STEM Curriculum Planning Guide

This instructional design guide serves as the template for the design and development of STEM units of instruction at the Dayton Regional STEM Center in Dayton, Ohio. The guide is anchored to the *STEM Education Quality Framework* also developed at the Dayton Regional STEM Center.

STEM Unit Title	**It's NOT Easy being Green Algae!**
Economic Cluster	Agricultural Engineering Environmental Engineering Power and Propulsion
Targeted Grades	10-11
STEM Disciplines	Science Technology Engineering Math
Non-STEM Disciplines	English Language Arts Social Studies Fine Arts

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Section I: STEM Unit Overview

Unit Overview

After being initially exposed to the basics of photosynthesis and cellular respiration, student teams design an algae growth chamber focusing primarily on producing large quantities of algae. Teams collect and measure algae on a daily basis, and research uses of algae for a sustainable fuel source. In order to inform the public about the potential benefits of using algae as a biofuel, students produce and film an infomercial depicting collected growth chamber results and research.

Essential Question

How can the environment of algae be altered in order to optimize its rate of growth and production for its potential use as a sustainable fuel source?

Enduring Understanding

Algae requires an ideal environment to optimize growth and oil production quantities for use as a sustainable energy source.

Burning of fossil fuels is not a sustainable source of energy; an alternative method of energy is needed in order to sustain life.

Engineering Design Challenge

Students are engaged in the engineering design process, and research to decide independent variables affecting algae's growth rate. Engineering teams design an algae growing chamber, and test it daily by measuring and recording the algae's growth. Students sketch conceptual design plans and use a decision analysis matrix to choose the optimal team design. Teams test the effectiveness of their design by measuring and recording their algae's dry weight daily. Results are analyzed daily and used to modify their design as necessary. In order to inform the public about the potential benefits of using algae as a biofuel, each team produces and films an infomercial depicting collected growth chamber results and research.

Time and Activity Overview

Day	Time Allotment	Actvities
1	50 Minutes	Pre-Test Video: "Nova Science Now: Algae Fuel" (10m) Engineering Design Challenge Introduction Brainstorm and Research Homework: Individual Sketches; Science American Algae Article
2	50 Minutes	Article Discussion Individual Sketches Scored on Decision Analysis Matrix Final Design Choice and Sketch
3	50 Minutes	Design Construction Base-Line Measurement Data Collection

4	50 Minutes	Collect Measurement Data Movie Clip: "2100" (15m) Begin PSA Brainstorming
5	50 Minutes	Collect Measurement Data PSA Lab Report
6	50 Minutes	Collect Measurement Data PSA Lab Report
7	50 Minutes	Collect Measurement Data Finalize PSA Lab Report
8	50 Minutes	Collect Measurement Data PSA Presentations
9	50 Minutes	Final Measurements Data Collection Post-Test

Pre-requisite Knowledge & Skill

Students apply their working knowledge of photosynthesis and cellular respiration.

Academic Content Standards

Add Standard	**Mathematics**	Ohio
Grade/Conceptual Category	9-12	
Domain	Statistics and Probability	
Cluster	Interpreting Categorical and Qualitative Data	
Standards	-Represent data with plots on the real number line (dot plots, histograms, and boxplots). -Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.	

Add Standard	**English Language Arts**	Ohio
Grade	9-10	
Strand	Reading Standards for Literacy in Science and Technical Subjects 6–12	
Topic	Key Ideas and Details	
Standard	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.	

Add Standard	English Language Arts	Ohio
Grade	11-12	
Strand	Reading Standards for Literacy in Science and Technical Subjects 6–12	
Topic	Key Ideas and Details	

Add Standard	English Language Arts	Ohio
Standard	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.	

Add Standard	English Language Arts	Ohio
Grade	9-10	
Strand	Reading Standards for Literacy in Science and Technical Subjects 6–12	
Topic	Craft and Structure	
Standard	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).	

Add Standard	English Language Arts	Ohio
Grade	11-12	
Strand	Reading Standards for Literacy in Science and Technical Subjects 6–12	
Topic	Craft and Structure	
Standard	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.	

