
Graduate Studies in Microbiology

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The pages that follow summarize our graduate program and degree requirements. For more information, you can contact:

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Synopsis of a Graduate Career

Submission of a Ph.D. dissertation containing the results of original, publishable research remains the culminating and defining event of a graduate career. Graduate students achieve that final event in stages, progressing from mostly academic course work to full-time research.

Throughout the first year, students take Core Courses designed to introduce topics that the faculty consider essential for anyone pursuing research in microbiology. In the fall semester of the first year, students familiarize themselves with the faculty research interests and they begin research by engaging in brief research projects in three laboratories ("rotations"). At the end of the fall semester, students apply to join a research laboratory in which to do their thesis research. Joining a lab is a requirement to remain in the Microbiology Graduate Program. In the spring semester of the first year, students fulfill their teaching requirement by serving as an associate instructor for one of the classes offered by the Biology Department.

During the second year, research occupies an increasing portion of a student's time, and formal academic course work usually occupies a decreasing fraction. The culminating event of the second year is the two-step preliminary examination, which students take during the spring and summer. This examination seeks to determine whether, through his/her academic and independent study and research experiences, a student has successfully prepared himself or herself for independent work. Students who pass both stages are admitted to formal candidacy for the Ph.D. degree.

Once admitted to candidacy, students spend the majority of their remaining time in graduate school working on their research projects. It is expected that every student will give a research talk open to the whole department at least once

before graduation, present their work at a regional, national or international meeting and publish at least one first-author manuscript prior to graduation. Appendix H lists requirements that must be met prior to defense of the doctoral dissertation.

Course and research credit requirements for PhD in Microbiology

The Microbiology program requires a total of 90 credit hours. Of these, 22.5 credit hours (21 credits if Responsible Conduct of Research workshop is taken to fulfill the Ethics requirement) come from the Core Program course work listed below. Most Advanced Courses are half-semester 1.5-credit hour courses in areas requested by students. Each student must also take Grant Writing and Research Ethics and Career Development courses. Students also typically do research rotations in three different labs during the first semester, after which they identify a lab in which to do their thesis research and form their advisory committee.

The courses that make up the 22.5 credit hours for the Microbiology major are indicated below. Other appropriate courses may be substituted in their place with permission from the Advisory Committee and the Microbiology Graduate Program Director. Any changes described here to course requirements can (but do not have to) apply retroactively.

Major Course Requirements

- BIOL-M511 Molecular Biology of Prokaryotes (3.0 cr)*
- BIOL-M541 Virology and host responses (3.0 cr)*
- BIOL-M585 Microbial Genetics and pathogenesis (3.0 cr)*

- BIOL-L523 Critical Analysis of Scientific Literature (1.5 cr)
- BIOL-Z620 Grant Writing (1.5 cr)
- BIOL-Z620 Ethics and Career Development (1.5 cr) or Responsible Conduct of Research workshops offered through the Offices of the Vice Provost for Graduate Education and Health Sciences, Research Compliance, and the Vice Provost for Research.
- BIOL-M500 Research rotations (3.0 cr)
- BIOL-L500 Independent study (3.0 cr)
- Elective Advanced Course work - Z620, one or more biochemistry course, one or more bioinformatics courses, or other relevant coursework (6-9 credits). 400 level courses approved for Bacteriology or Virology minors are also approved for elective advanced course work.

* Only one of these courses needs to be completed for the major. If a student takes both, the course that is not used toward major will be counted toward the student's minor or elective

A description for each of the courses is found on the Registrar's website. A suggested course order for Microbiology graduate students is included in Appendix F.

General course requirements

A student must maintain a minimum grade point average of 3.2 in order to remain in "good standing" and retain a merit-based fellowship or award. Furthermore, in order for a course to count toward degree requirements, it must be passed with a grade of B- or better.

At Indiana University grade points are assigned according to the following scale:

- A = 4.0
- A- = 3.7
- B+ = 3.3
- B = 3.0
- B- = 2.7
- C+ = 2.3

Minor requirement

The University Graduate School requires that each student declare a "minor" in a field other than his/her major field of study. Specific options for minors include Bacteriology (for students in Virology focused labs), Virology (for students in bacteriology focuses labs), Genetics and EEB from within the Department of Biology or from other programs such as applied health, biochemistry, biotechnology, chemistry, organic chemistry, education, statistics, bioinformatics and perhaps other fields. The requirements for a minor are set by the minor field. Please read the Graduate School Bulletin for more details. Microbiology graduate students cannot get a minor in Microbiology. No course can be counted for both major and minor credit.

Settling into graduate school

Faculty mentor: A faculty mentor will be assigned to each incoming graduate student, prior to their settling into a thesis lab. Students will meet periodically with their mentor throughout the first year, and should consult with him/her if questions or problems with coursework or rotations arise. The faculty mentor is there to help guide the student through the first year and is separate from the student's PI mentor who will be chosen at the end of the first Fall semester.

Peer mentor: A separate senior graduate student will be assigned as a peer mentor to each incoming graduate student. Please feel free to contact your peer mentor to discuss what it is like to be a graduate student in the department and information about getting adjusted to Bloomington and the University.

Other resources: Entering graduate school often brings many other challenges. A list of

resources within the Biology department and across the campus to help with both a personal and professional transition is included in Appendix K.

