MOLECULAR MICROBIOLOGY & IMMUNOLOGY, MHS

Introduction

The goal of the MHS training program in MMI is to provide a solid foundation in the biomedical sciences for a select group of students interested in addressing outstanding issues underlying infectious and immunologic diseases of public health importance. It aims to equip students with a diversity of disciplinary concepts and methodological tools to solve specific disease-related problems. This holistic approach requires a common core of knowledge of the population, clinical, cellular and molecular aspects of disease.

This MMI MHS Guidebook, which supplements the School's resources page, which can be found at https://publichealth.jhu.edu/offices-and-services/office-of-student-affairs (https://publichealth.jhu.edu/offices-and-services/office-of-student-affairs/) is intended to summarize most of the School and Departmental requirements for your degree program. In addition, other practical information is included for your convenience and consideration.

The MHS in MMI

The Department provides the Master of Health Science (MHS) program for students who wish to gain a greater depth of knowledge in molecular microbiology, immunology, and infectious diseases or in tropical public health, but who do not wish to commit to longer-term research training programs. MHS training is provided through coursework, special studies with faculty members, and participation in other Departmental activities. An elective opportunity to gain experience with basic molecular biological laboratory techniques is also available.

MHS to ScM Program Transfer

MHS students who excel in the program and wish to add a research component to their training may apply for transfer to the MMI ScM program. The integrated MMI Master's program is intended to facilitate transfer between ScM and MHS degree programs; the program requirements have a high degree of overlap for the first two academic terms. However, the programs diverge significantly in the third term and a decision on degree program, therefore, must be made before that time. At the time of application for transfer from the MHS to the ScM program, students are strongly encouraged to have identified into which laborator(ies) they wish to rotate and to have confirmed that those laborator(ies) would be amenable to taking on an ScM student.

Masters students who wish to transfer programs should inform the Student Coordinator in writing by December 1st. Applications for transfer to the ScM program are evaluated by the departmental Admissions Committee on the same basis as incoming ScM applications and a completed School application form must be available for review. In general, the Departmental copy of the student's original MHS application (held by the Student Coordinator) can be used. However, the student should confirm that the information contained on the application is still current, and may wish to modify the thesis to reflect the new goals of his/her proposed training program. Additional references may also be added. Note that because this application is submitted directly to MMI and not the School, no application fee is required.

Applicants for the MHS to ScM transfer will be informed of the Admission Committee's decision before the beginning of third term. Because there is no guarantee that an application will be successful, students should continue to follow the MHS academic program including thesis preparation (below) until they have received a final decision.

Program Requirements

There are several requirements for the completion of degree programs – some set by the school and others set by the department. The degree requirements for all programs, established by the School are contained in Policy and Procedure Memoranda available at https://my.jhsph.edu/Resources/PoliciesProcedures/ppm/Pages/default.aspx

The Departmental requirements are explained in this Student Handbook. Of particular note is the requirement to register each term for one credit of Special Studies specifically designed to assist MHS students in navigating the program requirements and timeline for completion of thesis steps.

Residency: Minimum duration is one academic year (9 months) in full-time residence (enrollment for 12 or more credits per term). Most students complete their degrees in 9 months, however, the period may be extended for up to 24 months.

Course location and modality is found on the BSPH website (https://publichealth.jhu.edu/academics/course-directory/coursesection-numbers-explained/).

Academic Program

Academic adviser

New students will be assigned to small advising groups – each group composed of 8-10 students. Each small group will be directed by a faculty member from MMI who will serve as the academic adviser for all students in the group. The academic adviser will assist the student in the selection of appropriate courses for the year and help the student with problems they may encounter.

In addition, full MHS cohort meetings will take place weekly via the Special Studies course through the academic year. Attendance at these meetings is required. These meetings will be used to disseminate information, build skills required for thesis preparation, detail requirements for the degree, establish benchmarks for Thesis preparation, review progress, promote career development, and address general questions.

MHS Thesis Mentors

Students will be presented with a list of potential thesis topics and thesis mentors early in the 1st term. MHS students will be responsible for identifying thesis topics of interest and reaching out to faculty to identify a thesis mentor who will serve as both supervisor of thesis preparation and primary reader of the thesis. Students may consult with their academic adviser to discuss potential thesis topics and identify potential thesis mentors. Thesis topics and mentors are formalized on a form turned in to the Student Coordinator during the 2nd term. Secondary readers for the thesis will be assigned by the MHS Committee in the 3rd term.

