Academy of Science, Research & Medicine
Biotechnology Independent Research Project (2015-2016)
Paulding County High School

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Course Description: This course is an advanced course primarily designed for seniors which places students in a workplace setting or offers the opportunity for students to complete an independent research project that applies biotechnology. The knowledge and skills gained in this course will enhance students' preparation for continuing a career pathway to post-secondary programs in biotechnology. Recommended course length is a minimum of 135 hours with content focus as delineated in the biotechnology curriculum and performance standards of the Georgia Career Related Education (CRE) Manual. A minimum of 90 internship/independent research project hours is required. The additional 45 hours may be utilized in the class or laboratory based on the guidelines set forth by the instructor and as required by affiliating agencies. This course requires strong commitment from students, parents/guardians, instructors, and affiliating agencies. Students who are participating in the internship must adhere to the Georgia Work Based Learning Standards and Guidelines. Students will be required to make a written and oral presentation at the end of the course summarizing their research project/internship experiences and submit an updated career portfolio.

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 but will not be limited to lab-based practicals, quizzes, unit tests, lab reports, research projects, portfolios and final exams.

Recommended Materials: In addition to paper and a writing utensil, students will also need a binder and a stitched or glue-bound research (graph) logbook and a designated area in their notebook for science materials (notes, labs, warm-ups, etc.).

Required Competitions: Students will also be required to compete in a variety of research and scientific knowledge competitions. Examples of this might include the Georgia Science Fair, Georgia Science Olympiad, Biogenius, etc. Below is a list of possible competitions:

Symposium: http://www.georgiacenter.uga.edu/youth/academic-special-programs/georgia-junior-science-humanities-symposium

Siemens Foundation Competition (can be part of science fair prep too): http://www.siemens-foundation.org/programs/the-siemens-competition-in-math-science-technology/

Young Naturalist Awards (American Museum of Natural History) also stems from Science Fair project: http://www.amnh.org/learn-teach/young-naturalist-awards

Google Science Fair (could also stem from similar science fair project): https://www.googlesciencefair.com/en/

ACS Chemistry Competition (students could choose this and show how they prepped to compete, etc): https://www.acs.org/content/acs/en/education/students/highschool/olympiad/process/competitions.html

Georgia Science Olympiad for high school teams: http://www.spsu.edu/gaso/division_c/index.htm

National Ocean Sciences Bowl (there are regional and state events too): http://nosb.org/

Global Environment Competition (using global satellite imagery on web): http://www.strategies.org/education/student-contests/thacher-contest/

Envirothon: http://www.envirothon.org/

Environmental Youth Award: http://www2.epa.gov/education/presidents-environmental-youth-award

Neuroscience studies: http://tools.aan.com/science/awards/?fuseaction=home.info&id=11

Brain Bee competition (on neuroscience) – several Atlanta based competitions, but Emory looked closest: https://sites.google.com/site/atlantaregionalbrainbee/2015-competition

Ecybermission: https://www.ecybermission.com/

Dupont Essay competition: http://thechallenge.dupont.com/essay/

Exploravision Competition: http://www.exploravision.org/for-teachers

Future Problem Solving Competition: http://www.fpspi.org/

National Science Bowl: http://science.energy.gov/wdts/nsb

I'm listing a few depending on what is done with DNA (as bristle worms) this one is for beetles so I didn't want to rule it out: http://www.coleopsoc.org/default.asp?Action=Show_SocietyInfo&ID=Youth

Biotechnology: http://www.biotechinstitute.org/go.cfm?do=Page.View&pid=89

Biogenius competition: http://www.biotechinstitute.org/go.cfm?do=page.view&pid=32

STEM: http://ung.igem.org/About

A major component of the Magnet program is scientific research. As you know, scientific research involves designing a study, collecting samples, measuring variables, analyzing data, and presenting the results in a formal report. The writing process makes the author think more deeply about the study. Accurate, clear and concise writing is essential to effective communication among researchers, teachers, and students. A scientific report provides a writing experience different from a library term paper because it is based on your own data and personal involvement in the investigation. Academy students are required to complete an independent research project, which will be due at the end of the course. I strongly recommend that all students view multiple exemplars, which are posted on the classroom website. The completed project will consist of three major components: **1)** research logbook, **2)** formal research paper and **3)** visual display. Please self-assess all of your work using the Project Rubric (click here if viewing electronically) available on the website.