Selecting a laboratory

Rotations. A student must join a research laboratory by the end of the first year to remain in the PhD program. Rotations are 5-week experiences in labs chosen, in part, by the student. During orientation, each PI actively looking to recruit students will present a short research talk to introduce you to the types of projects that they have active. To identify an appropriate research topic and environment, students are strongly encouraged to seek and interact with faculty members whose research piques their interest. In addition to meeting with faculty one-on-one, students should also feel free to talk to other students and postdocs, and read the papers published by our faculty.

Important Dates:

Aug 11-12: Faculty Presentations

Aug 19: Students' First requests due by 5 pm

Aug 22/Sep 23: Start/End First Rotation

Sep 21: Students' Second requests due by 5 pm

Sep 26/Oct 28: Start/End Second Rotation

Oct 26: Students' Third requests due by 5 pm

Oct 31/Dec 9: Start/End Third Rotation

Dec 14: Student Commitment requests due by 5 pm

Dec 16: Faculty Commitment decisions due by noon

Prior to each rotation period students will choose EXACTLY three labs in which they are interested in rotating and submit a ranked list to the Microbiology Graduate Program Director (MGPD). Once all bids are in, the MGPD will contact each of the labs, starting with everyone's top choice and each faculty member will have the choice to accept the bid or pass to the next lab in rank order. This process will repeat until all students have found rotations. If any student is not assigned a rotation after this process is complete, that student will meet with the MGPD to arrange a rotation. Finally, students are encouraged to meet with faculty to discuss

possible rotations and possible rotation projects prior to sending in a rotation request list.

Discussing potential rotations with the PIs prior to the rotation has the following advantages:

1. Gives the student a better idea of what goes on in the lab
2. Let the PI know the student is interested in advance to facilitate planning and coordination with subsequent rotations.
3. Gives the lab time to prepare for the student's arrival so that they will have a smoother rotation experience.
4. Allows the student to find out how many students the lab intends to accept.
5. PIs may only be willing to keep rotation spots available for students they know are interested.
6. Just because a PI has not approached a student about coming to their lab on a rotation does not mean that the faculty member is not interested in having them.
7. **Most importantly**, PIs are more likely to accept a rotation a student with whom they have spoken than a student with whom they have not spoken.

Both the faculty and potential rotation student must be aware, however, that no informal agreements are binding and that rotations are formally assigned only by the procedure described above.

Entry into a Research Laboratory: By the end of the semester, 1st-year students must choose three laboratories that they are interested in joining for their graduate career. A ranked list of laboratories, along with any comments, should be sent to the MGPD. Students are not guaranteed positions in laboratories, although in practice this is rarely an issue. Students are expected to choose a mentor based on three rotations. However, in rare cases, students do not find a home after three rotations and can try a 4th rotation. However, this is not recommended. It is **very important** to note that entry into a research lab is a requirement for our graduate program, and students must have joined a lab by the end of the spring semester of the 1st year.

Rotation Expectations. When a student enters a rotation they should expect to meet with the PI to discuss the PI's expectations for their performance in the lab. Students are encouraged to specifically ask for a lab expectations or lab culture document to help them understand the requirements and expectations of that research environment. When a student exits a rotation they should expect to meet with the PI to discuss the PI's evaluation of the student's performance using the rubric in Appendix A.

Microbiology events

Seminars: Throughout students' graduate careers, we expect them to attend and participate in our events that pertain to the Microbiology section (see below for more details): ***Check the "This Week in Biology" emails for more details as the semester progresses***

1. Microbiology Seminar.
Wednesdays 3pm – 4pm.
External speakers are invited to present their research. Students will have the opportunity to meet with the speakers 12:30-1:30 over a complementary lunch.
2. Microphiles.
Fridays, 12:40 - 1:30 pm
Internal graduate, postdoctoral, undergraduate and faculty speakers are invited to present their research.
3. Microbiology PhD Defenses
(variable).
PhD defenses are the most important event in graduate training and all students and faculty are expected to attend.
4. Microbiology retreat
(October 29, 2022).
This retreat is an opportunity to meet other Microbiology researchers on campus and present your findings in an encouraging, low stress environment.

Research progress

Research Advisory Committee. Students must select exactly three faculty members in addition to their lab PI mentor to fill the research advisory committee. One of these three must represent your minor. Students should discuss who the other members should be with their mentor, contact, and secure the other members by the end of summer of the first year.

Regardless of the PI, at least one other member of the committee besides the PI mentor must be a member of the Microbiology Core Faculty (See Appendix B). One member of the student's committee will serve as their prelim chair and thus one member of the Microbiology Core Faculty besides the PI must be available to fill this position. Second year students must complete their meeting in the Fall semester.

In subsequent years of graduate school, students must meet with their Advisory Committee at least once per 12-month period. A yearly meeting is mandatory. It is expected that all research advisors who accept Microbiology students into their labs will participate in committee meetings. Student preparation for the meetings and thoughtful feedback by committee members help students to: 1) avoid or minimize pursuing unproductive lines of investigation; 2) produce careful and thorough studies; and, 3) think critically and creatively about interpretations and possible future directions.

Critical in-depth analysis and discussion of recent data and plans for the overall research project are crucial for the development of any research program.

