

## Using Primary Literature to Engage Student Learning in Scientific Research and Writing

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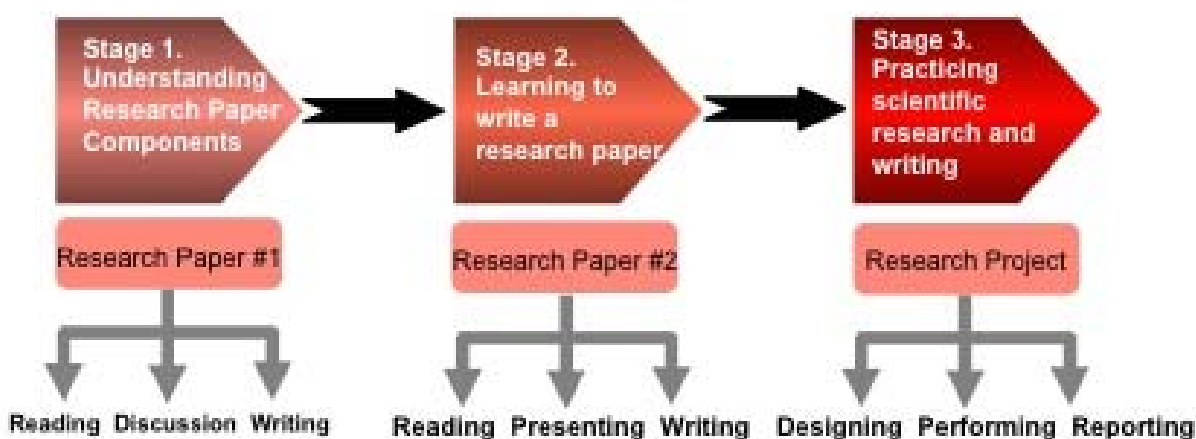
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**Name of course design: Read and wRite to reveal Research process - R<sup>3</sup>**

**Goal of Project:** increased understanding of the scientific research process as it is reflected in science reading, writing and reporting.

### Overview of Course:



### Learning Objectives:

1. Gain an understanding of the scientific research as illustrated in scientific research papers.
2. Gain an understanding of the steps for writing and publishing research results.
3. Improve skills in scientific data processing and presentation.
4. Appreciate the role of collaboration in the research process.
5. Enhance understanding of scientific techniques and their application in scientific research.
6. Improve oral and written presentation skills.

**Use of Backward Design to develop the course**

<b>Learning Outcomes Students will be able to</b>	<b>Learning Objective</b>	<b>Activities</b>	<b>Assessment</b>
Explain the purpose of each section of a published research paper and relate the design to that of a lab report.	1, 2	-Guided reading, -Guided discussion, -Guided writing, using Research Paper #1 as an example and sequentially addressing each section of a research paper	- Introduction Rubric - Materials/Methods/Results Rubric - Discussion Rubric - ROLA post-assessment
Read a scientific research paper and report on the value of each section in achieving the overall goal of the paper	1, 2, 3, 6	-Research paper #2 Oral Presentation	Oral Presentation Rubric
Process raw data (generated in lab or provided) into graphs and figures appropriate for presentation	3, 6	- Guided discussion of Data analysis - Process and present data generated in lab in lab reports and Group Research paper as graphs and figures.	- Lab Report Rubric - Group Research Paper Rubric
Write lab reports in the same format as published research papers	2, 3, 6	- Writing Lab reports 1-4 - Writing Group research paper	- Lab Report Rubric - Group Research Paper Rubric
Identify a research question, propose a hypothesis and appropriate experiments to address the research question	2, 5	-Group research project	- Lab Report Rubric - Group Research Paper Rubric
Work collaboratively	4	- Writing of the Group Research Paper -Group discussions in class	- ROLA post-assessment
Peer Review a student Research Paper	2, 6	-Peer Review Assignment	-Peer Review Rubric

