MOLECULAR BIOLOGY 4GG9
MOLECULAR BIOLOGY & GENETICS CO-OP SENIOR THESIS
COURSE OUTLINE, PERMISSION FORM AND GUIDELINE ON COURSE EVALUATION

Course Coordinator: Ana Campos (camposa@mcmaster.ca) LSB-541, Ext. 23095
Course Administrator: Rebecca Woodworth (biology@mcmaster.ca) LSB-215, Ext. 23049

Prerequisite(s): Registration in Level IV of the Honours Molecular Biology & Genetics program and permission of the Course Administrator, Life Science Building, Room 215A.

COURSE OUTLINE

The Department of Biology provides a research-intensive environment that offers a unique opportunity for Molecular Biology & Genetics Co-Op students to both participate in and contribute to the relevant research. Students enrolled in the Molecular Biology & Genetics co-op program must conduct a 9-unit Senior Thesis (MOL BIOL 4GG9) where they carry out research while earning credit towards their degree. This thesis course is ONLY open to students registered in Level IV of Honours Molecular Biology & Genetics Co-op program. This is a Winter & Spring or Summer & Fall term course that provides students an opportunity to acquire field and laboratory skills in Molecular Biology under the supervision of a Faculty member. Because of the additional work term requirement of the Co-op program, the amount of work required in this thesis represents a somewhat greater time commitment than the normal Biology 4C09 Thesis. Upon successful completion of this course, students will be proficient in carrying out independent research; specifically, they will be able to formulate a scientific hypothesis, design and conduct a project to support or refute the hypothesis, and analyze and present results in a thesis. Senior thesis students are further challenged to present and defend their findings in an oral defense.

Finding A Suitable Research Supervisor And Project

Students who wish to enroll in this course must seek the support of a supervisor. The first step is to consult the list of potential MOL BIOL 4GG9 supervisors (available on the Biology website). Other supervisors may be contacted and may accept students. Students should make appointments with Faculty to discuss potential projects and the general nature of their research program. During this meeting, you should also ask about their expectations with respect to laboratory hours per week, and whether or not weekend work is required or expected. It is also a good idea to talk to a prospective supervisor's current thesis students in advance of the meeting to gain some insight into his/her supervisory style. When interviewing prospective supervisors, students should seek clarification regarding supervisor expectations with respect to the amount of lab time they should devote to their project, as this component is highly variable.

Once you have found a suitable supervisor AND you have an assigned research topic you must find another professor in the department who is willing to be your co-supervisor. Together, the supervisor and co-supervisor constitute the Supervisory Committee, which will be responsible for grading your final written thesis and your defense, and for giving general guidance throughout the course.

It is important for both supervisors and students to agree on the topic of the research. In the past, some thesis projects have been so complete, and integral to the supervisor's research programs, that the results have been published and the students credited with authorship. At the other extreme, there are projects in which technical difficulties prevent the completion of planned experiments, and the results are ambiguous. In the latter situation a student may still earn high grades for his/her design and analysis, for suggesting and testing alternative experimental approaches to the problem, and for an overall understanding of the project. A high grade does not therefore necessarily depend...
upon collecting a large amount of data, but results from full and aggressive intellectual and physical involvement in attacking the problem.

Finally the student must obtain permission to enroll in the course by completing and submitting the permission form (attached) and a one-page research proposal to the Course Administrator in LSB-215. After review and approval by the Course Coordinator, the permission will be entered on-line. Students will not be granted permission to register into the course without the signature of both supervisor and co-supervisors (see below).

Roles And Responsibilities

The Supervisory Committee

The Supervisory Committee consists of the 1) supervisor, and 2) co-supervisor. Please note that supervisors working in institutions other than McMaster University and affiliated institutes are now eligible to supervise students enrolled in Mol Bio 4GG9. Note, however, that in these circumstances the co-supervisor MUST be from the Department of Biology. Additional committee members may sit on the student’s Supervisory Committee for resource purposes. The composition of the Supervisory Committee is subject to the final approval of the Course Coordinator.