Section 1: General Overview

- **Pick Your Topic.** Get an idea of what you want to study over the summer break. Several suggested resources are available on the class webpage, but these are just to get you started. Ideas might come from hobbies or problems you see that need solutions, but all projects must involve biotechnology, chemistry or biology. Many ideas come from websites and books. Limit your topic and focus, not your time and effort. As you narrow your ideas, remember to choose a topic that not only interests you, but can be done in the amount of time you have**.** Your research must pertain to biology, biotechnology or chemistry.
- **Research Your Topic.** Read everything you can find on your topic. The internet is a great resource for ideas. Talk to and email professionals in the field, write to companies for information, and obtain or construct needed equipment. Arrange where you will work and who will supervise you.
- **Organize and Theorize.** Organize everything you have learned about your topic. Narrow down your hypothesis by focusing on a particular idea and make sure your research is unique and original.
- **Do Not Procrastinate.** Get out a calendar to mark important dates. Give yourself plenty of time to experiment and collect data even simple experiments do not always go as you might expect the first time, or even the second time. When you finish your experiments, reserve a few weeks to write your research paper and put together your visual display.
- **Plan Your Research.** Once you have a feasible project idea and a timetable, write out a research plan in your stitched or glue-bound research logbook. This plan should explain how you will do your experiment and exactly what it will involve.
- **Consult Your Adult Sponsor.** You are required to discuss your research plan with your teacher for approval. Safety rules must be followed using the appropriate precautions, and supervision.
- **Conduct Your Experiments.** Give careful thought to designing your experiments. As you conduct your research and experimentation, keep detailed notes of each and every experiment, measurement, and observation in a stitched or glue-bound research logbook. Remember to change only one variable at a time when experimenting, and make sure to include control experiments in which none of the variables are changed. Include sufficient numbers of test subjects in both control and experimental groups. A group should have five or more subjects to be statistically valid.
- **Examine Your Results.** When you complete your experiments, examine and organize your findings. Did your experiments give you the expected results? Why or why not? Was your experiment performed with the exact same steps each time? Are there other causes that you had not considered or observed? Were there errors in your observations? Remember that understanding errors and reporting that a suspected variable did not change the results can be valuable information. If possible, statistically analyze your data.
- **Draw Conclusions.** Which variables are important? Did you collect enough data? Do you need to do more experimenting? Keep an open mind and never alter results to fit a theory. Remember, if

your results do not support your original hypothesis, you still have accomplished successful scientific research. An experiment is done to support or refute a hypothesis.

- **Prepare Your Formal Research Paper.** Your written report is a complete discussion of your research including and is comprised of the following components: title page, table of contents, abstract, introduction, methods and materials, results, discussion, appendix and references page. All typed in 12-point font, double spaced and in APA format.
- **Make Your Visual Display.** Your visual display should be attractive, simple, and informative. It should follow the same format as your formal research paper, but use concise wording, bulleted text, graphics and pictures throughout.