Add Standard	English Language Arts	Ohio
Add Standard	English Language Arts	Ohio
Grade	9-10	
Strand	Reading Standards for Literacy in Science and Technical Subjects 6–12	
Topic	Integration of Knowledge and Ideas	
Standard	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.	

Add Standard	English Language Arts	Ohio
Grade	11-12	
Strand	Reading Standards for Literacy in Science and Technical Subjects 6–12	
Topic	Integration of Knowledge and Ideas	
Standard	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.	

Add Standard	English Language Arts	Ohio
Grade	9-10	
Strand	Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects 6–12	
Topic	Text Types and Purposes	

Add Standard	English Language Arts	Ohio
Standard	1. Write arguments focused on discipline-specific content. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented. 2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).	

Add Standard	English Language Arts	Ohio
Grade	11-12	
Strand	Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects 6–12	
Topic	Text Types and Purposes	

Add Standard	English Language Arts	Ohio
Standard	1. Write arguments focused on discipline-specific content. a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases. c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). 2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).	

Add Standard	English Language Arts	Ohio
Grade	9-10	
Strand	Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects 6–12	
Topic	Production and Distribution of Writing	
Standard	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.	

Add Standard	English Language Arts	Ohio

Add Standard	English Language Arts	Ohio
Grade	11-12	
Strand	Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects 6–12	
Topic	Production and Distribution of Writing	
Standard	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.	

Add Standard	English Language Arts	Ohio
Grade	9-10	
Strand	Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects 6–12	
Topic	Research to Build and Present Knowledge	
Standard	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively;	

Add Standard	English Language Arts	Ohio
Add Standard	English Language Arts	Ohio
Grade	11-12	
Strand	Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects 6–12	
Topic	Research to Build and Present Knowledge	
Standard	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively;	

Add Standard	Social Studies	Ohio
Grade	High School	
Theme	Contemporary World Issues	
Strand (pk-8 only)		
Topic	Sustainability	
Content Standard	Decisions about human activities made by individuals and societies have implications for both current and future generations, including intended and unintended consequences. Sustainability issues are interpreted and treated differently by people viewing them from various political, economic and cultural perspectives.	

Add Standard	**Social Studies**	Ohio
Grade	High School	
Theme	Contemporary World Issues	
Strand (pk-8 only)		
Topic	Technology	

Add Standard	**Social Studies**	Ohio
Content Standard	The development and use of technology influences economic, political, ethical and social issues. Technologies inevitably involve trade-offs between costs and benefits. Decisions about the use of products and	

Add Standard	**Social Studies**	Ohio
Grade	High School	
Theme	American Government	
Strand (pk-8 only)		
Topic	Civic Involvement	
Content Standard	Political parties, interest groups and the media provide opportunities for civic involvement through various means.	

Add Standard	**Social Studies**	Ohio
Grade	High School	
Theme	American Government	
Strand (pk-8 only)		
Topic	Topic: Civic Participation and Skills	
Content Standard	Issues can be analyzed through the critical use of information from public records, surveys, research data and policy positions of advocacy groups.	

Add Standard	Science	Ohio
Grade		
Theme		
Topic		
Content Standard		

Add Standard	Science	Ohio
Strand	Life Science	
Course Content	Cellular Processes	
Content Elaboration	-Characteristics of life regulated by cellular processes -Photosynthesis, chemosynthesis, cellular respiration	

Add Standard	Science	Ohio
Strand	Earth Systems	
Course Content	Interconnected Spheres of Earth	
Content Elaboration	-Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere -Energy transformations on global, regional and local scales -Biogeochemical cycles -Ecosystems -Climate and weather	

Add Standard	**Fine Arts**	
Grade	9-12	
Subject	Visual Art Standards	
Standard	Producing/Performing	
Benchmark		

Add Standard	**Fine Arts**	
Indicator	Prepare artworks for display that demonstrate high levels of craftsmanship Explore and expand on personal art applications through the use of available digital tools, innovative technologies and	

Add Standard	**Technology**	
Grade	9-12	
Standard	Technology for Productivity Applications	
Benchmark	Students learn the operations of technology through the usage of technology and productivity tools.	
Indicator	Students use computer and multimedia resources to support their learning. Students understand terminology, communicate technically and select the appropriate technology tool based on their needs. They use technology tools to collaborate, plan and produce a sample product to enhance their learning and solve problems by investigating,	

