Advanced STEM Research Laboratory
Course Outline

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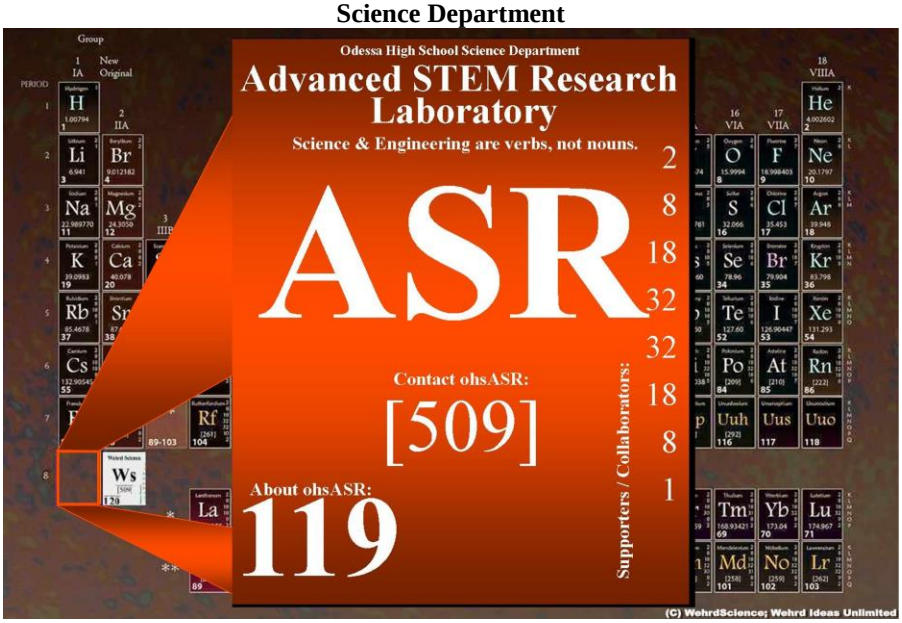

Students engaging in Advanced STEM Research will: 1) make observations on the real world, 2) create questions regarding their observations utilizing background research, 3) formulate a hypothesis or engineering goal centered on those questions/observations, 4) develop a method of quantitative experimentation, 5) analyze the data set using appropriate statistical analysis, 6) and discuss/conclude the details of the results in a concise, scientific manner. During the entire process, a scientific journal will chronologically keep any and all research questions, ideas, data, and analysis. Each student will be required to use technological means for creating, experimenting, or statistically analyzing the data sets. Once the journal article has been completed, reviewed, and approved, each student will create a presentation both physically (poster board) as well as digitally (PowerPoint), and present the scientific research to the scientific community.

The following is a weekly course outline; however independent research often assumes its own pace.

WEEK #	**TOPIC / AREA OF FOCUS**
1	**Discipline of STEM.** Some examples include: Animal Science, Behavioral/Social Science, Biochemistry, Cellular/Molecular Biology, Chemistry, Computer Science, Earth Science, Engineering (materials, bioengineering, electrical, mechanical), Energy / Transportation Science, Environmental Analysis, Environmental Management, Mathematical Science, Medicine / Health Science, Microbiology, Physics/Astronomy, or Plant Science.

WEEK #	TOPIC / AREA OF FOCUS
2-3	**Draft and Finalize Letter to Email.** Using the Internet, locate and begin a correspondence with professionals within the discipline chosen during Week 1. Start locally and move out farther as needed: research facilities, universities, colleges, vocational institutes, scientific businesses. Develop cutting edge ideas and questions regarding a specific scientific interest.
4-5	**Background Research.** Using the Internet, locate journal articles, scientific publications, scientific news articles, or even phone conversations regarding the ideas and questions created during Weeks 2 and 3. Have a solid understanding of the processes, terminology, people and places in the particular field and methods behind specific scientific ideas and questions.
6	**Hypothesis.** The hypothesis needs to be both quantifiable as well as testable. What equipment will be needed to gather data? Begin a rough sketch of the Materials and Methods needed to test and execute the research while creating a solid hypothesis. Email the hypothesis to any or all contacts made during Weeks 2-5 for advice or critiquing.
6	**Introduction and Hypothesis.** Set the stage for the main scientific argument. This section of the paper should interest or "hook" the reader, creating an awareness of the potential significance of the research. This piece describes the particular issue or issues that the paper will address, why these issues are important, and provides the reader with a brief introductory knowledge regarding terminology or processes unique to your research. Make sure the reader understands why such observations are needed by citing similar studies done by others. As the literature is being cited, begin creating a rough Literature Cited draft in MLA (or APA in some cases) Journal Style Format. The last paragraph of the Introduction should explain and describe the hypothesis.
7	**Valid Materials and Method.** This section explains to the reader how the research was conducted to get the new data presented. Mold the methodology that provides the context for evaluating the data. Plates (pictures), drawings, and figures are almost a must for this section. Possible explanations as to why the procedure was conducted in the manner chosen. This section should be so complete that a person with little scientific knowledge could completely reproduce the procedure created.

