There is a pursuit we all share in the Science Dept: a better education for our students!

Scientific Research Course Policy

Course Purpose

In Science Department, we strive to provide you with the best opportunity in science through our new and exciting interdisciplinary and STEM programs. Scientific Research is the capstone of this unique STEM (Science, Technology, Engineering and Math) pathway offered only at TOHS! This is an advanced and inquiry based course that incorporates STEM in its curriculum with special emphasis on ART and RESEARCH (STREAM). The course content provides an academically challenging course in Biotechnology, High performance Liquid Chromatography (HPLC), Biochemistry, Microbiology, Cell and Tissue Culture, Genomics, Cell and Molecular Biology, Chemistry and Technology that requires students to apply their academic study to the problem-solving tasks and critical thinking associated with scientific lab research . In addition to challenging students, this course will expose them to the current scientific lab techniques and prepare them for an undergraduate research program at any University in the nation.

The objective of this course is to enable students to apply their knowledge of different topics in biological sciences, chemistry, technology and Math while working on their research project with a mentor from the local biotechnology/pharmaceutical and academic institution. Students will present the results of their research in both formal written documents and public forums to further develop their written and oral presentation skills. These projects will be presented at the County and State Science Fair Competitions later during the year; some students may begin internships at various Universities, or present their work at a workshop or conference and qualify to publish their work in a scientific journal. After the Science Fair competitions, the main assignments will include the outreach event to the local community, scientific writing involving lab handouts for local middle schools students, conducting scientific demonstrations or labs for younger students in the community and writing research proposals for a future research internship.

This is an advanced course for students in grades 11-12 who have completed a year of Biology Honors/CP, Chemistry H/CP and Algebra I and/or II with at least a B grade. If you have completed STATS, Bio AP, Chem AP or Physics AP, this course is going to be even more fun! This course has been developed by Dr. Malhotra who teaches Science at Thousand Oaks High School. The course development also involved feedback, writing HPLC lab protocols and training from Dr. Cauchon of Amethyst Life Sciences/Ventura Biocenter. UCLA professors (neuroscience and molecular, cell and developmental biology), CSUCI, CLU professors (Chemistry and Biology) and Moorpark College have also been collaborating with our research students. This collaboration may involve feedback on the student research projects, allowing undergraduate and graduate students to be our guest speakers or giving a summer internship opportunity to SR students. Throughout the year, Amgen, Baxter, CLU, CSUCI and Moorpark College professionals will be involved in mentoring students on their Science Fair projects.

Throughout the year, students must maintain a minimum grade of B to stay in this class. The course is also articulated with Moorpark College which means in Semester II students can earn 4 college units for Biotechnology course offered at Moorpark College by just passing the college final exam!

Why are you in it?

You are about to take part in a landmark program/course that VERY few high school students ever have the chance to be involved in. You will be a contributor to a national and international effort to involve high school students in <u>real inquiry based scientific research</u>. In the beginning of the semester, you will be learning lab skills in biochemistry, microbiology, tissue culture and biotechnology. In the end of second semester, you will get into the DNA Barcoding unit. In the DNA Barcoding section, you will be involved in an international project to collect the specific genetic data from all organisms currently on the planet. If you are successful with the complex laboratory processes, you can claim authorship of scientific data! But, in order to be successful, there are many complexities to understand, skills to master and detailed protocols to follow – exactly.

In order to prepare you for this complex process of Scientific Research– the following will be expected of you:

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1. Be in attendance for EVERY laboratory experience as listed below.
2. Each student will be required to commit to 4 lab-service hours per semester (outside the regular lab period)
3. Your lab service hours can come from conducting literature searches for other students, teaching STATS and data analysis to your peers, preparing or autoclaving media/reagents, pouring plates or gels, compiling class data for analysis, cleaning and sterilizing lab glassware (plastic ware is not autoclavable), training other students in equipment like HPLC (mentors only), maintaining expensive equipment, setting up and cleaning up the labs, assist in grading lab reports and any other lab help needed in E8!
4. Create a Scientific Lab Notebook for this lab course – and treat it as such. All notes, procedures, required flow charts and comprehension questions are to be recorded – IN INK – in this notebook. If you work diligently to produce and maintain this notebook, you will have a detailed record of these protocols as well as something to show to a university professor to demonstrate your skill sets and scientific accomplishments!
5. Meet all deadlines for lab work, lab reports, research papers and projects.
6. Three detailed lab reports will be due by the end of first semester for Exam Credit.
7. Be prepared for a written exam on all lab protocols at the end of Semester I and Semester II.
8. Your assessment for the second Semester will be project-based (according to a specific rubric) and exam based (STEM-Biotechnology).
9. The lab and experiments schedule may change depending on the availability of chemicals, reagents and equipment for each unit.
10. While taking this class, you automatically become members of our famous **science club**! To be a member or a leader in this club, you are expected to attend all meetings, mentor other students on their science fair projects, participate in local science fair competitions and promote science at "Club Hello Day", Future Lancer Night and outreach events at local middle schools!