Add Standard	**Technology**	
Grade	9-12	
Standard	Design	
Benchmark	Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.	
Indicator	Students recognize the attributes of design; that it is purposeful, based on requirements, systematic, iterative, creative, and provides solution and alternatives. Students explain critical design factors and/or processes in the development, application and utilization of technology as a key process in problem-solving. Students describe inventors and their inventions, multiple inventions that solve the same problem, and how design has affected their community. They apply and explain the contribution of thinking and procedural steps to create an appropriate design	

Add Standard	Technology	

Add Standard	Technology	
Grade	9-12	
Standard	Designed World	
Benchmark	Students understand how the physical, informational and bio-related technological systems of the designed world are brought about by the design process. Critical to this will be students' understanding of their role in the designed world:	
Indicator	Students learn that the designed world consists of technological systems* reflecting the modifications that humans have made to the natural world to satisfy their own needs and wants. Students understand how, through the design process, the resources: materials, tools and machines, information, energy, capital, time and people are used in the	

Assessment Plan

What evidence will show that students have acquired the enduring understandings for this STEM unit?

Performance Task, Projects	Design an Algae Growing Chamber and Facilitate Growth Read and Reflect on Scientific Research on Biofuels Team Public Service Announcement
Quizzes, Tests, Academic Prompts	Pre/Post Test Technical Laboratory Report Team Public Service Announcement
Other Evidence (e.g. observations, work samples, student artifacts, etc.)	Individual Design Sketches Team Final Design Team Public Service Announcement Student Lab Reports
Student Self- Assessment	Reflections on Research Article Conclusion on Lab Reports

Technology Integration

ADISC Technology Integration Model*

	Type of Integration	Application(s) in this STEM Unit
A	Technology tools and resources that support students and teachers in ***adjusting, adapting, or augmenting*** teaching and learning to meet the needs of individual learners or groups of learners.	Level reading Headphones for distractions Web Clips/video for concept reinforcement
D	Technology tools and resources that support students and teachers in ***dealing effectively with data***, including data management, manipulation, and display.	Microsoft Excel Spreadsheet
I	Technology tools and resources that support students and teachers in conducting ***inquiry***, including the effective use of Internet research methods.	Web and database inquiry- research
S	Technology tools and resources that support students and teachers in ***simulating*** real world phenomena including the modeling of physical, social, economic, and mathematical relationships.	hydro filtration devise - measurement of algae growth algae drying techniques Team Public Service Announcement

C	Technology tools and resources that support students and teachers in ***communicating and collaborating*** including the effective use of multimedia tools and online collaboration.	computer generate movie maker (Team Public Service Announcement) Web clips: www.pbs.org/wgbh/nova/tech/algae-fuel.html www.soche.org/initiatives/sochetv/201-soche-talks-algae-is-the-answer
	**The ADISC Model was developed by James Rowley PhD, Executive Director of the Institute for Technology-Enhanced Learning at the University of Dayton*	

Career Connections

Career Description

Environmental engineers- use various engineering disciplines to carry out tasks pertaining to the management of environmental health risks. Their scope of work may include designing and planning waste management, site remediation and technologies related to pollution control.

Environmental consultant- offer advice on various environmental issues like pollution control measure, bio-energy, wildlife, climatic changes and so on.

Chemical Engineer-Some make designs and invent new processes. Some construct instruments and facilities. Some plan and operate facilities. Chemical engineers have helped develop atomic science, polymers, paper, dyes, drugs, plastics, fertilizers, foods, textiles, and chemicals. They devise ways to make products from raw materials and ways to convert one material into another useful form. Chemical engineers can make processes more cost effective or more environmentally friendly or more efficient. A chemical engineer can find a niche in any scientific or engineering field.

Mechanical Engineer- heavily involved in the management of people and resources as well as the development and use of new materials and technologies, especially computer-aided engineering. A rapidly growing field for mechanical engineers is environmental control, comprising the development of machines and processes that will produce fewer pollutants, as well as the development of new equipment and techniques to reduce or remove existing pollution. Mechanical Engineers are committed to the use of technology to improve the quality of life for society as a whole.