The Supervisor

Supervisors are responsible for the immediate direction and instruction of the student and should commit on average, a minimum of 30 minutes of contact time each week with the student. Supervisors will communicate their own expectations in terms of the day-to-day conduct of the student in the laboratory/clinic/field, as well as protocols used to track research progress and collect data (i.e. use of lab note books, etc.). Since it is impractical to insist on a single format for all disciplines and project types, as supervisor, you are responsible for setting guidelines and terms of reference for the research proposal or literature review for your own students. The supervisor should provide regular oral or written feedback to the student in regards to level of productivity, and degree of satisfaction of the student’s progress. Students should be clear on what is expected of them throughout the course. Supervisors are responsible for the safety of the students in the lab, and to ensure that all necessary equipment have been made available and appropriate safety courses have been taken by the student before commencement of laboratory or field work.

The Student

It is the responsibility of the student to keep the Supervisory Committee up-to-date regarding progress on the project throughout the year. In particular, the student must organize a Supervisory Committee before the end of January for the January to August thesis and before the end of May for the May to December thesis to seek approval on the nature and scope of the project. During this meeting, the student should also request guidelines and a marking scheme for the research proposal. Any issues of a scientific nature should be directed to the Supervisory Committee at any time. However, if conflicts arise that cannot be solved between the student and Supervisory Committee; it is the responsibility and right of the student to ask the Course Coordinator to intervene. The student should consult with the supervisor on all aspects of the course including the guidelines and requirements for the research proposal, mid-year report, and written thesis.

The Course Coordinator

There will be meetings throughout the term as needed, during which all students in the course can meet with the Course Coordinator to discuss various issues relating to deadlines, course requirements, etc. and to obtain guidance on time-management and how to communicate effectively with your Supervisory Committee. The Course Coordinator can also provide individual counseling if problems cannot be solved between student and supervisor.
Acknowledgement of Previous Work Related to the Project
Any work completed prior to the student’s registration in Mol Biol 4GG9 should not be included as part of the student’s evaluation or final report without clearly identifying and acknowledging it. Students who may have previously worked in the same laboratory in which they are completing a senior thesis research project are asked to provide a one-page summary of any work that is related to the project being undertaken in the course. This summary should be submitted with the research proposal.

Evaluation Rubric
Students in the course are evaluated on the basis of five components:

- Research proposal (10%)
- Mid-year progress report (15%)
- Laboratory performance (35%)
- Written thesis (20%)
- Defense (20%)

Both the proposal and mid-year progress report are marked by the supervisor alone, and will provide solid feedback to the students early in the project. The mid-year progress report can also be orally presented during a lab meeting, but should not substitute for the written report. The Supervisory Committee members and Course Coordinator must attend the final defense to ask questions and grade the student on this component. Following suitable revisions, the student must submit to the Course Administrator, either a PDF or CD version of the thesis, which may be posted on the web for archival purposes (upon Supervisor approval). See tables below with deadlines for completion and submission of all components. No extensions will be granted unless there is a compassionate or medical reason. Permission for an extension must be sought in writing by the supervisor to the Course Coordinator.

Safety Training and Liability Issues
Appropriate safety training (i.e. WHMIS, Radiosafety, Biosafety, Fire Safety) must be completed prior to beginning laboratory work. It is the responsibility of the supervisor to ensure that students have received the required safety training. The information regarding safety training can be found on the Biology web site (link?). The student is responsible for bringing written confirmation of training dates and location of training to Biology Reception Desk, LS-215 during the first full week of the Summer school term. The confirmation must be signed by the student and by the supervisor.

Application Deadlines
January-August theses: Second Friday of December
May-December theses: First Friday of March

Academic Dishonesty
Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university. For information on the various kinds of academic dishonesty, please refer to the Academic Integrity Policy located at: http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicIntegrity.pdf

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one’s own, any text or ideas from books, the internet or journals, or work for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations
# IMPORTANT DATES FOR MOL BIOL 4GG9 THESIS STUDENTS