Section 2: Research Logbook (stitched or glue-bound)

Your research logbook should contain accurate and detailed notes of everything you do for your research project. This includes all planning, brainstorming, initial background research, ideas, picture, sketches, rough tables, data, tables, etc. Good notes will not only show your consistency and thoroughness to the teacher, but will help when writing your formal research paper. Your research logbook should contain the following:

- Your entries should all be dated
- Your logbook should be written in ink or pencil. This is where you record your data, rough drafts of ideas, sketches, graphs, tables, pictures, etc. It does not need to be neat, but should be somewhat organized with table of contents and page numbers.
- Logbook must be bound - stitched or glued
- Divide logbook into sections (see exemplars)
- Leave Index space in the front or back of the logbook.
- Number your pages
- Include notes on contact people, emails, readings and bibliographic information
- Write down your research plan, thoughts on progress, problems, and direction
- Include your data and your thoughts about the results

Section 3: Formal Research Paper (written in third person)

Your formal research paper must be written in third person and must also contain the following sections in this order using American Psychological Association (APA) format (typed; 12-point font; double spaced):

- **Title Page.** Project title, running head, name, school and grade (APA format). The title should be informative, specific, concise and understandable. It should describe your specific research.
- **Table of Contents.** Number each section as you finish writing.
- **Abstract.** A 250-word summary of the entire research paper. The abstract is the last section written since it is a concise summary of the entire research project. It is a summary of the introduction, methods, results and discussion. The abstract must also include your hypothesis and implications of your research. Keep your abstract around 250 words in length.
- **Introduction.** The introduction should explain all the background information about your topic and the reasoning behind your choice of study. Assume the reader has very little background knowledge on the topic, so start broad and narrow your focus. Refer to previous research as well as your own experiments. Establish a strong rationale for the study by emphasizing unresolved issues or questions. Conclude by stating the research hypotheses. You should have literature citations included in American Psychological Association (APA) format. Purdue University maintains a

helpful site to guide you through the details of APA formatting. Google "APA Owl" or follow links on my website. Use proper scientific names if applicable. Be very thorough.

- **Methods & Materials.** Describe in detail the methodology used to derive your data and observations. This section is written in paragraph format (no bullets). Use photographs and drawings of your equipment to describe your experiment further. Include a precise description of the sample, any apparatus that was constructed or modified for the study, and methods of data collection. You want to be extremely detailed in your descriptions of the methods and materials.
- **Results.** The results section is not just a data summarization or a collection of tables and figures; it should contain an explanation and description of the data, including any qualitative observations you made during the study. Tell the reader exactly what you found, what patterns, trends, or relationships were observed. Present the data collected in the experiment using paragraph format and also reference and include all tables, figures and graphs. Each table, figure or graph should also include a short summary of the data in narrative form. For example, the sentence might read, "the researcher collected the following quantitative data on photosynthesis (see table 1)". The reader would then find table 1 and read the short summary of the data. Include all statistical analyses of the data in this section of the paper. Do not interpret the data in this section.
- **Discussion.** This is where you interpret your data and discuss the implications of your research. Compare your results with theoretical values, published data, commonly held beliefs and/or expected results. You will need at least two additional references in this section. You will need to revisit some of the background information from your introduction and discuss additional ideas and thoughts that have been generated as a result of your research and data. This section also includes a discussion of possible errors or problems experienced and how those errors/problems could have influenced your results. You should include proper APA citations when comparing your data to that of others. Lastly, discuss whether your data supported your hypothesis and what your next steps in experimentation may be. Discuss how a prospective researcher could extend, refine and modify your experiment to answer additional biological questions.
- **References/Bibliography.** Your reference list should include any material that is not your own (i.e., books, web sites, papers, journal articles and communications cited in the paper). When in doubt, always reference the source. Follow the prescribed APA bibliographic style manual. Purdue University maintains a helpful site to guide you through the details of APA formatting. Google "APA Owl" or follow links on my website.
- **Appendix.** Include critical information that is too lengthy for the main section of the paper, such as raw data, emails from professionals, photographs, additional tables and graphs, copies of surveys or tests, and diagrams of specialized equipment.
- **Acknowledgments/Credits** Credit assistance received from mentors, parents, teachers, and other sources.

