Academy of Science, Research, & Medicine
Honors Scientific Research II Syllabus (2017-2018)
Paulding County High School

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Course Description: Scientific Research II is a project-based, research-intensive course where students analyze and experiment using the scientific method and the engineering design process to produce authentic products in each student's area of interest. This course is designed to be a continuation of Honors Scientific Research I and offers an opportunity for biotechnology pathway completers to extend and refine their research from the first course. With support from mentors, researchers, and/or scientists, students will accelerate according to individual strengths and goals to develop research topics, follow specific methodologies, and share their results in engaging presentations. Projects will be interdisciplinary in nature, will require applications of new forms of technology mastered by the student, and will challenge students with high levels of critical thinking. All presentations must show cross curricular and real world relevance through proper use of technology, application, and value of the product or knowledge gained from the project. Students will be required to compete in the Georgia Science and Engineering Fair and the BioGENEius national challenge. Additionally, students will submit a research manuscript to the Journal of Emerging Investigators for peer-reviewed publication.

Grading Policy: (subject to change based county policy)

A	90-100	B	80-89	C	70-79	F	below 70

60% summative, 20% formative, 20% semester exam

Textbook: *Biotechnology by J. Kirk Brown (1st Edition; Bio-Rad Laboratories)* *Cost: $94.00*

Class/Lab Procedures and Rules: Students must return their signed Flinn Safety contracts before participating in lab-based activities. All school policies in the student handbook will be followed, as well as all lab safety rules and teacher policies. Tardy policy will be followed as listed in the handbook.

Performance Assessments will include weekly research synopses, various competitions, and manuscript.

Recommended Materials: Students will need a stitched or glue-bound research (graph) logbook for the research project. The protocol for maintain the notebooks is on www.PedersenScience.com

Next Generation Science Standards- Science & Engineering Practices:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Next Generation Science Standards- Cross-cutting Concepts:
1. Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
2. Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
3. Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
4. Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
5. Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
6. Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
7. Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Journal of Emerging Investigators (JEI): The process of going from manuscript submission to publication can take 6-10 months, depending on the reviewers' recommendations. Graduating students will likely need to continue correspondence with me to ensure eventual publication. Below are the guidelines for the manuscript format verbatim from www.emerginginvestigators.org:

"Title Page: The title page should include a title which succinctly describes the content of the manuscript. This page should also have all of the authors listed in the order in which they contributed, with the teacher or college/university mentor listed last. Please also include the school of the students and the school or place where the research was performed. Here is a Sample Title Page.

Summary (Abstract): An abstract should be a short (under 250 words) summary of the scientific question, major results, and conclusions. The abstract should be on a separate page, after the title page but before the remainder of the manuscript.

Introduction: The article must provide an appropriate and sufficient background on the subject matter and must include references. The introduction provides context for the manuscript. Think of the structure of the introduction as an "inverted pyramid" that starts very broad and then focuses on the specific question and hypothesis towards the end. It is not a comprehensive review of all the literature on the subject. The introduction should:

- briefly describe the overarching scientific topic of the paper
- provide background information on that scientific question (including references) such that the audience understands the question being asked AND why this question is of interest
- contain a clearly-stated scientific question/hypothesis
- briefly summarize the conclusions drawn from the authors' research.

Results: The results section is more than graphs and figures. The authors must describe in paragraph format how they test the scientific question with well-designed scientific experiments. It is important to discuss

experimental controls and statistical analysis when appropriate. It is also important to draw appropriate and reasonable conclusions from their experimental data. For each experiment, the authors must:

- describe the rationale for the experiment
- briefly explain how the experiment was performed (additional or lengthy details should be included in only the Materials and Methods section)
- interpret the scientific data, referencing the figures that contain the results (graphs, charts, tables, equations, etc).

Figures: Data must be presented in individually numbered figures that contain a descriptive caption. Each figure should be an individual JPEG, TIFF or PNG file. To convert an Excel graph, table or chart into a JPEG, TIFF or PNG, the easiest option is to "right click" on the graph, chart, or table and click "save as picture". Alternatively you can "copy" the graph, chart or table and "paste" it into Preview or an Adobe application such as Photoshop.

For the purposes of submission, figure captions should appear at the end of the article, after the references. If the article is accepted by JEI for publication, editors will place the figure caption underneath the appropriate figure.

Discussion: In the discussion section, the authors should discuss the results and their interpretation of the results. It is important that the authors draw appropriate and reasonable conclusions from their scientific data. The authors should:

- summarize the experimental results and draw conclusions from the experimental data
- discuss factors that could have influenced the results, such as sources of error or bias in interpretation
- address the significance of the results
- discuss remaining scientific questions and/or potential future experiments.
- Materials and Methods

The authors should describe the methods in enough detail such that a different scientist could perform the same experiments and obtain the same results. Materials should not be listed out, but should be mentioned within the context of the respective experiment that the materials were used. For example, when explaining a method within this section the author could state the materials used: "bacteria were grown in standard LB media (FisherSci) for 24 hours at 37C while shaking."

References: Citations should be in the appropriate MLA format at the end of the manuscript (http://owl.english.purdue.edu/owl/resource/747/07/). An example of a journal citation is as follows: Author(s). "Title of Article." Title of Journal. Volume. Issue (Year): pages. Medium of publication.

