Santa Monica College
New SMC Course

Expanded Course Outline for SCI 10 - Principles and Practice of Scientific Research

Course Cover	
Discipline	SCI-SCIENCE
Course Number	10
Full Course Title	Principles and Practice of Scientific Research
Cross Listed Course	
Catalog Course Description	This course explores the modern practice of science. The course focuses on the use of the scientific method; the history of science; how, why and where research is conducted; the ethical protocol in the scientific process; how peer review works; and how to formulate scientifically testable hypotheses and design/perform experiments to test the hypotheses. Students will apply the scientific method in inquiry-based laboratory projects and will communicate research design, data collection, and data interpretation in conventional scientific formats.
Rationale	
Rationale	This course is designed to expose beginning (second year) science students to the excitement and relevance of scientific research and the myriad of career opportunities for those with science degrees; to provide them with hands-on experience evaluating and conducting scientific research; and to prepare them for participation in undergraduate research at a four-year institution. This course will be offered in both regular and scholars versions to allow greater curricular flexibility for STEM students to obtain TAP certification; this course will initially be offered to members of the STEM grant student cohort with the goal to expand it as a regular course offering available to all SMC students; this course will serve as a prerequisite for three additional new courses to be developed in research methodologies in the life, physical and earth sciences.
Proposal Information	
Proposed Start	Year: 2014 Semester: Winter
Proposed for Distance Ed	No
Proposed for Global Citizenship	No
Course Unit/Hours	

Variable Hour Exist	NO
Credit Hours	Min: 2.00
Weekly Lecture Hours	Min: 1.00 (Sem: 18)
Weekly Laboratory Hours	Min: 3.00 (Sem: 54)
Weekly Arranged Hours	Min: 0
Total Semester Instructional Hours	72.00
Load Factor	1.00
Load Factor Rationale	Rigorous academic course with involved lecture/presentation preparations, direction of student laboratory projects and significant grading of written work.
Repeatability	May be repeated 0 time(s)
Notes on Repeatability (for the student)	
Maximum Enrollment	
Grading Methods	Letter Grade or P/NP

Transfer/General Ed

Transferability
Transfers to UC Transfers to CSU
IGETC Area:
Does NOT satisfy any area of IGETC:
CSU GE Area:
Does NOT satisfy any area of CSU GE:
SMC GE Area:
Does NOT satisfy any area of SMC GE:

Comparable Transfer Courses:

- **California Community College**
  Pasadena City College
  Biological Research Methods 10F

- **UC**
  UC Los Angeles
  Introduction to Laboratory & Scientific Methodology LS23L

Program Applicability	
Designation	Credit - Degree Applicable
Proposed For	**AS Degree** -General Science

Pre/Corequisites & Advisories

Prerequisite
UC-transferable science lab class

Prerequisite
MATH 20

Skills Advisory
ENGL 21B

Content Review

Course Objectives

Upon satisfactory completion of the course, students will be able to:
1. Trace the progression of modern scientific research projects from proposals through funding, experimentation, and dissemination.
2. Explain ethical conduct required in doing science.
3. Formulate a scientifically testable hypothesis.
4. Design and conduct experiments that will effectively test a scientific hypothesis.
5. Collect scientific data with safety and accuracy.
6. Employ appropriate statistical methods to evaluate collected data.
7. Critique peer-reviewed scientific articles.
8. Use oral and written communication methods to present findings in formats recognized by the scientific community, including journal articles and poster presentations.

Arranged Hours Objectives

Upon satisfactory completion of the course, students will be able to:

Course Content

5%	How scientific knowledge advances through the research process
25%	Developing and testing scientific hypotheses
30%	Collecting, analyzing and interpreting scientific data
20%	Scientific Communications
10%	Ethics in science
10%	Funding, collaboration and publication
Total: 100%	
Lab Content	
7%	Introduction to Model Scientific Systems to be used for Inquiry Based Experimentation
7%	Devising a Testable Hypothesis for Experimentation with one of the Model Systems
13%	Designing an Experiment to Test the Formulated Hypothesis
34%	Collecting Data in Experiments to Test the Formulated Hypothesis
27%	Analysis and Interpretation of Accumulated Data
12%	Communication of Research Results
Total: 100%	
Arranged Hours Instructional Activities	
Methods	
Other Methods	
Methods of Presentation	
Opt Heading	
Methods	Critique Experiments Field Trips Group Work Lab Lecture and Discussion Other Visiting Lecturers
Other Methods	Student groups will complete an inquiry-based laboratory project using a model system of their choice from the earth, physical or life science disciplines. Model systems that lend themselves to a variety of experimental approaches and allow data collection within a reasonable time frame will be selected by the instructors. Student groups will be guided through the process of hypothesis formulation and experimental design. They will collect, analyze and present data related to an original scientific research question. Case Studies will also be employed to illustrate advances made with the scientific research process.
Methods of Evaluation	

Methods	• 5% - Class Participation • 15% - Group Projects Poster Presentation • 25% - Lab Reports • 20% - Oral Presentation • 20% - Other Review and discuss journal articles • 15% - Written assignments • 100% - Total
Additional Assessment Information (Optional)	

Appropriate Textbooks

Textbooks such as the following are appropriate:

Formatting Style	APA

Textbooks

1. Creswell, J. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, ed. Sage Publications, Inc., 2008, ISBN: 1412965578.

