

2. Practice above skills in courtyard area with trees, light posts, flagpole. (40 min)

3. Students practice/study tree ID flashcards for homework. Make more flashcards of new terms from class.

Day 5: Field work measuring plots:

1. Students work in teams in a forest plot area to ID trees, make measurements of tree height, merchantable height, dBH, canopy, understory ID, biomass, animal inventory, soil samples (50 min)

Day 6: Bio fuels Introduction, Renewable/Non-Renewable Energy sources

1. Forest harvesting for wood would be the students’ first idea for economical gain. What other uses would have an economical gain? Lead into bio fuels. Show basic bio fuel power point presentation from MTU by Kristin Schmitt, No. Institute of Applied Carbon Science. Connect to Carbon Cycle handout from day 2. (20 min)

2. Forests are one kind of biomass for bio fuel, what are others? How do these contrast with other fuels? Lab Stations with information in folders on different types of bio fuels and other fuels. Use MEECS Michigan Renewable Energy Cards and have students sort, ask questions, discuss. Journal assessment at end: pros/cons to each kind of energy source? What is the human impact on the earth by using each type of energy source? (30 min)
3. Homework: Energy Survey of Past and Present Energy Use handout from MEECS (p. 13)

Day 7: Carbon in Trees connection to bio fuels and Carbon Cycle, Carbon footprint

1. Go over homework in pairs to discuss energy use now compared to the past. What can we do to stop or slow our carbon emissions? Lead into carbon sequestration discussion. (10 min)

2. Students will measure the dBH again of trees but now take into consideration the carbon sequestration. Students will determine how many trees would need to be planted to off-set their carbon emissions from basic transportation to school. (Activity from MTU course, Kristin Schmidt) (40 min)

Day 8: Details of bio ethanol production

1. How does the biomass actually get turned into bio fuel? PowerPoint/Discussion using power point from Dr. David Shonnard, Chemical Engineering, MTU- Grain and Cellulosic and Bio diesel Ethanol Production and Use in the U.S. (20 min)

2. Understanding Biomass: Plant Cell Walls handout (Jessica Wagenmaker, Holton Middle School), connections to plant structures- students read in small groups, answer questions (15 min)

3. Intro Bio fuel production lab procedures for tomorrow. Students read lab, go through expectations. (15 min)

Day 9: Bio fuel production laboratory


Day 10: Bio fuel Wrap-Up, Review

1. Students will work on their persuasive essay where they pick a position about bio fuels and support their thesis with at least 3 supporting pieces of evidence and one counter-argument. Students will be given library time to research and gain more supporting information. They will also look at these websites to gather more information and review what they have learned:

Websites to investigate:


Day 11: Turn in essays, take test
Unit Assessment:

1. Students write responses to journal questions daily in class. Most journal questions are at the beginning of lessons as you can see in the lesson plans, some are at the end as a ticket out the door.

2. Students will answer questions on laboratory exercises, such as calculating biomass of a tree and determining the carbon sequestration in a tree. That would be used as an assessment on that day.

3. Field days will be assessed by their documentation, data, ability to work and stay on task and their demonstration of how to measure each item.

4. During lab days and field days, students are assessed on their lab skills and ability to stay on task with a lab rubric on a scale of 1-10 where 1 is a low, not on task, not able to demonstrate the skill and a 10 is on task, contributing to the group, able to demonstrate skills, etc.

5. Students will write a persuasive essay about a thesis statement about bio fuels. They will write and introductory paragraph, three supporting evidence paragraphs, a counter-argument paragraph and a conclusion. We have a school-wide writing rubric we use that would be used to assess this essay.

6. Students will take an open ended assessment test where they will fill in a carbon cycle diagram with terms such as carbon dioxide, photosynthesis, glucose, fermentation, etc. Students will answer questions about different types of forests and uses of forests. Given data about a tree, students will be asked to measure the dDBH, merchantable height, etc. Students will be asked to list renewable and non-renewable energy sources and discuss the pros/cons of each. Students will be able to fill in a flow chart of the process of bio fuel production given a word list.