Prior to each meeting with the Research Advisory Committee, students should write up and distribute to the committee members a summary of research efforts, results to date, and plans for the future. Students must also complete an individual development plan (IDP) and discuss this plan with the research mentor prior to the Research Advisory Committee meeting. The IDP, updated yearly also must be sent to the

Microbiology Graduate program director. After each meeting, the student should write up a summary of the meeting and submit to the committee and the graduate advisor. In addition, a google form (linked in Appendix G should be filled). If the committee finds the progress to be unsatisfactory, probation may be recommended. The procedure to schedule advisory committee meeting and student expectations for this meeting (depending on the year in graduate school are described in Appendix G).

Attaining candidacy

During the spring of the second year students take a Preliminary Examination in order to qualify for Ph.D. candidacy. The Preliminary Exam is a traditional part of Ph.D. programs. Its purpose is to establish that students have successfully made the transition from purely academic study to independent learning, are adequately prepared for research, and are already making adequate progress toward a thesis. The Preliminary Examination is a two-part process. A detailed description of the prelim protocol is included in Appendix C.

Prelim Part 1, paper exam: At the end of the spring semester of the first year, students will be provided with 20 papers carefully balancing disciplinary representation and content chosen by the Microbiology Core Training Faculty. Students are responsible for becoming familiar with all of these papers such that, in an oral examination to occur during the spring semester of the second year, they will be able to answer questions on each of the studies. The exam is 90 minutes long and is administered by an Examining Committee (A chair chosen from the student's Research Advisory Committee and two randomly selected members from the Microbiology Core Faculty). Each faculty member asks questions on two different papers from the list, 15 minutes per question. These questions focus on a set of criteria covering the following aspects of each study:

- (i) understanding of the concepts and technology in the set of papers and relevant information from related articles and coursework;
- (ii) ability to critically evaluate the experiments and offer alternative approaches;
- (iii) ability to relate the authors' results and conclusions to previous/competing work;
- (iv) ability to propose future experiments that challenge or extend the authors' conclusions.

Students must pass Part 1 of the Preliminary Examination before proceeding to the next step. A detailed description of the procedure for this exam is described in Appendix C.

Prelim Part 2, proposal exam: During the spring semester of the second year, students will enroll in Z620 Grant Writing to write a formal, professional research proposal that describes their progress on and plans for their thesis research. Students should interact with their mentor and any other students or faculty with which they wish to receive input on the proposal. The final written proposal must be submitted to the Research Advisory Committee selected by the student and defended orally in a committee meeting to be held in the summer of the second year and no later the first two weeks of the Fall Semester of the third year. A detailed description of the procedure for this exam is described in Appendix C.

Students who pass both parts of the Preliminary Examination and who have met all course requirements are admitted to candidacy for a Ph.D. Students that voluntarily decide to not take either Part 1 or Part 2 in the normal time frame lose their eligibility to remain in the Ph.D. program.

Graduate school after candidacy

After qualifying to become a PhD candidate, the main activities are research, seminars, and taking additional Advanced Courses to fulfill elective requirements. In addition, students are required to enroll in a course on Research Ethics and Career Development, a half-semester course that explores practical and ethical issues in scientific careers and different types of career options. In case this course is not offered, the students may instead substitute this course with an Ethics workshop offered by the University office of research ethics and the graduate school.

After passing the Preliminary Exam, for a student to remain in "good standing" in the Microbiology program requires that she/he be making sufficient progress toward completing a dissertation. If the research advisor and/or other members of the Research Advisory Committee become concerned about or dissatisfied with a student's progress or efforts, a meeting of the student with the Research Advisory Committee must be called to discuss the reason(s) for concern/dissatisfaction. If the Committee determines that the student's progress is not satisfactory, then the student will be placed on probation. The probationary period (usually a semester) will provide an opportunity for the student to demonstrate effectiveness and progress in research. This research may be conducted in the same lab with the same research advisor or in a new lab with a different research advisor. At the end of the probationary period, if the Research Advisory Committee judges the student's progress to be satisfactory, then probation will be lifted. If the Research Advisory Committee judges the student's progress to remain unsatisfactory, then the student will be required to leave the Program and any departmental commitment of further

financial support for the student will be suspended at the end of the semester during which the student is discharged from the program.

Completing a Dissertation

Once a student has passed the Preliminary Exam and all of the other requirements mentioned in these pages, research toward the Ph.D. thesis becomes the focus of her/his work. There are two timing rules to of which to be aware: the advisory committee must meet at least once each year to evaluate the progress of the research and, the dissertation must be accepted formally within 7 years following admission to candidacy.

The dissertation itself must represent a body of independent, publishable work that makes a significant contribution to science. Ph.D. degrees are not awarded for purely academic achievement, nor are they awarded in recognition of "time served". Programmatic expectations for earning a PhD in Microbiology are described in Appendix H.

It is also important that students understand the University's formalities for enrollment in courses and for tuition charges. For each of the first 3-4 years of enrollment, students can take up to 12 credits of course work during each semester of the academic year and may take up to 6 credits during the summer. These credits come from lecture courses, seminar courses, and research (M800). Students will normally have completed 90 hours of coursework by the end of the 3rd or 4th year. Students who have completed 90 hours are thereafter eligible to enroll in G901 (advanced research; 6 credits/semester during the academic year) in place of M800, at greatly reduced tuition rates. The University permits a student to enroll in G901 for up to 3 years. If a student should exhaust this eligibility for G901, his/her tuition will return to the original higher level.