WEEK #	TOPIC / AREA OF FOCUS
8-9	**Submission and Approval from Scientific Review Committee and/or the Institutional Review Board.** A Scientific Review Committee (SRC) is a group of adults knowledgeable about regulations concerning experimentation especially with vertebrate animals and potentially hazardous biological agents. The SRC must review and approve all projects in these areas before experimentation may begin. Shortly before competition, the Fair SRC will also review the documentation for ALL projects to ensure that students have followed all applicable rules and that the project is eligible to compete. The Institutional Review Board (IRB) is constructed to evaluate the potential physical or psychological risk of research conducted by high school students. Members of the SRC and/or the IRB read each research proposal and assess if each individual project warrants more information before data collection begins.
10-12	**Experimentation.** Data collection using the created and SRC/IRB approved Materials and Method.
13	**Statistical Analysis of Data.** Analyzing and comparing the experimental data with the control data. Choosing the correct statistical tool: Chi Square, t-test, z-test, ANOVA, or many others.
14	**Interpretation of Data.** Making sense of the data and recognizing important trends and patterns. Creating the correct graphs: scatterplot, bar / column, pie, or many others.
15	**Results.** Summarize and illustrate the findings. Create tables showing the mean, standard deviation, variance, and population of each trial; minimum and maximum values from your data set are not uncommon. Since the experiment is trying to show the relationship of the experimental data compared with the control data, then the results should include sentences that relate to this topic. Any data supported by graphs or tables in the report should reveal a "trend" for that data. Input these trends in the results, specifically if the trend is positive (slope rises) or inverse/negative (slope falls), including standard deviation.
16	**Discussion and Conclusion.** Explain to the reader what the newfound data means and tie in any findings by other researchers. Describe how the interpreted data fits any direct observations or any derived quantities presented in the previous sections. This interpretation should lead the reader to some new insight to the particular research area: perhaps a re-determination of some critical idea used by other researchers, a new refinement to a theory, or evidence that some previously-held understanding is incomplete or incorrect in some fundamental way. Your statistical analysis will be included in the discussion. Often in the past, this portion is the most neglected because it is left until the end to complete; however, this segment of the research paper is perhaps the most important! It should also include the "real world" relevance of why the topic that was chosen may or may not impact the scientific world.

WEEK #	TOPIC / AREA OF FOCUS
16	**Appendix or Appendices.** Often in research, a particular bit of information needed to help explain methodology, mathematical computation, or literature needed to support experimentation (such as questionnaires for human studies) is too large for the main body of the research paper. In this case, it is common to refer to the larger portion as, say, Appendix A, linking it from a descriptive sentence in the main portion of the paper. Create your Appendix during this timeframe if needed.
17-18	**References and Literature Cited.** Cite journal articles / sources used throughout the research paper. Do not cite dictionaries, encyclopedias, websites, or other reference materials. In this portion, the research should be supported by journal articles paralleling your research.
17-18	**Abstract.** In usually 200-250 words or less, write a paragraph summarizing your entire research. Although the abstract needs to introduce your research, as well as explain the high-lites of the methodology, the focus should be on your findings and the implications of your findings.
17-18	**PowerPoint and Poster Display.** Using the final draft of the journal paper, create a PowerPoint presentation for digital sharing as well as a poster display for close contact sharing. Certain symposia require PowerPoint while others use a traditional poster board display.
19-34	**Presentation to Scientific Community.** Share your scientific findings with the local community, businesses of interest, government agencies, other interested research facilities or universities, and various science symposia, fairs, and events.
19-34	**Fine-Tune Your Research and Update.** Many of the events where you will present do not demand that your research stop by any means. Therefore, you should continue further research that will stem from your current research: run more trials to solidify your results, reflect on your limitations and see if it is possible to overcome the limitations in your time left, or make connections with new contacts along the way. Any changes to your data require going back and reworking your Materials and Methods, your Results, your Discussion and Conclusion, and possible other areas of your paper
35-36	**Clean Up, Thank You, Paper Submission.** Clean up all labware and supplies, check materials borrowed back in to surplus room, and write, acknowledge, and thank the people and places that contributed toward the research project this year. Finally, submit your research to the online publication forums provided by Mr. Wehr (JEI, CNR).