## JANUARY- AUGUST THESIS TERM

<table>
<thead>
<tr>
<th>Deadline / % of Final Grade</th>
<th>TASK</th>
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| **Before the end of January** | **INITIAL MEETING**  
The student will schedule a meeting with the supervisory committee to establish the nature and scope of the research project, expectations of conduct in the laboratory, time commitment (when and how long), and guidelines for all written components. |
| **First week of January** | **WHMIS DOCUMENTATION**  
To Biology Reception Desk, LSB 215 |
| To supervisor and co-supervisor(s)  
Last Friday of February by 16:00 | **RESEARCH PROPOSAL**  
The supervisor will grade the research proposal. The marking sheet will be signed by the student and returned to the Course Administrator within two weeks. Problems with the project and suggested solutions should be communicated to the student by the supervisor at this time. If appropriate, the student should also consult with the co-supervisor regarding the proposal. |
| 10% |  |
| To supervisor and co-supervisor(s)  
Second Friday of April by 16:00 | **MID-YEAR REPORT**  
The supervisor will grade the mid-year report. The marking sheet will be signed by the student and returned to the Course Administrator within two weeks. If appropriate, the student should also consult with the co-supervisor. Problems identified at this time by either the student or the supervisor and that cannot be solved by the Supervisory Committee, should be communicated to the Course Coordinator. |
| 15% |  |
| Mid-late June | **COMPLETION OF LABORATORY EXPERIMENTATION**  
Students should not be expected to perform further laboratory experimentation after this date but should concentrate on the preparation of the final thesis/project submission. |
| 35% |  |
| To supervisor and co-supervisor(s)  
Second Friday of July by 16:00 | **FIRST DRAFT SUBMISSION**  
A first draft of the thesis/project should be given to EACH member of the Supervisory Committee and the Course Coordinator to allow time for correction. Samples of theses are available in LS-215. |
| 20% |  |
| Last business day of July | The Supervisory Committee will provide comments to the student on the first draft by this date. |
| Mid-January | **DEFENSE**  
Thesis defenses will be scheduled in mid January (beginning of the last academic term of the program) in a 1-day Symposium for all MolBio 4GG9 thesis students (date TBD). |
| 20% |  |
| To supervisor, co-supervisor(s)  
and course administrator  
First Friday of September by 16:00 | **FINAL THESIS SUBMISSION**  
Copies of the final written thesis will be submitted to the Supervisory Committee in the format the committee desires. A PDF must be submitted to the course administrator. |
**MAY- DECEMBER THESIS TERM**

<table>
<thead>
<tr>
<th>Deadline / % of Final Grade</th>
<th>TASK</th>
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<tbody>
<tr>
<td>Before the end of May</td>
<td><strong>INITIAL MEETING</strong></td>
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<td>The student will schedule a meeting with the supervisory committee to establish the nature and scope of the research project, expectations of conduct in the laboratory, time commitment (when and how long), and guidelines for all written components.</td>
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<tr>
<td>First week of May</td>
<td><strong>WHMIS DOCUMENTATION</strong></td>
</tr>
<tr>
<td></td>
<td>To Biology Reception Desk, LSB 215</td>
</tr>
<tr>
<td>To supervisor and co-supervisor(s)</td>
<td><strong>RESEARCH PROPOSAL</strong></td>
</tr>
<tr>
<td>Last Friday of June by 16:00</td>
<td>The supervisor will grade the research proposal. The marking sheet will be signed by the student and returned to the Course Administrator within two weeks. Problems with the project and suggested solutions should be communicated to the student by the supervisor at this time. If appropriate, the student should also consult with the co-supervisor regarding the proposal.</td>
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<tr>
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<td><strong>MID-YEAR REPORT</strong></td>
</tr>
<tr>
<td>To supervisor and co-supervisor(s)</td>
<td>Second Friday of August by 16:00</td>
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<td>The supervisor will grade the mid-year report. The marking sheet will be signed by the student and returned to the Course Administrator within two weeks. If appropriate, the student should also consult with the co-supervisor. Problems identified at this time by either the student or the supervisor and that cannot be solved by the Supervisory Committee, should be communicated to the Course Coordinator.</td>
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<td>Mid-late October</td>
<td><strong>COMPLETION OF LABORATORY EXPERIMENTATION</strong></td>
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<td>Students should not be expected to perform further laboratory experimentation after this date but should concentrate on the preparation of the final thesis/project submission.</td>
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<tr>
<td>To supervisor and co-supervisor(s)</td>
<td><strong>FIRST DRAFT SUBMISSION</strong></td>
</tr>
<tr>
<td>Second Friday, of November by 16:00</td>
<td>A first draft of the thesis/project should be given to EACH member of the Supervisory Committee and the Course Coordinator to allow time for correction. Samples of theses are available in LS-215.</td>
</tr>
<tr>
<td>Last business day of November</td>
<td>The Supervisory Committee will provide comments to the student on the first draft by this date.</td>
</tr>
<tr>
<td>Mid January</td>
<td><strong>DEFENSE</strong></td>
</tr>
<tr>
<td>20%</td>
<td>Thesis defenses will be scheduled in mid January (beginning of the last academic term of the program) in a 1-day Symposium for all MolBiol 4GG9 thesis students (date TBD).</td>
</tr>
<tr>
<td>To supervisor, co-supervisor(s) and course administrator</td>
<td><strong>FINAL THESIS SUBMISSION</strong></td>
</tr>
<tr>
<td>Second Monday of December by 16:00</td>
<td>Copies of the final written thesis will be submitted to the Supervisory Committee in the format the committee desires. A PDF of the corrected thesis must be submitted to the course administrator.</td>
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MOLECULAR BIOLOGY 4GG9 SENIOR THESIS
PERMISSION FORM