Once the student and his/her advisor agree that the thesis is nearly done, a student should begin to plan the dissertation defense. At least six months in advance of defense, the advisory committee members and the University Graduate School must approve the thesis prospectus (expectations for this prospectus are listed in Appendix G). The student should then select a date for the defense when all of the thesis committee members can be present. Prior to the defense, each committee member must receive a copy of the dissertation that both the student and her/his advisor consider to be complete and polished – it should be properly printed and include all figures and references.

Our rules state that this copy must be submitted to the committee no later than 6 weeks prior to the defense. Procedure for scheduling a defense is described in Appendix I. Committee members are expected to read the dissertation promptly and carefully. If they have major objections, they will express them at this stage and the defense may be deferred. It is more common that committee members will suggest revision of only portions of the dissertation, and then they may reserve their comments for the dissertation defense.

The dissertation defense comprises two parts. It begins with a public presentation (i.e. a seminar), which must be announced in advance; the University Graduate School requires that a one-page summary and announcement of the dissertation be submitted 30 days prior to the scheduled defense, and the Department posts the seminar in "This Week in Biology". Following the presentation, the candidate meets with the thesis committee and is examined on the contents of the dissertation. Dissertations may be accepted in their current form (rare), rejected (also rare), or accepted pending revision (common). Once a dissertation has been revised to meet the committee's standards and the University's format requirements, the committee and research advisor certify its acceptance to the Graduate School and recommend that the Ph.D. degree be awarded.

The Teaching Requirement

Ph.D. candidates are participants in a venerable tradition that involves both learning and passing on knowledge. They have a responsibility to help teach others and to refine their ability to do so effectively. In recognition of this responsibility, all Ph.D. programs in the department require that each student teach at least one semester during his/her graduate career. In addition, it is expected that graduate students participate in the research training of other students and personnel in their laboratories.

It is also a requirement of the College of Arts and Sciences that all Ph.D. students take formal instruction in college teaching methods. Also first year students must participate in the Teacher Training Session that is offered during the fall semester orientation at the beginning of each year if they will be teaching in their first year. They may opt to postpone doing this until their second or third year if they have fellowship support during the first three years. <http://vpfaa.indiana.edu/policies/handbooks-guides.shtml>

Student Rights and Responsibilities

As members of the Indiana University academic community, graduate students have both rights and responsibilities. Minimally, students have the right to be free of racial and sexual harassment, whether by other students or by faculty. They should also expect to be treated fairly, impartially, and with dignity as colleagues in the academic enterprise. Some of these rights are protected by specific University regulations described in the "Academic Handbook" and the "Code of Student Ethics".

More informally, students should feel free to bring problems to the attention of their advisor, program directors, or the departmental chairperson.

Students also have responsibilities both as scholars and as teachers. As teachers they are subject to the same rules that apply to permanent faculty, rules that are designed to protect students against bias and harassment. Associate Instructors (A.I.s) should make themselves aware of these rules. Beyond the rules, A.I.s should be aware that they will be important role models to undergraduates and that their behavior toward their students should be beyond reproach. See Appendix K for list of resources available in the department and at the university.

Plagiarism - definition, guidelines, and consequences

For members of the scholarly community, the cardinal rule guiding both academic and research work is one of honesty and open attribution. Plagiarism, cheating, and forgery will not be tolerated and will be punished severely when detected. Credit for ideas, experiments, models, etc. must be given to their originators. Undergraduate courses are often lax in their enforcement of such regulations since undergraduates are frequently confused about the origins of ideas. Graduate students are expected to be informed on such matters, and faculty are alert to intellectual theft whether in papers, examinations, or purportedly original work.

Indiana University Academic Handbook, August 2005, p. 175:

"Honesty requires that any ideas or materials taken from another source for either written or oral use must be fully acknowledged. Offering the work of someone else as one's own is **plagiarism**. The language or ideas thus taken from another may range from isolated formulas, sentences, or paragraphs to entire articles copied

from books, periodicals, speeches, or the writings of other students. The offering of materials assembled or collected by others in the form of projects or collections without acknowledgement also is considered **plagiarism**. Any student who fails to give credit for ideas or materials taken from another source is guilty of **plagiarism**."

In assignments for class and in research articles you write in the future, your writing should:

- reflect your thinking about and interpreting what you read and hear
- express ideas in your own words
- give credit to the sources of the ideas

A good strategy is to make yourself to do the writing without the primary references in front of you. That will force you to use your own words.

When cases of plagiarism are discovered, the disciplinary actions are severe:

-- After a 1st incident of plagiarism, we will assign a 0 on the assignment that contained a plagiarized portion or portions, and we will notify the Dean of the Graduate School of the incident and our action. **Note that in the Preliminary Examination, a first incident of plagiarism may lead to the grade of 0 on the full Preliminary Exam, even if the plagiarism occurs in the first attempt at the written part of the exam. In such a case, the student would have failed the Preliminary Exam and would not be able to continue in the Ph.D. program.**

-- After a 2nd incident of plagiarism, we will recommend to the Dean of the Graduate School that the student be expelled from our graduate program.

You are now entering a training program in which you will be asked often to evaluate the ideas, data, and conclusions from journal articles, reviews, the web, and other sources. In addition to avoiding outright plagiarism (as described above), you should also avoid mindlessly stitching together ideas from various sources even if they are appropriately referenced. You need to gather ideas and information together, synthesize your own "big picture", and then describe your thoughts in your own words, citing your sources for the ideas and information you discuss.