2. Patten, M. *Understanding Research Methods: An Overview of Essentials*, ed. Pyrczak Publishing, 2009, ISBN: 1884585647.

3. Herreid, C.F., Schiller, N.A., Herreid, K.F. *Science Stories: Using Case Studies to Teach Critical Thinking*, 1st ed. National Science Teachers Association Press, 2012, ISBN: 1936137259.

4. Engineering, and Public Policy Committee on Science (Author), National Academy of Sciences (Author), National Academy of Engineering (Author), Institute of Medicine (Author) . *On Being a Scientist: A Guide to Responsible Conduct in Research*, 3rd ed. National Academies Press, 2009, ISBN: 0309119707.

Manuals

You have no manuals defined.

Periodicals

You have no periodicals defined.

Software

You have no software defined.

Other

You have no other defined.

Assignments

Sample Assignment

ASSIGNMENT #1: Review of Peer Reviewed Journal Article

Much of modern science is communicated to the public via peer reviewed articles published in scientific journals. *Peer review* is the process whereby research papers submitted for publication are sent by the editors of the journal for review and commentary by scientists whose past body of work qualifies them as credible to determine the paper's suitability for publication. This process acts to maintain standards agreed upon by the scientific community.
In this assignment, students will read a peer reviewed article that has been published in a scientific journal and then write about the important scientific aspects of the paper. Students will identify the research question(s), hypotheses, data collection methodology, data analysis methodology, results of the experiment(s), and the author's conclusions. In addition, students will outline future research directions based on the conclusions reached in the article they reviewed. Appropriate published journal articles will be selected in consultation with the professors. Students will be required to review one published article from a scientific journal relevant to their major, and one article from a scientific journal in a discipline outside of their major. In this manner, students will see how the scientific publication process is standardized across different disciplines.

Each review should be organized as follows:
[Author(s), article title, journal publication information:]
Research question(s):
One sentence per each research question. Use bullet points to clearly separate each research question.
Hypotheses:
One sentence per each hypothesis. Use bullet points to clearly separate each hypothesis.
Data collection methodology:
Minimum of one paragraph explaining the different methodologies of data collection used in the experimental design.
Data analysis:
Basic description of statistical analyses used to interpret the data. Minimum of one paragraph explanation required.
Experimental results:
Minimum of one paragraph explanation required. Note that it is important to include both positive and negative results here.
Author(s) conclusions:
Minimum of one paragraph explanation required.
Further Questions and directions of additional research:
At least two unanswered questions or statements of additional research needed should be included here. Use bullet points or separate paragraphs to clearly separate additional questions & research.

ASSIGNMENT #2: Poster Presentation

Students groups will prepare posters that summarize the design and outcome of the hypothesis-based testing that they completed in one of the model scientific systems available in the laboratory.
Directions: Scientific conferences frequently hold poster sessions where large groups of investigators can communicate their findings in visual format to facilitate discussion with interested colleagues. In this course, we will have

such a poster session at the end of the semester for your group to present the outcome of the experiment you proposed and completed. Your group will design a poster to summarize the methods, results and data interpretation for your experiment.

Working with your group, include the following items on your poster:

1. Title of the Study and Names of Group Members
2. Scientific Question that your experiment was designed to test. Provide some brief background information on why the model system was useful in addressing this question.
3. Hypothesis that was tested. As formulated under the guidance of your instruction, the hypothesis must include an independent variable, a dependent variable and a proposed relationship between the variables.
4. Methods and Materials: Outline the steps of the experiment used to test the hypothesis, identifying the reagents and instruments required. Give specific information regarding the controls and treatments that were included. Describe how the data was collected and analyzed.
5. Results: Present the data in appropriate format, showing figures and tables with captions that describe the included data.
6. Discussion: Present an accurate interpretation of the data and relate the results to previously published results. Explain how your group's results contribute to a greater understanding of the scientific question that was tested.
7. Conclusion: Summarize the main findings of your research project.
8. Literature Cited: Include references relevant to the scientific question, methods and/or discussion sections.

Your poster can have any design that effectively communicates the required items. Be sure that all items are of a large enough size to be easily read and/or analyzed by colleagues who will be examining your poster. Your group grade will be based on the clarity, accuracy, and comprehensiveness of the poster as well as the ability of group members to discuss the outcome of the experiments with colleagues and professors.

Student Learning Outcomes
1. Demonstrate the ability to formulate a scientifically testable hypothesis and design experiments to test the hypothesis.
2. Demonstrate the ability to generate and analyze scientific data.
3. Describe how modern scientific research is conducted, reviewed, disseminated, and accepted.
4. Distinguish between ethical and unethical behavior in experimental design, data collection, and presentation of scientific results.
5. Demonstrate the ability to communicate scientific work effectively.

Minimum Qualification	
Minimum Qualifications:	Anthropology (Masters Required) Astronomy (Masters Required) Biological Sciences (Masters Required)

	Chemistry (Masters Required) Earth Science (Masters Required) Engineering (Masters Required) Geography (Masters Required) Physical Sciences (Masters Required) Physics/Astronomy (Masters Required)
Library	
List of suggested materials has been given to librarian?	No
Library has adequate materials to support course?	Yes
Additional Comments/Information	
Attached Files	
Lab Course Prereq English Advisory Math Prereq	