Coursework

Masters students must register for a minimum of 16 credits each term. (The maximum a student can register for is 22 credits per term.) These credits include didactic courses, special studies, seminars, etc. A minimum of 64 credits are required by the School for a Master's degree. Course requirements and suggestions are summarized in the accompanying table.

In core courses, Master's students must receive a 'C' or higher. A student who earns a grade below that threshold in a course listed as a core requirement must, at the next opportunity, make a second attempt to complete the core course by repeating the same course or by completing another course that has been approved by the Graduate Program Committee (GPC) Chair. A grade below the threshold on the second attempt may be grounds for dismissal and must be reported to the School's Committee on Academic Standards. To remain in good academic standing, Master's students must maintain a minimum grade point average of 2.75. If a student's GPA falls below the requirement, the student will be placed on academic probation. School policy states that a Master's student cannot graduate with a GPA lower than 2.75.

COURSE DISTRIBUTION REQUIREMENT

The School requires MHS students to complete at least 5 credits of formal coursework outside of their home department. All 5 credits must be taken for a letter grade (Audit or Pass/Fail is not acceptable). Many university-wide courses can be used to fulfill specific requirements. Consult the catalogs of the various university divisions available for viewing on line.

1. Bloomberg School of Public Health catalog -- see interdepartmental program.
2. School of Medicine catalog.
3. School of Arts and Sciences (Homewood Campus) catalog.

MHS CURRICULUM

Outlined below is an example of a curriculum based on the choices of past MHS students. The specifics of your personalized curriculum is likely to vary from the list below depending on your interests and needs. Students should consult with your Academic Adviser and/or The Director of Graduate Studies as they build their curriculum.

The 1 credit courses "Departmental Research Forum" and "Seminar" Series are requirements that students need to register for each term.

In addition to required courses, for each term there is a list of selected elective courses that previous MHS students have rated favorably. Students will note that several of these suggested courses are outside MMI and can be used to fulfill the **Course Distribution Requirement**.

Course	Title	Credits
First Term		
Summer		
Introduction to Online Learning: https://courseplus.jhu.edu/core/index.cfm/go/course.home/cid/90 (https://courseplus.jhu.edu/core/index.cfm/go/course.home/cid/90/)/ (non-credit)		0
Required		
PH.260.623	Fundamental Virology [1]	4
PH.260.653	Molecular Biology Literature [2]	2
PH.260.704	Critical Dissection of the Scientific Literature: Taking the Scalpel to Journal Articles	3
PH.260.840	SS/R: Mol Microbiology & Imm [3]	Varies
PH.552.6XX	Cells-to-Society (p. 4)	Varies
PH.260.822	Seminars in Research in Molecular Microbiology and Immunology	1
PH.260.821	Research Forum in Molecular Microbiology and Immunology	1
PH.550.860	Academic & Research Ethics at BSPH (non-credit) [4]	
Suggested Electives		
PH.260.636	Evolution of Infectious Disease	
PH.260.700	How Do We Know? - Theory and Practice of Science (R3)	
PH.260.707	Evidence-Based Teaching in the Biomedical and Health Sciences: Foundations (R3)	
PH.140.611	Statistical Reasoning in Public Health I	
PH.180.609	Principles of Environmental Health	
PH.550.630	Public Health Biology	
PH.220.601	Foundations of International Health	
PH.120.600	[5]	
PH.120.602	Concepts of Molecular Biology [5]	
PH.318.603	Applied Microeconomics for Policymaking	
PH.120.607	Premedical Seminars: Planning and Preparing for Medical School Application	
	Credits	**11**
Second Term		
Required		
PH.260.631	Immunology, Infection and Disease	3
PH.260.635	Biology of Parasitism [1]	5
PH.260.840	SS/R: Mol Microbiology & Imm [3]	Varies
PH.260.654	Current Literature in Microbial Immunity [2]	1
PH.552.6XX	Cells-to-Society (p. 4)	Varies
PH.260.822	Seminars in Research in Molecular Microbiology and Immunology	1
PH.260.821	Research Forum in Molecular Microbiology and Immunology	1
Suggested Electives		
PH.260.701	Anatomy of Scientific Error	
PH.260.710	Communication Practice for Health Science Professionals (R3)	
PH.340.627	Epidemiology of Infectious Diseases	
PH.223.662	Vaccine Development and Application	
PH.183.631	Fundamentals of Human Physiology	
PH.120.607	Premedical Seminars: Planning and Preparing for Medical School Application	
PH.260.844	Causation	
	Credits	**11**
Third Term		
Required		
PH.260.627	Pathogenesis of Bacterial Infections [1]	4
PH.260.650	Vector Biology and Vector-Borne Diseases [1]	3
PH.260.655	Pandemics of the 20Th Century	1
PH.260.840	SS/R: Mol Microbiology & Imm [3]	Varies
PH.552.6XX	Cells-to-Society (p. 4)	Varies
PH.260.822	Seminars in Research in Molecular Microbiology and Immunology	1
PH.260.821	Research Forum in Molecular Microbiology and Immunology	1
Suggested Electives		
PH.260.700	How Do We Know? - Theory and Practice of Science (R3)	