Financial Assistance

Students who are U.S. citizens may be eligible for support from training grants (if their mentor is trainer on the grant). Assignments to the training grant are made as vacancies arise and take into account a student's accomplishments and interests. Assignments are generally made in response to nominations by the student's advisor. Please note that an NIH research-teaching payback provision is in effect on training grant support.

In addition, all students may be eligible for support by a number of Graduate Fellowship awarded under the auspices of the College of Arts and Sciences and the University Graduate School. Students are also eligible for Biology Associate Instructorships, which provide full stipend support and require at most 20 hours teaching per week. Finally, many advanced program students are supported as Research Assistants on the research grants of their thesis advisors.

The University sets standards of English competence for A.I.s. To make sure that all funding options are available to students whose native language is not English, it is critically important that foreign students meet those standards as early as possible during their graduate careers.

See this website for more information:
<https://dsls.indiana.edu/programs/tepaic.html>

APPENDIX A: ROTATION RUBRIC

Rotation Period: Fall 1, Fall 2, Fall 3

Please evaluate the rotation student in the following categories, modify comments as appropriate:

Grading scale: 21-30 = A; 16-20 = B; 1-15 = C

	Exceeds expectations 3 points each	Acceptable 2 points each	Insufficient 1 point each
Attendance Work ethics Punctuality	Spends over expected time in lab Excellent work ethics Punctual	Spends expected time in lab (~20 hours per week) Good work ethics Punctual	Not enough time spent in lab Work ethics needs improvement Misses meetings
Organization	Superior organization skills improve efficiency in lab	Good balance between planning, executing, and analyzing experiments	Unfocused Disorganized Forgetful
Understanding of project	Reading and thinking go beyond specifics of project	Understands big picture and specifics of project	Effort and/or background insufficient for good understanding
Independence (by the end of the rotation)	Confident Rapidly became independent but kept mentor informed	Good balance between seeking instruction and working independently	Timid Unable to execute or analyze experiments independently
Productivity	Went beyond rotation goals and/or results advanced project in the lab	Completed rotation goals	Problems in one or more of the above areas impeded progress
Discussion of project with mentor and PI	Clear, organized, thought-provoking, and engaging discussions.	Clear and well-articulated explanation of all aspects of project	Unclear explanations and/or insufficient preparation
Oral presentation	Thought-provoking, engaging	Clear, logical, concise	Confusing, disorganized
Written communication	Superior writing ability, able to tie specific goal of the project to big picture	Clear, logical, concise, and complete	Substantial problems with grammar, sentence structure, flow, and/or logic
Attitude and interaction with others	Makes special efforts to interact with lab members and discuss science. Considerate of others	Good interaction with lab members and good lab citizen.	Insufficient interaction with and/or inconsiderate of lab members; difficult interaction with mentor and/or professor.
Interest in science	Enthusiastic, excited, highly-motivated	Interested and involved in the process	Indifferent or disengaged

Disclaimer: The following two checkboxes in no way constitute a commitment either from the student or from the faculty member that the student will eventually commit to joining the lab. The boxes below only indicate the willingness of the faculty member to consider that student among potential candidates for a position in the lab at time the commitment process is formally initiated.

I am willing to consider this student for a spot in my lab.

I am unwilling to consider this student for a spot in my lab.

Additional comments (if necessary):

APPENDIX B: MICROBIOLOGY TRAINING FACULTY

Microbiology Core Training Faculty

Lab	Subject	Dept
Dalia, Ankur	Natural transformation and horizontal gene transfer	Bio-Micro
Danthi, Pranav	Viral and cellular determinants of virus-induced cell death and disease.	Bio-Micro
Fuqua, Clay	Multicellular interactions of bacteria.	Bio-Micro
Hardy, Rich	Genome functions of RNA viruses and virus-host interaction.	Bio-Micro
Kearns, Dan	Bacterial motility and multicellular behavior.	Bio-Micro
Kehoe, David	Environmental regulation of gene expression in bacteria.	Bio-Micro
Landeta, Cristina	Disulfide bond formation; biotechnology; microbial interactions and pathogenesis	Bio-Micro
McKinlay, Jake	Microbial metabolism in physiology, ecology, and biotechnology	Bio-Micro
Mukhopadhyay, Tuli	Structure and assembly of enveloped, RNA viruses.	Bio-Micro
Newton, Irene	Functional genomics of environmental microbes and symbiosis.	Bio-Micro
Patton, John	Replication of rotavirus, innate immune responses to viral infection	Bio-Micro
Rowe-Magnus, Dean	Integrins and Super-Integrins; biofilm formation; natural competence; ecology and pathogenesis in the Vibrionaceae	Bio-Micro
van Kessel, Julia	Regulation of quorum sensing and other group behaviors	Bio-Micro
Wang, Xindan	Bacterial chromosome organization and segregation	Bio-Micro
Winkler, Malcolm	The physiology, pathogenesis, molecular genetics, stress responses, and genomics of <i>Streptococcus pneumoniae</i> .	Bio-Micro