Section 4: Visual Display

The visual display should follow the basic order of your formal research paper, but be presented in a way that will attract and inform the reader. You want to make it easy for readers to assess what you have done and the results you have obtained. Use your limited space well with concise language and compact visuals throughout. Make headings (title, hypothesis, methods, results, etc.) stand out to guide your reader through your research. Make all text and graphics large enough to read from 2-3 feet away. It is recommended that you create a poster with PowerPoint (32 inches x 48 inches) using the format that is utilized in Colleges and Universities. If you are viewing this document electronically, (CLICK HERE), or view the exemplars folder on the class website. You may also choose to create your visual display using display board or a brochure. All other visual ideas must be approved. Here are a few additional requirements:

- Take Photographs: You are required take pictures to document your research. Limit photographs of you to those showing the actual experimentation.
- Be Organized: Your display should be logically presented and easy to read. It is basically a truncated version of your formal research paper.
- Have a Good Title: A good title should concisely and accurately represent your specific research.
- Make it Eye-Catching: Use strong, large lettering and labels; simple, striking color combinations; and well-labeled charts and graphs.
- Presentation: You may either turn in a display board, a PowerPoint poster or a computer generated brochure. Any other visual ideas are welcomed, but must be approved.

Section 5: Additional Suggestions

- This project will be challenging and I have very high expectations for the final product that you will submit at the end of the course, but I will help guide you through this process. I will gladly critique rough drafts of your research paper and help you to overcome any obstacles that you may encounter. However, procrastination is the culprit for most low grades, so please do not procrastinate.

- Do not ignore results because they differ from textbook generalizations. Your data are not incorrect just because they do not agree with some general principle or a conclusion in another report. Do not discard data because of variability and biases. There are some errors in nearly all scientific data. If recognized and accounted for in interpretation of results, errors of reasonable size need not discredit your data.

- Round off final quantitative results to no more digits than can be reasonably justified. What sense does it make to compare two numbers such as 17.289761 and 19.82946? Do the last several digits have any special meaning? Reporting 17.3 and 19.8 may suffice in your case.

- Label figures and tables properly and thoroughly and cite them in your text. Each figure should have a 1-2 sentence descriptor. Too often figures and tables are inserted in a report without identifying their contents or explaining their purpose to the reader. Always clearly indicate the units of measurement. Number figures consecutively and in the sequence in which they appear in the text. Do the same with tables. Place each figure or table after, and close to, the first place it is referred to in the text. Make sure you have an adequate sample size. The larger the sample size, the more accurate the data.

Scientific Research I Project Rubric: Research Paper Portion

Paper Requirements	10 – 9 - 8 Well Done	7 – 6 – 5 Moderate	4 - 3 Limited	2 - 1- Needs Improvement
Overall Problem, Hypothesis, Title	Problem is meaningful and unique, well researched, hypothesis clearly stated (use if…then). Title concisely describes research	Problem is somewhat unique addressed and researched, hypothesis is stated. No if…then. Title does not describe actual research	Problem is somewhat addressed and some research done. Hypothesis is unclear. Generic title.	Problem is not stated and research is unclear, hypothesis is not stated. Generic title
Abstract	Concise synopsis of the entire research follows format description	Concise synopsis of most research follows format description	Concise synopsis of most research does not follow format description	Abstract is incomplete and not formatted correctly.
Introduction and Background Research	Research is thorough, many specific examples, ideas are explained and proper citations made. **4 or more citations**. Clear explanation of how topic relates to biological	Research has some specifics and a couple of examples, few ideas are explained and proper citations made. 2-3 citations. Semi-clear	Research has little specifics and one example. Two or less ideas are explained. Citations not in proper format. 1-2 citations. Unclear explanation of how	Research has not specifics and one example. No ideas are explained. No citations are made. No explanation of how topic relates to biological