PH.260.705	Fundamentals of Quantitative Reasoning in the Biomedical and Health Sciences	
PH.260.709	Evidence-Based Mentoring	
PH.260.613	Techniques in Molecular Biology (Winter Intercession - see below)	
PH.180.640	Molecular Epidemiology and Biomarkers in Public Health	
PH.260.656	Malariology	
PH.340.612	Epidemiologic Basis for Tuberculosis Control	
PH.340.654	Epidemiology and Natural History of Human Viral Infections	
PH.140.615	Statistics for Laboratory Scientists I	
BU.150.710	Discovery to Market I	
PH.120.607	Premedical Seminars: Planning and Preparing for Medical School Application	
	Credits	**10**
Fourth Term		
Required		
PH.260.657	Vector Biology and Disease Ecology Literature [2]	1
PH.260.840	SS/R: Mol Microbiology & Imm [3]	Varies
PH.552.6XX	Cells-to-Society (p. 4)	Varies
PH.260.822	Seminars in Research in Molecular Microbiology and Immunology	1
PH.260.821	Research Forum in Molecular Microbiology and Immunology	1
Suggested Electives		
PH.260.601	Vector-Borne Disease Control	
PH.260.701	Anatomy of Scientific Error (R3)	
PH.260.710	Communication Practice for Health Science Professionals (R3)	
PH.340.651	Emerging Infections	
PH.340.653	Epidemiologic Inference in Outbreak Investigations	
PH.140.616	Statistics for Laboratory Scientists II	
BU.150.715	Discovery to Market II	
PH.223.689	Biologic Basis of Vaccine Development	
PH.120.607	Premedical Seminars: Planning and Preparing for Medical School Application	
PH.260.844	Causation	
	Credits	**3**
First Year		
Third Term		
PH.260.705	Fundamentals of Quantitative Reasoning in the Biomedical and Health Sciences	
	Credits	**0**
	Total Credits	**35**

[1] MHS students are required to take only two of the following MMI core courses:
- PH.260.623 Fundamental Virology
- PH.260.627 Pathogenesis of Bacterial Infections
- PH.260.650 Vector Biology and Vector-Borne Diseases
- PH.260.635 Biology of Parasitism

[2] Only one literature course is required. Selection made in consultation with academic adviser. Options include:
- PH.260.653 Molecular Biology Literature
- PH.260.654 Current Literature in Microbial Immunity
- PH.260.655 Pandemics of the 20Th Century
- PH.260.657 Vector Biology and Disease Ecology Literature

[3] Special studies credit hours are to be used for thesis preparation. During each term, this will entail attending noon meetings on thesis preparation and meeting with your academic adviser to discuss how to approach thesis preparation, writing and presentation.

[4] As a School-wide requirement, all students must take Academic and Research Ethics in the first term of their enrollment (PH.550.860 Academic & Research Ethics at BSPH).

[5] Students with little or no Molecular Biology or Biochemistry background are strongly encouraged to take one or both of these courses, offered by the Department of Biochemistry and Molecular Biology.