Microbiology Affiliated Training Faculty

Lab	Subject	Dept
Bashey-Visser, Farrah	Evolution of social strategies and virulence	Bio-EEB
Bauer, Carl	Oxygen and light regulation of gene expression; Biosynthesis of heme and chlorophyll; Prokaryotic development.	MCB
Bell, Stephen	Molecular Biology of the Archaea	Bio-GCDB
Bochman, Matt	Genome integrity, DNA helicases, microbiology of fermented beverages	MCB
Bush, Karen	Antibiotic mechanisms of action and resistance.	Btech
Chen, Lingling	Protein-protein structural interactions in GroEL-mediated protein folding and microbial communications.	MCB
Gerdt, J.P.	Interkingdom symbioses	Chem
Giedroc, David	Bacterial Zn- and Cu- sensor proteins, RNA structure and function in mammalian coronavirus replication.	Chem
Lennon, Jay	Microbial ecology and evolution	Bio-EEB
Phillips, Rich	Consequences of human-accelerated environmental change on plant-soil-microbial interactions.	Bio-EEB
Reynolds, Heather	Plant community ecology; plant-soil-microbial interactions.	Bio-EEB
VanNieuwenzhe, Mike	Peptidoglycan biosynthesis and viral capsid assembly.	Chem
Zlotnick, Adam	Biophysics of virus assembly, development of antiviral strategies, and construction of virus nanostructures.	MCB

APPENDIX C – PRELIMINARY EXAM PROTOCOL

ROLES

Student/Examinee - A student and member of the Microbiology Graduate Program, typically in their second year, who will take the prelim exams for PhD candidacy.

Thesis Advisor – The PI chosen by the student to serve as their PhD mentor.

Microbiology Graduate Program Director (MGPD) – Nominates members for the Prelim Steering Committee, selects the chair of each Prelim committee, and informs each student the result of their literature exam.

Research Advisory Committee – A unique committee will be chosen by each student to serve an advisory role throughout the process of obtaining a PhD. The committee will be comprised of the student's chosen PI and 3 other members chosen by the student and agreed to by each committee member. One of the other members must be chosen from the Microbiology Core Faculty. The PI will serve as the Research Advisory Committee Chair in all regards save those pertaining to the literature-based and proposal-based components of the prelim exams.

Prelim Steering Committee – One group of three members of the Microbiology Core Faculty who 1) choose 15-20 papers from the list submitted by the Microbiology Core that will serve as the basis of the literature examination and 2) collect the scores from all Prelim committee chairs, 3) decides who passes and who fails, and 4) communicates their decision to the MGPD.

Prelim Examining Committee – A unique committee will be assigned for each student taking the literature prelim. Each committee will consist of three members, a Prelim committee chair and two members of the Microbiology Core Faculty randomly chosen by the MGPD.

Prelim Committee Chair – One member of the Microbiology Core Faculty will be nominated by the Microbiology Graduate Program Director to serve as a unique chair for each Prelim Committee. When possible, the chair will be selected from a member of each student's Research Advisory Committee. The Prelim Committee Chair will be informed of their position by the Microbiology Graduate Program Director and in addition, they will be informed of the two other members of the Prelim Committee and the student that they will be examining.

The Prelim Committee Chair has two responsibilities. 1) For the paper exam: serve as a liaison between the graduate student and two randomly chosen anonymous (to the student) members of the Microbiology Core faculty in order to schedule the exam date and time. The Prelim Committee Chair will also coordinate which papers will be highlighted by which faculty members to avoid overlap during the exam. 2) For the proposal exam: compile faculty comments on the proposal and communicate the comments to the student. Ensure that the prelim is completed in a timely manner.

Objectives of the Examination Process

The preliminary examination is one of the most significant academic milestones of the Microbiology (MIC) graduate program. Examining Committees are charged with evaluating whether or not graduate students are prepared and qualified to carry out their doctoral thesis work, as well as whether they have sufficient depth and breadth of knowledge relevant to their future as scientists (Paper exam -

Part 1). When completed successfully, and once the student presents their thesis proposal (Proposal exam - Part 2), the examinee is formally considered a doctoral candidate.

Part 1: Literature Examination

A. Administrative Structure

The literature exam will be administered by the Microbiology Graduate Program Director and a Prelim Steering Committee comprised of several Microbiology faculty. The Prelim Steering Committee will guide the process and advise the Microbiology Graduate Program Director on the appropriate examination content and procedures. They will also communicate the results of the exam to the Microbiology Graduate Program Director and mediate second examinations and appeals.

B. Prelim Committee Composition

The MGPD will organize Examining Committees for each student. Each Prelim Committee will be led by a chair. For each student, the Program Director will select a Prelim Examining Committee Chair from the student's Research Advisory Committee or a Microbiology Core Faculty member whose research interests are as close to the student's thesis work as possible. The other two members of the Prelim Examining Committee will be chosen at random by the MGPD (See Appendix A). The student's thesis advisor will not be a member of that student's Prelim Committee. The student will know the Chair of the Prelim Committee but will not know the identity of the two other committee members.

C. Examination Format and Timetable

PhD students must take this exam in the Spring semester of their 2nd year in the program. The exam format is oral, with questions and discussion based on a pre-defined set of approximately 20 primary research articles spanning a breadth of topics within microbiology. The MGPD will solicit paper nominations from each member of the Microbiology Core Faculty. The Prelim Steering Committee will select no more than 20 papers from this set, carefully balancing disciplinary representation and content. The final reading list for each year's exams will be distributed to the students at the end of their third semester (Fall of year 2 in graduate school),

The exam is **strictly 90 minutes long** and is administered by the Examining Committee. Each faculty member asks questions on two different papers from the list (6 papers for the entire exam), with roughly 15 minutes per paper. These questions focus on a set of criteria, of which the students are aware (see template student guidelines below) covering the following aspects of each study:

- (i) understanding of the concepts and technology in the set of papers and relevant information from related articles and coursework;
- (ii) ability to critically evaluate the experiments and offer alternative approaches;
- (iii) ability to relate the authors' results and conclusions to previous/competing work
- (iv) ability to propose future experiments that challenge or extend the authors' conclusions.