11. **Lab Notebook Rubric:**
    a. Title and Complete Table of Contents – 10%
    b. Dates and Signatures on all pages – 10%
    c. Appropriate treatment of mistakes/errors in writing – 10%
    d. Appropriate referencing and treatment of blank spaces – 10%
    e. Experiments well documented- Purpose, Hypothesis, Materials, Procedure, Data, Results/Discussion, Conclusion, Sources of error etc. –20%
    f. Data Analysis Complete with Tables, Graphs, Legends and Statistics –20%
    g. Legibility and reproducibility of your work –20%

Student Signature_____Date_____

Student E mail _____

Parent/Guardian Name (Please print)_____

Parent Signature_____ Date _____ ___

Parent email: _____

Student cell phone #: required for SR course only_____

(This contract is not valid until signed by all parties and turned in to the instructor by the due date)

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Scientific Research Lab Policy

Lab Rules:

1. It is a real scientific lab with all the high tech equipment and reagents! So, it is a serious business!
2. With all this fancy equipment in the lab, comes all the responsibility on your shoulders.
3. It is not your teacher's or one student's responsibility to take care of the equipment! It is everyone's responsibility to take care of this expensive and high tech equipment in E8.
4. Handle all equipment and devices with care and report any accidents and damages to Dr. Malhotra immediately!
5. You must read all the lab safety rules in the Biotech lab manual, sign the lab safety contract and turn it in before you work in this lab
6. To be successful in the lab, you must have good work ethics, show concern about other's safety, be a good team player in your lab group and in the class. Always follow the lab safety rules while doing your lab/experiment.
7. During the lab if you finish your part before someone else, there are several things you can do to help the instructor or your classmates and earn lab service points.

How to Maintain a Laboratory Notebook

Under U. S. law a patent is granted to the first to conceive the idea for the invention, not the first to apply for the patent. So a laboratory notebook is an essential evidence of the date of conception. In scientific laboratories, the notebook is a permanent record of procedures utilized, adaptations of those procedures and any findings made.

When properly kept, a laboratory notebook permanently records, for future proof, what was done on a project, and particularly what protocols were used, when they were used and any findings or inventions. You will maintain your lab notebook in the same manner that a laboratory notebook is maintained in a typical research lab (read all the guidelines in your biotechnology lab manual before you start your lab notebook).

1. Do not tear out any pages from your Notebook.
2. Make all entries with ink (**blue** or **black** ink only).
3. If an invention is made, the dates of "conception" and "reduction to practice" are essential; therefore, **date** every assignment.
4. Diagrams and illustrations should have information to identify and explain the subject matter. Make sure they are all properly **titled, labeled, dated**, and **initialed**. Another investigator, by examining these drawings, should be able to determine the nature of the project, when it started, and what ideas were considered.
5. **Don't erase.** Cross out errors using a **single strike-out line**, then **initial**. Make a new entry to correct the error. For example, *here is an ~~eror~~*.WB error. Notice the error is clearly visible underneath the strike-out line, followed by initials. Never scribble out/white out the error.
6. In actual practice, to protect the credibility of the notebook, there should never be any blank pages or blank spaces below an entry. Blank pages need to be **crossed out** and initialed and blank areas under images, tables or graphs should be labeled "**NWUI** – or Nothing Written Under Insert" then **initialed.**
7. Your lab notebook must be turned in **regularly** on time to get credit for your lab write ups. It is also due at the end of semester I as a part of your final grade for this semester. Failure to do so will result in obtaining a partial credit!
8. For the second semester, your final grade comes from your data log book for the science fair (set up is similar to your semester I lab notebook), science fair poster board, science fair research report, biotech final exam and participation in outreach events.

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Scientific Research lab Safety

Once you have read all the safety information in the Biotechnology lab manual and the course policy and are sure you understand all the rules, fill out the safety contract that follows. Signing this contract tells your instructor that you and your parent/guardian are aware of the rules of the laboratory. Return your signed contract to your instructor before you begin any lab work. **You will not be allowed to work in the laboratory until you have returned your signed contract.**

I, (please **print name**) _____ _____ Course title: _____

have read the Science Safety Rules in the Biotechnology lab manual and course policy handout. I understand its contents completely, and agree to follow all the lab safety rules and guidelines that have been established in each of the following areas (please check), and others as outlined by my instructor. Failure to follow all lab rules will result in losing all privileges to perform experiments/research in this course.