STEP 1. Student to complete the following:

Student Name ____________________________________________ Student No. ___________________
SURNAME                     GIVEN NAME
MACID ________________________________ Preferred E-mail ___________________________________
Current Program: ________________________________________________________________

STEP 2. Obtain the permission of a Supervisor.

Supervisor ______________________________________ Signature____________________________
please print
Department______________________________________________________________________________
E-mail Address __________________________ Telephone Ext. ________________________________
Office Address __________________________ Mailing Address______________________________
Student will be working in Room __________________________ Ext.__________________________

Project Title

STEP 3. Obtain the permission of a co-supervisor.

Supervisor ______________________________________ Signature____________________________
please print
Department______________________________________________________________________________
E-mail Address __________________________ Ext.__________________________
Office Address __________________________ Mailing Address______________________________

STEP 4. Student and supervisor to review course evaluation rubric and deadlines, and agree
upon format of various written submissions (see below).

Final marks must be submitted to Ms. Woodworth before the end of exam period of the academic
term in which the research project occurred (LSB-215A, biology@mcmaster.ca). Please consult
McMaster calendar for precise dates (http://registrar.mcmaster.ca/category/dates/sessional/).

- Research proposal 10%
- Mid-year progress report 15%
- Laboratory performance 35%
- Written thesis 20%
- Oral Defense 20% (date TBA)
STEP 5. Attach a ONE-PAGE summary of the research proposal

Students who may have previously worked in the same laboratory in which they are the 4GG9 senior thesis are asked to provide an additional one-page summary of any work that is related to the project being undertaken in the course. Any work completed prior to the student’s registration in Mol Biol 4GG9 cannot be included as part of the student’s final report without clearly identifying and acknowledging it.

STEP 6. The Communication Agreement must be reviewed and signed by the student and both supervisors.

Mol Biol 4GG9 Communication Agreement

1. Should the Supervisor be unavailable for more than 2 weeks, adequate supervision by a colleague, postdoctoral fellow or senior graduate student must be arranged and communicated in advance to both the Student and Course Coordinator.
2. The Supervisor will ensure that the Student has completed the required Health and Safety Training prior to beginning work in the laboratory.
3. The Student is responsible for ensuring the entire Supervisory Committee [Supervisor, Co-Supervisor(s) or other Supervisory individuals if any] are kept up-to-date on progress and change in research topic or experimental procedure throughout the course.
4. Supervisors are expected to communicate grades for each component in a timely manner. The Student should consult with the Course Coordinator if a mark for the first two course components has not been received within one week of the due date (see List of Important Dates).
5. Any modifications of the mark breakdown for the course must be discussed and approved by the Supervisor, Student and the Course Coordinator.
6. Any change in submission deadline for the final thesis or project report must be justified at least 5 days in advance, and in writing to the Course Coordinator. The Course Coordinator reserves the right to penalize late submissions by up to 5% per day.

I acknowledge that I have read, understood and accept the above course requirements:

_________________________________________  Date
Signature of Student

_________________________________________  Date
Signature of Supervisor

_________________________________________  Date
Signature of Co-Supervisor

STEP 7. Return this form and the ONE-PAGE summary of the research proposal to Rebecca Woodworth (LS-215A) for final approval by the Course Coordinator. The Course Coordinator will consider the application only after submission of ONE-PAGE summary and all forms duly filled and signed.

The information gathered on this form is collected under the authority of The McMaster University Act, 1976. The information is used for the academic, administrative, and statistical purposes of the Department of Biology including, but not limited to, maintaining records; academic counseling and the administration of examinations. Personal student information provided on this form will not be used for any unrelated purpose without the consent of the student. This information is protected and is being collected pursuant to section 39(2) and section 42 of the Freedom of Information and Protection of Privacy Act of Ontario (RSO 1990). Questions regarding the collection or use of this personal information should be directed to the Manager of Instructional Programs, Department of Biology, McMaster University.
FOR DEPARTMENT USE:
COURSE COORDINATOR APPROVAL: ______________________

Retain a copy for your records and make sure that both supervisors have a complete copy of the signed forms.
MOLECULAR BIOLOGY 4GG9 SENIOR THESIS
GUIDELINE ON COURSE EVALUATION AND WRITTEN SUBMISSIONS

Preamble

Writing well, concisely and in an engaging manner is one of the most transferable skills acquired when carrying out an undergraduate senior thesis. The writing of such a large and complex document can be a daunting task. A finished text is the product of multiple revisions over a long period of time, requiring repeated input from a more experienced writer, the instructor, and mastery of the subject matter by the student. For this reason three of the five components of the 4GG9 course evaluation rely on written submissions amounting to 45% of the total mark in this course which are extensively revised by both supervisor and student. The three written submissions overlap in content and represent essentially the same document in increasing levels of complexity, completeness and precision. At the end, a polished document reflecting the scientific and intellectual accomplishments of the student emerges to be submitted and examined orally in a thesis defense resembling that of a post graduate degree. Here we describe in detail the various components of the course evaluation with particular emphasis on the written components. Please don’t hesitate to contact the course coordinator (Dr. A. Campos ext 23095 camposa@mcmaster.ca) in case there are any additional questions.

- a) Research proposal 10%
- b) Mid-year progress report 15%
- c) Laboratory performance 35%
- d) Written thesis 20%
- e) Oral Defense 20% (date TBA)

a) Research Proposal (10%)

The research proposal must be submitted directly to the supervisor. This submission should include the background (Introduction or review of the literature) for the project, the hypothesis, question or model that will be addressed and/or tested and the methodology (Materials and Methods) employed. It is not only a plan but also a justification for why this work should be undertaken, its significance and expected impact. The research proposal document represents the initial outline of the final report and is the first step towards the completion of the senior thesis. It is suggested you follow the format of a standard journal in Biology (discuss with your Supervisor which journal) and include the following sections:

1. Title Page:
   - Title of project
   - Student name and number
   - Supervisor name
   - Course name
   - Date submitted

2. Table of Contents (with page numbers)

3. List of Abbreviations:
   Only describe abbreviations that are not commonly used; for instance, do not describe acronyms such as “DNA”, “RNA”, etc… or units of time and mass
4. Abstract:
   Provide a one-page concise summary of the background, question(s) asked, (expected, and possible) results and significance of the project.

5. Introduction:
   Review the state of knowledge in the area of study as published in the current scientific literature, provide a rationale for the project, state the question(s) and hypothesis addressed in the project and brief outline of approach (as) used in your studies.

6. Materials and Methods:
   This section should contain sufficient details of the experimental protocols for someone else to repeat the experiment. If the procedure has already been published in a journal article in detail, a reference will suffice. However, if a published procedure was modified, the alterations to the original protocol should be clearly outlined. Describe in detail any new techniques developed during the project.

7. Experimental Outline:
   Here you should describe the experimental plan. You must include a brief description and justification for the chosen methodology, sample size and any analysis undertaken with the data collected. Possible outcomes and alternative approaches should also be included.

8. References:
   All statements of facts that appear anywhere in your research proposal must be substantiated with a citation of a peer reviewed publication. Include the most relevant and current papers on the subject. In the case that the observation or conclusion described has not yet been published but has been directly communicated to you by members of your laboratory or colleagues in another Institution a statement to this effect must be included (e.g. S. Harper and J. Chretien data not published or E. Snowden and J. Assange, personal communication). Accuracy is important. The use of a referencing program (ex. Endnote) is strongly recommended. Any standard style of referencing used in scientific journals is acceptable. We request that the format chosen include the complete title of the article.

