STUDENT GUIDE 2021/22

OTTAWA SCIENCE INNOVATION CHALLENGE

OSIC

Ottawa Science Innovation Challenge

GREETINGS

Welcome to the Ottawa Science Innovation Challenge!

In this document, you will find all the details and instructions you need to create an excellent proposal to submit for the competition. Although it might seem intimidating to read through scientific literature and to be judged by graduate students and professors at the university level, this student guide will help you through the entire process. We hope you have a lot of fun creating your research proposals and find this entire competition an enriching experience. We cannot wait to see what kind of creative and innovative ideas you will all come up with!

-The OSIC Organizing Team

IMPORTANT DATES

Please note that due to current circumstances with the COVID-19 pandemic, this year's OSIC competition will be entirely virtual.

Date	Event
November 1st	Round 1 begins: Case Reveal
December 10th	Round 1 ends: Written submission deadline
*January 15th	Round 1 results announced
Mid-February	Virtual final round

*Approximate date

SUBMISSION INFORMATION

Your written research proposals are due at **11:59 pm** on **December 10th, 2021** in PDF format. Please submit it by email to osic.uottawa@gmail.com. Submit with only one email per team and make sure the email appears in your "sent" mailbox. You will receive a submission confirmation via email within 24 hours.

Submission guidelines:

- Submit two copies of your written proposal in PDF format
- Both copies must include a title page
  - The first should contain your school name, team number and members' names along with your project title
    - Name the first PDF file: team number_your project title.pdf (abbreviations may be used)
    - Ex: E24_ROSGlycMitosis.pdf (Where E24 is the team's number)
  - The second should ONLY contain your team number along with your project title (Should **not** contain any other identifying information)
    - Name the second PDF file: team number.pdf
    - Ex: E24.pdf (Where E24 is the team's number)

***Please note that any violation of the above mentioned guidelines such as the submission of a non-PDF file will result in penalties and possible disqualification.**

WRITTEN PROPOSAL CONTENT REQUIREMENTS - 1000 WORD LIMIT

- **Abstract** (not included in the word limit, but must not exceed 250 words)
- **Background Information / Introduction**
- **Research Idea / Hypothesis**
- **Rationale**
- **Significance of Research Idea**
- **Research Approach / Methodology**
- **Conclusion**
- **Definitions Sheet** (not included in the word limit)
- **References** (not included in the word limit)

Written proposal format

Abstract

Your abstract should include a clear and concise summary of your research proposal. It should include the issue it is trying to resolve, the methods you will use, your expected results, and a brief conclusion. Your abstract should not exceed 250 words.

Abstract Example:

Lyme Disease, a prevalent bacteria-caused illness, requires a long period of time to diagnose. If identified during its early stages, late symptoms of the disease and Post Treatment Lyme Disease Syndrome could be prevented. The primary pathological cause of Lyme disease, bacteria Borrelia Burgdorferi (B), has been shown to thrive when using a host's transition metals, incorporating them in a process to achieve microbial growth. Research has shown that B differs from other organisms in that it utilizes other metal ions instead of iron in this process. This, among other mechanisms, allows it to thwart the immune system. The aim of this study is to research a possible connection between concentration of transition metals in the body and presence of the bacteria B. A mouse model will be used, in which half of the mice will be infected with B and half will be healthy. At scheduled times over the course of five weeks, blood tests will be taken from every subject and analyzed for concentrations of various selected metals. While the ultimate goal is to develop faster methods to accurately test for Lyme Disease, this research can progress experimental work in treatment of the illness.

Judges Notes and Comments:

It is important to briefly indicate how variables, such as age of mice and its effects on different transition metal concentrations, will be controlled. It would be appropriate to specify which transition metals have been commonly involved in the infection process as seen in scientific literature and to indicate which metals will be analyzed.

Background Information / Introduction

This section is a complete ensemble of the information you have gathered that relates to the main ideas of your proposal. It is important that this section also elaborates on why the said issue is relevant. You must refer to previous experiments performed in literature to explain why your idea has potential. It should be a summary of the problem for which you are proposing a solution. In this section, you must also refer to previous or current scientific research related to your topic and clearly indicate how your study will add to this pre-existing bank of information. Keep in mind that many who will be reviewing your research proposal will not necessarily have the knowledge to understand how your idea works and why it is relevant. It is therefore important to include details pertinent to your idea that will allow any reader to understand your message. **This section should only be written in a third person present tense.**

Use this section to walk your reader through how you got your idea and why you think it will work.

1. Identify the problem you chose and briefly discuss previous work that is relevant to your research.
2. Start to connect ideas in a cohesive manner that shows your train of thought of how you came up with your research idea. This linking of thoughts should hint at your research idea, but not explicitly state it (you'll state your idea later). You must consider various factors that may affect your research proposal. The background information section is your chance to show off all of the cool research that fueled your ideas. **Remember to cite your sources.**

Background Information Example:

Modern detection of Lyme Disease can be inaccurate and time-consuming. Late diagnosis leads to development of severe symptoms and Post Treatment Lyme Disease Syndrome. This study aims to research a possible connection that would lead to better testing and treatment methods of the illness. For Lyme, blood testing is often done in two parts, most commonly an Enzyme Immunoassay test followed by a Western Blot test. In most cases, both tests need to be positive in order to give a positive diagnosis. Methods such as these are most reliable a few weeks after infection. These antigen tests assume that specific antibodies will be produced when corresponding proteins from the cell surface of infectious organisms are present. Because they rely on the detection of antibodies, these tests may give false negatives, if the body hasn't yet started fighting off an infection. Polymerase chain reaction (PCR) tests may be used, but their verdicts may produce false negatives or conflict with other tests' results. PCR involves many complex stages of precise analysis of DNA samples. These methods are relatively difficult to access and require weeks of time. Microorganisms such as Borrelia Burgdorferi (B) require metals to survive. Pathogens use a host's store of iron, zinc, manganese, and more, to grow and flourish. The body attempts to hide, or "sequester" its metal ions to starve bacteria, with a process termed "nutritional immunity". The body has been shown to flood areas infected with salmonella with antimicrobial proteins, removing zinc-a physiological need of salmonella.

The bacteria uses specialized transporter proteins in order to overcome the immune response and use the zinc anyway. This suggests the infected area may have lower levels of zinc. If salmonella could have an impact on the concentration of zinc in a host, can B? In fact, the body appears to hinder microbial growth of B specifically, by sequestering zinc and hiding it from the bacteria. Zinc transporters in immune system cells control intracellular movement of the zinc ions, effectively "hiding" them. Although the primary metal ion required by bacteria is iron, B has adapted to use manganese instead, and there are manganese transporters as well. Presence of the bacteria B could influence how much manganese, zinc, or iron is in an infected area.

Judges Notes & Comments:

It would be more appropriate to call the bacteria B Burgdorferi throughout the entire text rather than call it "bacteria B" in some cases and "B" in others. The use of these different terms could cause some confusion. Furthermore, no sources have been cited in this section. These are very important in order to support the data behind the research idea. For example, as this team did not discover the fact that salmonella has an impact on the concentration of zinc in a host, they would have needed to cite a source for this fact. The section outlines why several other pre-established methods of diagnosis are not ideal, however it fails to mention current research surrounding the diagnosis of Lyme Disease.

Research Idea / Hypothesis:

Your research idea / hypothesis will consist of a proposed explanation and prediction for the outcome of your elaborated research method. It needs to solidate the theory and ideas mentioned in the background information. It should be clearly stated and well researched. This idea must be based on facts and previous scientific research. Judges do not expect completely new research ideas, rather they expect teams to pull information from previous research and adapt it with the goal of improving it or modifying it for a different purpose. It is not necessary to justify yourself in this section, as the reasoning behind your hypothesis should be in the section 'Rationale'. Avoid mentioning variables you cannot control as these will restrict you in your methodology. Try to be as creative as possible.

Research Idea / Hypothesis Example:

Aim/Goal:

The purpose of this research is to determine if there is a link between selected transition metal levels in a host and the presence of B.

Research Question: Will the presence of B affect concentrations of zinc, iron, and manganese in a host?

Hypothesis: Throughout five weeks of blood tests, the levels of zinc and manganese in a group of mice infected with B will become lower than those in a control group of healthy mice. The levels of iron will remain constant throughout the two groups.

Judges Notes & Comments:

Keep in mind that although the eventual goal is to apply these methods to the treatment of humans, the current research project is geared towards mice. The term 'host' should be replaced by 'mice' for accuracy.

*Please note that when writing your Research Idea / Hypothesis section, the three subsections (Aim, Research Question and Hypothesis) will be combined into one paragraph. It is separated in this example for clarity's sake.

Rationale

A rationale is justification and reasoning offered by a researcher for conducting research on a specific subject. As a researcher, you want to explain why you think your methodology will work. You must state your reasons with support from existing literature which will reinforce your justification. The rationale can be placed before or after the hypothesis.

Rationale Example:

Microorganisms require metal to grow, and bacteria such as B take those metals from a host. However, B has been shown to use manganese as a substitute to iron, so we hypothesize levels of iron in infected mice should be unaffected by the bacteria. Once the body has realized it is under attack, it attempts to hide or sequester the metal ions in an attempt to starve the bacteria. Both of these phenomena (B consuming the metal and the body sequestering that metal) could result in lower concentrations of the metals used by B in an infected host. B has been shown to use zinc and manganese, so we hypothesize the infected mice will demonstrate lower concentrations of zinc and manganese ions.

Judges notes and comments:

Existing scientific literature should be used to support the rationale. The term ‘we’ should not be used, as a third person analysis is always preferred in scientific articles.

Significance of Research Idea

What is the significance of your proposed research? What are the benefits and potential impact that it may have? These are the questions you need to ask yourself when writing your significance. How will it impact the field of interest, and what will be the outcome on the treatment of this particular disease? This section will demonstrate the importance of your research.

Significance Example:

If the link is indeed there, it would be very useful in finding a possible way of determining the state of illness faster and more effectively, along with potential treatment methods for the illness. A trend could be key in determining if a patient is infected much faster than current methods.

Judges notes and comments:

In the field of science, all discoveries are important. You may mention that whether the results corroborate the hypothesis or not, they will contribute to scientific knowledge and can be used to further research in this domain.

Research Approach / Methodology

The methodology section of your research proposal is not the classic "list your materials and methods". This section is one of the largest, and most important ones on the proposal as it outlines the various scientific procedures, techniques and control groups that you will use. It should explain how you will test your hypothesis by using various scientific techniques.

It is very important to:

- **Outline the different groups that will be involved in your experiment** (experimental group(s) vs control group(s))
- **Size of these groups.** The sizes of the groups you're using are key - they must be realistically large (you may need to research what is considered reasonable).
- **Establish controls.** Aim to reduce the number of variables to increase the validity of your findings.
- **Choose a model in which you will conduct your experiments:** either **in vitro** (on cells) or **in vivo** (on animals) and why you chose this model.
- Please be aware that you are **not permitted** to propose clinical trials (i.e. humans as test subjects)

Methodology Example:

Examining the passage of the bacteria in the circulatory system of the mice allows more comparability to human systems than an in vitro study. An in vivo mouse model will be used to study the effect of the independent variable on the dependent variables in live mammalian hosts.

Independent variable: presence of B in the mouse.
Dependent variables: levels of iron, zinc, and manganese in the mouse. In order to provide accurate results, controls will be put in place on our study. A control group of healthy mice will be used.
Controlled variables: weight of mouse (mice of similar mass will be selected), diet of mouse (all mice will have identical nutrition), sex of mouse (half female, half male), size of enclosure, absence of other drugs/treatments on mouse, health of mouse.

1. Selection Process: 20 mice of similar mass and seemingly good health are selected. 10 are female and 10 are male. Two groups are formed: X and Y. Each group is split up, half males and half females. Each mouse is assigned a value to keep track of them.
2. Preliminary Testing: Basic tests such as blood pressure, heart rate, etc. are performed to make sure there are no initial health concerns in each mouse. Mice deemed unhealthy or unfit will not be used.

3. Baseline Metal Testing: Blood samples (~50 µL) from the mice undergo careful electrothermal atomization. The now gaseous sample becomes the analyte in an absorption test. This process is called atomic absorption spectroscopy and it will be used to quantitatively test concentrations of zinc, iron, and manganese in the sample. These measurements are recorded as individual baselines. The average concentration of each metal is calculated per group to compare with the final results.

4. Infection: Every mouse in group Y is injected with B in the ventral artery of the tail, allowing the bacteria into the bloodstream. Group X is not a part of this step as they are healthy controls.

5. Metal Research Process: The process from step 3 is repeated every week over a five week period; results are recorded. (average concentrations calculated weekly)

6. Analysis: The average concentrations from each week are compared. This gives an idea of when a possible trend may have appeared. Visuals and percent differences are used to analyze results.

Judges Notes & Comments:

It's very important to include justifications of the experimental tests you run. Firstly you should explain how you chose your time frame and how it impacts the experiment. Secondly, deepen your explanation of the techniques you'll be using. Thirdly, you should expand your sample size to thoroughly support your hypothesis. A good addition would be to include limitations of the study design; ie. things you cannot control.

***Please note that when writing your methodology section, you may format it as desired, (Flowchart, sequential steps...) although the preferred method would be to have it in paragraph form to explain the most information you can. The flowchart approach is more commonly used in a poster proposal.**

Conclusion

The conclusion section should be a short summary of the content and purpose of your proposal. You need to answer the questions “what, how, and why”. The conclusion also often allows you to either confirm or refute your proposed hypothesis by drawing key points from the proposal and offering creative approaches for contextualizing the research problem based on the findings of your study. You should link your proposal to a real-life application in this section. You should reinforce that your research idea is feasible, worthwhile, and important in real-life applications.

Conclusion Example:

If the hypothesis is proven after the first week or two of testing, this trend can be used to accurately detect the Lyme disease bacteria faster than modern tests. If a trend at any point is noticeable during the course of the study, this knowledge could be used in further experimental research in treatment of Lyme disease. If no trend is noticed, this knowledge may eliminate a possible area of study and open the door to other research.

Judges Notes & Comments:

This conclusion is missing a summary of the main topic and also doesn’t directly address the specifics of the hypothesis; no mention of transition metals.

Definitions

Your research proposal should include definitions. This section should be at the end of your proposal, right before your “References” section. In this section, you may define any complex terms or concepts mentioned in your proposal. The terms should appear in alphabetical order. You do not need to reword the definitions that you find online, but do make sure to **reference your sources** in your “References” section. Note that the Definitions sheet **will not** be counted in your total word count.

Definitions Example:

PCR (Polymerase Chain Reaction): A method that rapidly makes millions of copies of a specific DNA sample, allowing scientists to take a very small sample of DNA and amplify it to a large enough amount to study in detail. (“Source”)

Post Treatment Lyme Disease Syndrome: A condition in which a patient suffers lingering symptoms of Lyme disease after finishing treatment. (“Source”)

References

Citing reliable sources is an essential part of your proposal. Any time you mention what you found in your research, you must give credit to where that information came from. To this effect, you must include a “References” section at the very end of your proposal. This section will include a full list of all the sources that you cited throughout your paper. Note that your “References” section will not be counted in your total word count.

To do this, throughout your paper, put a superscript number after stating any information that you are citing (fact, concept, idea...etc.); you will later include the full citation for each source in your “References” section. Each superscript number in your paper must have a corresponding full citation in your “References” section. Furthermore, the sources cited in your “References” section will appear in the same order as the corresponding superscript numbers appear in your proposal. **Do not include in-text citations,** as the “References” section will include all of your references at the end of your proposal. In your “References” section, cite your sources using the formatting style of **APA 7th edition.**

Consult the following ressource for more information on how to format your "References" section according to APA 7th edition guidelines:
https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_formatting_and_style_guide/reference_list_basic_rules.html.
Mendeley is an excellent program for compiling and creating a reference list. Please refer to the following link to access Mendeley: **https://www.mendeley.com/reference-management/reference-manager/.** Please remember to use credible sources. Stay away from unreliable websites. Referencing research articles is ideal. You may find an online news story about a study with valuable information. While it is acceptable to cite this news story, you can usually dig deeper and find the actual research paper they're talking about. You can also use tools like Google Scholar and research article databases (such as Pubmed) to find reliable sources. If you come across a paper that is locked or costs money, simply email the OSIC team (osic.uottawa@gmail.com) and we can unlock the document for you free of charge. Please note that we will only unlock up to a maximum of **10 research articles** per team.

Reference Example:

(1) Sancar, F. (2019). New Indications for Lyme Disease Tests. *JAMA*, *322*(11), 1036. https://doi.org/10.1001/jama.2019.13901

(2) Troxell, B., Ye, M., Yang, Y., Carrasco, S. E., Lou, Y., & Yang, X. F. (2013). Manganese and zinc regulate virulence determinants in Borrelia burgdorferi. Infection and Immunity, 81(8), 2743–2752. https://doi.org/10.1128/IAI.00507-13

RUBRIC

Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Research and knowledge of the subject (25%)	Less than 2 articles are cited. Very little basis for ideas presented. Background presented is not relevant to the question or hypothesis posed.	2-4 articles are cited in the background presented. Two or fewer ideas are supported. Background presented is only weakly relevant to the question or hypothesis posed.	5-6 articles are cited in the background presented. Most ideas are supported with research. Background presented is relevant to the question or hypothesis posed.	Research is thorough and ideas are well supported. Background presented is clearly relevant to the question or hypothesis posed.
Formulating a question or research hypothesis (30%)	Question or hypothesis is not stated or is a simple repetition of a hypothesis found in published research. Hypothesis is irrelevant to the field.	Question or hypothesis stated but unclear or is just a slight variation of the published research.	Question or hypothesis is stated, is clear and relevant.	Question or hypothesis is clearly stated, is well researched and relevant to the field.
Experimental design (25%)	Experimental design is unclear. Some steps are missing or not sequentially listed. No justification for the choice of experimental design is given. No mention of sample size and variables not explained or missing.	Experimental design is appropriate however still lacking some steps. Justification for the choice of experimental design is given. Sample size is inappropriate and variables are somewhat explained.	Experimental design is appropriate. Steps are listed in sequence. Justification for the choice of experimental design is given. Sample size is appropriate and variables are explained.	A clear, controlled experimental design is presented. All steps are listed. Clear, concise justification for the choice of experimental design is given. Sample size is appropriate and variables are clearly identified and explained.
Creativity and novelty (10%)	Research idea is not creative. Hypothesis and experimental design are closely replicated and bring no knowledge to the field.	Research idea is somewhat creative. Hypothesis and experimental design contain similarity with previous research and bring little knowledge to the field.	Research idea is creative. Hypothesis and experimental design are novel and provide knowledge to the field.	Research idea demonstrates great creativity. Hypothesis and experimental design are novel and bring insight to the field.
Expression, organization, written ideas and information in written form (10%)	Proposal lacks organization or logical structure. Overuse of technical jargon. No definitions of scientific terminology provided.	Proposal is somewhat organized but contains logical gaps. Overuse of technical jargon makes understanding challenging. An inadequate number of definitions were provided.	Proposal is organized. One or two logical gaps or unaddressed issues leave the reader with unanswered questions. A sufficient quantity of definitions were provided.	Proposal is well organized with logical arguments. References are written in proper format. Definitions are provided for scientific terminology.

HOW TO GENERATE AN IDEA

1. Research:
    a. Research and google keywords and related topics.
    b. Look for unsolved problems/issues or criticisms.
    c. Research and read articles/reviews on these unsolved problems and criticisms.
    d. Identify the problem(s) and all possible entry points to attack the problem.
    e. Document all relevant articles and keep detailed notes of your findings.
2. Narrow your topic and brainstorm ideas
    a. Now that you have a broad knowledge base of the problem, narrow down the topic.
    b. Choose your selected point of entry to the problem.
    c. Delve deeper into this selected topic.
    d. Write down any ideas that come to mind (no idea is a bad one).
    e. Try to base your ideas on current scientific literature.

*The more you narrow down your topic/problem, the easier it will be to brainstorm ideas to address it.

3. Choose your idea and hypothesis. Develop your research proposal.

Before you begin generating ideas, it is important to inform yourself on the case by reading news articles, research papers, and anything that may increase your knowledge on this topic. Start off by searching some keywords and terms related to the case topic. Keep detailed notes of relevant articles and sources so that you may return to them later.

The more knowledge you have regarding the general information of the case, the easier it will be to find and identify where you wish to solve the problem. If you find something interesting and want to find out more about it and current research, read a research paper about it. This will give you a clear idea on where further research is needed, and where your idea will fit in.

Case specific example - Lyme disease

- Obtain general knowledge on Lyme disease by reading articles and encyclopedias on the disease
- Afterwards, begin to research more specific aspects of the disease, such as, the transmission of the bacteria to the host, the tick's life cycle, why humans aren't immune to the bacteria...
- Look up current scientific advancements and discoveries on the topic of Lyme disease so that you may have an idea of how this issue was solved by others
- While reading up on the transmission of the Lyme disease bacteria to the host you read that the Lyme disease bacteria uses a host's store of iron, zinc and manganese to survive. You choose to delve deeper into this topic and begin a broad search on bacteria which use transition metals from their host's stores. You find that salmonella uses its host's stores of zinc. Scientific research has proven that a host's level of zinc therefore decreases when they are infected with salmonella. You decide you wish to test whether the same principle can be applied to the Lyme disease bacteria. Thus, your research question is whether a host's levels of zinc, iron and manganese will decrease when they are infected with the Lyme disease bacteria. The significance of this research idea is that if this hypothesis is corroborated, it could be used to diagnose Lyme disease in the future.

SUGGESTED TIMELINE

- Brainstorm ideas: Research keywords and issues related to the topic by November 8th
- Finalize a research idea & hypothesis by November 13th
- Read literature and past experiments related to your research idea & hypothesis by November 18th
- Write your proposal by November 30th
- Proofread and Edit (Make sure it meets all requirements) by December 6th

FIRST ROUND

Each submission is judged according to the given rubric by 3 or 4 judges who are either professors or graduate students. The scores from each judge will be standardized so that each judge's average score is approximately the same. The average of the scores will be the project's final score. The top teams will be invited to the final round.

RESOURCES AVAILABLE

1. Information Session

Halfway through the writing period of the competition (Late November), a virtual information session will be held to help students with their proposal, addressing each section of the research proposal. The information session will be non-mandatory, offered in English (but OSIC team members will be able to translate or answer questions in French) and will require registration beforehand. The information session will take place virtually on Zoom.

2. Email

Feel free to email us at **osic.uottawa@gmail.com** if you have any questions or concerns.