

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

Materials and Resources

What specific materials and resources (books, print materials, videos, websites) will you make available to support potential student investigations?

What other special supplies, materials, or resources will you use (e.g., books, print materials, videos, websites)?

Books:

- Miller/Levine. "Biology". Pearson-Prentice Hall, 2010.

Articles:

- "Biofuel Research Boosted by Discovery of How Cyanobacteria Make Energy" (December 15, 2011). <http://www.sciencedaily.com/releases/2011/12/111215141613.htm>.
- Mack, Sean. "Enzymes and Algae May Spur a Biofuel Boom: Ian Gilson." *The Energy Report*, June 12, 2012. <http://www.theenergyreport.com/pub/na/13602>.
- "Nebraska Biofuel Enzyme Plant Hosts Tour with Senior DOE Official." *Energy.gov*, February 10, 2012. <http://www.nrel.gov/biomass/pdfs/39436.pdf>.
- Silvertin, Ken. "Will Algae Biofuels Hit the Highway." *The Energy Report*, May 22, 2012. <http://www.theenergyreport.com/pub/na/13432>.
- Sulaiman Al-Zuhair,(1) K. B. Ramachandran,(2) Mohamed Farid,(3) Mohamed Kheireddine Aroua,(4) Praveen Vadlani,(5) Subramanian Ramakrishnan,(6) and Lucia Gardossi(7). "Enzymes in Biofuels Production" Volume 2011, no. Article ID 658263 (2011). <http://www.hindawi.com/journals/er/2011/658263/>.

People to contact:

- Great Lakes Bioenergy <http://www.glbrc.org/about/ourleadership>
- Purdue Discovery Park
- Dr. Clint Chappell <http://www.gradschool.purdue.edu/PULSe/faculty.cfm?fid=165&range=0>
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Email: kwalz@matcmadison.edu
- NREL <http://www.nrel.gov/biomass/news/2010/896.html>

Videos:

- National Geographic Channel: Aftermath World Without Oil (Part 1); <http://www.youtube.com/watch?v=mVzG98zHQrc>
- National Geographic Channel: Aftermath World Without Oil (Part 2) <http://www.youtube.com/watch?v=RVvacFmgoB4&feature=related>

- National Geographic Channel: Aftermath World Without Oil (Part 3)
<http://www.youtube.com/watch?v=tozcI--pqnl&feature=relmfu>

Websites: Used for Labs

- Brown, Judy. “Beano Lab”, n.d. <http://www.accessexcellence.org/AE/ATG/data/released/0167-JudyBrown/description.php>.
- “Enzyme Activity Lab”. Oracle Think Quest, n.d. http://library.thinkquest.org/27819/enzyme_activity_lab.html.
- “Enzyme Lab”, n.d. www.schenectady.k12.ny.us/.../Enzyme%20Activity%20Lab.pdf.
- Wartski, Bert. “Lactase Enzyme Lab”, n.d. <http://www.learnnc.org/lp/pages/3398>.

Supplies for Individual Laboratories:

Laboratory	Materials to Use
Toothpick Breakdown Enzyme Simulation	-Toothpicks (an entire box for each student group) -Stopwatch -Graph Paper
Exploring Enzymes Experimental Investigations	<i>Some of these items will be used in multiple labs</i> -Glucose Monitors -Glucose Test strips -Cellulase Enzymes -Cellulose Source -Potatoes -Hydrogen Peroxide -Beano -Vernier Gas Pressure Sensors -Vernier Labquest Probes -Test Tubes -test tube racks -pH Buffers -Hot water bath -Ice -Refrigerator -Microwave -Blender -Thermometers
Quantitative Analysis of Experimental	Bio Rad: Biofuel Enzyme Kit - 166-5035EDU

Mushroom Extracts	
Lactase Lab	<p>-Lactase Tablet: These can be bought in any drugstore or grocery store.</p> <p>-15 ml of Milk: Any milk will work.</p> <p>-Water: Used for dissolving the lactase tablet, dissolving the sucrose and boiling the lactase.</p> <p>-Sucrose: 5 grams per group.</p> <p>-100 ml Graduated Cylinder/10 ml Graduated Cylinder: Measuring water and enzyme amounts.</p> <p>-3 - 400 ml Beakers: Used for dissolving the lactase tablet, dissolving the sucrose and boiling the lactase.</p> <p>-Marking Pencil: Mark the test tubes so that confusion does not occur.</p> <p>-Hot Plate with a Pyrex Test Tube: For denaturing the enzyme.</p> <p>-Stirring Rod: Helps to mix up the lactase tablet in the water.</p>
Enzyme Lab: Chicken Liver	<p>-Chicken Liver</p> <p>-3 -100mL beakers</p> <p>-10mL graduated cylinder</p> <p>-Ice</p> <p>-15 test tubes</p> <p>-Triple Beam Balance</p> <p>-Petri Dish</p> <p>-Scalpel</p> <p>-Ruler</p>
Enzyme Activity Lab (various biological conditions)	<p>-colorimeter test tubes</p> <p>-Spec 20 colorimeter</p> <p>-diluted turnip extract (1mL of extract per 200 mL of water)</p> <p>-guaiacol (Sigma-Aldrich)</p> <p>-micropipette</p>