MHS & Biotechnology

A subset of MHS students are interested in a career in the biotechnology arena. To accommodate this interest MMI is offering MHS students an elective set of four courses focused on how innovative technologies are moved to a commercial sphere to receive wider distribution. The goal of this program is to teach students how to apply the science they will learn in traditional courses to a translational setting. Students who successfully complete this course of study will be able to indicate to potential employers that in addition to having a strong background in the science of immunology and infectious diseases, they also have a foundational understanding of how innovative science is translated into commercial products. No certificates will be issued for this program, but provided that all four of the below courses are completed, at the student's request, the Department Chair will provide a letter describing the skill sets developed through this path of study.

Descriptions of the four courses can be found in the course catalogues for the School of Public Health and the Carey Business School. The courses cover basic microeconomic theory, practical exposure to the molecular tools used by biotechnology companies and, in a set of two courses offered by the Johns Hopkins Carey Business School, direct experience with addressing the issues involved in moving technology from the laboratory to the marketplace. Please note that these four courses will be taken as elective courses to compliment the core MMI MHS requirements. The Applied Microeconomics is required as a pre-requisite for the Discovery to Market courses.

The courses include:

Code	Title	Credits
PH.260.613	Techniques in Molecular Biology	3
PH.318.603	Applied Microeconomics for Policymaking	3
BU.150.710	Discovery to Market I	2
BU.150.715	Discovery to Market II	2

MHS & Medical School

A subset of MHS students are interested in pursuing medical careers. Students who plan to apply to medical school should strongly consider enrolling in the premedical seminars course (120.607), which is a one-

credit course offered all four terms that helps students prepare to apply to medical school. The course covers specific topics to address the complex premedical journey, including planning the months/years leading up to the application, reviewing the application process, addressing the medical schools' expectations, medical school selection, writing the personal statement, requesting letters of evaluation, interviewing, and more. Each term focuses on different aspects of preparing for medical school and medical careers, so interested students should plan on registering for this pre-med seminar course every term.

Cells-to-Society Requirements for All Degree Programs

The Council on Education for Public Health (CEPH) requires didactic coursework covering and assessing 12 CEPH-defined Introductory Public Health Knowledge Learning Objectives. It is important to emphasize that this is a School-level requirement of all degree programs.

The School's Committee on Academic Standards approved 12 online, 0.5 credit, mini-courses, graded S/U (satisfactory/unsatisfactory) that will cover each of the 12 Learning Objectives (see table below). Each of the mini-courses consists of 3-5, 30-40 minute presentations with an accompanying assessment. **Note:** Certain learning objective can be fulfilled by taking a course that covers this material instead of the mini-course (noted in the table below).

Each of the C2S mini-courses will be offered multiple times starting in the summer term and extending through terms 1, 2 and 3. NOTE: In the 4th term, only C2S LO #12 will be offered.

The 2022-2023 schedule is here: https://publichealth.jhu.edu/academics/course-directory/schedule-of-cells-to-society-course-offerings (https://publichealth.jhu.edu/academics/course-directory/schedule-of-cells-to-society-course-offerings/)

Please note that for the presentation of these mini-courses each term has been split into a A section covering the first 4 weeks of the term and a B section that covers the second 4 weeks of the term.

These 12 mini-courses must be completed by the end of your MHS program.

Code	Title	Credits
PH.552.601	Foundational Principles of Public Health	0.5
PH.552.602	The Role of Quantitative Methods in Public Health (or take any of the following courses: 140.611-12 (term 1 and 2) or 140.615-16 (term 3 and 4) or 260.705 (term 3 or term 4))	0.5
PH.552.603	The Role of Qualitative Methods and Science in Describing and Assessing a Population's Health (or take 260.700 (term 1 or term 3))	0.5
PH.552.604	Causes and Trends in Morbidity and Mortality (or take 260.600 (summer, credit in term 1) or 260.844 (term 2 or term 4))	0.5
PH.552.605	The Science of Primary Secondary and Tertiary Prevention in Population Health	0.5
PH.552.606	The Critical Importance of Evidence in Advancing Public Health Knowledge (or take 260.700 (term 1 or term 3))	0.5
PH.552.607	Essentials of Environmental Health	0.5
PH.552.608	Biologic, Genetic and Infectious Bases of Human Disease (or take 260.600.81 in summer (credit in term 1))	0.5
PH.552.609	Psychological and Behavioral Factors That Affect A Population's Health	0.5
PH.552.610	The Social Determinants of Health (or take 260.844 (term 2 or term 4))	0.5
PH.552.611	Globalization and Population Health	0.5
PH.552.612	Essentials of One Health	0.5
Total Credits		**6**

Additional Course Requirements for MHS Students

The School requires MHS students to complete at least 5 credits in formal courses outside of their home department. All 5 credits must be taken for a letter grade (Audit or Pass/Fail is not acceptable).