_____Dress Code
_____General Safety Rules
_____First Aid
_____Heating and Fire Safety
_____Using Chemical Safety
_____Safe Handling of Microorganisms
_____Safe disposal of preserved specimen
_____ maintaining a lab notebook
_____ turning in lab notebook on time
_____Using Glassware Safety
_____Using High Tech and expensive equipment
_____Handling/disposal of Live Organisms
_____End-of-Investigation Rules
_____No "Horseplay"
_____Using sharp tools for dissections/experiements
_____Lab Clean up rules
_____ Never work alone in the lab rule
_____ informing instructor about lab accidents/spills

Student Signature_____Date_____

Student E mail _____

Parent/Guardian Name (Please print)_____

Parent Signature_____ Date _____

Parent email: _____

Student cell phone #: required for SR course only_____

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WRITING ASSIGNMENTS-Lab Report Guidelines

In addition to regular lab reports for all inquiry labs, there will be three detailed formal lab reports that must be submitted to meet the requirements for the laboratory component of this course. These lab reports will be worth 20% of the total grade. Students may choose any three laboratory exercises to write up including at least one lab from Biotechnology, Cell and Tissue Culture or HPLC units. Students must use the data collected by their group and write individual lab reports. Members of the same group are not required to submit formal lab reports on the same labs. If you made an error during the experiment/lab, you may use another group's data with your instructor's permission. Make sure you acknowledge this in your report and describe why your data was not used. Include all different sources of error that made your lab unsuccessful. No reports will be accepted after the due dates unless family or medical emergencies have been reported.

Reports will be graded based on their content and correct format. Each report must contain the following eleven components:

- Title
- Abstract
- Introduction
- Objectives/Purpose
- Hypothesis
- Materials and Methods
- Results
- Discussion
- Conclusion
- Sources of error
- Literature Cited/References (APA format)

The recommended length of the lab report is between 1000-1500 words, plus data tables, figures and references. If the report is too long, it may be returned ungraded. Use typed double space with a font size of 11 or larger. Please look at several journal articles during your scientific literature unit to get familiar with different journal formats. When you write a scientific article, it is important to follow the format of the journal you are submitting it to. Please follow the format given below:

1) **Title**: Descriptive and to the point. Informs the reader what is in the report. Do not copy the title from the lab manual and lab handout. Be creative!
2) **Abstract**: A one paragraph summary of the entire report. Briefly state the objectives here and present the major results and conclusions of the experiment. This section is usually written last, when the results and their conclusions are clear to you. This part has an important role in skimming scientific journal articles, as it provides the reader with the overall results of the research.
3) **Introduction:** In this part describe the importance of the topic being studied. This also involves a discussion of any results of previous studies in order to review literature. Include important literature that is relevant to the current study. You must clarify if the current study is being conducted to confirm, expand on or refute the previous research in this filed. You may introduce briefly any techniques or methods used in this experiment.

4) **Objectives/Purpose:** Clearly identifies the objectives of the lab; this also includes the problem and how will you go about finding the answer?
5) **Materials and Methods:** This section must include a list of all the materials you used and all the protocols you applied during your experiment. This section also includes the temperature/pressure/other growth conditions that were used for the experiment. You can keep it brief and to the point. Remember to include references for any lab manuals or other articles that you used the methods from. Safety: Identifies the lab safety precautions followed in the lab.
6) **Hypothesis**: Use your prior knowledge to make a prediction about the expected results of your investigation.
7) **Safety: Results:** This section includes all the tables, charts, figures and pictures that you must have collected during your experiment. The length of this section depends on the amount of data you have gathered and recorded during the experiment. Do not repeat your data; present your data either in tables or graphs. Each table must have a descriptive heading and each figure must have a detailed legend. Headings are included at the top of the tables and at the bottom of the figures. All graphs must be labeled with axes, titles and units. The written part of this section should describe the major trends in the data presented in tables and graphs. In this section, state the trends in the data, do not discuss or interpret them. Evaluation and interpretation of the data is dealt with in the discussion section. Refer to the data as "Table 1" or "Figure 1". Do not refer to the data with labels such as "Graph. Drawing" etc.

   Examples of results: The effect of temperature on the rate of enzyme activity in E. Coli is shown in Figure 1. As the temperature increased, the enzyme activity increased until a maximum activity was reached at 37C. The enzyme activity declined at a temperature higher than 37C.
8) **Discussion:** This is the longest section of the report and requires understanding of the concept that is being tested or examined in a lab. The data presented in the results section are interpreted and evaluated as it relates to previous literature. As mentioned above, refer to the data by label it was given in the results section. Here is an example: The results in Figure 1 suggest that ……are consistent with the previous data and confirm that ……Organize this section and do not repeat what was stated in the results but discuss the trends mentioned there and relate them to the current literature. It is a good idea to deal with each trend in a separate section and consider if your results agree with the previous research? Why or why not? You must discuss the significance of experimental errors on the results obtained. All research by others, which is mentioned, must be included in the references section of the report. If you used any materials from other labs or institutions, it must be mentioned here.
9) **Conclusions:** Make a simple statement concerning what you can conclude from the experiment. What did you learn from this lab? Was your hypothesis correct?
10) **Sources of error:** List specific sources of error and how they influence the data and results.
11) **References:** the literature mentioned in your report must be referenced by one of the following methods: "author, date" or "number". Please see the examples below:

….these results support those described by Marshall *et al*. (2004)….

….these results are similar to those described previously (Taylor and Gibbs, 2005)

….these results are similar to those described previously (1)…