What kinds of outside experts will you involve in the unit? Who are some specific people you might contact? Where in the unit will you include them?

Outside Experts: When each individual group is ready to discuss with an expert. Potentially it will probably be the second week of the project. Alternatively, expert knowledge may also be useful toward the end of the first week when students are researching biomass to biofuels chemical reactions. The expert may be useful in explaining and answering questions about the nature of the reactions students are researching. Students could ask the expert to clarify any misunderstandings about the content they are struggling with.

- Great Lakes Bioenergy <http://www.glbrc.org/about/ourleadership>
- Purdue Discovery Park
- Biodigesters

- Reynolds, In
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(812) 865-3232
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- Wisconsin: Kenneth A. Walz, Ph.D.
 - Chemistry and Engineering Instructor
 - Phone: 608-843-0126
 - Email: kwalz@matcmadison.edu
- NREL <http://www.nrel.gov/biomass/news/2010/896.html>

Where can students find labs that test the role of an enzyme:

- www.learnnc.org/lp/pages/3398
- glencoe.mcgraw-hill.com/sites/0078759864/.../virtual_labs.html
- www.phschool.com/science/biology_place/labbench/lab2/intro.html (virtual lab)
- www2.vernier.com/sample_labs/BWCALC-06A-enzyme_action.pdf
- www.schenectady.k12.ny.us/.../russellenzymelab/
- www.uta.edu/biology/1441_lab/Notes_Enzymes.pdf
- mdk12.org/.../enzyme_activity/teachers_guide_engagement2.html
- www.youtube.com/watch?v=BCJpxCgS2DE
- library.thinkquest.org/27819/LabPack.pdf
- www.hwscience.com/.../Labs/U1-L-Enzyme%20Activity%202011-12.p...

What technology will be available for student use?

Computers with Internet connections and printers
cell phones (belonging to the students)
cameras (still and video)
Google Docs
Google Sites
Glogster
Prezi
Wikispaces
Aggregators
Diigo
Prism/Moodle/Angel
Easybib

How will you help students identify and use appropriate resources and tools to gather, analyze, and present information from these investigations?

PROCEDURES: Students will use the internet to research procedures for their lab questions after they have come up with the question they wish to investigate and worked on a procedure as a group. Writing lab procedures is something we work on all year so students have already worked

on this aspect. With the right type of questions from the teacher students should be able to write at least part if not all of their procedure in their groups. If not we can point them to an internet search of labs that have been written testing the variable they have chosen. This should help them with their procedures.

TOOLS: We will have practiced many of the data collecting tools throughout the course of the year to this date. Any the students who are not familiar with any particular lab tools will be addressed on a one on one basis or we will allow the students to look up videos and instructions on the internet.

PRESENTATIONS: Student groups will be expected to turn in written lab reports. Before they are turned in they will share their information through what we call a BoardRoom Discussion. Students will use whiteboards to record the essential parts and data from their lab and will then share them with their classmates during the discussion time. Classmates will have an opportunity to question each of the other groups.

Guiding Questions for Lab Activities:

- Brown, Judy. “Beano Lab”, n.d. <http://www.accessexcellence.org/AE/ATG/data/released/0167-JudyBrown/description.php>.
How do the environmental factors of **temperature** and **pH** influence enzymatic reactions?
- “Enzyme Activity Lab”. Oracle Think Quest, n.d. http://library.thinkquest.org/27819/enzyme_activity_lab.html.
How do selected environmental factors influence the **rate** of an enzyme-controlled reaction?
- “Enzyme Lab”, n.d. <http://www.schenectady.k12.ny.us/techresources/EETT/russellenzymelab/Enzyme%20Activity%20Lab.pdf>.
What are the **independent** and **dependent** variables in this lab?
- Wartski, Bert. “Lactase Enzyme Lab”, n.d. <http://www.learnnc.org/lp/pages/3398>.
What is meant by the **specificity** of an enzyme? What does it mean when an enzyme is said to be **denatured**?