Environmental scientists- carry out researches and investigations to abate and eliminate the factors that pose threat to the environment and its denizens.

Environmental technicians- use comprehensive knowledge of waste recycling and environmental hazards management measures in acquiring and handling data. They mostly use computer software to do so.

Section II: STEM Lesson Plan

Title of Lesson

Day 1: Brainstorming

Time Required

50 minutes

Materials

Appendix A: Pre/Post-Test (1 per student)
Appendix H: Pre/Post-Test KEY (1 per teacher)
Appendix B: Engineering Design Challenge and Rubric (1 per student)
Appendix C: Material Price List (1 per student)
Appendix D: Decision Analysis Matrix (1 per team)
Appendix K: Teaching Notes (1 per teacher)
Appendix E: "Is Algae the Biofuel of the Future?" Article Analysis (1 per student)
"Is Algae the Biofuel of the future?" Scientific American Article:
http://www.scientificamerican.com/article.cfm?id=algae-biofuel-of-future
Video: "Nova Science Now: Algae Fuel:" http://www.pbs.org/wgbh/nova/tech/algae-fuel.html (10m57s)

Suggested Materials for use Throughout Challenge (not inclusive-supplies can be added or quantities changed)
Make enough of each available from which teams can choose:
Gatorade Bottle (1)
24 oz Glad Container (1)
6 Inch Piece of Aluminum Foil (1)
Gallon Size Ziploc Freezer Bag (1)
Aluminum Pie Plate (1)
Drinking Straws (1)
Assorted Sized Balloons (2)
Empty Milk Carton (1)
Craft/Popsicle Sticks (2-4)
Dixie Cup ½ Filled with Aquarium Gravel (1)
Pipe Cleaners (2-4)
4-inch Piece of PVC (1)
Active Dry Yeast Packet (1)
Alka-Seltzer Tablet (1)
Plastic Flexible Tubing-any available length (1)
18g or 1 tbs. Miracle Grow (1)
Hot Glue Gun (1)
Hot Glue Sticks (5-10)
Piece of Sand Paper (1)
Roll of Scotch Tape (1)
Roll of Masking Tape (1)
500 ml Beaker (1)
Distilled Water (1 liter)
5g of Algae (1)

Objectives

Students will practice effective brainstorming and collaborating techniques in order to plan the design an algae growing chamber.

Students will explore the use of algae as sustainable biofuel, and be able to explain the benefits of using algae as a biofuel.

Instructional Process

1. Administer Pre-Test.
2. Show "Nova Science Now: Algae Fuel:" http://www.pbs.org/wgbh/nova/tech/algae-fuel.html (10m57s) video. Discuss and analyze the video as a class.
3. Facilitate a discussion on the need for an alternate, sustainable fuel sources.
4. Review concepts of photosynthesis and cellular respiration.
5. Distribute and discuss Engineering Design Challenge and Rubric and Material Price Sheet and discuss the challenge.
6. Explain that they each have a budget of $500 and will need to decide which supplies to purchase for their design and design.
7. Distribute Decision Analysis Matrix and have teams define goals (constraints and objectives) needed for their team's algae growing chamber.
8. Distribute “Is Algae the Biofuel of the future?” Scientific American Article and instruct students to complete “Is Algae the Biofuel of the Future?” Article Analysis. Assign for homework if not completed in class.
9. Homework: Individual design plan.

Differentiation

Small group instruction to review key vocabulary/concepts re: Alternative fuel sources, Photosynthesis and Cellular Respiration possibly provide guided cloze notes. For brainstorming activity, consider providing more or less post-it notes based on individual student needs. Provide small group instruction for students to explore the engineering process prior to introducing the challenge.

Assessments

Pre-Test scores should be used for assessing student's prior knowledge and modifying the unit accordingly.
Discussion
Decision Analysis Matrix team goals

Section II: STEM Lesson Plan

Title of Lesson	**Day 2: Team Collaboration and Design Plan.**
Time Required	50 minutes
Materials	See Day 1

Objectives	Students will engage in team discussions in order to decide on a final design for an algae growing chamber. Students will be able to gather needed supplies for growing chamber and stick to a budget.
Instructional Process	1. Have students present individual design ideas to their teams while scoring each on the Decision Analysis Matrix. Instruct them to follow the Matrix Instructions for scoring and using it as a tool for choosing and sketching a final team design plan. 2. Instruct teams to determine a method for recording and deducting costs as materials are purchased. Consider initialing or checking off each purchase made if you feel there is a need. Have teams create a cost analysis of materials needed for their team design. Dependant on time, they may either begin purchasing now or wait until the following class period.
Differentiation	No modifications needed for this day's lesson. Inclusion students will be part of the decision of final design and supplies needed for their design. Previous day's small group instruction served as preparation for them for today's engineering process activities.
Assessments	"Is Algae the fuel of the future?" Article Analysis Individual design plan Design Matrix Final Design Plan Cost Analysis

Section II: STEM Lesson Plan

Title of Lesson

Day 3: Team Design and Building Prototypes

Time Required

50 minutes

Materials

Appendix B: Engineering Design Challenge and Rubric (1 per student)
Appendix C: Material Price List (1 per student)
Appendix D: Decision Analysis Matrix (1 per team)
Appendix L: Vacuum Filtration Set-Up Diagram (1 per team)

Materials per Team:
Stopwatch (1)
Filter Circles or Heavy Coffee Filters (5)
Filter Flask (1)
12 - 24 inch Plastic Tubing (1)
Rubber Stopper with Hole (1)
Buchner Funnel (1)

Materials per Class:
Vacuum pump faucet aspirator (dependant on number of sinks available)

Objectives

Students will apply knowledge gained by constructing a chamber for growing algae, and be able to explain the factors needed for algae growth.

Students will be able to extract and record baseline data from algae growing chamber using an apparatus for vacuum filtration.

Instructional Process

1. Have students purchase materials and begin construction of their algae growing chamber. Remind them to gather base-line data.
2. Instruct students to set up their apparatus for vacuum filtration as shown in Vacuum Filtration Set-Up Diagram.
3. Designate a storage area for algae growing chambers.

Differentiation

Provide assistance for gathering baseline data.

Assessments

Prototype construction
Baseline data collection

Section II: STEM Lesson Plan

Title of Lesson	**Day 4: What is Algae Good For?**
Time Required	50 minutes
Materials	Computer with Internet Access and Projection Capabilities (1) Appendix F: Team PSA Rubric (1 per student) Webcams, Video Camera, or Cell Phone Video Recorder Post-it Notes (5 per student) Large Chart Paper (1 per team) Video: "Earth 2100" ABC News (DVD): http://abcnews.go.com/Technology/Earth2100 (15m)
Objectives	Students will analyze the process by which their growing chamber was designed as well as collected data in order to brainstorm ideas for the production of a public service announcement.
Instructional Process	1. View and discuss the first 15 minutes of “Earth 2100” video. 2. Assign Team Public Service Announcement using the rubric as a guide. Have teams use webcams, video camera, or cell phone camera to record these. Teams may also use video editing software of their choice. 3. Give students time to use brainstorm PSA ideas using post-its placed on large chart paper.
Differentiation	No modifications needed for this day’s lesson. Inclusion students will be part of the process of determining the burn rates of kerosene, ethanol and algae. Assist with calculations as needed. Small group/inclusion students will read “Is algae the Bio-fuel of the Future?” and answer accompanying questions. Small group instruction to prepare for/understand the parts required to complete a technical report.
Assessments	Discussion PSA brainstorming

Section II: STEM Lesson Plan

Title of Lesson

Day 5: Constructing an Individual Laboratory Report and a Team Public Service Announcement

Time Required

50 minutes

Materials

Computers with Internet Access (1 per student)
Appendix F: Team PSA Rubric (1 per student)
Appendix G: Laboratory Report Rubric (1 per student)
Cardboard or a tri-fold presentation board (1 per team)

Objectives

Students will reflect on the engineering design process by integrating quantitative observations into laboratory report format.

Instructional Process

1. Allow time for teams to collect data from algae growing chamber
2. Distribute Laboratory Report Rubric and instruct them to begin completing a rough drafts of the introduction, design selection process, and final design sections of their reports.
3. Collect rough drafts and provide feedback.

Differentiation

Depending on the skill/ability level of students, technical report (if homogenous grouping is used for efficient use of time and small group instruction) could be in “chart” format. All sections would be listed (given) then filled-in based on individual need.

Assessments

Rough Drafts of Introduction, design selection and final design

Section II: STEM Lesson Plan

Title of Lesson	**Day 6: Constructing an Individual Laboratory Report and a Team Public Service Announcement (continued)**
Time Required	50 minutes
Materials	Computers with Internet access (1 per person) Appendix F: Team PSA Rubric (1 per student) Appendix G: Laboratory Report Rubric (1 per student) Cardboard / or Presentation Tri-Fold (one per team of 4-6 students)
Objectives	Students will reflect on the engineering design process by integrating their quantitative information into a report format.
Instructional Process	1. Allow time for teams to collect data from algae growing chamber. 2. Hand back the rough drafts with feedback from the previous day. 3. Instruct students to complete rough drafts of technical aspects of report, charts and graphs for report -OR - finalize their Team PSA if needed. 4. Homework: Continue work on Laboratory Report Rubric. Teams my distribute tasks amongst themselves.
Differentiation	Small group instruction to review process to date; work on group's rough draft of the technical aspects of the report, charts and graphs.
Assessments	Rough draft of technical aspects of report, charts and graphs

Section II: STEM Lesson Plan

Title of Lesson	**Day 7: Individual Laboratory Report and Team Public Service Announcements**
Time Required	50 minutes
Materials	Computers with Internet Access (1 per student) Appendix F: Team PSA Rubric (1 per student) Appendix G: Laboratory Report Rubric (1 per student)

Objectives	Students will reflect on the engineering design process by integrating their quantitative information into a report format.
Instructional Process	1. Allow time for teams to collect data from algae growing chamber. 2. Hand back rough drafts with comments from the previous day. 3. Instruct students to complete final draft of their lab reports and finalize their team PSA presentation the following day.. 4. Homework: Complete lab reports and/or PSA if needed. Teams my distribute tasks amongst themselves.
Differentiation	Small group instruction to review process to date; work together on rough draft of the technical aspects of the report, charts and graphs with particular teams.
Assessments	Prototype Data

Section II: STEM Lesson Plan

Title of Lesson

Day 8: eam Public Service Announcement Presentations

Time Required

50 minutes

Materials

Team Final Prototypes
Team Public Service Announcement
Appendix F: Team PSA Rubric (1 per student)
Computer/ DVD player

Objectives

Students will be able to effectively communicate their prototype design and outcomes through a multimedia public service announcement.

Instructional Process

1. Allow time for teams to collect final data from algae growing chamber.
2. Have teams present their Team Public Service Announcement to the class as you score them on the rubric.
3. Homework: Complete Laboratory Report if needed.

Differentiation

No differentiation needed.

Assessments

Team Public Service Announcement Rubric

Section II: STEM Lesson Plan

Title of Lesson	**Day 9: Post-Test and Wrap-Up**
Time Required	50 minutes
Materials	Appendix A: Pre/Post-Test (1 per student)

Objectives	Students will demonstrate knowledge gained throughout the unit by completion of a post-test.
Instructional Process	1. Administer Post-Test. 2. Collect Lab Reports. 3. If time remains, instruct students to write a reflection regarding their results, concepts learned, ways in which their design was successful/unsuccessful, and suggestions for future improvements.
Differentiation	Modify test as needed for individual students.
Assessments	Post-Test Laboratory Report Rubric Reflection

Section III: Unit Resources

Materials and Resource Master List

"Earth 2100" ABC News Video Clip (DVD)
Post-It Notes (10 - 15 per student)
Chart Paper (1 piece per team)
Vacuum Pump Faucet Aspirator (depends on number of sinks available)
Computers with Internet Access and Projection Capabilities (1)
Computers with Internet Access (1 per student)
Cardboard or a Tri-fold Presentation Board (optional-for displaying laboratory reports)
DVD player