Required for all MMI graduate students:

Code	Title	Credits
PH.260.822	Seminars in Research in Molecular Microbiology and Immunology (all terms 2nd year)	1
PH.260.821	Research Forum in Molecular Microbiology and Immunology (all terms 2nd year)	1
PH.552.6XX	Cells-to-Society	

Additional Course Information

Many university-wide courses can be used to fulfill specific requirements. Consult the catalogs of the various university divisions available for viewing online:

1. Bloomberg School of Public Health catalog -- see interdepartmental programs.
2. School of Medicine catalog.
3. School of Arts and Sciences (Homewood Campus) catalog.

Winter and Summer Institute Courses

Tuition for these courses is charged separately by the School of Public Health Registrar, and is not covered by tuition paid during the academic year. An exception to this rule is a course offered specifically for MHS students interested in gaining some experience with laboratory techniques in molecular biology, PH.260.613 Techniques in Molecular Biology. This course will be offered during the last week of the winter institute, but the final examination for the course will occur at the beginning of the third term, allowing the course to be registered as a third term course without additional tuition.

Departmental Seminars

A weekly Departmental Seminar is held at 12:00 pm on Thursdays during the academic year and **all students are required to attend.**

Research Forum is held at 12:00 pm on Mondays and **all students are required to attend.**

MHS Thesis

The student will select the topic for the thesis in consultation with his/her academic adviser or another faculty member. The thesis will typically involve a critical review of the scientific literature on a substantive public health issue. MHS students will meet weekly in Special Studies, which will outline the expectations for the thesis including focus, scope, structure, and criteria for evaluation.

Important Graduation Requirement

Your MHS Thesis needs to be submitted to the Student Coordinator, via email/PDF for binding, for our department library. (You do not need to

submit your MHS thesis to the JHU library.) Guidelines for formatting the thesis can be found here: https://www.library.jhu.edu/library-services/electronic-theses-dissertations/formatting-guidelines/

Readers and Deadlines for MHS Thesis Completion

Students are responsible for finding a primary thesis reader who will act as a mentor through the thesis-writing process. Students may consult their academic adviser for advice on choosing a primary reader appropriate for their thesis topic. The primary reader must have an appointment in MMI. A secondary reader will be assigned by the department. The primary and secondary readers cannot be from the same laboratory group.

The MHS student and primary reader are required to have regular meetings to review progress and to ensure that the benchmarks and deadlines listed in the following table are meet. The responsibilities of the primary reader includes guidance on the crafting of the hypothesis to be tested, guidance on the focus and scope of the thesis, as well as editorial and technical critiques to aid in this learning experience. When the primary reader is satisfied with the quality of the thesis draft, the student will submit the final draft of the MHS Thesis to the secondary reader whose responsibility is to evaluate the thesis manuscript for scientific validity, approach, and intelligibility.

An outline of the evaluation criteria that will be used by the faculty can be viewed in the MMI MHS Thesis Scoring Form found at the end of this handbook.

It is the student's responsibility to meet the benchmarks and deadlines listed below. Students who fail to meet the April & May deadlines will be removed from the May graduation list.

Important Dates for MHS Thesis 2022-2023

Date	Description
November 2, 2022	Select topic, identify primary reader, Submit 'MHS Thesis Proposal' form to the student coordinator
November 11, 2022	Provide a provisional outline to primary reader
December 2, 2022	Advanced outline with provisional bibliography
January 23, 2023	Submit first draft of MHS thesis to the primary reader
February 3, 2023	Select secondary thesis reader
February 24, 2023	Submit second draft of the MHS thesis to the primary reader
March 10, 2023	Submit revised draft of the MHS thesis to the secondary reader for comments
March 27, 2023	Third draft of MHS thesis to primary reader
April 7, 2023	Final version of MHS thesis to secondary reader for review and scoring
April 21, 2023	Deadline for primary and secondary readers to submit review results to the student coordinator.
April 28, 2023 (or earlier)	Submit approved MHS Thesis to the student coordinator (via PDF)
May 10 and 12, 2023	Oral presentation of MHS thesis research

For those individuals who require assistance, writing/editing assistance is offered at:

- JHMI: Editing Referral Service: http://www.hopkinsmedicine.org/fac_development/researchers/publishing.html#ERS
- JHU: Writing Center: http://krieger.jhu.edu/writingcenter/about/
- https://www.jhsph.edu/offices-and-services/student-affairs/resources/writing-resources.html

MHS Thesis Presentation

As part of the requirements of the MHS degree, each student must present their Thesis orally in the special MHS Forum held in the fourth term, schedule details pending. All MHS students are required to attend the MHS Forum for the entire time.

Vacation/Holiday Policy

Graduate student holiday and vacation schedules traditionally have been flexible to accommodate the varied demands of individual research projects. Guidelines which reflect the Department's expectations are outlined below. These guidelines are not intended to eliminate flexibility in the scheduling of holidays and vacation, and do not replace any conditions that might be imposed by fellowships/funding agencies. These guidelines also do not restrict legitimate academic or research activities conducted off campus, such as attendance at scientific meetings and field work. Students are generally entitled to the following holidays and vacation time:

- University holidays
- Spring break
- The period between last day of 2nd term and the first day of winter intersession

Leave of Absence (https://e-catalogue.jhu.edu/public-health/policies/academic/academic-leave-absence/)

Application for LOA must be made on a form available from the Student Coordinator. Please discuss any potential LOA with your mentor and the Student Coordinator.

Graduate Student Organization

All MMI graduate students are members of the MMI Graduate Student Organization (GSO). The GSO generally meets at the annual departmental retreat to elect officers, and can meet at other times as often as the students desire. Apart from the annual retreat meeting, GSO meetings and activities are organized by the students. Officers elected by the GSO who bear specific official responsibilities are a President, a faculty liaison who attends faculty meetings, a representative to the School's Student Assembly, and Student Admissions Coordinators. Additional officers (Social Chair, Treasurer, etc.) can be chosen by the GSO if it wishes. In the past, activities sponsored by the GSO have included charity events, fundraisers, picnics, student birthday celebrations, etc.

Academic Performance

Academic Performance and Academic Probation

MHS students are required to maintain a 2.75 grade point average or better. Students who do not satisfy this and other academic requirements will be placed on Academic Probation by the Graduate Program Committee. Formal notification of Academic Probation generally will be accompanied by conditions that the student must fulfill in order to be returned to good academic standing. Students who fail to meet those conditions may be dismissed from the program. Students cannot graduate with a GPA lower than 2.75.

Criteria for Dismissal from the MHS Program

Students may be dismissed from the MMI MHS program for reasons that include (but are not limited to) failure to satisfy conditions specified for removal from academic probation, failure to maintain an adequate GPA, violations of academic or professional ethics, and failure to adhere to School and Departmental time limitations.

Academic Ethics and Responsible Conduct of Research

MMI requires students to adhere rigorously to the School's standards for Academic Ethics and Responsible Conduct of Research in all activities. Violations of these standards are ground for dismissal from the program. Policies are detailed in Policy and Procedures Memoranda (PPMs) "Students 01 Academic Ethics" and (for research, including student research) "Faculty 07 Scientific Misconduct". A lecture introducing students to these topics will be presented during the first term. Time and location will be announced by the Student Coordinator.

Attendance is required. Each student is also required to complete the online module on Academic and Research Ethics in their first term of enrollment (PH.550.860 Academic & Research Ethics at BSPH)

Student Conduct Code

The fundamental purpose of the JHU's regulation of student conduct is to promote and to protect the health, safety, welfare, property, and rights of all members of the University community as well as to promote the orderly operation of the University and to safeguard its property and facilities. As members of the University community, students accept certain responsibilities that support the educational mission and create an environment in which all students are afforded the same opportunity to succeed academically and professionally. The JHU Student Conduct Code is outlined at: https://studentaffairs.jhu.edu/policies-guidelines/student-code (https://studentaffairs.jhu.edu/policies-guidelines/student-code/)

Learning Outcomes

Key educational objectives for MHS students include:

1. Develop knowledge through coursework in the areas of immunology and microbiology;
2. Develop skills for the critical evaluation of scientific literature;
3. Develop literature-based analytical and research skills; and
4. Develop the ability to communicate scientific information orally and in writing.