All power points, handouts and labs were part of the MTU Fuels From the Forest Course, Summer 2010. I did not include them here as attachments since they were provided to all members of the course. The rubric for the essay is attached as a separate attachment since the formatting was weird when I tried to include it here at the end of this document. The assessments are embedded in journal questions already included, lab activities already included or in the overview section of the assessment page.
# Persuasive Writing Rubric

<table>
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<tr>
<th>Thesis &amp; Focus</th>
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<th>4</th>
<th>3</th>
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<tbody>
<tr>
<td>____ Shows a clear understanding of the prompt</td>
<td>____ Shows a clear understanding of the prompt</td>
<td>____ Shows an understanding of the prompt</td>
<td>____ Shows some understanding of the prompt</td>
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<tr>
<td>____ Takes a position &amp; gives reasons</td>
<td>____ Takes a position &amp; may give reasons</td>
<td>____ A specific focus is maintained through <em>most</em> of the essay</td>
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<tr>
<td>____ A clear, specific focus is maintained</td>
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<tr>
<th>Reasoning &amp; Development of Ideas</th>
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<tr>
<td>____ Ample, specific, and logical development</td>
<td>____ Specific and logical development</td>
<td>____ Adequate development</td>
<td>____ Limited or repetitious development</td>
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<tr>
<td>____ Most ideas are fully elaborated with clear movement between reasoning and evidence (general to specific)</td>
<td>____ Most ideas are elaborated with clear movement between reasoning and evidence (general to specific)</td>
<td>____ Adequate elaboration with some movement between reasoning and evidence (general to specific)</td>
<td>____ Little if any elaboration or movement between reasoning and evidence</td>
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<tr>
<td>____ Fully responds to counterarguments</td>
<td>____ Partially responds to counterarguments</td>
<td>____ Some response to counterargument</td>
<td>____ Brief or unclear acknowledgement of counterarguments</td>
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<th>Evidence &amp; Explanation</th>
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<tr>
<td>____ Fully developed with specific and logical examples and details, including valid data and prior knowledge of subject</td>
<td>____ Many specific and logical examples and details, including valid data and prior knowledge of subject</td>
<td>____ Adequate examples and details, including data and prior knowledge of subject</td>
<td>____ Specific examples are limited or repetitious; includes data and/or prior knowledge of subject</td>
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<td>____ Followed by effective explanation</td>
<td>____ Followed by some explanation</td>
<td>____ Followed by some explanation</td>
<td>____ Followed by little or no explanation</td>
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<th>Essay Format &amp; Organization</th>
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<td>____ Clear, logically ordered/sequenced organization</td>
<td>____ Clear, logically ordered/sequenced organization</td>
<td>____ Organization is apparent with some logical order/sequencing</td>
<td>____ Organization is simple with some logical order/sequencing</td>
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<tr>
<td>____ Transitions occur smoothly and are integrated into the essay</td>
<td>____ Transitions are simple and obvious</td>
<td>____ Transitions are simple and obvious</td>
<td>____ May not include transitions or transitions may be misleading or inappropriate</td>
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<tr>
<td>____ Introduction and conclusion are present, clear, and well-developed</td>
<td>____ Introduction and conclusion are present, clear, and somewhat developed</td>
<td>____ Introduction and conclusion are present, clear, and somewhat developed</td>
<td>____ Introduction and conclusion are somewhat present, but</td>
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**NAME:**

**TEACHER**
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<th>well-developed</th>
<th>underdeveloped</th>
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<td><strong>Command of Language</strong></td>
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<td>Good command of language</td>
<td>Competent command of language</td>
<td>Adequate command of language</td>
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<td>Varied sentence structure</td>
<td>Somewhat varied sentence structure</td>
<td>Some sentence variety</td>
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<td>Varied and precise word choice</td>
<td>Somewhat varied and precise word choice</td>
<td>Appropriate word choice</td>
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<td>Basic control of language</td>
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<td>Little variety in sentence structure</td>
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<td>Appropriate word choice</td>
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<td>Few but rarely distracting errors</td>
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<td></td>
<td>Some distracting errors</td>
<td>Errors may be distracting and occasionally hurt understanding</td>
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Teacher Feedback: