

Lab Report Writing Guidelines

The lab report is due on Sunday, October 22nd at 11:59 pm and must be submitted by Nexus into the appropriate dropbox as a PDF document. There will be a penalty of 5% for each 24 hours late or part thereof. Lab reports will no longer be accepted after Sunday, October 29th at 11:59 pm (one week late).

The following sections must be included in your report:

- Title Page
- Abstract: 200 to 250 words
- Introduction: 500 to 750 words
- Methods: no word limit
- Results: no word limit
- Discussion: 750 to 1000 words
- Citations and References

The text of the lab report should be double-spaced and left-aligned, each paragraph should be indented, and a simple 12-size font should be used. Figure and table captions should be single-spaced and not indented.

Title Page (1 mark)

The title page should include the following details; a descriptive title for your report, your first and last name, and your lab section. This information should appear on a separate page at the beginning of your report.

Abstract (4 marks)

The abstract should contain the essential details of your report, including the methods and results, and some of the topics found in the introduction and discussion. It is often written like a mini-paper, summarizing all these sections in the order that they appear in your paper. For this reason, this section of the paper should be written last. Because there will not be anything mentioned in the abstract that does not appear in greater detail elsewhere in your paper, it is not necessary to put citations in the abstract. The abstract should be between 200 and 250 words.

Introduction (12 marks)

The hypothesis, which you are trying to support or disprove, is that it is possible to identify bacterial species based on their cellular morphology. This section should introduce the various stains and slide-preparation techniques that were employed in the first three in-person labs. Explain, using references, the general scientific principles behind the experiments. Provide the necessary information for the reader to understand your results (ie. what are the various possible cell morphologies and arrangements?). Explain how the contents of the report are related and not just a collection of isolated experiments. Assume your reader has background knowledge of university biology, but is not familiar with this course. Do not end the introduction with a summary of your findings; this is

redundant to both the results and the abstract. Instead your introduction should end with a paragraph outlining the study purpose and your hypothesis. Your introduction should be a maximum of 750 words. 1 mark will be subtracted for every 75 words over the limit.

Methods (5 marks)

The methods section should provide a detailed description of how the experiments were performed and using what resources. Note anything that differed from the established protocol, such as increasing or decreasing the staining time. Always clearly describe the species you worked with, the procedures performed, and any media or reagents used (this includes indicating the types of stains used when multiple possibilities exist). Use the following examples below to guide your writing in this section.

- Gram stains were performed on *E. coli* and *S. aureus* following established laboratory protocols. Crystal violet was applied as a primary stain for 1 minute, followed by Gram's iodine for 1 minute. Finally, counterstaining with safranin for 45 seconds was applied.
- Negative stains were performed on *E. coli*, *S. aureus*, and the unknown bacterial strain following established laboratory protocols. The negative stain used was nigrosin.
- Catalase tests were performed on the unknown bacterial strain and the previously-identified six known bacterial species following established laboratory protocols, except that, instead of applying hydrogen peroxide directly to agar plates, bacteria were transferred from the agar plates to glass microscope slides. Hydrogen peroxide was then added to the slides as described in the laboratory protocol.

All bacterial stocks are provided by the University of Winnipeg. Never use pointform notation, bullet-point lists or numbered lists of instructions in your methodology. If you perform a specific experiment multiple times for different bacteria, you only need to introduce the methodology once and then clarify it was performed for each species.

Results (15 marks)

The results section must include text to guide the reader through the data presented in figures and tables. Text can also be used to present data that does not conveniently or logically fit into figures or tables. The text guides the reader through the sequence of experimental procedures and results. The results should be presented in full sentences in properly formatted paragraphs. Properly formatted tables and figures should be included in the results section and used to support and clarify your findings. Figures and tables should appear in the results section shortly following their mention in the text, not in an appendix at the end of the report. All figures and tables must be effectively referenced in the text of the results section.

Each table and figure should include a caption. For tables, this caption should be at the top of the table; for figures, this caption should be below the figure. The figure captions should be informative: provide as many technical details as you feel are necessary for

the reader to understand the image, even in the absence of the rest of your text. If there is information that you want your reader to learn from a figure, such as the morphology shown in that figure, include it in the caption.

When presenting figures with two or more different organisms or structures in them, the figure caption must explain what each thing is, by colour, by shape or using clear labels. When using multiple images within a single figure, identify each one with a letter so that, when you refer to the figure in your text, you can direct the reader to exactly what you want them to see (e.g. Figure 1A, 1B, etc.).

There are three major components to the results section in this lab report:

- comparison between simple, negative, and wet mount stains
- Gram staining
- Identification of organisms in mix broths

The first component is an examination of ways to view bacteria under the microscope, comparing the relative advantages of simple staining, negative staining and wet mounts based on your personal experiences working with these techniques in the lab. Do not describe the theoretical advantages and disadvantages of each technique, but compare and contrast what happened when you used these techniques on the same samples and what you observed in Lab 1 and Lab 2 (ex. simple stains allow for better definition of cell morphology, while negative stains allow for better viewing of cellular arrangement). You do not need to include figures of all six species under all three slide preparation techniques. However, you must include enough figures to effectively demonstrate your observations (ex. at least one example of each type of stain).

The second component of the results is the Gram staining of the six known species in tryptic soy broths, performed in Lab 3. Present detailed, captioned figures and written descriptions of the Gram stain results for all six of our known species. The third component is the identification of the organisms found in the two mix broths performed in Lab 3. The identities of the organisms in the mix broths should be proposed with supporting evidence for these conclusions. This can be done most effectively by including figures and using a comparison table between the known and unknown species. Please note that while the ramifications of identifying the organisms in the mix broths should be addressed in the discussion (Are these results supported by external literature? Do the results support the hypothesis?), you should propose identities for the two organisms in each of the mix cultures in your results section and present all of the relevant evidence that you collected in the lab. Provide at least one table supporting your identifications of the organisms in the mix broths. You may include any other figures or tables that you feel strengthen your report.

Therefore, your results should include the following tables/figures in addition to the written text.

- figure(s) showing an example of a simple, negative, and wet mount
- 6 Gram stain figures, 1 for each known bacterial species

- 2 Gram stain figures, 1 for each unknown bacterial mix
- 1 comparison table presenting similarities between the known bacteria and unknown bacteria of the two mixes.

Discussion (20 marks)

Along with addressing common concerns, such as possible sources of error, you should include a discussion of questions more specific to the experiments performed in this report. For example, the discussion should put your results within the context of established scientific knowledge. Are there flaws in the experiment (ways in which the procedure was inherently inaccurate or biased) and sources of error (ways in which human errors while conducting the experiment may have affected the results) that undermine your confidence in your data? How did the different techniques for preparing microscope slides affect your conclusions? Remember to be specific in your statements. Do not forget to address your hypothesis and draw conclusions as to its validity. Be sure to propose how these results could be verified using an alternative identification method. When discussing possible errors, use specific examples from your results and outline the correct observation with literature reference verification. Your discussion should be a maximum of 1000 words. 1 mark will be subtracted for every 100 words over the limit.

Citations and References (3 marks)

Failure to properly reference material will be penalized within the section of the report in which the failure was made. Ongoing or egregious failure to reference material will be treated as academic misconduct and will be subject to departmental review.

Citations should be numbered in the order that they appear in your report. In the body of your report, cite by including a superscript number immediately after the statement you are citing, or at the end of the sentence. At the end of the report, include a references section that details the citations in the order that they appeared in the report. If you cite the same source more than once, use the same number that you used earlier in your report. However, if you cite two different sections/chapters (e.g. lab 1 and lab 2 from *Bacteria & Archaea: The Laboratory Manual*), please treat these as two separate citations with different numbers and different entries in the references section.

Some references are considered to be more reputable or have gone through a higher degree of scrutiny than others. Part of the evaluation of your references is based on your ability to find and use information from sources that are considered academically robust. This tends to fall along a spectrum, with peer-reviewed literature from scientific journals being considered the most reputable, then edited books, then other expert sources, and so forth. It is better to reference a less robust source for your information than to fail to reference it entirely.

For this course, we use the Council of Science Editors (CSE) Citation-Sequence citation and reference with the modification that all references to books, including the lab manual and textbook, must include a page number or specific page range where this information can be found, and journal titles do not need to be abbreviated.

Below is an example of referencing Lab 1 and Lab 2 from the lab manual, a page from a textbook, and a journal article.

1. Kachur, K. Lab 1: Microscopy I. In: Biology of Bacteria and Archaea: The Laboratory Manual. Winnipeg: University of Winnipeg; 2022. p. 10-13.
2. Kachur, K. Lab 2: Microscopy II. In: Biology of Bacteria and Archaea: The Laboratory Manual. Winnipeg: University of Winnipeg; 2022. p. 14-16.
3. Foster JW, Aliabadi Z, and Slonczewski, JL. Microbiology: The Human Experience. Preliminary edition. New York: W. W. Norton & Company; 2016. p. 79.
4. Zahid S, Udenigwe CC, Ata A, Eze MO, Segstro EP, and Holloway P. New bioactive natural products from *Coprinus micaceus*. Natural Products Research. 2007; 20(14): 1238-1289.

In order to provide sufficient support for the information presented within the report, 5 external references must be included. These references are in addition to the laboratory manual. Therefore, your report will contain, at minimum, 6 references.

Mark Breakdown

Title Page.....	1
Abstract.....	4
Introduction.....	12
Methods.....	5
Results.....	15
Discussion.....	20
Citations and References.....	3
Total.....	60