Suggested Materials for use Throughout Challenge (not inclusive-supplies can be added or quantities changed)
Make enough of each available from which teams can choose:
Gatorade Bottle (1)
24 oz Glad Container (1)
6 Inch Piece of Aluminum Foil (1)
Gallon Size Ziploc Freezer Bag (1)
Aluminum Pie Plate (1)
Drinking Straws (1)
Assorted Sized Balloons (2)
Empty Milk Carton (1)
Craft/Popsicle Sticks (2-4)
Dixie Cup ½ Filled with Aquarium Gravel (1)
Pipe Cleaners (2-4)
4-inch Piece of PVC (1)
Active Dry Yeast Packet (1)
Alka-Seltzer Tablet (1)
Plastic Flexible Tubing-any available length (1)
18g or 1 tbs. Miracle Grow (1)
Hot Glue Gun (1)
Hot Glue Sticks (5-10)
Piece of Sand Paper (1)
Roll of Scotch Tape (1)
Roll of Masking Tape (1)
500 ml Beaker (1)
Distilled Water (1 liter)
5g of Algae (1)

Materials per Team:
Stopwatch (1)
Filter Circles or Heavy Coffee Filters (5)
Filter Flask (1)
12 - 24 inch Plastic Tubing (1)
Rubber Stopper with Hole (1)
Buchner Funnel (1)
Webcams, Video Camera, or Cell Phone Video Recorder

Materials per Class:
Vacuum pump faucet aspirator (dependant on number of sinks available)

Key Vocabulary

Bio-fuel -
a source of energy which has been derived from living matter.

Biomass -
the total amount of living material in a given habitat, population or sample.

Cellular Respiration -
the oxidation of organic compounds that occurs within cells, producing energy for cellular processes.
Dry weight -
used to express biomass and is the weight of the living material after the removal of the water.

Energy -
the ability to do work or to cause change.

Inexhaustible energy -
energy that cannot be used up by humans for many years.

Nonrenewable energy -
an energy source that is used up much faster than it can be replaced.

Photosynthesis -
the complex process by which carbon dioxide, water and certain organic salts are converted into carbohydrates by green plants, algae and certain bacteria, using energy from the sun and chlorophyll.

Renewable energy -
an energy source that is replenished continually.

Sustainability -
something's ability to endure

Transform -
to change into something else.

Technical Brief

Design Process Vocabulary:
Brainstorming Designs: (sketches) present each design to group and be able justify the chosen design.
Final Design: Give details of the final design your group decided to go with and build. Save this sketch for your final report. Show dimensions and materials you plan to use. Give as much detail as you can.
Technical Aspect of Design: Describe the math, science and engineering principles that you applied in designing your project. Describe the logical reasoning as to why you chose one shape over another. How does this project connect to what you are learning in class?
Testing the Design: your methods and specific information regarding how your algae weighed

Photosynthesis and Cellular Respiration:
Photosynthesis is the process that plants undergo that uses the energy from the sun to convert Carbon Dioxide and water into oxygen and glucose. Respiration is the process that animals undergo during cellular metabolism to convert Oxygen and sugars (glucose) into Carbon Dioxide and water. These processes are similar in that they both convert energy from one form to another at the cellular level. Photosynthesis converts solar energy to chemical energy and respiration converts chemical energy to mechanical energy.
Algae
Algae are tiny biological factories that use photosynthesis to transform carbon dioxide and sunlight into energy so efficiently that they can double their weight several times a day. In addition to using process of photosynthesis, algae produces oil and can generate 15 times more oil per acre than other plants used for bio-fuels, such as corn and switch grass. Algae can grow in salt water, freshwater or even contaminated water, at sea or in ponds, and on land not suitable for food production.
In order to extract the oil from algae, a drying process must be implemented filtering off the water and leaving behind the algae and the oil. This process is done using a vacuum filtration system that is attached to a faucet aspirator on a laboratory sink.

Safety and Disposal

Students will be working with living organisms, gloves are not necessary but washing hands with soap is recommended.
Algae should be collected and can be poured in a local pond or creek, used as aquarium food. Do not pour down the sink drain.
Container supplies can be recycled.
Broken glass should be disposed of in a marked container.

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University of Dayton Algae Culturing Lab - Dayton Ohio

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Section IV: Appendices

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Appendix D: Decision Analysis Matrix
Appendix E: "Is Algae the Fuel of the Future?" Article Analysis
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Appendix E-2: "Is Algae the Fuel of the Future?" Article Analysis
Appendix G-2: Laboratory Report Rubric
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