Citations within the manuscript should be numbered based on when they appear in the manuscript. For example, the first citation should have a (1) at the end of the sentence; this (1) should correspond to the first citation in the reference section.

Often, scientists cite research that is published in scientific journals (like JEI). Given the complexity of these journals and their lack of public availability, we encourage students to cite textbooks, encyclopedias, and science magazines as well. Internet sources, such as a well-documented Wikipedia articles, are acceptable. However, only 50% of the references may be internet sources. All internet sources will be assessed by the reviewers.

*Plagiarism: It is important that authors cite all information obtained from their sources. However, it is unacceptable to use sentences and paragraphs verbatim from a source, even if that source is cited. We encourage students to try to interpret texts to the best of their ability and explain concepts in their own words. Any manuscript that has plagiarized material will be sent back to the author for major revisions, and in extreme cases the manuscript will be declined.

Example of plagiarism: For more extensive repair, stem cells are maintained in the quiescent state, and can then be activated and mobilized to the required site.

Why is that sentence considered plagiarized? First, there is no citation, so the reader has no idea where the information came from. This is important because a reader may want more information on the topic and therefore needs to know where to obtain that information. Second, this sentence is verbatim from the website: http://www.csa.com/discoveryguides/stemcell/overview.php.

Acknowledgments: This is a section to acknowledge people who have made minor contributions to the manuscript. For example, people who have read and commented on your manuscript before submission should be acknowledged. This is also the section to state your funding sources (if any). Authors (such as the mentor, teacher, or professor) should not be acknowledged as outside help because they help write the manuscript."

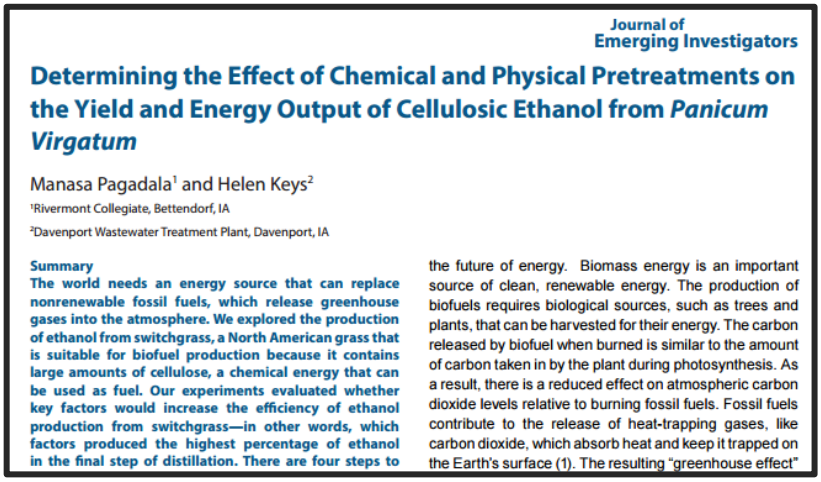
SUBMISSION:

I will submit the manuscript and directly correspond with the reviewers. This is a requirement of JEI. Please view the JEI Submission Protocol available on www.PedersenScience.com for detailed instructions.

Manuscript must be submitted as a .zip file that includes the text of the article in Word (.doc or .docx) format and each figure as a separate image (.jpg, .jpeg, or .tif). The maximum manuscript length (excluding the title page, references, figures and figure captions) is 10 pages (size 11 font, Times New Roman, 1.5 line spacing, 1 inch margins), but shorter manuscripts are quite acceptable. Do not format with columns.

All students that contributed to the project should be listed as authors, ordered based on their contribution to the project (largest contribution first). If multiple authors made the same contribution to the manuscript, note this by placing an asterix next to the students' names and a footnote on the title page that these students made equal contributions.

Here is a sample of the final publication →



Journal of Emerging Investigators

Determining the Effect of Chemical and Physical Pretreatments on the Yield and Energy Output of Cellulosic Ethanol from *Panicum Virgatum*

Manasa Pagadala[1] and Helen Keys[2]

[1]Rivermont Collegiate, Bettendorf, IA

[2]Davenport Wastewater Treatment Plant, Davenport, IA

Summary

The world needs an energy source that can replace nonrenewable fossil fuels, which release greenhouse gases into the atmosphere. We explored the production of ethanol from switchgrass, a North American grass that is suitable for biofuel production because it contains large amounts of cellulose, a chemical energy that can be used as fuel. Our experiments evaluated whether key factors would increase the efficiency of ethanol production from switchgrass—in other words, which factors produced the highest percentage of ethanol in the final step of distillation. There are four steps to

the future of energy. Biomass energy is an important source of clean, renewable energy. The production of biofuels requires biological sources, such as trees and plants, that can be harvested for their energy. The carbon released by biofuel when burned is similar to the amount of carbon taken in by the plant during photosynthesis. As a result, there is a reduced effect on atmospheric carbon dioxide levels relative to burning fossil fuels. Fossil fuels contribute to the release of heat-trapping gases, like carbon dioxide, which absorb heat and keep it trapped on the Earth's surface (1). The resulting "greenhouse effect"