	concept. Ends with Hypothesis using if,then format. Over 3 pages.	explanation of how topic relates to biological concept. Under 3 pages	topic relates to biological concept. Incomplete	concept. Incomplete
Experimental Design/ Materials/Procedure	Procedure is appropriate and thorough. Steps of procedure are listed in sequential order; all material is listed with any safety issues being addressed. Sample size considered. Paragraph format used throughout.	Procedure is appropriate. Steps of procedure are listed and mostly sequential and most materials are listed. Safety may have been addressed. Sample size not considered	Procedure is appropriate. Steps are mostly listed and some materials are listed. Safety issues were not addressed. Not in paragraph form. Sample size not considered	Procedure is inadequate with few steps listed and no materials are listed. Safety not addressed. Sample size not considered
Writing Conventions	There are 3 or less minor spelling, punctuation, capitalization, and grammar errors in research paper.	There are more than 3 minor spelling, punctuation, capitalization, and grammar errors in research paper.	There are more than 5 major spelling, punctuation, capitalization, and grammar errors in research paper.	There are major spelling, punctuation, capitalization, and grammar errors throughout research paper.
Data Collection and Results	Proper use of the metric system. Adequate number of trials or sample size. Appropriate use of photos/charts/graphs to display data. 3 or more tables and 3 or more graphs used. All labeled properly. Paragraph format	Use metric system with adequate number of trials or sample size. Fair use of photos/charts/graphs to display data. 1-2 tables and 1-2 graphs used. All labeled properly. Paragraph format	Use of English system, poor number of trials/sample size. Poor use of photos/charts/graphs to display data. 1 or less table and/or graph used and not labeled properly. No Para.	Use of English system. Poor number of trials, sample size and no photos. Charts graphs to display data. 1 or less data table or graph used and not labeled properly. No paragraphs
Discussion and Conclusion	Conclusions are supported by data. Sources of error have been considered. Explanation is made for how or why the hypothesis was not supported or rejected. Experimental meaning is conveyed and reflection of what was learned and how it could be better was made. 2 or more additional citations made. Future direction for research discussed. Over 3 pages.	Conclusions are not clearly supported by the data. Some sources of error have been considered. Explanation is attempted for how or why the hypothesis was supported or rejected. Reflection of how it could be better was made. 1-2 proper citations made. Future research not discussed thoroughly. Under 3 pages	Conclusions are not supported by the data. A few sources of error have been considered. Explanation is attempted for how or why the hypothesis was supported or rejected. Reflection was poor. 1 or less citations made with error.	Conclusions are not supported by the data. No sources of error have been considered. Explanation is not attempted for how or why the hypothesis was supported or rejected. Reflection of what was learned and how it could be better was not made. No citations made.
Literature Cited, References, APA	**6 or more references** are cited in proper APA format throughout the paper. APA followed entire paper; 3rd person	3-4 references are cited in proper APA format throughout the paper. APA format not followed entire	1-2 references are cited in APA format throughout the paper, or not proper format	No references are cited in APA format throughout the paper.

Scientific Research I Project Rubric (Visual display and log book)

	10 – 9 - 8 Well Done	7 – 6 – 5 Moderate	4 - 3 Limited	2 - 1 Needs Improvement
Visual (PowerPoint, brochure, display board, other-with permission)	Neat, attractive, creative, no spelling or grammar errors. Information displayed properly and is appropriate. All information present. Information is concise.	Neat, attractive, creative, few spelling or grammar errors. Information displayed properly and is appropriate. Most information present, but somewhat unorganized.	Fair, some spelling or grammar errors. Information displayed properly and is somewhat appropriate. Missing much of the research information and unorganized	Poor, many spelling and grammar mistakes. Missing graphs and charts. Most information is missing. Unorganized
Log Book	Clear and concise information, dated accurately and in logical order. Handwritten in pen. Contains original drafts of data material. Information is written from start of project to finish. Very detailed	Clear and concise information, in somewhat of a logical order. Handwritten in pencil. Contains original drafts of data material. Info is logged from start to finish. Not detailed enough	Legible and appropriate information with no logical order. Handwritten in pencil. Contains original drafts of some written and data material. Info is not from start to finish. Incomplete	Information not appropriate or legible. Missing information for original drafts and written in pencil or typed. Missing most information.