Important note prior to begin working in the laboratory

Safety in any laboratory setting is first and foremost. Before performing any protocol, students should be familiar with the materials, reagents and possible hazards involved in the experiment. Students are reminded to consult the Material Safety Data Sheets (MSDS) for each reagent that they use. Don’t hesitate to ask questions in case you are not comfortable with any aspect of the experimental procedures.

b) Mid-Year Progress Report (15%)

The mid-year progress report should contain all the data obtained so far (even if incomplete or preliminary) in a format that is as close as possible to the final format required for the submission of the thesis. Therefore the mid year progress report helps the student prepare for the final submission of the thesis by getting a substantial fraction of the writing done well ahead of the final deadline. The objective of this submission is to give the student the opportunity to organize, analyze and reflect upon the progress to date and to receive input for the supervisory committee. This is the time for a
critical evaluation of the progress by both student and supervisor. Changes or adjustments to the original plan may occur at this point after careful evaluation. For this a complete and well-organized document must be submitted.

It should follow the general format of the research proposal (see above). If major changes to the original plan did not occur then this submission may in great part be very similar to the research proposal. Three additional sections must be included; the “Results” immediately following the “Materials and Methods” section, “Future Experiments” and the “Discussion” at the end of the document. The “Results” and the “Future Experiments” sections substitute the experimental outline section in the previous written submission, in which the planned experiments were described.

1. Title Page
2. Table of Contents (with page numbers)
3. List of Abbreviations
4. Abstract
5. Introduction
6. Materials and Methods

7. Results:
   All the results obtained even if preliminary should be shown and described and grouped into sections carrying descriptive subtitles. At the beginning of each result section a brief statement describing the objective or model being tested by the experiments and an experimental outline. Summarize the data obtained from your experiments in figures and/or tables, as appropriate and including a proper heading (for tables) and figure legend. Figures and tables should be clearly labeled and easy to interpret. Figure legends should be included. Proper statistical analysis is required in most cases or at least some statement about reproducibility. Include both positive and negative results, making mention of failed experiments. Morphological, qualitative or visual data such as micrographs should be treated according to guidelines and assembled as multi panel figures as required. The conclusions and interpretation of the results should be stated at the end of each result section.

8. Future experiments
   A timeline and description of the experiments to be completed should be included here. It may or may not be a repeat of the “Experimental Outline” section of the research proposal document. It depends on whether there were changes in direction or a re-evaluation of your priority list. It is a very important section that establishes a priority list of missing experiments.

9. Discussion
   This is in general a difficult section to write. Here you will revisit the hypothesis and/or model as stated in the Introduction in light of the results obtained in your experiments. Thus it is important to carefully read the introduction again as well as the pertinent literature. Speculation is expected but always logically and rooted in facts and never beyond what is supported by the results presented. You will juxtapose your new data against the previous knowledge from your laboratory and the field at large. You will determine whether or not and to what extent your work extends, confirms or contrasts with previously published data. Provide the interpretations of your results in this section. Do not simply restate the conclusions but analyze the meaning of these results in the context of the question addressed in your project and stated at the end of your Introduction. If appropriate, use models or diagrams to illustrate your point. Discuss the
potential caveats and pitfalls of the experiments, why an experiment may have failed and provide alternative approaches if possible. Here is a link (http://www.sfedit.net/discussion.pdf) to a useful document on how to tackle this kind of scientific writing.

10. References

c) Laboratory Performance (35%)

This component of the course evaluation will take into consideration the daily work of the student in the laboratory. The supervisor will evaluate the work habits (15%), ability at research (10%) and initiative of the students in the laboratory (10%). Learning in a research environment requires students to interact and communicate adequately with their laboratory colleagues. Problem solving is an acquired and highly transferable skill that is essential for all students who want to become independent investigators. Moreover good work habits (approximately 12 hours per week), ability in research and a good degree of initiative are all required to be a successful scientist. Students are encouraged to explore alternative interpretations of data and to suggest line of investigation to be undertaken.

d) The final report (30%) should be submitted to the supervisor, co-supervisor and course coordinator by the last official day of classes.

The final report should follow the format of a standard journal in Biology and include all the sections as described above for the Mid-year progress report extended to include the remaining of the data collected. Changes in the Introduction, Material and Methods and Discussion should be carried out as needed by the inclusion of new and complete data. The reference list should also be updated accordingly. The student may choose or not to include a section of suggested future experiments separate from the Discussion or within the body of this section.

