

REBEL SCIENCE: A PROBLEM-BASED TRANSDISCIPLINARY CAPSTONE COURSE

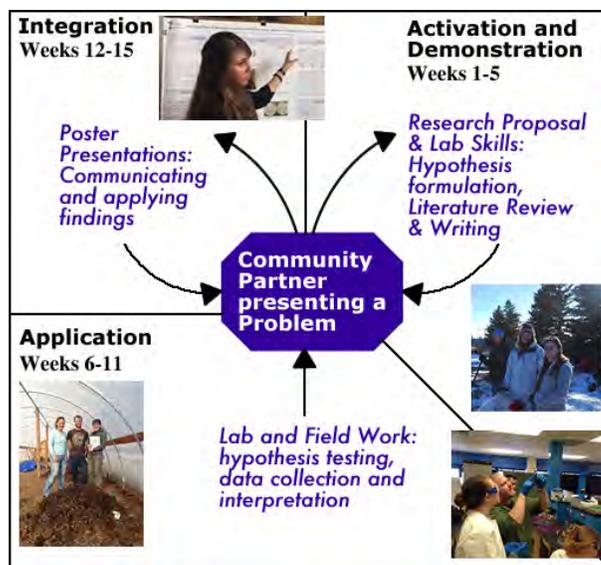
MICR 4321 (4 credits, M 1:20-4:10pm, TR 2:10-4pm blended online and in-person)

Course Description

Using a problem-based student learning model (Merrill, 2002), this course allows you to conceptualize, propose, perform and present a scientific research study to address a real problem within our community. You will select one of the community-based problems and further cultivate the relationship with the service organization. You 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 your project at a final, culminating poster presentation. You will be assessed, using rubrics, for accomplishment of curricular and service-based learning objectives.

You will gain skills in writing and maintaining a lab notebook and writing a research proposal. You will also master applied lab/computational methods, formulate hypotheses, and engage in hands-on hypothesis testing. You will also glean skills for designing and presenting an effective scientific poster. Throughout all phases of instruction, the problem presented by the community partner will be maintained as our central focus. In our final weeks, we will engage in a critical deconstruction of the scientific method and use Queer & Crip theory as well as feminism and Afrofuturism to consider alternative ways of doing science.

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



Pictured above are the phases of Problem-based learning: Activation and Demonstration, Application and Integration

"...this course allowed me to be in the driver's seat, rather than be along for the ride."

"The unique aspect of applying knowledge to solve community problems was central to this class and enhanced learning in many ways, as I not only learned lots of "textbook" knowledge, but I also learned volumes about real-world problem solving, communication skills, and working as part of a team."

"This course has taught me more about lab research than I can ever imagine. I feel more prepared to take on graduate life because of this course."

"I learned new skills, like proposal writing, creating a poster, using excel to create graphs, writing a legitimate lab notebook, and solving a real life problem that served to better the community"

Chem Dept. & Microbiology Program Goals

We aim to develop the laboratory skills to apply chemistry / molecular techniques to microbial systems. We will hone student's information literacy-access skills as well as the oral and written communication skills necessary to access, evaluate and summarize scientific information relevant to contemporary topics/issues in microbiology and chemistry. We will also develop oral and written communication skills necessary to present findings to both peers and experts.

Your Primary Learning Coach is Rachel!

Lining the walls of my office are deep layers of thank you cards. Precariously hanging over my bookshelves and on my walls are stoles and ski medals. Together, this chaotic mishmash is my most prized possession as each card, each stole and each gifted medal speaks the voice of a uniquely special student, athlete or advisee who helped to form me as an educator, a coach and a person.

My pedagogy/andragogy is learner-centered; it roots in humanism and I am ever in search of new ways to listen to students, to hear diverse voices and to find new forums for student expression and interaction. Paulo Freire's Social Emancipatory philosophy informs my view that transformational learning is the truest form of liberation. I believe that transformational learning is born through creation, innovation, through building scaffolds both literally and cognitively. But the web of cognitive growth is watered only when the affective domain is nurtured. Passion and love for process allows advanced, world-changing, liberating knowledge.

The web of affect, cognition and transformation is strongest when curriculum surrounds finding solutions to real problems within our local or global community and communicating those solutions in meaningful ways.



In the photo above, Rachel is sampling ground water at the field site for the 2019 Capstone class. *My greatest pleasure is learning along with my students!*

The best way to reach Rachel is by email rwatson@uwyo.edu. For this course, my office hours are 4-5pm (in the same physical or virtual location as class) on Tuesdays and Thursdays. I will hold a general office hour on Wednesdays from 2:00 to 3:30pm on Zoom. Confidential meetings must be scheduled by appointment.

Our Community Partners

We will be partnering with Zach Siler of Perfectus Biomed Group in Jackson Hole, WY.



<https://perfectusbiomed.com/about/>

Zach Siler is the Lab Manager at the Jackson Hole, Wyoming Perfectus site. He manages a large team of scientists who provide customized microbiological testing services. Zach's team works on problems regarding antimicrobials and biofilms. They also engage in fungal and cellular research. Zach was a University of Wyoming graduate where he earned undergraduate and graduate degrees in Microbiology! In his very little free time, Zach enjoys fine dining, theater and getting outdoors.



Our Community Partners

The Wyoming Department of Environmental Quality Harmful Cyanobacterial Blooms Team



Harmful Cyanobacterial Blooms

Lindsay Patterson, Kelsey Hurshman and Ashleigh Pilkerton are part of the HCB team and work to answer questions ranging from what types of genera and species of cyanobacteria produce cyanotoxins to whether cyanobacterial blooms at particular waterbodies are comprised of the same cyanobacteria genera or do whether they change? In answering these smaller questions, the team aims to eventually be able to determine best strategies to protect public human and animal health.

Learning Coaches

Ella



Ella was a Microbiology Capstone in 2018 and has been coming back to Capstone as a learning coach ever since. Recently earning her Masters degree in Botany, her research has ranged from the interactions of plants with soil microbes to the influence of water lilies on the chemistry and microbiology of aquatic ecosystems. Through this

research, she has developed a passion for data analysis and visualization and hopes to share her expertise in this area with current and future capstone students. She continues to foster her love of all things data as an educational researcher and developer for LAMP. She currently lives in Grand Junction, CO where she coaches the Nordic ski team at Colorado Mesa University and works as an assistant winemaker at Chill Switch Wines, incidentally the community partner for her micro capstone project.

Jaynie



Jaynie is a recent UW graduate and former Microbiology Capstone. Her project was done in two parts with the first focusing on the Riverton Landfill Collaboration and the second focusing on telling the story of that project through the lens Participatory Action Research (PAR). She was hooked by PAR for its “catalytic energy” to move things forward and the notion that PAR is “an imaginative leap from

a world of ‘as it is’ to a glimpse of the world ‘as it could be’” (Participatory Action Research by Alice McIntyre). While in school, Jaynie frequently applied the concepts of PAR through her student government involvement. She is currently part of the COVID Surge Team at the Wyoming Public Health Laboratory, a position obtained through the connections she made in Capstone.

Dr. Andrews



With a long history of experience in working with pathogens, Dr. Andrews (Dr. G), is well-known for his stories and real-life anecdotes. Dr. G worked as a Military Biomedical Scientist from 1983 to 2003. He then became a Senior Microbiologist in Clinical Research Management working in Bacterial Select Agent Medical Countermeasures.

Those in the Microbiology Program at the University of Wyoming are now lucky to call Dr. G our fearless leader! With interests in Identification and characterization of new/novel virulence determinants of bacterial pathogens (with emphasis on select agents), Determining the basis of protective immunity in the host against plague antigens and Pathoadaptive evolution of bacterial select agents, Dr. G is a wealth of knowledge.

Course Outcomes

This course fulfills the Communication 3 (COM3) requirement of the 2015 University Studies Program. Students will develop skills in written, oral, and digital communication as appropriate to specific disciplines and courses at the introductory, intermediate, and advanced level. Through repeated instruction, practice, and feedback, the communication sequence will emphasize and progressively develop transferrable skills for students' academic work and future professions. Advanced courses (COM3) will emphasize using the discourse of a discipline or interdisciplinary field to communicate to academic or professional audiences through written, oral, and digital communication. Thus, upon successfully completing Microbiology Capstone, learners will be able to do all of the following:

Broad COM₃ USP Learning Outcomes

1. Use the discourse of a discipline or interdisciplinary field to communicate that field's subject matter to academic or professional audiences through written, oral, and digital communication.
2. Find, analyze, evaluate, and document information appropriately as applicable to the discipline, interdisciplinary field, or professional setting as demonstrated by completing a substantial communication project that requires appropriate research skills.
3. Recognize and evaluate more advanced aspects of communication that respond to the purposes and needs of audiences in a discipline, interdisciplinary field, or professional setting.
4. Make effective use of multiple drafts, revision, computer technology, peer and instructor comments, and collaboration to show understanding of communication standards in a discipline or interdisciplinary field.
5. Observe the accepted conventions of spelling, grammar, organizational structure, punctuation, delivery and documentation expected in disciplinary, interdisciplinary, or professional contexts.
6. Deliver presentations in a confident and professional manner, consistent with the standards of the discipline or interdisciplinary field.
7. Interact effectively with audience members, engage opposing viewpoints constructively, and demonstrate active listening skills.



Above is a sign that says: Treat the person sitting next to you as though she or he has accomplished amazing things; you will never be wrong and you will certainly never be sorry.

Specific Course Learning Outcomes

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/chemical principles with individuals outside of the science discipline (within the community service organization).
8. relate (recognize the relevance of) microbiology/chemistry concepts to the unique problem of the community service organization.
9. write a scientific research proposal, laboratory notebook and abstract / project summary.
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 research principles / findings.
12. relate (recognize the relevance of) science 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, 2018, 3rd 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.

Course Syllabus and Rubrics by Rachel M. Watson, course packet.

Graded Learning 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 should 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. *This assignment assesses USP 2015 Learning Outcomes #s: 1 through 5.*

The Research Proposal will be worth 200 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. *This assignment assesses USP 2015 Learning Outcomes #s: 1, 2, 3 and 5 .*

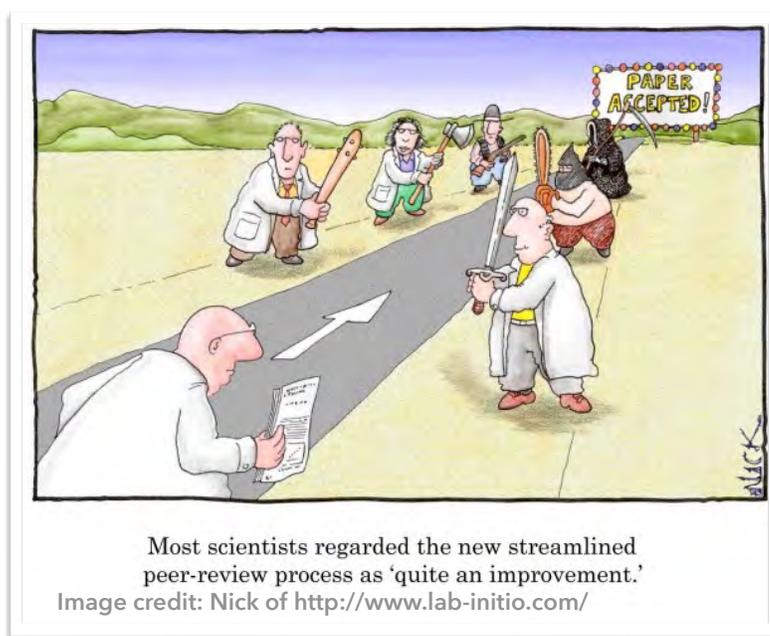
The lab notebook will be worth 100 points toward your final grade.

Community Partner Communications

Communications with the community service partners will occur at the beginning of the semester, mid-semester and at the end of the semester. At the beginning of the semester, a representative of the community organization will present the problem. Students will informally interact with the partner and ask clarifying questions. At mid-semester, a photo and digital documentary will be created by the student group and recorded as a vodcast using digital media. This will be shared with a representative from the community organization. At the end of the semester, a representative from the community organization will attend the final poster presentation. This 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. An assignment description for the photo and digital documentary and the rubric provided to the community service representative can be found at the end of this syllabus. *This assignment assesses USP 2015 Learning Outcomes #s: 1, 3, 6 and 7.*

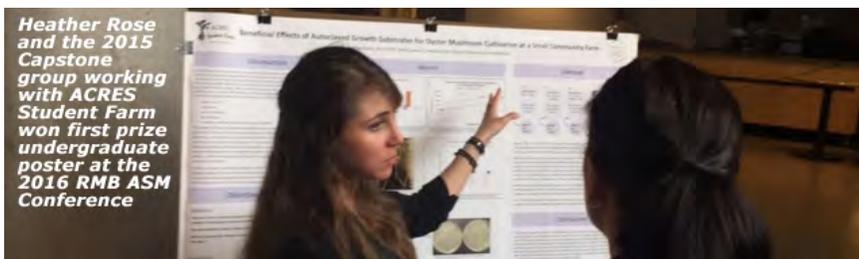
Communications with community service organizations will be worth 100 points toward your final grade.



The image above is a cartoon that shows a scientist headed down a one-way road with reviewers holding various weapons. At the end of the road is a lighted sign saying "paper accepted". The caption says, "Most scientists regarded the new streamlined peer-review process as 'quite an improvement'".

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. *This assignment assesses ALL (#1-7) USP 2015 Learning Outcomes. **The Poster Presentation will be worth 200 points toward your final grade.***



A prior Capstone student named Heather Rose presents her poster to an onlooker. Heather's team's poster won 1st prize at the 2016 Rocky Mountain Branch American Society for Microbiology Conference

Teammate and Self Assessments:

During your work in the lab, interacting with your community partner and in production of the proposal and poster, good teamwork is essential. Thus, you will assess yourself and your teammates using a rubric of your own creation. Each team will create their rubric. This rubric will be converted to a Google form that is submitted anonymously at midterm and upon course completion. **Self and teammate evaluation is worth 100 points (40 at midterm and 60 at completion).**

Required but Ungraded Learning Assessments

Skill Tests:

Skill tests will be administered by instructors and will assess prerequisite discipline-specific lab skills. Students will repeat all prerequisite skills until they are competent or accomplished in each skill area. The assessment rubric can be found at the end of this syllabus. **Skill tests will not contribute a point value to the final grade; however, they must be marked complete in order to pass the class.**



In the picture above, Sarah, a prior Capstone student monitors the odor of a small-scale Compost pile. Sarah's team worked with ACRES student farm.

Online Discussions:

These discussions provide a forum for practice in accessing and critically assessing source material. They also provide a space in which to plan, brainstorm and outline major graded assignments. Finally, these spaces will enable critical interpretation of prior microbiology knowledge as it pertains to major assignments. **Discussions will not contribute a point value to the final grade; however, they must be marked complete in order to pass the class.**

Attendance and / or presentation at a professional conference or presentation at a pertinent community meeting /outreach or in-reach event or production of a public perspective piece (such as a newsletter for the community partner):

Professional conferences such as regional, discipline specific science conferences can be attended by students. Students can present regarding their project (if appropriate) or they can simply attend. Additionally, community events / meetings pertinent to the project are often available. Outreach and In-reach events with Wyoming K-12 students will be available and students can design active learning for these. **Attendance and / or presentation at a professional conference (not including UW's Undergraduate Research Day) or community meeting / event, or Outreach/In-reach with students will not contribute a point value to the final grade; however students must do this prior to the end of the semester in order to pass the class.**

Grades

Grades:

The Capstone grade is based on a maximum of 700 points.

Points are divided as follows:

The Research Proposal	200 pts
Individual draft	(100 pts)
Group draft	(100 pts)
Laboratory Notebook	100 pts
Community Partner Interactions	100 pts
Poster Presentation	200 pts
Individual draft	(100 pts)
Group draft	(100 pts)
Teammate and self assessment	100 pts
Skill Tests	must be complete to pass
Online Discussions	must be complete to pass
Conference or Outreach	must be complete to pass
<u>Attendance</u>	<u>90% attendance required</u>
Total	700 pts

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

90-100%	(630 – 700 pts)	A
80-89%	(560 - 629 pts)	B
70-79%	(490 – 559 pts)	C
60-69%	(420 – 489 pts)	D
<60%	(0 – 419 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.

Late Policy

Late work will be accepted; however, please recognize that when you have lost touch with the pace of the class, feedback on these important assignments loses much of its value. Thus, if your work is submitted up to one week after the final due date, it will be scored without deduction but given only minimal feedback. Work that is more than 1 week late will not be given feedback and will receive a 50% deduction in score.

Attendance

As this is an upper-division course in which continuous lab work and professional interactions with community partners, professors and student peers are expected, attendance is also expected. All students must attend at least 90% of official class meetings in order to pass. Class time missed due to University Excused absences or class time conflicts will be made up by logging additional hours in the lab. These hours will be reported to your primary learning coach. As is true in an authentic research lab, it is common that the science (e.g. microbial growth) dictates our schedules more than does the clock. Thus, there will be some days in which you may have to be present in the lab during non-class times. Your “homework” may actually be additional lab time.



The 2019 Capstone students are shown in the lab. These students partnered with the Riverton Middle school students, teachers, City Officials and Inberg Miller Engineers to study possible phytoremediation solution for an old landfill site.

Academic Dishonesty

Academic dishonesty (any type of cheating in a formal academic environment) will not be tolerated in this class. Cases of academic dishonesty will be treated in accordance with UW Regulation 2-114. The penalties for academic dishonesty can include, at my discretion, an “F” on an exam, an “F” on the class component exercise, and/or an “F” in the entire course. Academic dishonesty means anything that represents someone else’s ideas as your own without attribution. It is intellectual theft – stealing - and includes (but is not limited to) unapproved assistance on examinations, plagiarism (use of any amount of another person’s writings, blog posts, publications, and other materials without attributing that material to that person with citations), or fabrication of referenced information. Facilitation of another person’s academic dishonesty is also considered academic dishonesty and will be treated identically.

Non-discrimination Statement & Statement of Inclusion

As your instructor, Inclusive pedagogy is one of my greatest passions! I work hard to integrate best practices in inclusivity: <http://www.slu.edu/ctl/resources/teaching-tips-and-resources/inclusive-teaching?site=mobile>. If there is any way in which I can provide a more inclusive environment for you, please do not hesitate to contact me.

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.

As an instructor, I work hard to adhere to the principles of Universal Design: <http://enact.sonoma.edu/c.php?g=789377&p=5650606>. If, for any reason, you are feeling barriers to your learning and that these barriers can be lessened by my course design or policies, please contact me.

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 109, at 307-766-3073.



Jenny, Daulton and Kali worked with the Albany County Downtown Clinic. Their poster won second place in the undergraduate category at the 2016 RMB-ASM Conference.

¹ <https://www.berkeleycitycollege.edu/wp/de/what-is-academic-dishonesty/>

Duty to Report Statement

While I want you to feel comfortable coming to me with issues with which you are struggling or concerns you may be having, please be aware that I have some reporting requirements that are part of my job requirements at UW.

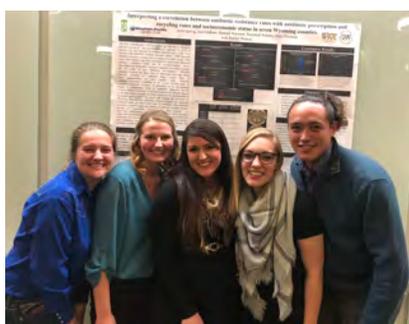
For example, if you inform me of an issue of sexual harassment, sexual assault, or discrimination I will keep the information as private as I can, but I am required to bring it to the attention of the institution's Title IX Coordinator. If you would like to talk to those offices directly, you can contact Equal Opportunity Report and Response (Bureau of Mines Room 319, 766-5200, report-it@uwyo.edu, www.uwyo.edu/reportit). Additionally, you can also report incidents or complaints to the UW Police Department. You can also get support at the STOP Violence program (stopviolence@uwyo.edu, www.uwyo.edu/stop, 766-3296) (or SAFE Project (www.safeproject.org, campus@safeproject.org, 766-3434, 24-Hour hotline: 745-3556).

Another common example is if you are struggling with an issue that may be traumatic or unusual stress. I will likely inform the Dean of Students Office or Counseling Center. If you would like to reach out directly to them for assistance, you can contact them using the info below or going to www.uwyo.edu/dos/uwyocares.

Finally, know that if, for some reason, our interaction involves a disruptive behavior or potential violation of policy, I inform the Dean of Students, even when you and I may have reached an informal resolution to the incident. The purpose of this is to keep the Dean apprised of any behaviors and what was done to resolve them.

Classroom Behavior Policy

Failure to abide by the classroom behavior rules may result in your immediate dismissal from the class and potential loss of points. Repeated violations may result in permanent dismissal from the course and a failing grade. It is a requirement for this course that all students act in a respectful, civil, and professional manner at all times. This includes arriving on time, completing work in a timely and professional manner, and adhering to course deadlines. While the expression of different views, spirited debate, and disagreement are an expected and supported part of the course, disrespectful, demeaning, degrading, hateful, harassing, abusive, profane, vulgar, lewd, personal attacks, name-calling, dismissive gestures, and similar kinds of behaviors, whether they be verbal, physical, or of any other nature, will not be tolerated. Any participant in the course who acts in a way the instructor believes violates these conduct rules, or in any other way creates an environment that is hostile and/or not conducive to learning or a positive learning environment, will be warned and/or asked to leave the class immediately. In the event an individual is asked to leave for the afore stated reasons and refuses to exit the classroom, the instructor has the right to call law enforcement to escort the individual out of the class. Further, as the instructor, I have the right to dismiss you from the classroom, study sessions, electronic forums, and other areas where disruptive behavior occurs. If such behaviors are repeated it may result in your permanent dismissal from the course and/or a lowered grade, including a failing grade. The University of Wyoming Student Code of Conduct applies to this course. The Code of Conduct can be found at: <http://www.uwyo.edu/dos/conduct/index.html>. Each student is expected to read and adhere to the code at all times. Failure to do so may result in a student being subject to Code of Conduct procedures and other university-level disciplinary actions. Please note, Code of Conduct proceedings and university-level discipline may be in addition to any of the disciplinary measures noted above.



Mary, Ariel, Hannah, Susannah and Jess worked with the Wyoming Medication Donation Program and Mountain Pacific Quality Health to investigate antibiotic resistance in wastewater in seven Wyoming counties.

Current COVID-19 Plans and Policies

In all of our in-person meetings, we will adhere to the WDH and CDC recommendations. More details on University plans and policies are found on the links below.

[COVID Campus Plan](#)

[UW COVID Policy](#)

Tentative Schedule

All deadlines, requirements, and course structure is subject to change if deemed necessary by the instructor. Students will be notified verbally during our synchronous sessions, on our *WyoCourses* page announcement, and via email of these changes.

Day # (Date)	Pre-party	Activities	Assignment Due
Day 1 (Mon, Aug 23) <i>Instructional Phase: Activation and Demonstration</i>	Read the syllabus & tour the course shell. Register for NCBI.	Learning like a Jungle Tiger; Literature research activity; meet your community partners!	
Day 2 (Tue, Aug 24)	Read the 7 elements of Collaborative Communication; Read Chapter 1 & 2 of <i>Writing Successful Science Proposals</i> by Andrew J. Friedland, Carol L. Folt and Jennifer L. Mercer	Collaborative Communication practice (CC); small-group instructional diagnosis; Team Charter introduction	Purchase your laboratory notebook
Day 3 (Thur, Aug 26)	Participate in the online literature discussion and post about your current research direction. Read Friedland, Folt, and Mercer Chapters 3 & 4; find and read an example of writing that exemplifies the precepts; collect 2-4 articles related to your proposed research	Team Charter/Rubric creation; matching definitions game; Literature report-out; NSF RFP activity; significance statement assessments; timelines and elevator speeches	Prepare a draft of your <i>Conceptual Map</i> (this will be used in class to support your elevator speech)
Day 4 (Mon, Aug 30)	Review proposal assignment description, Read Friedland, Folt, and Mercer Chapter 8; Prepare your elevator speech about significance of the project	Deliver elevator speeches; accessing and summarizing journal articles - practice funneling; <i>Activating basic laboratory skills</i>	The <i>Relevant Literature</i> Section of the Introduction, a list of references with annotations, and the conceptual map draft are due before September 2nd.
Day 5 (Tue, Aug 31st)	Compile literature sources, read autoclave SOP, review example Significance statements	Determining experimental protocols from hypotheses; evolving your Statement of Problem Significance; <i>lab protocols/policies</i>	The <i>Statement of Problem and Significance</i> is due before class starts. We will workshop it during class.
Day 6 (Thur, Sept 2nd)	Read Friedland, Folt, and Mercer Chapter 7; write practice hypotheses	Hypothesis writing, generating research plans from hypotheses	<i>Relevant Literature</i> , References with Annotations and <i>Statement of Significance</i> are due today!
Day 7 (Tue, Sept 7th)	Read Friedland, Folt, and Mercer Chapter 9; Carefully review the sample Methods sections on pages 144 and 145	Draw a Research Design Schematic; Methods Discussion; Poster Gallery Walk; Determine referencing; Data output mockup	The <i>Objectives, Hypotheses and Specific Aims</i> as well as a draft of the <i>Research Design Schematic</i> are due before Sunday, September 12th.
Day 8 (Thur, Sept 9th)	Read Friedland, Folt, and Mercer Chapter 11	Creating timelines	

Day # (Date)	Pre-party	Activities	Assignment Due
Day 9 (Mon, Sept 13th)	Review assignment description and sample research schematics	Broader Impacts Writing Exercise; Title Writing and Assessment Activity	A draft of the <i>Research Plan & Timeline</i> a re due before Sunday, September 19th.
Day 10 (Tue, Sept 14th)	Read provided sample proposals	Proposal assessment and application activities - double entry journal Review game	
Day 11 (Thur, Sept 16th)	Draft your Project Summary; Read Friedland, Folt, and Mercer Chapter 13; Draft a budget. Chapter 5 & 6; Complete a draft of your <i>Project Summary</i> and have it ready for class; Skim <i>Writing the Laboratory Notebook</i> pp. 63 – 79 & pp. 81 – 101	Editing the <i>Project Summary</i>	The pilot notebook entry is due by the end of the day.
Day 12 (Mon, Sept 20th)	Carefully review the Lab Notebook Vodcast Skim pp. 1 – 26 and 53 - 63 Kanare's <i>Writing the Laboratory Notebook</i>	Prepare the notebook front and spine and all front matter; assess and discuss prior notebooks Creating a graphic introduction for a notebook entry; completing a pilot notebook entry	<i>Your individual Research Proposal is due on either Friday, the 24th or Saturday, the 25th.</i>
Day 13 (Tue, Sept 21st)	Read Friedland, Folt, and Mercer Chapter 17; watch the <i>Solving Complex Problems</i> vodcast	Collaborative Communication regarding team science; Individual Proposal work	
Day 14 (Thur, Sept 23rd)	Compile all of the proposal sections that you have already written. Be sure that you have attended to rubric feedback that you have received for each proposal section.	Individual proposal preparation	<i>Your individual Research Proposal is due on either Friday, the 24th or Saturday, the 25th.</i>
Day 15 (Monday, Sept 27th)	Review and categorize comments on your proposal; Read Friedland, Folt, and Mercer Chapter 15	Coalescing team proposals and creating a timeline for teamwork	Work with Rachel to determine a suitable due date for your team's final proposal. Be absolutely certain that you share the proposal in a timely manner with ALL stakeholders.
Day 16 through Day 39 (Sept 29th through Nov 18th): Instructional Phase: <i>Application</i>	<u>Selected pertinent literature as suggested by the instructor; Matthews handout (The Scientific Poster: Guidelines for Effective Visual Communication)</u>	Laboratory experimentation, hypothesis testing, lab manual maintenance, communication with community partners	Lab manual should be continually maintained and will be collected for feedback. By mid-term, <i>a photo and digital documentary must be created and recorded as a vodcast using digital media</i> . This must be shared with a representative from the community organization. Submit your teammate evaluation rubric at midterm. <i>An individual poster draft with the formatting, Introduction and Methods is due on November 25th. *We will attend the Regional American Society for Microbiology or American Chemical Society Conference</i>
Day 40 through end Instructional Phase: <i>Integration</i>	Hall and Robinson, Forward and Chapter 1 (pp. xv-7) Chapter 5 (pp. 35-40) and Chapters 7 and 10 (pp. 51-55 and 67-73); selected writings/art from feminist, queer and afrofuturist scholars.	Poster presentation printing / preparation, Poster presentation delivery, using the capstone experience to help in finding your career; final instructional diagnosis session and reflection on the capstone experience	*All lab and field site must be fully cleaned; leave no trace! The final laboratory notebook is due by December 13th. Individual poster drafts are due by December 6th. Final team posters must be completed and ready to present.

Research Proposal Assignment Description

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

***Helpful notes relating to the text are in blue.**

This assignment assesses USP 2015 Learning Outcomes #s: 1 through 5

I. GENERAL DESCRIPTION

Before beginning your research proposal, be sure that you have a large conceptual framework for your proposed project. Be sure that your science is clear to you and that it is built on a sound experimental approach. Ask yourself whether you could summarize your overall concept in one succinct statement that could be understood by a scientifically literate audience. Next be sure that you know your audience/funding agency and that you understand the Request for Proposals (RFP). In this case, your RFP is this assignment description. 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 to DREAM! This may mean that you consider ways in which science has typically been constrained by academic silos; consider reaching beyond your own discipline to propose the enactment of radical ideas.

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 14 pages (use 1.5 spacing) and observe the organizational structure below. Please be certain that every section is clearly labeled and easy to find/reference in your Table of Contents. Impeccable spelling, grammar and punctuation are important because a reviewer might quickly dismiss a proposal without these qualities. Thus, even the most well-thought-out proposal might not be assigned merit due to these small errors.

II. SECTIONS

A. Title

Your title should be a clear, concise (succinct yet informative) and meaningful statement that states *what* you intend to do, and *where* and *how* you intend to do it. 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. Where possible, limit the length of the title to eight to twelve words. Some warn against a title that is too 'cutesy' but certainly it is unarguable that an interesting title is much more likely to be read than a boring one.

Exercises on page 66

B. Project Summary or Abstract

In this section, present a broad overview of the goals, scope, methods, hypotheses and outputs. The *intellectual merit* should be included and should explain how the proposed project has the potential to advance knowledge. The *broader impacts* should explain how the project benefits society.

The Project Summary 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 to 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 significance is followed by a statement of the research questions in the form of hypotheses. 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 (or 2-4):

Begin by outlining the techniques / study sites and organisms to be used. State projected results / output. State the *intellectual merit* and *broader impacts*. These latter two statements should be labeled in some way (e.g. Intellectual Merit, colon, section content).

Examples on pages 83-85

C. Table of Contents (*please simply list each section of the proposal and the page on which it can be found*)

D. Project Description (*this is the Main Body of your proposal and has several sections that should be clearly labeled in your proposal*)

1) Statement of problem and its significance

This section should be the root of your proposal; it should drive the research! Begin by persuasively establishing broad interest for readers both inside and outside the field. In short, articulate why this research matters to *everyone*? Next, funnel your reader, eventually justifying and stating your *specific research questions*. 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 (basic and applied/immediate and long-term) 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. The suggested length for this section is 1-2 paragraphs but it can be longer if it requires articulation of a large network of impacts.

Examples on page 50 through 53 (Exercises on page 58 and 59)

2) Introduction and Background

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 two or three pages (dependent upon inclusion of preliminary data). Following are suggestions for clearly labeled subsections:

a. Relevant literature

Review the pertinent background information and choose quality sources rather than a vast quantity of sources. That is, focus on key/pivotal references (current, well-accepted and germane). *Highlight* key arguments. However, particularly when pointing to a hole in the literature, be sure to fully elucidate that hole. Begin with broad interest and then use the existing literature to *funnel* to your specific goals. If you are addressing a contentious issue, be sure to review all sides of the

issue. If you reference controversial papers, explain the relationship between your work and the controversial work. After reading the *Relevant Literature* section, your audience should be able to predict your objectives, hypotheses and aims. [**Note – It will not be possible to find all key resources using Google Scholar alone. Please utilize the Library’s Web of Science and at least on other search engine or database.*]

b. *Preliminary data*

In the event that you have done some small, pilot experiments, present pertinent results here. This can include on-site observations that you have collected, or it might be unpublished data and results from prior students who have worked on the same project. It can also include prior unpublished results from our community partners or other collaborators and stakeholders. Do not overstate the implications of these pilot studies, simply note the findings.

c. *Conceptual model*

This section may include quantitative modeling and computer simulation. If so, equations and predicted solutions from mathematical modeling may be appropriate. Additionally, a conceptual model should show (visually / schematically) the research plan and *how the research fits into the larger picture* (p. 122). The goal of this figure is not to detail your specific experiments but instead, to show how the research impacts / is impacted by the larger context ("big picture"). This figure will not be counted in the page total for this section.

d. *Justification of approach and novel methods*

Provide a justification for the approach that you have chosen. In this section you are not writing your planned protocol; instead you are telling your reader why you selected the methods you did and explaining that either these are established methods (listing lots of *citations*) or that your novel methods (methods you made up) are the best ones to get the job done. If you are using novel methods, fully explain why they are the best way to get the job done and include citations to related literature that supports the new methods.

3) Research Plan

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

a. *Objectives and Specific Aims*

Objectives are 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. 99.) Specific aims 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 102 for additional examples).

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 100 for additional examples). After reading a hypothesis, it should be quite possible to visualize the experiments that would test that conjecture. Hypotheses must be grounded, testable and

narrow enough in scope to allow experiments testing them to be accomplished. For our purposes, we will limit the number of hypotheses to between 1 and 3.

c. *Research Design Schematic*

This is a visual schematic that shows your planned methods. Unlike the conceptual map, this figure zooms in on your specific planned experiments and it visually links each experiment to the hypothesis that it tests.

d. *Methods and Materials*

Choose feasible methods that are the best methods for testing the stated hypotheses. Be certain to clearly cite the resources used for established methods and if methods are novel, describe them thoroughly. Reference your above Design Schematic to link procedures below to hypotheses above.

- i. Sampling procedures / population / context (site)
- ii. Culturing methods
- iii. Experimental protocols (procedures) / methodological steps / instruments used
- iv. Explanation of your competence to implement the methods. Express not only your existing expertise but also how you are collaborating to gain access to instruments and outside expertise. Make it clear that you have access to what you need in order to test the proposed hypotheses.

[See examples on page 145](#)

e. *Analysis and Expected Results*

Present and discuss both results that are expected and unexpected results. Discuss interpretations of these results. A diagram or schematic may be helpful in showing differing outcomes. If you have some preliminary data than show rather than tell how you will work up the data. If you do not have preliminary data than pull data from literature or mock-up data so that you can show how you will analyze your research data. Consider including a table. Finally, explain how you will save, store and archive your samples and data.

f. *Timeline/Timetable*

Present a plan for the timeframe in which all elements of the project will be accomplished ([pp. 163-164 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. Your timeline allows you to show that the work you are proposing is feasible. You may use any format you like for the timeline but it must be detailed enough that it will guide your both your lab/on-site/computational research and your preparation of the final poster.

E. References cited

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 a citation format often used by authors submitting research proposals to the NSF. Please consult *The Chicago Manual of Style* for more details.

Basic format

1) *Journal Article*

Names of all authors (Last name, First name). year. "Article Title." *Journal title*, volume number (issue): page numbers. If the article / book is available electronically than also include the DOI.

2) *Book*

Names of all authors (Last name, First name). year. *Book title*. Publisher location: Publisher.

Following are examples:

Journal:

Favazzo, Lacey, John D. Willford, and Rachel M. Watson. 2014. "Correlating Student Knowledge and Confidence Using a Graded Knowledge Survey to Assess Student Learning in a General Microbiology Classroom." *Journal of Microbiology & Biology Education* 15(2): 251–258. <https://doi.org/10.1128/jmbe.v15i2.693>.

Book:

Eldor, Paul. 2014. *Soil Microbiology, Ecology and Biochemistry*. Berkeley: Elsevier.

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. 174-175 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

F. Reference Annotations

For each reference (above), describe the method used to access that reference (e.g. through the Stanford Highwire RSS feed or through the University of Wyoming's Web of Knowledge Database). Also, provide one or two sentences of assessment (e.g. timeliness of publication, number of times cited, appropriateness to topic etc...). Finally, state why this reference is important in guiding your work.

Research Proposal Rubric

Proposal Section	Unsatisfactory (lacking / inaccurate / inappropriate) (0 to 50%)	Evolving (appropriate but partially-formed) (51%-74%)	Competent (appropriate and accurate) (75%-90%)	Accomplished (precise and descriptive / nuanced / exemplary) (91-100%)
Title	The title fails to summarize the proposal content. It may even indicate content that is not covered by the proposal.	Title summarizes proposal content but only partially. It lacks descriptiveness, succinctness or clarity.	Title accurately summarizes the proposal content. It is a concise, clear informative introduction that expresses what the researcher intends to do and where and how she/he/they intend to do it.	Title clearly summarizes the proposal content without overstating. It is concise, clear, interesting and nuanced with a succinct and informative introduction that expresses what the researcher intends to do and where and how she/he/they intend to do it.
Abstract / Project Summary	Goals, scope, methods, hypotheses and outputs are completely missing AND/OR Intellectual Merit and Broader Impacts sections are missing or completely inappropriate.	Goals, scope, methods, hypotheses and outputs are only partially described. AND/OR Intellectual Merit and Broader Impacts sections only partially indicate how proposed work will advance knowledge / benefit society.	Goals, scope, methods, hypotheses and outputs are clear. A section is dedicated to Intellectual Merit and this section clearly explains how the proposed work will advance knowledge. The section dedicated to Broader Impacts clearly explains how the project benefits society.	Goals, scope, methods, hypotheses and outputs are clear. A section is dedicated to Intellectual Merit and this section clearly explains how the proposed work will advance knowledge. The section dedicated to Broader Impacts clearly explains how the project benefits society. Overall, the section funnels the reader, is nuanced, exciting and persuasive!
Table of Contents	absent	partial	present	nuanced and highly usable
Project Description: Problem and Significance	Problem is not described or the description is completely inappropriate. The reader feels neither convinced or clear about the necessity of the work.	The problem is described and broad and discipline-specific interest is established. However, one or more of these areas is partial or lacks clarity / conviction. The reader may not understand the importance of the research / may feel only partially informed and/or not entirely convinced of or even clear about necessity.	The problem is described. Broad and discipline-specific interest is established. Funneling is used to lead to the specific research questions. The reader understands why the research might be important and can adequately understand predicted impact.	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 (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.
Project Description: Introduction and Background: Relevant Literature	Background literature is omitted or entirely inappropriate or all key/pivotal references are omitted.	Background literature is presented but may be only partial and/or some key references may be excluded. 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 an ineffective (even biased) way.	Pertinent background literature is reviewed; sources are current, well-accepted and germane to your work (most are peer-reviewed and recent / others are appropriate). If pointing to a hole in literature, that hole is elucidated. If topic is contentious than both/all sides of the issue are presented.	Pertinent background literature is thoroughly reviewed; sources are current, well-accepted and germane to your work (most are peer-reviewed and recent / others are appropriate). 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.
Project Description: Introduction and Background: Preliminary Data	Despite preliminary data being available, they are omitted or inaccurate / inappropriate.	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.	If preliminary data have been collected or are available through collaborators/stakeholders, they are presented. Effort is made to show how these data pertain to the proposed research.	If preliminary data have been collected, or are available through collaborators/stakeholders 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.
Project Description: Introduction and Background: Conceptual Model	A visual schematic and quantitative model are omitted and/or are inaccurate/inappropriate.	A visual schematic and quantitative model are included but it is unclear as to how the research fits into the big picture and/or the figure is nebulous/difficult to interpret.	A visual schematic and quantitative model adequately elucidate how the research fits into the big picture.	Visual schematic and quantitative model are nuanced and creatively show the research plan and how the research fits into the larger picture. The research impacts on and/or how the research is impacted by the larger context ("big picture") is elegantly depicted.
Project Description: Introduction and Background: Justification of Approach and Novel Methods	Methods are not justified or justifications are lacking/inappropriate / inaccurate.	Methods and approach are not fully/adequately justified. Citations for established methods may also be unclear/partial. And / Or section may confuse writing of materials and methods with justification of approach.	A sufficient justification is included for approach and methods. Novel methods are adequately described and citations are included for established methods.	Clear justification is given for the choice of approach and methods to be used. Full descriptions are given for novel methods and established methods are succinctly described and fully cited.

Proposal Section	Unsatisfactory (lacking / inaccurate / inappropriate) (0 to 50%)	Evolving (appropriate but partially-formed) (51%-74%)	Competent (appropriate and accurate) (75%-90%)	Accomplished (precise and descriptive / nuanced / exemplary) (91-100%)
Research Plan: Objectives and Specific Aims	Objective and or specific aims statements are lacking and/or inappropriate.	An objective statement is given but it may be partial. Specific aim lacks some elements (e.g. conditions or outputs).	A broad, far-reaching statement clearly states the purpose of the research. This is followed by a statement of aims "We will measure X in Y to establish Z".	A broad, far-reaching statement clearly and eloquently states the purpose of the research. This is followed by an articulate, thorough and nuanced statement of aims "We will measure X in Y to establish Z".
Research Plan: 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.
Research Plan: Design Schematic	The visual schematic is lacking or inappropriate / there is no link to the hypotheses and aims.	A visual schematic shows the planned methods but it is partial and/or may not entirely align with hypotheses and aims.	A visual schematic shows the planned methods. The figure shows the connections between each hypothesis / aim and each planned experiment.	A nuanced visual schematic shows the planned methods. The figure shows in a clear and concise way, the connections between each hypothesis / aim and each planned experiment.
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 4) explanation of researcher competence/access to needed resources.	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 4) explanation of researcher competence/access to needed resources.	Methods are not only feasible but they are the best methods to achieve the objectives. References 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 4) explanation of researcher competence/access to needed resources.
Research Plan: Analysis and Expected Results	Data collection is omitted or methods to collect, store and analyze data are inappropriate.	There are gaps in how expected and unexpected results will be interpreted. It is unclear how data will be collected, analyzed or stored.	Expected and unexpected results as well as interpretations of these results are discussed. Differing outcomes are considered. A clear explanation indicates how you will save, store and archive your samples and data.	Expected and unexpected results as well as interpretations of these results are discussed. A diagram or schematic shows differing outcomes. Author/s show/s the readers (rather than telling) how they will work up results. A clear explanation shows how you will save, store and archive your samples and data.
Timeline	Timeline is omitted, completely inconsistent with the project objectives or unfeasible.	Timeline has gaps, may not fully consider time needed to complete equipment scheduling, sampling, culture growth. Feasibility is suspect.	Timeline is reasonable/feasible, 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...The proposed timeframe is clearly feasible.
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 or style is inaccurate.	References are primarily recent, germane peer-reviewed and accurately cited.	References are primarily recent, peer-reviewed, germane and accurately cited. Special care is taken to be thorough and all pivotal references are included.
Reference Annotations	Reference annotations are either lacking or inappropriate. There is no evidence of ability to either access or assess literature through RSS feeds or library / other appropriate databases.	Ability to access/assess literature through RSS feeds and library or other appropriate databases is suspect.	Ability to access/assess literature through RSS feeds and library or other appropriate databases is competent.	Ability to access/assess literature through RSS feeds and library or other appropriate databases is refined.
General	Proposal either fails to use the given organizational structure and / or poor writing (improper spelling, punctuation or grammar) causes the reader to question to proposal.	The proposal only partially follows the given organizational structure and / or writing is occasionally compromised by poor spelling, grammar or punctuation.	The given organizational structure is followed and writing exhibits appropriate spelling, grammar and punctuation.	The given organizational structure is followed and writing is eloquent. Spelling, grammar and punctuation are impeccable but also the writing flows and is clear to all readers.

Laboratory Notebook Assignment Description

The text resource for this assignment is *Writing the Laboratory Notebook* by Howard M. Kanare.

This assignment assesses USP 2015 Learning Outcomes #s: 1, 2, 3 and 5.

I. The Hardware

The lab notebook should be bound, durable (made of permanent paper) and have serially numbered pages. 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 solvents¹). 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 as robust as we often hope it to be. 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. 27 May 2020)) 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 unused 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 (or silver marker) 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. For the latter, please include both the course context and the specific project on which you are working (e.g. *In this notebook I will document my work in MICR 4321 (the Microbiology Capstone). Specifically, I will log experiments done in effort to assist our community partner in finding solutions to*)

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. Clearly list the objectives/aims & hypotheses being tested. Make clear reference to *where the full Proposal can be found*. State 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.

¹ Other fade-resistant pens are also fine and may allow for color-coding in the notebook.

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. Reference the original objective/aim and the hypothesis/es that is/are being tested. Further note why this experiment was chosen and list the possible benefits of the experiment. Briefly note pertinent literature. List safety concerns for the experiment you are doing (pertinent pathogen classes & MSDS notes). [This can be accomplished using a graphic schematic that was developed by the 2019 Capstone students.]

 <u>Hypothesis:</u>	 <u>Relevant Literature:</u>
 <u>Benefits:</u>	 <u>Safety:</u>

b. *Experimental Plan* (consider giving 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!** 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, specific computational software/data packages, proper names for labware; composition of vessels; order in which reagents are added; who is doing what task [see page 70.]! Draw any novel devices or 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. Try to make sense of the data here.

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 Communications with Service Organizations

After each meeting with or presentation to/by the service organization whose problem we hope to address, please reflect on the meeting, presentation or conversation 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.

Laboratory Notebook Rubric

Notebook Area	Unsatisfactory (lacking / inaccurate / inappropriate)	Competent (appropriate and accurate) (75%-100%)
<i>Hardware:</i> Notebook	Notebook is either not bound/durable or lacks serially-numbered pages	Notebook is bound, durable and has serially-numbered pages
<i>Hardware:</i> The Pen	Writing is done with a pen that is not permanent/resistant	Writing is done with a permanent, fade-resistant pen
<i>Hardware:</i> Storage	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:</i> Timeliness of entry	Entries are delayed/not made immediately after performing the work	Entries are made immediately after performing the work
<i>Writing and Maintaining:</i> Legibility	Entries are difficult to read and/or ambiguous	All entries are legible/numbers and symbols are unambiguous
<i>Writing and Maintaining:</i> error correction	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:</i> Active voice	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:</i> Date and Running Title	Dates and or running titles are lacking/insufficient	All pages are clearly and appropriately dated and have a running title
<i>Writing and Maintaining:</i> Unused space	Unused space is not filled/not Xd-out or initialed	All unused space is both Xd-out and initialed
<i>Writing and Maintaining:</i> Attaching Loose Sheets	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:</i> Exterior Title	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:</i> Signout page	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:</i> Table of Contents	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:</i> Preface	Either researcher, coworkers, goal, hypotheses & aims or context is lacking or insufficient/and/or it is not clear where the full proposal can be found	Identifies researcher, coworkers (project partners), goal of research, location of full proposal, hypotheses & aims and context
<i>Front Matter:</i> Table of Abbreviations	Table is either lacking or not all common abbreviations are defined	All commonly used abbreviations are defined
Reflections on communications with service organizations	Reflections or self-assessment on meetings with service organizations are lacking or insufficient	Reflections are included for each communication with the service organization and each category of self-assessment is appropriately addressed (see assignment descripton)

Write self-assessment here

Write self-assessment here

Laboratory Notebook Rubric

Section of the Body of the Notebook	Unsatisfactory (lacking / inaccurate / inappropriate) (0 to 50%)	Evolving (appropriate but partially-formed) (51%-74%)	Competent (appropriate and accurate) (75%-90%)	Accomplished (precise and descriptive / nuanced / exemplary) (91-100%)
<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> Objective/Aim/ Hypothesis	Objective/aim & hypothesis are not referenced.			Objective/aim and hypothesis are clearly referenced.
<i>Introduction:</i> Benefits of Experiment	A description of benefits of the experiment is lacking. It is not clear as to why this experiment was chosen.			Benefits of the experiment are sufficiently noted. It is clear why this experiment was chosen.
<i>Introduction:</i> Literature Review	Pertinent literature is missing or it is completely inappropriate or inaccurate.			Pertinent literature is sufficiently noted.
<i>Introduction:</i> Experimental safety	Safety concerns are lacking or inaccurate.			Safety concerns are sufficiently addressed as are potential pathogens & properties of pertinent substances / chemicals. ATCC and MSDS are consulted.
<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>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, calculations or ramblings are insufficient to 'make sense of the data'.	Raw data are sufficiently summarized in the form of charts, tables, calculations or ramblings wherever appropriate. The Discussion 'makes sense' of all data.	Raw data are thoroughly, clearly and accurately interpreted using charts, tables, calculations or ramblings wherever appropriate. No data are left uninterpreted and/or unconsidered.
<i>Conclusions :</i> Accomplishments	Accomplishments are not included and/or hypothesis 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 & or Novel Ideas	There is no discussion of what should be done differently next time. Novel ideas are not discussed.	Discussion of what should be done differently next time is incomplete. Discussion of novel ideas stimulated by the research is partial / incomplete.	Discussion of what should be done differently next time is sufficient. Novel ideas stimulated by the experiment are summarized.	Discussion of what should be done differently next time is thorough, succinct, precise and nuanced. Novel ideas stimulated by the experiment are summarized thoroughly, succinctly and precisely.

Photo and Video Documentary

The photo and video documentary serve the purpose of communicating your project progress at mid-semester. The primary audience for this documentary is the community partner. However, the documentary will likely be viewed broadly by individuals with diverse backgrounds. Thus, please limit the technical ‘jargon’ in your video and take Einstein’s advice, “The definition of genius is taking the complex and making it simple.”

Your only ‘grade’ for the mid-semester documentary is in the form of the community partner rubric. That is, your community partner will mark you either satisfactory or unsatisfactory on this effort. However, below is a self-assessment checklist to ensure that you create the best documentary possible and leave your community partner wishing that she/he could mark an ‘Out of this World’ category on the rubric. You will upload this checklist with the link to the documentary on the WyoCourses assignment.

<i>The photo and video documentary</i>	<i>Place a checkmark & comment here when this component is accomplished!</i>
<i>Communicates the project objectives (perhaps also hypotheses and aims) using accessible language and visuals.</i>	
<i>Communicates accomplishments made to date using accessible language and visuals.</i>	
<i>Communicates ‘next steps’ in the project.</i>	
<i>Has a clear message for each visual (a.k.a. is not packed full of cool pictures and video that have no meaning).</i>	
<i>Is well-planned. (Your viewer will be able to tell that prior to putting your video together, you planned the flow and pacing.)</i>	
<i>Is long enough to communicate the important project goals and accomplishments but is short enough to remain engaging. (Despite common opinion there is no standard ‘attention span’. However, we do know that people do not pay attention to boring things (John Medina, Brain Rules). Thus, a video that is around 4 minutes and interesting likely keeps your audience engaged.</i>	
<i>Gives an appropriate acknowledgement to the community partner and without whom the work would not have been possible.</i>	
<i>Is creative, innovative or in some way engages the viewer!</i>	

The documentary can be found at the following link: _____

Community Partner Rubric

Community Service Organization Student Group Evaluation / Section	Unsatisfactory (lacking/inadequate)	Satisfactory (fitting/adequate)	Comments or considerations that should be made in your evaluation of the student team.
Professionalism	Professional skills were lacking. Students were not punctual or courteous in interactions.	It is evident that students took their responsibilities seriously. Punctual and courteous in interactions with your 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: Mid-semester photo and video documentary	Students did not effectively communicate their research progress. Improvement in the explanation of scientific approaches being used was needed.	Students effectively communicated their research progress; they explained scientific concepts at an appropriate level.	
Communication: Poster Presentation	Students did not effectively communicate research results. Improvement in the explanation of scientific concepts is needed.	Students effectively communicated research results to your organization; they explained scientific concepts at an appropriate level.	

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

This assignment assesses ALL (#1-7) USP 2015 Learning Outcomes.

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. Impeccable spelling, grammar and punctuation are important as failure in any of these areas may compromise the seriousness with which the poster is received.

II. SECTIONS

A. Title

A succinct statement that summarizes the work that was done, how it was done and what was found. A reader should be able to get an idea of the design methodology and content of the poster by simply reading the title. 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. Please note that this title differs from the title of your proposal because it communicates your central findings!

B. Objectives, Hypotheses and Specific Aims

These were developed and finalized for the Research Proposal (see Research Proposal Assignment Description). On the poster only those hypotheses that were successfully addressed by the research can be restated.

C. Main Body (IMRaD Convention):

a. Introduction

State the problem and its significance. Establish broad and discipline specific interest. Establish the framework of the study. Present an overview of the most important literature. Focus on key, pivotal and germane sources. Clearly provide a justification for the research. Make the background leading to and impetus for the objectives/specific aims & hypotheses 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. Just as you did in the proposal, you will want to funnel, focus and unify. In fact, much of the work of this section was done in your proposal. However, in the poster, you will need to be much more succinct. *Remember your conceptual model? Might it be a great visual addition to your poster? If so, be sure to give it a clear figure caption and refer to it in-text.

b. Methods

Begin by incorporating or adapting *the Research Design Schematic* that you created for your proposal. Include just enough captioning text to make it clear how the data were derived, collected, and analyzed. If methods are novel, describe them in detail. Describe the site, population and context, method of sample collection, culturing, data collection, and analysis as well as data analysis (e.g. statistical and computational 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. Tell the kind of engaging 'story' that you would want to hear. 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

Interpret and assess the results, make generalizations and *references to the literature*. Explain how your findings allow you to call into question, support and/or expand and expound upon the current body of knowledge. 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 and 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. *[To create a standard poster-size PowerPoint slide, hit the design tab and on the far right, you will see an icon labeled 'slide size'. Click on the arrow next to this icon and select 'page setup'. A standard poster is 48 inches wide and 36 inches tall. On a poster this size, the title font should be 82-92 points. Section headings work well between 50 and 60 points. Body text can be between ~24 and 30 points.]*
 - 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, and rows & columns is clear. Appropriate use of photographs can be very effective and always enhances engagement.

IV. Delivery

- a. Consider your audience.
- 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 Rubric

Poster Section	Unsatisfactory (lacking / inaccurate / inappropriate) (0 to 50%)	Evolving (developing but very partial) (51%-80% Individual, 51%-74% Team)	Appropriate for draft (appropriate and accurate) (80%-93% Individual, 75%-90% Team)	Beyond Draft Expectations (precise and descriptive / nuanced / exemplary) (93%-100% Individual, 90%-100% Team)	Comments
Title	The title fails to summarize what was done, how it was done and what was found. It may even indicate content that is not covered by the research.	The title only partially summarizes what was done, how it was done and what was found. It may not be entirely engaging/may be too long or overstated.	The title adequately but not elegantly summarizes what was done, how it was done and what was found.	The title clearly, succinctly summarizes what was done, how it was done and what was found. It is engaging and not overstated or too long.	
Objectives / Hypotheses and Specific Aims	assessed as part of the Research Proposal Rubric				
Introduction	More than one essential portion of the introduction is lacking or inadequate.	One of the essential components of the introduction is lacking or insufficient (e.g. literature review, justification, statement of problem or significance.) Lead in to objectives, hypotheses or specific aims may not be clear. Conceptual map may be only partially used to augment message.	Literature overview is adequate; key, pivotal and germane sources are included. Justification is complete. Problem and significance are stated. Reader understands the lead-in to objectives, hypotheses and specific aims. Conceptual map adds an effective visual.	Literature overview is thorough, clear and complete; key, pivotal and germane 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. Conceptual map allows much of the above to be accomplished visually or elegantly augments the text.	
Methods	The description of how data were derived is lacking or inadequate.	The description of how data were derived is incomplete.	Provides an adequate description of how the data were derived, collected and analyzed. Novel methods are clearly described.	Provides a brief, highly visual and clear description of how the data were derived, collected and analyzed. Any novel methods are very thoroughly and succinctly described.	
Results	Figures, tables, and/pr graphs are uninterpretable or completely inappropriate in conveying the central poster message.	Some figures, tables, and/or graphs may be hard to interpret or may not be fully or effectively used to support the central poster message/s.	Data adequately convey the central poster message/s. Figures, tables, and/or graphs can be independently interpreted and flanking text is kept to a minimum.	The perfect amount of data are clearly and visually shown. Each figure, table, and/or graph can be easily interpreted and never attempts to convey too much. Flanking text is kept to a minimum and serves only to highlight.	
Discussion	Discussion fails to interpret findings within the context of the background or proposed objectives/aims, hypotheses and literature.	One of the elements of the discussion / interpretation is not complete. Discussion may fail to connect the findings to the introduction, objectives/aims, and hypotheses.	Sufficient discussion / interpretation connects the findings to the introduction and literature. The objectives/aims and hypotheses are addressed. Impacts and contributions of the research are considered.	The results are discussed / interpreted within the framework of introductory literature. Connections to the introduction, objectives and hypotheses are clear and eloquent. Impacts and 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.	
Conclusion/s	Outcomes lacking or do not follow from data/findings. Suggestion for further research is lacking or does not follow from findings.	Outcomes are incompletely stated or do not entirely follow from data - connection is nebulous. Suggestion for further research may be incomplete.	Outcomes are adequately stated and are based on data. Further research is suggested.	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.	
Acknowledgements	Funding sources, individuals / entities are not acknowledged or are inadequately acknowledged.		Funding sources, individuals/entities (all significant contributors) are acknowledged.		
References	Reference list is lacking / inappropriate or it is not formatted in at all the appropriate style.	Either the reference list is incomplete / lacks some key references or the Vancouver Style is not full followed.	An adequate list of key references is included in the Vancouver Style.	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.	
General	Poster either fails to use the given organizational structure and/or poor writing (improper spelling, punctuation or grammar) compromises the proposal.	The poster only partially follows the given organizational structure and/or writing is occasionally compromised by poor spelling, grammar or punctuation.	The given organizational structure is followed and writing exhibits appropriate spelling, grammar and punctuation.	The given organizational structure is followed and writing is eloquent. Spelling, grammar and punctuation are impeccable but also the writing flows and is clear to all appropriate readers.	
					Elements
					Design
					Overall

Poster Rubric

Appearance / Delivery Category	Unsatisfactory (lacking / inaccurate / inappropriate) (0 to 50%)	Evolving (developing but very partial) (51%-80% Individual, 51%-74% Team)	Appropriate for draft (80%-93% Individual, 75%-90% Team)	Beyond Draft Expectations (precise and descriptive / nuanced / exemplary) (93%-100% Individual, 90%-100% Team)	Comments
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/inadequate/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 labeled. Tables have no more than 20 rows/columns. Graphs are limited to three lines or 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 or 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>	