### Organization of the Course

Period	Out of class activities	In class activities	Lab activities
<b>Stage 1. Understanding research paper components</b>			
Week 1	<ul style="list-style-type: none"> <li>- Read the introduction of the research paper 1 by Krishnamurthy, et al.</li> <li>- Write Introduction section for Lab 2</li> </ul>	<ul style="list-style-type: none"> <li>- Guided Discussion of Introduction Section</li> </ul>	<ul style="list-style-type: none"> <li>- Lab 1. Identification of Immune Organs and Cells</li> <li>- Lab 2. Antibody-Antigen precipitation (Ouchterlony Test)</li> </ul>
Week 2	<ul style="list-style-type: none"> <li>- Read the methods/materials and result sections of the paper 1</li> <li>- Write the methods/materials and result sections for Lab 3</li> </ul>	<ul style="list-style-type: none"> <li>- Guided Discussion of Methods/Materials/Results Sections</li> </ul>	<ul style="list-style-type: none"> <li>- Lab 3. Agglutination</li> </ul>
Week 3	<ul style="list-style-type: none"> <li>- Read the discussion section of the paper 1</li> <li>- Write the result and discussion sections for Lab 4</li> </ul>	<ul style="list-style-type: none"> <li>- Guided Discussion of Discussion Section</li> </ul>	<ul style="list-style-type: none"> <li>- Lab 4. Immunofluorescence</li> </ul>
<b>Stage 2. Learn to write research paper</b>			
Week 4-6	<ul style="list-style-type: none"> <li>- Read the introduction of the research paper 2 by Paccani et al.</li> <li>- Write a full report for Labs 5-6</li> </ul>	<ul style="list-style-type: none"> <li>- Identify the research questions in research paper #2</li> </ul>	<ul style="list-style-type: none"> <li>- Lab 5. Immunoprecipitation</li> <li>- Lab 6. Western blot</li> </ul>
Week 7-8	<ul style="list-style-type: none"> <li>- Read the result section of the research paper 2</li> <li>- Write full reports for Labs 7 and 8</li> </ul>	<ul style="list-style-type: none"> <li>- Guided Analysis and Data Presentation</li> <li>- Discussion on how to process and present ELISA data in scientific context</li> </ul>	<ul style="list-style-type: none"> <li>- Lab 7. ELISA</li> <li>- Lab 8. Microbial killing by macrophages</li> </ul>
Week 9	<ul style="list-style-type: none"> <li>- Read the discussion section of the paper 2</li> <li>- Write a full lab report for Lab 9</li> </ul>	<ul style="list-style-type: none"> <li>- In class discussion to summarize the results and conclusions of research paper #2</li> <li>- Discussion on how to present flow cytometry data in scientific context</li> </ul>	<ul style="list-style-type: none"> <li>- Lab 9. Flow cytometry</li> </ul>
<b>Stage 3. Practice scientific research and writing</b>			
Week 9	<ul style="list-style-type: none"> <li>- Propose a scientific question and a hypothesis based on group scenario chosen</li> <li>- Identify research methods to address the question</li> </ul>	<ul style="list-style-type: none"> <li>- Read research project scenarios and choose project for group</li> </ul>	

Week 10	- Propose experimental procedures	- Discuss the scientific question, hypothesis, and experimental approaches in groups - Plan experiments in groups	- Lab 10. Complement mediated cytolysis
Week 11-13	- Write Group Research Report	- Write Group Research Report in groups	- Run experiments
Week 14	- Modify Group Research Report based on comments from peer review	- Peer review of Group Research Reports - Peer review of contribution by individuals in a group	
Week 15	Submit Group Research Report		

### **Grade comparison of student writing assignments at Stage 1 with those at Stage 3.**

Student performance on Stage 1 writing of introduction section, results section, and discussion section was compared to student performance on similar sections of the Group Research Paper. Performance was evaluated according to the lab report rubric. Data is presented as percentages of the total points for each assignment. Shown are average values and standard deviation (n=35 at Stage 1 and n=6 at Stage 2). Data indicates that students gained an understanding of the scientific research process over the course of the semester: Increased scores on writing activities, less deviation. Note that the work for the group research paper was more challenging than the work expected in stage 1 assignments