D. Examination Procedure

Although the actual exam will take no more than 1.5 hours, the chair should reserve, and the

committee should plan, for a 2 hour commitment. The last half hour is a period where the committee, in the absence of the student, records their notes and evaluation scores.

Before the student enters the examination room, the Prelim Examining Committee Chair will briefly prepare the Prelim Examining Committee by verifying which papers each member is going to ask questions about, and then determine order of the questions. Once the student is called into the room, the Prelim Examining Committee Chair will introduce the committee and introduce the first faculty member who becomes the active examiner. The active examiner will introduce their first paper. When a paper is introduced, the Prelim Examining Committee Chair will locate the PDF file of this paper and project the title page. The student will be given one minute to review their notes. Then the notes must be set aside and fifteen minutes of questioning will commence. If a discussion point revolves around a particular figure of key interest, a committee member can request that the figure be displayed on screen. Only the active examiner may ask questions and make comments. After the paper has been discussed, the process is repeated with another paper from the same or a new active examiner (chair's prerogative). Each faculty member will get to choose and discuss two papers in 16 minute intervals. After 96 minutes, the Chair will conclude the exam, the student will be dismissed from the exam, and the Committee will complete their evaluation forms. The evaluations will be collected by the Prelim Examining Committee Chair who will in turn submit all of the evaluations to the MPGD.

Students may bring printed copies of all papers to the exam. The printed copies may contain notes taken by the student. During the exam, students will have one minute to review their notes prior to the 15 minute questioning period for each paper, after which, notes must be set aside.

CONFIDENTIALITY: To provide fairness to all students taking the examination, students are prohibited from disclosing the examiners, the papers they were examined on, and the questions they were asked until all the students have completed the current exam period. Students are also prohibited from attempting to determine who their examiners will be ahead of time, including but not limited to purposefully monitoring attendees and activities in the exam room. Violation of this policy will be considered a breach of the honor code (a form of cheating) and grounds for dismissal from the program. The first exam period and the retake exam period are considered separate events. Thus, students who did not pass during the first period have full freedom to discuss the contents of the exam with both faculty and peers to prepare for the retake exam. During the retake exam period, confidentiality will again be enforced.

E. Examination Grading

Dates for the 2021-2022 exam schedule:

Prelim 1a Jan 9 - 14, 2023 (9:00am – 1:30pm)

Prelim 1b Jan 17 - 20 , 2023 (9:00am – 1:30pm) *Do not schedule exams on MLK day*

Prelim 2 (retakes) Feb 21 – Mar 24, 2023 (9:00am – 1:30pm)

Students should make the Prelim chair aware of conflicts with any religious holidays or events at the time of scheduling.

Each Prelim Examining Committee member will assign grades of 1 to 10 points (10 = best), evaluating the student's performance on (i) their specific questions, and (ii) on the entire exam (Highest total of 60 points). Each Prelim Examining Committee member will assign their values independently and each committee member shall not discuss their scores with the others during deliberations. The rubric in Appendix D will be used for evaluation. After recording their evaluations, the committee members are allowed to confer with one another to assess whether factual information was provided by the student. After conferring, scores may be modified independently but again, no discussion of scores assigned is permitted. Once scoring is complete, the Prelim Examining Committee Chair will collect and submit the

three evaluations from the committee to the MGPD. Immediately after the season's exams have been completed, and all evaluations have been submitted, the MGPD will submit all evaluations to the Prelim Steering Committee. The Prelim Steering Committee will review the results of all of the exams and decide the absolute threshold for a passing grade.

The Prelim Steering Committee will also consider the written comments from the Prelim Examining Committee as they deliberate any decision to pass or fail a student. The Prelim Steering Committee may choose to recognize outstanding student performances as "Passed with Distinction." Decisions will be e-mailed to the MGPD. The MGPD will e-mail each student to inform them of the outcome of their exam. Students and the advisor will also receive a copy of the evaluation form, including any written comments. Students should contact the Chair or other Examining Committee members if they have questions.

F. Outcomes of Examination

PASS: If the scores assigned by the Prelim Examining Committee are judged to be a passing grade by the Prelim Steering Committee, the student will proceed to the Thesis Proposal Exam (part 2).

FAIL: If the scores assigned by the Prelim Examining Committee are judged to be a failing grade by the Prelim Steering Committee, the student will be given a second opportunity to take the literature exam. This second exam will be scheduled no less than four weeks after the first exam results are released, and the Prelim Examining Committee will consist of one previous member supplemented by two new members. The Program Director will consult with the Prelim Examining Committee Chair regarding the replacement of any committee members. The re-examination will be conducted exactly the same way as the original exam, with all of the papers still open for discussion. The Prelim Steering Committee will review the scores and comments of this re-examination and they will decide whether the student passes or fails and communicate this information to the MGPD. The MGPD will communicate the result to the student, including in the case of a fail decision, a brief explanation of the decision provided by the Prelim Steering Committee. If the student fails the second exam, they will be dismissed from the PhD program. If the student feels that the decision of the Prelim Steering Committee was incorrect due to a procedural flaw in the examination process, the student may submit a written appeal to the MGPD.

