

**Problem and Community Service-Based Microbiology Capstone Course
MOLB 4010
Spring 2013**

Instructors	E-mail	Office	Phone	Office hours*	Credit & Schedule
Rachel Watson	rwatson@uwyo.edu	AG 5010	307-760-2942 (cell)	Monday 2:00 – 3:00 pm AG 5010 7:30 – 8:30 pm Monday (online <i>Elluminate</i>) Friday 12:00 – 2:00 pm (in AG 5030) *General open-door policy.	Three semester hours from January 14 th through May 10 th
John Willford	willford@uwyo.edu	AG 5024	307-766-4249	By appointment	

*Office hours are not designed and do not cater to students desiring a confidential meeting. There is often more than 1 student in our offices or online at once and we talk as a group. We are always available in our offices or online for additional appointments. Please schedule alternative times for confidential meetings.

Course Description:

Using a problem-based student learning model (Merrill, 2002), this course is designed to allow students to conceptualize, propose, perform and present a scientific research study to address a real problem within the community. Students will select one of the community-based problems and further cultivate the relationship with the service organization. They will write a formal scientific research proposal, engage in hands-on laboratory and fieldwork to address the problem, communicate progress / solutions with the community service organization and present their project at a final, culminating poster presentation. Students will be assessed, using rubrics, for accomplishment of curricular and service-based learning objectives.

Content coverage will include principles for writing and maintaining a lab notebook and writing a research proposal. Applied laboratory methods will also be presented and students will formulate hypotheses and engage in hands-on laboratory hypothesis testing. Principles for designing and presenting an effective scientific poster will also be covered. Throughout all phases of instruction, the problem presented by the community partner will be maintained as the central focus.

Merrill, M. D. (2002). First Principles of Instruction. *Educational Research Training and Development*. 50. 43-59.

Course Goals:

The broad learning goals of this course parallel the Microbiology Program Goals. Thus, students completing this course will develop the technical laboratory skills to apply molecular biology techniques to microbial systems. Students will also develop information literacy-access skills as well as the oral and written communication skills necessary to access and evaluate scientific information relevant to contemporary topics/issues in microbiology. In addition to accessing, evaluating, and summarizing available information, students will develop oral and written communication skills necessary to present their findings to both student peers and Microbiology faculty.

Specific Course Learning Objectives:

Upon successfully completing the course, learners will be able to

- 1) perform a thorough overview of a topic (access and assess literature) without being overwhelmed by the extent of available resources.
- 2) formulate / propose hypotheses.
- 3) propose experimental tests of hypotheses.
- 4) apply appropriate experimental methods to test hypotheses.
- 5) make and interpret observations / data and relate them to hypotheses.
- 6) present, write and converse using the vocabulary of the field (communicate effectively with those in the field).
- 7) communicate important microbiological principles with individuals outside of the microbiology discipline (within the community service organization).
- 8) relate (recognize the relevance of) microbiology concepts to the unique problem of the community service organization.
- 9) write a scientific research proposal, notebook and abstract.
- 10) understand when and how to reference source material and recognize this process as an important part of communicating with other scholars.
- 11) write, converse and present clearly and thoroughly about microbiological principles / findings.
- 12) relate (recognize the relevance of) microbiological concepts to other disciplines and to society.
- 13) understand the social ramifications (social perceptions), applications and implications of scientific actions / studies.
- 14) value scientific knowledge as a tool to enact change (be aware of the limits to this and responsibility inherent with this).

Textbooks and required material:

Writing Successful Science Proposals by Andrew J. Friedland and Carol L. Folt, 2009, Second Edition, Yale University Press.

Writing the Laboratory Notebook by Howard M. Kanare, 1985, American Chemical Society.

How to Present at Meetings by George M. Hall and Neville Robinson, 2012, Third Edition, Wiley-Blackwell.

Submitted Assessments

The Research Proposal:

This proposal provides a thorough description of the proposed problem and community service-based research project. The proposal should clearly communicate the problem and its significance. Relevant literature and preliminary data should be reviewed. A conceptual framework will be presented and all methods and approaches justified. Objectives, hypotheses and specific aims will be clearly enunciated as will the research plan (design, methods and expected results). A timeline will be provided along with an appropriate reference list. Proposals will be limited to 8-10 pages double-spaced. An in-depth description of this assignment and a grading rubric can be found at the end of this syllabus. **The Research Proposal will be worth 150 points toward your final grade.**

The Laboratory Notebook:

A laboratory notebook will be kept as a record of all work done in the lab / field and as a means to document interactions with the community service organizations. An in-depth description of this assignment and a grading rubric can be found at the end of this syllabus. **The lab notebook will be worth 100 points toward your final grade.**

Discussions with Service Organizations:

Meetings with the community service partners will occur at the beginning of the semester, at mid-semester and finally once the project has been completed. A representative from the community service organization will be asked to complete a rubric on which she/he assesses the groups' ability to communicate relevant potential solutions to the problem in a professional way. The rubric provided to the community service representative can be found at the end of this syllabus. **Discussions with community service organizations will be worth 50 points toward your final grade.**

Poster Presentation:

The research project will be presented in the form of a poster. The assignment description can be found at the end of this syllabus. Rubric scoring of the posters will be done by the instructor as well as a team of four external raters: current or retired faculty members and/or university laboratory staff or outside professionals within the community. The scoring rubric can be found at the end of this syllabus. **The Poster Presentation will be worth 200 points toward your final grade.**

Grades:

The Capstone grade is based on a maximum of 500 points. Points are divided as follows:

The Research Proposal	150 pts
The Laboratory Notebook	100 pts
Discussions with Community Organizations	50 pts
Poster Presentation	200 pts
Total	500 pts

The following percentages (point distributions) outline the breakdown of grades.

90-100%	(450 – 500 pts)	A
80-90%	(400 – 449 pts)	B
70-80%	(350 – 399 pts)	C
60-70%	(300 – 349 pts)	D
< 60%	(0 – 249 pts)	F

After semester end grades have been submitted to the registrar, a grade may only be changed if there is a clerical error made. It is not possible to submit extra work after the end of the semester in order to raise a grade.

Academic Dishonesty:

Representing the work of others as your own constitutes academic dishonesty and is strictly forbidden in this course. The official University definition of academic dishonesty is: *An act is academically dishonest when it is an act attempted or performed which misrepresents one's involvement in an academic task in any way, or permits another student to misrepresent the latter's involvement in an academic task by assisting in the misrepresentation.* Further information and some specific examples of academic dishonesty can be found at: <http://uwadmnweb.uwyo.edu/legal/Uniregs/ur802.htm>. All sources (whether printed or verbal) used in assignments and projects, including those located on the WEB, need to be correctly cited. If you use 5 or more words from a source just as they are used in the source, you need to put those words in quotation marks and cite the source. It is better to not use quotes, but rather paraphrase and cite the source. If necessary, we will use electronic means to detect plagiarism. Students involved in any form of academic dishonesty can as a minimum, receive an automatic "F" in this course.

Non-Discrimination Statement:

A campus environment characterized by diversity, free inquiry, free expression has always been a top priority of the University of Wyoming. Civil discourse is an essential aspect of the search for and transmission of knowledge. Words and actions that promote and encourage self-worth, respect and dignity are consistent with the university's mission. Conversely, words or actions that reflect prejudice, stereotypes and discrimination are antithetical to the mission of the university and will not be tolerated. Specifically, racist and other discriminatory or harassing conduct based on gender, color, disability, sexual orientation, religious preference, national origin, ancestry or age impair and disrupt legitimate university functions. Every effort, within the context and protection of the First Amendment rights, will be expended to eliminate such conduct from the campus community. Teaching students to live productively in a multicultural/multiethnic society is a process that must take place within a constructive and harmonious environment. It is the obligation of the faculty, staff, students and the administration of the University of Wyoming to provide this environment.

It is the policy of the University to accommodate students with disabilities, pursuant to federal and state law. Any student who needs accommodation because of a disability should inform the instructor at the beginning of the course. Students with disabilities who seek accommodations must contact Student Educational Opportunity Services, Knight Hall room 330, at 766-6189.

Tentative schedule:

Week # (Date)	Topics covered	Reading Assignment	Assignment Due
1 (Jan. 14-20) <i>Instructional Phase: Activation</i>	<p><u>Process:</u> Conceptual overview of problem-based learning; focus-group discussion of prior lab experience; introduction to online microbiology informational feeds / journals and initial discussion with service organization</p> <p><u>Content:</u> Lab Notebook: Writing in and maintaining the lab notebook, The lab notebook front matter Proposal: Writing the statement of problem and significance</p>	Kanare, The Reasons for Notekeeping and the Hardware (pp. 1 – 26 and 53 - 63) Friedland and Folt, Chapter 1, 3 and 4 (pp. 1 – 14 and 26 – 48)	First meeting with the service organization must be scheduled and Knowledge Survey must be entered into eCompanion by the end of the week.
2 (Jan. 21-27) <i>Instructional Phase: Activation and Demonstration</i>	<p><u>Process:</u> Finding recipes, making media and buffers in the lab</p> <p><u>Content:</u> Lab Notebook: The Body of the Notebook Proposal: Introduction (relevant literature), Objectives, hypotheses and specific aims, references</p>	Kanare, The Notebook body and examples of Notebook Entries (pp. 63 – 79 skim pp. 81 – 101) Friedland and Folt, Chapter 7, 8 and 12, (pp. 78 – 105 and 134 – 140)	Lab notebook should be purchased and prepared, A draft of the statement of problem significance (one for each community problem) will be due in class.
3 (Jan. 28- Feb. 3) <i>Instructional Phase: Activation and Demonstration</i>	<p><u>Process:</u> Laboratory culture stock preparation: streaking plates, inoculating broth and making and utilizing frozen stocks.</p> <p><u>Content:</u> Proposal: Introduction (conceptual or empirical model, justification of approach / methods), the Research Plan</p>	Friedland and Folt, Chapter 9 and 10 (pp. 106 – 128)	A draft of objectives, hypotheses and specific aims will be due in class as well as the relevant literature section of the introduction. This should be accompanied by an ever-waxing list of references.

4 (Feb. 4 – 10) <i>Instructional Phase: Activation and Demonstration</i>	<u>Process:</u> Laboratory decontamination principles and a review of the plate count for enumeration. <u>Content:</u> Proposal: Title, Project Summary /Abstract and Timeline	Friedland and Folt, Chapter 5, 6 and 11 (pp. 49 – 77 and 127 – 133)	A full draft of the proposal will be due by the end of the weekend.
5 (Feb. 11-17) <i>Instructional Phase: Demonstration and Application</i>	<u>Process:</u> Group assessment of proposals, Basic bacteriological identification or project-specific tasks / skills in the laboratory <u>Content:</u> Proposal: Revising and rethinking	Friedland and Folt, Chapter 15 (pp. 156 – 161)	Any needed proposal revisions are due by the end of the weekend.
6 through 11 (Feb. 18 – Apr. 7) <i>Instructional Phase: Application</i>	<u>Process:</u> Laboratory experimentation, hypothesis testing, lab manual maintenance	Selected pertinent literature as suggested by the laboratory instructor	At least one meeting must be scheduled with the service organization by midterm. Lab manual should be continually maintained.
12 (Apr. 8-14) <i>Instructional Phase: Integration</i>	<u>Process:</u> Complete laboratory tests, fully clean lab space <u>Content:</u> Presenting findings as a poster	Hall and Robinson, Forward and Chapter 1 (pp. xv-7)	
13 (Apr. 15-21) <i>Instructional Phase: Integration</i>	<u>Process:</u> Poster presentation preparation <u>Content:</u> Presenting findings as a poster	Matthews handout (<i>The Scientific Poster: Guidelines for Effective Visual Communication</i>) Hall and Robinson, Chapter 5 (pp. 35-40)	A draft of the final poster will be due by the end of the weekend.
14 (Apr. 22-28) <i>Instructional Phase: Integration</i>	<u>Process:</u> Poster presentation revision <u>Content:</u> Subversive Science / a critical discussion of positivism, Creating inclusionary environments in science that welcome diversity	Selected readings from the writings of Francis Bacon, Josephine Donovan, Donna Haraway, Patricia Erwick and Sandra Harding	Posters must be finalized and ready to print by the end of the weekend.
15 (Apr. 29 – May 5) <i>Instructional Phase: Integration</i>	<u>Process:</u> Poster presentation printing / preparation, focus group discussion of the capstone experience <u>Content:</u> Poster presentation delivery Using the capstone experience to help in finding your career Guest lecture: Microorganisms in Snow	Hall and Robinson, Chapters 7 and 10 (pp. 51-55 and 67-73)	Posters will be presented during the week of Final Exams along with the General Microbiology Posters. Knowledge Survey must be entered into eCompanion by the end of the week.

Research Proposal Assignment Description

The text resource for this assignment is *Writing Successful Science Proposals* by Andrew J. Friedland and Carol L. Folt

Frank Pajares of Emory University also provides a useful online resource at

<http://www.des.emory.edu/mfp/proposal.html>

***Notes to instructor are in blue**

I. GENERAL DESCRIPTION

Before beginning your research proposal, be sure that you have a large conceptual framework for your proposed project and that you understand the assignment description. Ask yourself whether you could summarize your overall concept in one succinct statement that could be understood by a scientifically literate audience. As you begin your research proposal remember to think big! Consider problems that have meaning to not only you but that also have a greater impact on members of society. As you write your proposal, avoid tunnel vision and do not rush.

Remember that the purpose of a proposal is to effectively communicate your ideas to your reader. As such, good writing is key. Thus, make sure that your proposal is focused, organized and unified; be certain that it highlights important points and that it effectively funnels (that is, it begins with broad statements of significance and narrows to explicit ways in which these broad statements will be addressed by the research). Please keep your proposal to between 8 and 10 pages (double-spaced).

II. SECTIONS

A. Title

Your title should be a clear, concise (succinct yet informative) and meaningful statement that introduces the framework and project perspective. One should be able to get a good idea of the content of the proposal just by reading the title. Try not to overstate the title or use a lot of jargon or buzzwords. Some warn against a title that is too 'cutesy' but certainly it is unarguable that a creative title is more engaging.

Exercises on page 50

B. Abstract / Project Summary

In this section, present a broad overview of the goals, scope, methods, hypotheses and expected results. This is basically a brief summary of the entire proposed project and is the first thing the reader sees. However, as it does summarize the entire proposal, it is generally recommended to write this section last. This section should engage the reader! It should be exciting and persuasive. In order to be such, this section will need be well written and have broad application and intellectual merit. As always, funnel the reader from large ideas to specific objectives. This section is limited to 300 words. One model for distributing these words is in two paragraphs.

Paragraph 1:

A broad statement of context is followed by a statement of the research questions in the form of hypotheses or objectives (pp. 78-89).

Follow this with a sentence that identifies gaps in the current knowledge and a statement of how the proposed research will fill these gaps. Use the last

two or three sentences to succinctly describe the actual work that will be done.

Paragraph 2:

Begin by outlining the techniques / study sites and organisms to be used. State projected results / output. State significance (how the work will advance your area and more broad societal benefits).

Examples on pages 66-68 (Exercises on page 69)

C. Statement of problem and significance / value (or Overview and Significance)

It is important to establish the significance of the work very early in the proposal. Begin by establishing broad interest in the research for readers both inside and outside the field and then funnel your reader, eventually stating your specific aims. Clearly state/describe the problem! Clearly indicate the types of impacts / contributions that may result from the work as well as noting the possible uses of your work by others. This section should serve to establish the framework for your study. After reading this section, your audience should know why the research is necessary and understand the predicted impact / importance of the research. This section need be no longer than a paragraph or two.

Examples on page 46 and 47 (Exercises on page 38)

D. Introduction

This section should provide background information that naturally leads the reader to the objectives / hypotheses. After reading the introduction, any scientifically literate reader should understand the need for the objectives/hypotheses without having to do outside reading. For our purposes, we will limit this section to no more than two or three pages (dependent upon inclusion of preliminary data). Following are suggestions for subsections:

a. Relevant literature

Review the pertinent background information and chose quality sources rather than a vast quantity of sources. That is, focus on key / pivotal references. However, particularly when pointing to a hole in the literature, be sure to fully elucidate that hole. If you are addressing a contentious issue, be sure to review both (all) sides of the issue.

b. Preliminary data

For the purposes of our proposals, it is unlikely that we will have any preliminary data. However, in the event that some small, pilot experiments have been done, present pertinent results here.

c. Conceptual or empirical model

In grant-funded proposals, this section may include quantitative modeling and computer simulation. However, for our purposes, we will use this section to simply show (visually / schematically) the research plan and how the research fits into the larger picture (p. 104). This figure will not be counted in the page total for this section.

d. Justification of approach / methods

Provide a justification for the research methods that will be used. This is important for all methods but must be particularly well developed if the methods are not already well established / commonly used.

E. Objectives, Hypotheses and Specific Aims

Although these were stated briefly in the project summary / abstract, they can now be stated with more detail.

a. Objectives

Broad, far-reaching statements (e.g. “to further our understanding of the impact of urban runoff containing increased concentrations of nitrogen, phosphorus and potassium (NPK-rich) on the bacterial biodiversity of community gardens” (p. 79).)

b. Hypotheses

A more specific set of testable predictions (e.g. “We hypothesize that bacterial biodiversity is lower in soils of community gardens that are exposed to NPK-rich urban runoff than those unexposed soils”. See page 81 for additional examples). For our purposes, we will limit the number of hypotheses to one or two.

c. Specific Aims

These are similar to hypotheses but focus on that which will be needed to fulfill the aim or the predicted outputs of the aim. (e.g. We will measure the bacterial biodiversity in soils of community gardens to establish the difference between those exposed to NPK-rich urban runoff vs. those not exposed. See page 82 for additional examples).

Exercises for writing objectives, hypotheses and specific aims are on page 88 and 89

F. Research Plan (design / methods / expected results)

a. Overview of research design

In one paragraph, state the overall research strategy (a road map). Be sure to link the research plan to the significance, objectives, aims and hypotheses. Justify your approach and describe why it is the best approach to achieve the objectives. It may be effective to provide a table that links hypotheses to methods.

b. Methods and Materials

Choose feasible methods that are the best methods for achieving the stated goals. Be certain to clearly cite the resources used for established methods and if methods are novel, describe them thoroughly.

i. Sampling procedures / population / context (site)

ii. Culturing methods

iii. Experimental protocols (procedures) / methodological steps / instruments used

See examples on page 122

c. Data Collection and Analysis

Demonstrate how you will collect data and how you will analyze your output. What data are expected and how will they be dealt with? Please make a statement as to how sensitive data will be stored / protected.

Exercises for writing methods on pp. 121-123

d. Analysis and expected results

Present and discuss both results that are expected and unexpected results. Discuss interpretations of these results. A diagram or schematic is often helpful in showing differing outcomes.

G. Timeline

Present a plan for the timeframe in which all elements of the project will be accomplished (pp. 132-133 for examples). In order to do this effectively, this may require you to consider need for equipment scheduling, time required for sampling or culture growth and seasons when sampling must occur.

H. References

Cite all pivotal references and particularly those most directly applicable to the proposed work. Try to rely most heavily on recent, peer-reviewed sources. **ONLY** cite publications that you have read! We will use the citation format required by authors submitting research proposals to the NSF. Thus, all citations must include the following:

Names of all authors (in the same order as they are listed on the actual publication), article title, journal / book title, volume number, page numbers, and year of publication. If the article / book is available electronically than also include the URL.

Following are examples:

Journal:

Tambalo, D.D., Fremaux, B., Boa, T. and C. K. Yost, "Persistence of Host-associated Bacteroidales Gene Markers and their Quantitative Detection in an Urban and Agricultural Mixed Prairie Watershed," *Water Research*, 46(2012)2891-2904.

Book:

Ogunseitan, O., *Microbial Diversity: Form and Function of Prokaryotes*. John Wiley & Sons, New York, New York (2004) Chapters 3 and 4.

Following are examples of how the above journal source would be referenced in text:

A study in the Qu'Appelle Valley showed that *Escherichia coli* counts did not correlate with the presence of pathogenic bacteria such as *Salmonella* and *Campylobacter* (Tambalo et al. 2012).

Additional examples of in-text citations are given on pp. 137-140 of the textbook.

Exercises for writing references on page 140. The citation guidelines given by NSF are not highly prescriptive. They can be found at:

http://www.nsf.gov/pubs/gpg/nsf04_23/2.jsp

Proposal Section	Unsatisfactory (lacking / inaccurate / inappropriate)	Evolving (appropriate but partially-formed)	Competent (appropriate and accurate)	Accomplished (precise and descriptive / nuanced / exemplary)
Title	<i>The title fails to summarize the proposal content. It may even indicate content that is not covered by the proposal.</i>	<i>Title summarizes proposal content but only partially. It lacks descriptiveness or succinctness that would fully inform the reader about proposal content.</i>	<i>Title summarizes the proposal content. It is appropriate and accurate but not nuanced.</i>	<i>Title clearly summarizes the proposal content without overstating. It is concise and nuanced with a succinct and informative introduction to the framework of the proposal.</i>
Abstract / Project Summary	<i>Summary lacks either hypotheses, objectives, context, justification, techniques or significance or these components are inappropriate / inaccurate.</i>	<i>Hypotheses, objectives, context, justification, techniques and significance are stated but one or more of these sections lacks succinctness (clarity), fails to inform the reader fully.</i>	<i>Hypotheses, objectives and context are stated. Justification for the research is included. Techniques, study sites and organisms to be used are outlined. Projected results and significance/relevance are also introduced. Section is appropriate but lacks nuances that additionally inform / draw the reader.</i>	<i>Hypotheses, objectives and context are clearly stated. Justification for the research is included. Techniques, study sites and organisms to be used are outlined. Projected results and significance/relevance are also introduced. Section is nuanced, concise, informative yet succinct; it flows.</i>
Problem and Significance	<i>Problem, interest and or specific aims are not stated / described or these sections are inappropriate.</i>	<i>The problem is described and broad and discipline-specific interest is established. Specific aims are stated. However, one or more of these areas lack clarity / conviction. The reader may not clearly understand the importance of the research / may feel only partially informed and/or not entirely convinced of or even clear about necessity.</i>	<i>The problem is described. Broad and discipline-specific interest is established. Funneling is used to lead to the specific aims. The reader understands why the research might be important and can adequately understand predicted impact.</i>	<i>The problem is clearly articulated / described. Both broad interest and discipline-specific interest is established. Effective funneling is used to lead the reader to specific research aims (it flows). The reader understands and is convinced of (in a detailed and nuanced way) the necessity of the research but also its predicted impact.</i>
Introduction: Relevant Literature	<i>Background literature is omitted or entirely inappropriate or all key/pivotal references are omitted.</i>	<i>Background literature is presented but may be only partial or some but not all key/pivotal references are included. Quality/pertinence of sources may be suspect/lacking. A hole in the literature may be noted but not entirely elucidated. Contentious issues may be presented in a unaffected way.</i>	<i>Background literature is pertinent and adequate (most are peer-reviewed and recent / others are appropriate). Effort is made to competently introduce pivotal references. Holes in literature are adequately elucidated and contentious issues are discussed from both/all sides.</i>	<i>Pertinent background literature is thoroughly reviewed; sources are of high quality (most are peer-reviewed and recent / others are appropriate) and all key/pivotal references are included. If pointing to a hole in literature, that hole is clearly, succinctly and fully elucidated. If topic is contentious than both/all sides of the issue are clearly / fully / expertly presented.</i>
Introduction: Preliminary Data	<i>Despite preliminary data being available, they are omitted or inaccurate / inappropriate.</i>	<i>If preliminary data are collected, they are presented but perhaps only partially. And/or, It may be unclear to the reader how these data pertain to the proposed research.</i>	<i>If preliminary data have been collected, they are presented. Effort is made to show how these data pertain to the proposed research.</i>	<i>If preliminary data have been collected, they are fully, clearly and succinctly presented. It is not only very clear as to how these preliminary results pertain to the proposed research, but the proposed research flows from these findings in an eloquent way.</i>
Introduction: Conceptual Model	<i>A visual schematics is omitted and / or it is inaccurate / inappropriate.</i>	<i>A visual schematic is included but it is unclear as to how the research fits into the big picture and/or the figure is nebulous/difficult to interpret.</i>	<i>A visual schematic adequately elucidates how the research fits into the big picture.</i>	<i>A visual schematic clearly, eloquently, succinctly shows exactly how the research fits into the big picture. The figure is creative/unique and fully informed.</i>
Introduction: Justification of Methods	<i>Methods are not justified or justifications are inappropriate / inaccurate.</i>	<i>Some methods are not fully/adequately described and / or reasons for chosen methods are unclear. Citations for established methods may also be unclear/partial.</i>	<i>A sufficient justification is included for all methods. Novel methods are adequately described and citations are included for established methods.</i>	<i>Clear justification is given for the choice of each of the methods to be used. Full descriptions are given for novel methods and established methods are succinctly described and fully cited.</i>

Proposal Section	Unsatisfactory (lacking / inaccurate / inappropriate)	Evolving (appropriate but partially-formed)	Competent (appropriate and accurate)	Accomplished (precise and descriptive / nuanced / exemplary)
Objectives	An objective statement is omitted or is inappropriate (does not state the purpose of the research).	An objective statement is given but it may be partial and / or no more focused than the broad statements of the significance section.	A broad, far-reaching statement is given. It adequately presents relevance in a more focused way than the significance section.	A broad, far-reaching statement clearly and eloquently states the purpose of the research. It is clear, succinct and presents relevance in a more focused way than the significance section.
Hypotheses	Hypothesis/es are omitted or entirely inappropriate.	Hypothesis/es may lack background, testability or clarity and / or they may be too broad in scope / unfocused.	Hypothesis/es is/are testable, grounded, has/have appropriate scope, and is/are clear.	Hypothesis/es is/are testable, grounded, has/have appropriate scope, and is/are clear. It is / they are succinctly stated, comprehensive and focused.
Specific Aims	Specific aims are omitted / inappropriate or exactly the same as the objectives or hypothesis.	Specific aims are stated but are unclear / incomplete. They may not focus on that which is needed to fulfill the aim or on outputs.	Specific aims are adequately stated and focus on that which is needed to fulfill the aim or the predicted output of the aim.	Specific aims clearly focus on that which is needed to fulfill the aim or the predicted output of the aim. The aims are clearly different from the hypothesis and are eloquently stated.
Research Plan: Overview	The approach presented may be inappropriate. The road map may be completely lacking or it may actually be at odds with the stated objectives, aims or hypotheses.	The overview presents a road map but it is incomplete / lacking some elements and / or it may not be clearly linked to the objectives, aims and or hypothesis.	The overview presents and adequate road map of the research and is consistent with the significance, objectives, aims and hypotheses. The approach is justified.	In one succinct paragraph, a clear road map of the research is outlined. There is an evident and comfortable coherence between the plan and the significance, objectives, aims and hypotheses. The approach is excellently and fully justified.
Research Plan: Materials and Methods	Methods are omitted / inappropriate or inaccurate.	Methods are only partially described; there are gaps either in citation or one of the following: 1) Sampling procedures / population / context 2) culturing methods 3) Experimental protocols (procedures) / methodological steps / instruments used.	Methods are feasible and will allow for the objectives to be achieved. Methods are sufficiently described and citations are included where needed. All of the following are presented: 1) Sampling procedures / population / context 2) culturing methods 3) Experimental protocols (procedures) / methodological steps / instruments used.	Methods are not only feasible but they are the best methods to achieve the objectives. Resources are clearly cited and all methods are fully described. All of the following are expertly intertwined: 1) Sampling procedures / population / context 2) culturing methods 3) Experimental protocols (procedures) / methodological steps / instruments used.
Research Plan: Data Collection and Analysis	Data collection is omitted or methods to collect, store and analyze data are inappropriate.	There are some gaps in how data will be collected, analyzed or stored and/or unexpected data are not considered.	Data collection, analysis and storage are adequately described. Both expected and unexpected data are considered.	It is very clear both how data will be collected and how it will be analyzed and stored. Expected and unexpected data are not only considered but a plan for dealing with both is clear. Methods for both collection and analysis are creative and very coherent with objectives.
Research Plan: Analysis of Expected Results	Results interpretation is omitted or inappropriate (does not follow from plan).	Interpretation of results is only partially discussed. There are gaps and may be no consideration of unexpected results.	Interpretation of results is adequately discussed. Expected and unexpected results are considered. A helpful diagram/schematic may clarify.	Interpretation of results is fully discussed. A very clear consideration of interpreting expected results is included but so to is a full discussion of interpreting unexpected results. A helpful diagram/schematic may clarify.
Timeline	Timeline is omitted or completely inconsistent with the project objectives.	Timeline has gaps, may not fully consider time needed to complete equipment scheduling, sampling, culture growth.	Timeline is reasonable, considers need for equipment scheduling, time required for sampling, culture growth etc...	Timeline is thoughtful, based in extensive groundwork. It clearly considers need for equipment scheduling, time required for sampling, culture growth etc...
References	References are primarily lacking and or inappropriate. Large gaps in citation information may preclude a reader from finding sources.	Either reference list could be more complete or citation information is incomplete (e.g. author name or date of publication is lacking in places.)	References are primarily recent, peer-reviewed and accurately cited with names of all authors (in the same order as they are listed on the actual publication), article title, journal / book title, volume number, page numbers, and year of publication (URL where appropriate)	References are primarily recent, peer-reviewed and accurately cited with names of all authors (in the same order as they are listed on the actual publication), article title, journal / book title, volume number, page numbers, and year of publication (URL where appropriate). Special care is taken to be thorough and all pivotal references are included.

Laboratory Notebook Assignment Description

The text resource for this assignment is *Writing the Laboratory Notebook* by Howard M. Kanare. Ron Beavon provides a helpful online resource at http://www.rod.beavon.clara.net/lab_book.htm *Notes to instructor are in blue. [The instructor should read Appendix A in the text before beginning lab notebook coverage.] The Lady Gaga Bad Project Video on YouTube would be a funny and pertinent way to begin this coverage.

I. The Hardware

The lab notebook should be bound, durable (made of permanent paper) and have serially numbered pages. Carbon copies are desirable as copies can be submitted to your instructor. Writing in notebooks should be done with permanent pen (black, ballpoint pen is preferred as it dries fast and is resistant to light and organic solvents). Notebooks should be stored in a protected / locked, safe place with standard 23°C temperatures and 45-50% humidity.

II. Writing in and Maintaining the Notebook

Make your notebook entries immediately after performing the work. Our memory is not trustworthy. Be certain that all entries are legible (have good penmanship), honest and that numbers and symbols are unambiguous. If you make an error, cross it out with a single line and initial. Write in the active voice so as to clearly specify who did the work. As the lab notebook author, you should sign and date each entry. The top of each page should be dated (on outer left margin of left-hand pages and outer right margin of right-hand pages (e.g. 25 April 2013)) and have a short (4 to 5 word) running title.

Every page of the notebook should either be filled with writing or left-hand pages can be reserved for calculations, drawings and other miscellaneous notes. Be sure to clearly X-out, date and initial and un-used pages / space. Do not tear out or add pages to your notebook. If you do need to attach a loose sheet in your notebook, use starch paste, a high-quality white glue or mending tape (fig. 7.1). Date and initial the added sheet.

III. The Front Matter

a. *Exterior Title*

This is the title on the front and spine of the lab book. This should include the project name and number (if there is more than one notebook). White, correction fluid can be used to write on the spine if it is dark in color.

b. *Signout page* (fig. 2.1)

This is the first page of the notebook. If the notebook is issued by the employer than this page includes the date the notebook was issued. For our purposes, this page will include the date that the notebook was purchased, by whom and a short description of the purpose of the notebook.

c. *Table of Contents* (Fig. 5.1-3)

Include the date, subject matter and page number in tabular format for each experiment / pertinent section in the notebook

d. *Preface* (fig. 5.4)

This is a short narrative in which you identify yourself as author, your supervisor and coworkers (project partners). Clearly state the goal of the project/research, the context (where the work is being done) and where any other records relating to the project are stored.

e. *Table of Abbreviations* (Fig. 5.6)

Define any commonly used abbreviations in tabular format

IV. The Body of the notebook

Record all of the following for each experiment

a. *Introduction*

Start each experiment on a new page and note the date and title. State the goal/purpose/objectives of the experiment (Why was the experiment chosen and what are the possible benefits of the experiment? Briefly note pertinent literature.) Also state hypothesis/es and specific aims addressed by this experiment.

b. *Experimental Plan* (give this section a specific name based on the experiment)

Fully describe the experimental procedure (use flowcharts, lists or outlines) * Be certain that someone could come back later and repeat your work! List safety concerns and material properties (pertinent MSDS notes). Do not omit any detail (e.g. all info on reagents used: manufacturer, lot, purity etc.; type of water and purity; calibration dates / sensitivity of instruments, proper names for labware; composition of vessels; order in which reagents are added;... [see page 70.]! Draw any novel devices or unusual lab setups that are used.

c. *Observations and Data* (fig. 6.3)

Record, completely and accurately, all raw data (whether it fits the hypothesis or not – be prepared for the unexpected). Observations should be written as a narrative. Use first person to make it clear that you did the work. Record every observation immediately and in writing that anyone could understand. Plan notebook writing into the allotted time for your experiment.

d. *Discussion of Results* (fig. 6.4)

This section is a place to, “think in your notebook” (p.74). Record all calculations, charts, tables, ramblings and interpretations. Include all details (e.g. on graphs - label titles, dates, axes etc...). Do not restate data in this section, instead use it as a section in which to *understand* data. Clearly address and discuss the hypothesis/es in this section.

e. *Conclusions*

In this section, succinctly state the accomplishments of the experiment (what was done and what was found? Was the goal achieved? Was the hypothesis supported/rejected?) Also discuss what should have been done differently and what will be done next. Record any novel idea that you have had after completion of the experiment.

V. Reflection on Meetings with Service Organizations

After each meeting with the service organization whose problem we hope to address, please reflect on the meeting and self assess your group with respect to your ability to: 1) relate (recognize the relevance of) microbiology concepts to the unique problem of the community service organization, 2) communicate important microbiology principles / microbiological solutions with an individual within the community service organization, 3) understand the social ramifications / applications and implications of scientific actions / studies to the community organization, 4) value scientific knowledge as a tool to enact community change and the responsibility inherent with this. Be certain to start a new notebook page for each reflection and clearly date and denote this section.

Notebook Area	Unsatisfactory (lacking / inaccurate / inappropriate)	Competent (appropriate and accurate)
<i>Hardware: Notebook</i>	Notebook is either not bound / durable or lacks serially-numbered pages	Notebook is bound, durable and has serially-numbered pages
<i>Hardware: The Pen</i>	Writing is done with a pen that is not permanent / resistant	Writing is done with a permanent, black, ballpoint pen
<i>Hardware: Storage</i>	Notebook is not stored in a protected, locked, safe, ambient place	Notebook is locked, safe and at standard temperature and humidity
<i>Writing and Maintaining: Timeliness of entry</i>	Entries are delayed / not made immediately after performing the work	Entries are made immediately after performing the work
<i>Writing and Maintaining: Legibility</i>	Entries are difficult to read and / or ambiguous	All entries are legible / numbers and symbols are unambiguous
<i>Writing and Maintaining: error correction</i>	Errors are not crossed out with a single line and / or not initialed	All errors are crossed out with a single line and initialed
<i>Writing and Maintaining: Active voice</i>	It is not clear who made the entry / did the work	Entries are made in the active voice thus making it very clear who did the work
<i>Writing and Maintaining: Date and Running Title</i>	Dates and or running titles are lacking / insufficient	All pages are clearly and appropriately dated and have a running title
<i>Writing and Maintaining: Unused space</i>	Unused space is not filled / not Xd-out or initialed	All unused space is both Xd-out and initialed
<i>Writing and Maintaining: Attaching Loose Sheets</i>	Loose sheets are not appropriately attached	Loose sheets are pasted into the notebook using high-quality glue or mending tape. These attachments are dated and initialed
<i>Front Matter: Exterior Title</i>	Project title is either lacking or not clear / visible on either front and /or spine	Project title is clearly / visibly written on the front and the spine
<i>Front Matter: Signout page</i>	Either date of purchase, person purchasing or description of the purpose of the notebook are absent or insufficient.	Includes the date the notebook was purchased, by whom and a short description of the purpose of the notebook
<i>Front Matter: Table of Context</i>	Either table lacks page numbers, subject matter or is not tabular	A clear table that gives page number and subject matter for each experiment / pertinent section in the notebook
<i>Front Matter: Preface</i>	Either researcher, coworkers, goal or context is lacking or insufficient	Identifies researcher, coworkers (project partners), goal of research and context
<i>Front Matter: Table of Abbreviations</i>	Table is either lacking or not all common abbreviations are defined	All commonly used abbreviations are defined
<i>Reflections on meetings with service organizations</i>	Reflections or self-assesment on meetings with service organizations are lacking or insufficient.	Reflections are included for each meeting with the service organization and each category of self-assessment is appropriately addressed.

Section of the Body of the Notebook	Unsatisfactory (lacking / inaccurate / inappropriate)	Evolving (appropriate but partially-formed)	Competent (appropriate and accurate)	Accomplished (precise and descriptive / nuanced / exemplary)
<i>Introduction:</i> Distinguishing New Experiments	New experiments are not clear as they do not start on a new page and / or are not titled.	New experiments may start on a new page but may not be titled / dated. Or, new experiments are titled and dated but do not start on a new page.	Each experiment begins on a new page, is dated and titled.	Each experiment begins on a new page, is clearly dated and titled.
<i>Introduction:</i> Statement of Goals	Introduction lacks statements of goals / purposes / objectives / hypotheses or specific aims and / or these are insufficient	Goals / purposes / objectives / hypotheses may be stated but they are incomplete (not well formed).	Goals / purposes / objectives / hypotheses and specific aims are sufficiently stated.	Goals / purposes / objectives / hypotheses and specific aims are precisely/eloquently stated.
<i>Introduction:</i> Literature Review	Either no comment on pertinent literature is made or it is completely inappropriate or inaccurate.	Mention of pertinent literature is made but is incomplete / not sufficient.	Pertinent literature is sufficiently noted.	Not only is pertinent literature noted but connection to experiment is clearly / precisely described.
<i>Introduction:</i> Benefits of Experiment	A description of benefits of the experiment is lacking or completely inappropriate.	A description of benefits of the experiment is included but it is incomplete.	Benefits of the experiment are sufficiently noted.	Great care is taken to write a descriptive background of benefits of the experiment.
<i>Experimental Plan:</i> Description of Procedure	Experimental procedure is either lacking or completely inaccurate.	Experimental procedure is included but is incomplete. Flowcharts, lists and outlines may be omitted or partial. It may be difficult for someone to replicate the experiment. Details are lacking.	Experimental procedure is fully described (using flowcharts, lists or outlines where needed). It would be possible for someone to use this plan to repeat the work. All details are included.	Experimental procedure is nuanced, precise and flows. It would be very easy to reproduce the described experiment and flowcharts and lists are eloquently interwoven to complement descriptions wherever necessary.
<i>Experimental Plan:</i> Safety concerns and MSDS properties	Safety concerns and or chemical / material properties are lacking or inaccurate.	Safety concerns and or chemical / material properties are only partially outlined.	Safety concerns are sufficiently addressed as are properties of pertinent substances / chemicals.	All pertinent safety concerns are thoroughly addressed. Many details of chemical properties of reagents are included (manufacturer, lot, purity etc.; type of water and purity; calibration dates / sensitivity of instruments, proper names for labware; composition of vessels)
<i>Observations and Data:</i> Raw Data	Raw data is lacking.	Record of raw data is incomplete.	All raw data is accurately recorded.	All raw data is clearly, thoroughly and accurately recorded.
<i>Observations and Data:</i> Observations	Observations are lacking.	Observations are incomplete.	Observations are accurately recorded using first person narrative.	All observations are clearly, thoroughly and accurately recorded using first person narrative.
<i>Discussion of Results:</i> Interpretation	Interpretations are lacking or are inaccurate.	Raw data are only partially interpreted. Charts, tables, or calculations may be insufficient.	Raw data are sufficiently summarized in the form of charts, tables, calculations or ramblings wherever appropriate	Raw data are thoroughly, clearly and accurately interpreted using charts, tables, calculations or ramblings wherever appropriate. No data are left un-interpreted.
<i>Discussion of Results:</i> Used to understand data	Discussion is lacking or is only a recapitulation of results.	Discussion may partially recapitulate results.	Discussion is used sufficiently to understand data, not to re-capitulate.	Discussion is used to understand data, not to re-capitulate. In this case, discussion is nuanced, detailed and clear.
<i>Discussion of Results:</i> Hypothesis addressed	Hypothesis/es is not addressed.	Hypothesis/es are only partially addressed.	Hypothesis/es are sufficiently addressed	Hypothesis/es are thoughtfully / thoroughly addressed
<i>Conclusions:</i> Accomplishments	Accomplishments are not included and/or hypothesis is not addressed.	Accomplishments are only partially described and / or it is unclear as to whether the hypothesis was supported / rejected.	The accomplishments are adequately described. It is very clear whether the goal/s was/were accomplished. It is clear as to whether the hypothesis was supported / rejected.	The accomplishments are succinctly, thoroughly, precisely described. It is very clear whether the goal/s was/were accomplished. It is clear as to whether the hypothesis was supported / rejected.
<i>Conclusions:</i> Future Changes	There is no discussion of what should be done differently next time.	Discussion of what should be done differently next time is incomplete.	Discussion of what should be done differently next time is sufficient.	Discussion of what should be done differently next time is thorough, succinct, precise and nuanced.
<i>Conclusions:</i> Novel Ideas	Novel ideas are not discussed.	Discussion of novel ideas stimulated by the research is partial / incomplete.	Novel ideas stimulated by the experiment are summarized.	Novel ideas stimulated by the experiment are summarized thoroughly, succinctly and precisely.

Community Service Organization Student Group Evaluation Section	Unsatisfactory (lacking/inadequate)	Satisfactory (fitting/adequate)
Professionalism	Professional skills were lacking. Students were not punctual or courteous in interactions.	It is evident that students took responsibilities seriously. Punctual and courteous in interactions with organization.
Relevance	Student developed solutions may not fully address key components of problem presented.	Students developed solutions fully addressing key components of the problem presented.
Communication	Students did not effectively communicate research results. Improvement in the explanation of scientific concepts is needed.	Students effectively communicated research results to organization, explaining scientific concepts at an appropriate level.
Comments		

Poster Presentation Assignment Description

(See also the Poster Format Handout for a visual aid in poster construction)

The text resource for this assignment is *How to Present at Meetings* by George M. Hall and Neville Robinson (2012). Additionally the texts entitled *Scientific Papers and Presentations* by Martha Davis (1997) and *The Chicago Guide to your Career in Science* by Victor A. Bloomfield and Esam E. El-Fakahany (2008) provided background information for this assignment description.

Other useful resources include:

Guidelines for Effective Visual Communication by Diane L. Matthews (class handout)

Preparing and Presenting Effective Research Posters by Jane E. Miller, Health Research and Educational Trust

A useful online resource is:

http://www.clemson.edu/cafls/sclife/documents/how_to_create_a_poster_ur.pdf

A. GENERAL DESCRIPTION

Posters are an efficient way to both visually and verbally present a scientific study. They tell the story of the research in a straightforward and succinct way, yet they allow for more flexibility in time and conversation than a traditional oral presentation. When designing a poster, remember to keep it simple as many visitors will take only 1-10 minutes to take in your whole poster. Use straightforward language and short sentences; balance figures (visual imagery) and text. Maintain focus on the central message (retain coherence) and use only short sections of text (more than 20 continuous lines may be too much). 'Chunk' sections of text into small 'digestible' bites (Matthews). Often lists are an effective way to quickly summarize objectives or conclusions. This assignment description is designed to assist in constructing a poster that effectively presents / communicates important elements. However, remember that creativity and uniqueness will likely enhance the poster and engage the audience.

II. SECTIONS

A. Title

A succinct statement that summarizes the work that was done. A reader should be able to get an idea of the design methodology and content of the poster by simply reading the title. Make certain that your title reflects your findings! It is a good idea to avoid jargon or buzzwords in the title. However, a title that is engaging will be more likely to draw the reader.

B. Objectives, Hypotheses and Specific Aims

These were developed and finalized for the Research Proposal (see Research Proposal Assignment Description). On the poster these will simply be restated.

C. Main Body (I M RaD Convention):

a. Introduction

Present an overview of the most important literature. Focus on key / pivotal sources. Clearly provide a justification for the research. Establish the significance of the work / why it is important; clearly state the problem! Make the background leading to and impetus for the objectives, hypotheses and specific aims very clear. After reading this section, your audience should

know why the research was necessary, why you stated the objectives, hypotheses and specific aims that you did.

b. Methods

This section will be very brief unless a novel method is presented. Include just enough text to make it clear how the data were derived/collected/analyzed. A list or flow chart may be effective here. If methods are novel, describe them in detail with illustrative figures. Describe the site / population / context, method of sample collection / culturing and analysis as well as statistical methods.

c. Results

In this section, which is the most important and central part of the poster, present only enough data to make the point. That is, only those data that relate to 'take-home' messages. Data should primarily be presented as clear tables and illustrations that can be interpreted alone. The small amount of flanking text can draw attention to / highlight certain findings. Carefully consider the clearest way to present your data; do not let the medium get in the way of the message.

d. Discussion

Assess the results / make generalizations and references to the literature. Connect your discussion to the introduction and directly address the objectives, hypotheses and specific aims. Clearly indicate the impacts / contributions of the research and how what was found might influence programs / policies of the community service group for whom the research was done.

e. Conclusion/s

In this final section, state the overarching outcomes and be certain they are based on the data. Use one final sentence to suggest future research. Some argue that this section should be placed at the top of the poster to enhance visibility (Bloomfield & El-Fakahany). This may not comfortably fit some poster designs (e.g. Poster Format Handout) but regardless of location on the poster, be certain that this section is visible.

D. Acknowledgements

Recognize funding sources and any other individuals/entities that provided support / contributed significantly (e.g. facility provided access to equipment or resources).

E. References

If possible, limit this to between 6 and 10 key references. We will use the Vancouver style for references. A handout will be given in class but can also be accessed online at <http://openjournals.net/files/Ref/VANCOUVER%20Reference%20guide.pdf>

III. APPEARANCE

a. Font, font size and color

- i. Readability is paramount! A sans serif typeface is most effective for titles / subtitles. This can be continued throughout the main body of the text for a modern look. Alternatively, a readable serif font such as Times New Roman can be used for the main body.
- ii. Be certain that your poster can be read from 1 meter away. The title should be readable from 5 to 10 meters away. References can be of smaller typeface.

- iii. Avoid capitals as they are uncomfortable / slow to read (unless your goal is to slow down your reader – such strategy can be effectively used in titles).
- iv. The body of the text should be 1.5 to double spaced for readability.
- v. Use colors for contrast and to highlight / improve visibility but do not overuse colors. Black on white is the most effective for the main body of the text (see Poster Format Handout). The background can be a subdued color (pastel or earthy greens and blues are often effective). Avoid distracting images in the background.
- b. Spacing, placing and flow
 - i. Be sure to know the size of your display easel before beginning poster design.
 - ii. Use white space effectively. Approximately 50% of the poster should be blank.
 - iii. Alignment is important; keep margins consistent and chose and stick to one type of justification.
 - iv. Be sure that the poster has either a vertical or horizontal flow. The Poster Format Handout shows a vertical flow.
 - v. It may be effective to place important information at the center of the poster (see the Matthews handout – section devoted to the ‘Golden Rectangle’).
- c. Tables, diagrams, figures and graphics

Keep these visuals simple and accessible. Each graph should relate only one message. Always label axes and include legends. Try to have no more than 20 columns / rows in a table and try to limit graphs to three lines or six bars. Try to limit pie graphs to six wedges. Be sure labeling on lines / bars / rows and columns is clear. Appropriate use of photographs can be very effective and always enhances engagement.

IV. Delivery

- a. Consider audience but assume that it will likely be a small group of interested, scientifically literate individuals.
- b. Maintain eye contact and be audible and engaging.
- c. Dress to fit the function but also to maximize confidence.
- d. Welcome questions.
- e. Pay attention to non-verbal communication.
- f. As you present be sure to highlight: 1) Why the work was done, 2) How it was done, 3) What was found and 4) What it means.
- g. Try not to allow communication to be unidirectional. Engage your listener. Find out what she/he knows and build from that scaffold.
- h. Say what you’re going to say, say it and then say what you’ve said.
- i. Practice.

Poster Section	Unsatisfactory (lacking / inaccurate / inappropriate)	Evolving (appropriate but partially-formed)	Competent (appropriate and accurate)	Accomplished (precise and descriptive / nuanced / exemplary)
Title	<i>The title fails to summarize the research. It may even indicate content that is not covered by the proposal.</i>	<i>The title only partially summarizes the research / reflects the findings. It may not be entirely engaging / may be too long or overstated.</i>	<i>The title adequately but not elegantly summarizes the research and reflects the findings.</i>	<i>The title clearly, succinctly summarizes the research. It reflects the findings, is engaging and not overstated / too long.</i>
Objectives / Hypotheses and Specific Aims	<i>assessed as part of the Research Proposal Rubric</i>			
Introduction	<i>More than one essential portion of the introduction is lacking / inadequate.</i>	<i>One of the essential components of the introduction is lacking / insufficient (e.g. literature review, justification, statement of problem or significance.) Lead in to objectives, hypotheses or specific aims may not be clear.</i>	<i>Literature overview is adequate; key / pivotal sources are included. Justification is complete. Problem and significance are stated. Reader understands the lead-in to objectives, hypotheses and specific aims.</i>	<i>Literature overview is thorough, clear and complete; key / pivotal sources are included. Justification is complete. Not only is the problem stated but it is clear and succinct. The significance of the work is obvious and eloquently leads the reader to the stated objectives, hypotheses and specific aims.</i>
Methods	<i>The description of how data were derived is lacking or inadequate.</i>	<i>The description of how data were derived is incomplete.</i>	<i>Provides an adequate description of how the data were derived / collected / analyzed. Novel methods are clearly described.</i>	<i>Provides a brief, highly visual and clear description of how the data were derived / collected / analyzed. Any novel methods are very thoroughly and succinctly described.</i>
Results	<i>Figures / tables / graphs are uninterpretable or completely inappropriate in conveying the central poster message.</i>	<i>Some figures / tables / graphs may be hard to interpret or may not be fully / effectively used to support the central poster message/s.</i>	<i>Data adequately convey the central poster message/s. Figures / tables / graphs can be independently interpreted and flanking text is kept to a minimum.</i>	<i>The perfect amount of data are clearly and visually shown. Each figure / table / graph can be easily interpreted and never attempts to convey too much. Flanking text is kept to a minimum and serves only to highlight.</i>
Discussion	<i>Discussion fails to summarize findings within the context of the background or proposed objectives / hypotheses / literature.</i>	<i>One of the elements of the discussion is not complete. Discussion may fail to connect the findings to the introduction / literature / hypotheses etc..</i>	<i>Sufficient discussion connects the findings to the introduction and literature. The objectives / hypotheses are addressed. Impacts and contributions of the research are considered.</i>	<i>The results are discussed within the framework of introductory literature. Connections to the introduction / objectives / hypotheses are clear and eloquent. Impacts / contributions of the research are not only elucidated but they are succinct and specific. It is very clear how the research will impact the service organizations.</i>
Conclusion/s	<i>Outcomes lacking or do not follow from data / findings. Suggestion for further research is lacking or does not follow from findings.</i>	<i>Outcomes are incompletely stated or do not entirely follow from data / connection is nebulous. Suggestion for further research may be incomplete.</i>	<i>Outcomes are adequately stated and are based on data. Further research is suggested.</i>	<i>Clearly, succinctly states the overarching outcomes. Outcomes are based on data and connections between data and outcomes are expertly drawn. Further research is suggested and eloquently follows from the findings.</i>
Acknowledgements	<i>Funding sources, individuals / entities are not acknowledged or are inadequately acknowledged.</i>		<i>Funding sources, individuals/entities (all significant contributors) are acknowledged.</i>	
References	<i>Reference list is lacking / inappropriate or it is not formatted in at all the appropriate style.</i>	<i>Either the reference list is incomplete / lacks some key references or the Vancouver Style is not full followed.</i>	<i>An adequate list of key references is included in the Vancouver Style.</i>	<i>A succinct list of key references is included in the Vancouver Style. Reference list shows thoughtful selection, diversity and appropriateness. All references lend clout to the work.</i>

Appearance / Delivery Category	Unsatisfactory (lacking / inaccurate / inappropriate)	Evolving (appropriate but partially-formed)	Competent (appropriate and accurate)	Accomplished (precise and descriptive / nuanced / exemplary)
Readability	<i>The poster is difficult to read at 1 meter away and / or the title cannot be read from 5 to 10 meters away.</i>		<i>The poster can be read comfortably from 1 meter away; the title can be read from 5 to 10 meters away.</i>	
Color	<i>Colors are either overused or inappropriately used in all cases.</i>	<i>Colors may be used to add contrast and to highlight but they are overdone in some places or may be used inappropriately in certain areas.</i>	<i>Colors are used to highlight and add contrast but are not overdone.</i>	<i>Colors very effectively highlight importance / increase engagement. They are expertly included to enhance contrast but they are never overdone.</i>
Spacing	<i>White space is not effectively used. Either much more than or less than 50% of the space is white.</i>		<i>White space is effectively used. Approximately 50% of the space is white.</i>	
Flow	<i>The poster neither uses effective vertical or horizontal flow.</i>		<i>The poster has either consistent vertical or horizontal flow.</i>	
Tables, figures, digrams, graphs	<i>Visuals are inappropriate / in adequate / impossible to interpret.</i>	<i>Either some visuals are unlabeled or too busy (more than 1 message) or photographs seem unrelated.</i>	<i>Visuals are adequate. Graphs relate one message and are fully / expertly labeled. Tables have no more than 20 rows/columns. Graphs are limited to three lines / six bars. Photographs seem to support central message.</i>	<i>Visuals are simple and very accessible. Graphs relate one message and are fully / expertly labeled. Tables have no more than 20 rows/columns. Graphs are limited to three lines / six bars. Photographs expertly enhance the central message of the poster.</i>
Delivery: Engagement	<i>Presenters do not engage with / consider their audience.</i>	<i>Presenters only partially engage with the audience and / or they are only somewhat professional. They try to invite conversation but it is strained.</i>	<i>Presenters consider their audience, maintain eye contact and dress to fit the function. They try to ask for questions, pay attention to non-verbal communication and try to invite bidirectional conversation.</i>	<i>Presenters consider their audience, maintain eye contact and dress to fit the function. They welcome questions, pay attention to non-verbal communication and eloquently invite bidirectional conversation.</i>
Delivery: Content	<i>Presenters inadequately relate the work; they do not elucidate why / how it was done or what was found.</i>	<i>Presenters may only partially cover some of the following: 1) Why the work was done, 2) How it was done, 3) What was found and 4) What it means. They may only partially inform the visitor.</i>	<i>Presenters adequately communicate 1) Why the work was done, 2) How it was done, 3) What was found and 4) What it means. They say what they are going to say, say it and say what they have said.</i>	<i>Presenters expertly highlight 1) Why the work was done, 2) How it was done, 3) What was found and 4) What it means. They fluidly and effectively say what they are going to say, say it and say what they have said.</i>