Format Guidelines:

- 20-30 pages in length
- Double-spaced throughout (but excluding the reference list)
- 12 point font
- 2.5 cm side margins
- 3 cm top and bottom margins
- All pages numbered consecutively, including title page, references, tables and figures
- The report may be bound in any manner the student desires

e) Oral Defense (20%)

The thesis defense represents the capstone activity of an undergraduate honour’s thesis. MBG co-op students participate in an oral examination that resembles that of Master’s defense. To that end the course coordinator will organize a mini symposium where all students will have the opportunity to listen to their colleagues and be present for the oral examination by the supervisory committee. The thesis defense shall not take more than 1 hour total. It will begin with a no more than 15 min
presentation by the student highlighting the main findings and conclusions, followed by a first round of questions by each of the members of the supervisory committee (10 min each). Time permitting a second round of final questions (3 min each) will take place. The students and the audience leave the room such that examining committee can deliberate about the grade and decide upon the feedback provided to the student.
A few words about the Laboratory Notebook

Maintaining a good laboratory notebook or any other kind of record of activities is essential in government, industrial and academic laboratories for many reasons. In government health laboratories, detailed records of procedures must be kept for later scrutiny. In the biomedical industry (e.g. pharmaceutical manufacturing), properly recorded laboratory notebooks must be supplied for patent applications. In academic laboratories and other research environments, the laboratory notebook also provides the “memory” or archives of the research project, containing detailed information on past procedures, results/data and pitfalls/problems encountered in the research project. Since research projects often span a period of several years, the amount of accumulated documentation can be considerable. It is therefore important to learn to keep good, complete and accurate notes in the laboratory notebook.

We recommend that you purchase the “Student Laboratory Notebook” in the bookstore. Alternatively in consultation with your Supervisor and in accordance to the procedures dictated by his/her laboratory or Institution you can adopt a different kind of record keeping tool. The laboratory notebook should be thought of as a diary of activities that are described in sufficient detail to allow another scientist to follow your steps. In the vast majority of institutions it is common practice to request that the notebook remain in the laboratory with your immediate supervisor. You must discuss this issue with your immediate supervisor.

The most important aspect of your laboratory notebook will be its accuracy, completeness and organization. You should write legibly all information and procedures required to understand and to repeat the experiments by an investigator who is not familiar with the project. Draw tables with rules (you may also create tables and graphs on the computer, print and paste them in) and clearly label the different subsections and figures of your writing so that others (and you) can easily comprehend what you did. We do not recommend to first writing the information on a loose piece of paper and then transcribing the information in your laboratory notebook. This practice creates errors or omissions that are not compatible with proper research practices. We understand that errors may occur when notes are taken at the bench and do expect that laboratory notebooks may not always be “neat”. It must however be complete and accurate.

Copying the content of a manual or other published source is strictly forbidden and, when discovered, will be penalized (see statement on Academic Integrity).

For each experiment or study, the following format is recommended:

1. Date at the beginning of each section/experiment.

2. Title: e.g. Microscopy and Examination of Living and Stained Cultures

3. Objective: Briefly state what you are attempting to do/determine (measure, weight, stain, identify, infect…)

4. Materials and Methods: If the same as an established procedure (routinely used in the lab), used in previous studies described in your laboratory notebook or drawn integrally from a published source (ex. Textbook), provide the relevant reference. If different, state the modifications. For your own understanding, use flow charts to illustrate procedures.
5. Results: If possible, use table(s) and/or figure(s) to present raw data. Provide brief descriptions of what the data mean.

6. Discussion: Briefly and critically evaluate your results. Identify possible sources of errors. Summarize your conclusions. If your results deviate from expectations, identify possible sources of error, provide alternative hypotheses, and suggest improvements for future experiments. A hand written point form evaluation is appropriate here. There is no requirement for an extensive typed text to be included.

7. Sign each single page. This is an essential practice in government and industry labs.

50-59: Did not meet standards expected of third year student (D)
60-69: Met minimum standards expected of third year student (C)
70-76: Met average standards expected of third year student (B to B-)
77-79: Met above average standards expected of third year student (B+)
80-84: Readily exceeded expectations of third year student; shows promise in placement work (A-)
85-89: Greatly exceeds expectations of a third year student; demonstrated placement work competence (A)
90+: Greatly exceeded expectations of third year student; accomplished placement worker (A+)