APPEAL. To submit an appeal, the student must write a one page (front and back permissible) document describing the procedural flaw in the prelim process that resulted in the incorrect negative evaluation by the Prelim Evaluation and Steering Committees and submit the document to the MGPD. Next, the MGPD will appoint a member of the faculty who was not part of either the original or retake exam to serve as a Counselor for consideration of the appeal. The MGPD will submit the appeal to the Counselor and the Prelim Steering Committee (who made the original decision). The Counselor and the Prelim Steering Committee will meet to discuss the appeal and together they will come to a final decision. The Counselor will draft a short statement that explains the committee's decision and submit the decision to the MGPD. The Counselor's document will be the final word on the case and remain on record to serve as policy precedent for all subsequent exams until overturned by faculty vote. The MGPD will notify the student of the outcome and share the Counselor's document with the Microbiology core faculty.

G. Guidelines for Students

1. One of the primary purposes of this examination is to broaden your background and bring you up-to-date on a wide range of topics. We recognize that many of the areas that the papers address will be

new to you. While you will be tested on the papers contained in the bibliography provided, you will likely need to find extra background reading in order to fully understand them. Start your preparation early.

2. Other important aspects of this exercise are to learn how to read the primary literature with efficiency and to determine what information must be critically evaluated and retained. Remember that the Prelim Examination Committee has a limited time to examine you, and no single paper will be discussed for more than about 15 minutes. Given that time frame, the Prelim Examination Committee will assess whether you can carry on a meaningful conversation about the science and its impact on the field rather than determining whether you have memorized details. You will have access to the PDF of the manuscript during the oral examination.

3. Be aware that the methods by which the data are generated are as important as the conclusions the authors draw. Make sure you understand how techniques critical to the argument are conducted.

4. Opinions are important in science. Have an opinion about what you read. Do you believe the results and interpretation? Do the results make sense in the context of other things you have learned? Be able to support your opinion with background knowledge or with evidence from the paper.

5. Know the main point of the paper. Decide for yourself what you think is the best evidence that supports the main point. Think about whether you agree that the data is convincing and supports the conclusions. Understand the models that the paper is based on and understand how the conclusions of the paper result in changes to the models.

H. Faculty Guidelines

1. Be prepared to ask questions on at least two of the papers on the reading list. Given the limited time for the exam, no single paper will occupy more than 15 minutes of discussion. When you have selected the papers of interest to you, please contact the Prelim Examining Committee Chair to be sure that these papers have not already been selected by other Committee members.

2. Remember that the students are responsible for the entire set of papers covering a broad variety of topics, while you have selected only a few (and probably in areas familiar to you). They will be nervous and may have trouble remembering isolated points from papers they read in depth months earlier. As you evaluate their performance, do not confuse occasional memory lapses with comprehension, analysis, and synthesis.

3. All the students will have taken the core curriculum, but the exact content of this may vary year to year. Unless you have personal knowledge of what a given student “should know” from coursework, you should be careful not to make too many assumptions about their background. Instead, your expectations for adequate responses should be based on the reading list as well as the relevant background information needed to understand those papers.

4. Grade the student on the entire exam performance, in addition to the answers to your questions. If you think the student’s overall performance meets your expectations, the score should be in the 7-10 range. Of course, lower individual scores may still result in a passing grade when all the scores are totaled. Remember that it is the Prelim Steering Committee’s job to look at the scores and comments for all of the students, and they will ultimately determine which students pass.

Part 2: Thesis Proposal Exam

A. Goals and requirements

Developing the ability to plan and conduct thoughtful, rigorous, independent research is the core goal of the Microbiology doctoral program. As a means of assessing a student’s progress towards this

goal, the second part of the Preliminary Examination process involves the formulation and presentation (written and oral) of a research proposal outlining the student's thesis research.

B. Prelim Committee Composition

If the Prelim Committee Chair from the paper exam is part of the student's Graduate Advisory committee, then that individual will remain as chair for the Thesis Proposal Exam as well. Students are encouraged to remind the Prelim Chair of their role. The rest of the committee will be composed of the Graduate Advisory Committee chosen by the student, as the student has decided that these individuals are best suited to evaluate their research project. The Thesis Advisor may also attend the Thesis Proposal Exam but is barred from speaking during the exam and must leave for the deliberations after the exam. It is the responsibility of the Prelim Committee Chair to ensure that Doctoral Advisor does not participate in the exam.

C. Examination format and Timetable

A student cannot progress to this part of the Preliminary Examination until they have successfully completed the Paper Based Examination (Part 1). The Thesis Proposal Exam should be completed prior to the first two weeks of the Fall semester of the student's third year. PhD students must take this exam in the summer between their 2nd and 3rd year in graduate school. Students who have switched laboratories (and have therefore had insufficient time to collect preliminary data to support their proposal) may request an extension from the program director, in consultation with their mentor.

Students will write a research proposal outlining their plans for their thesis research. The proposal format is described in more detail below. The students will already have received assistance in formulating this proposal through the Z620 Grant Writing class taken in their 2nd year but should anticipate to continue working on the proposal after this course. Students should both seek and receive further assistance from their Doctoral Advisor and other scientists. **Plagiarism will result in dismissal from the PhD program** (see page 9 of handbook). Students who are unclear on what constitutes plagiarism should seek advice from their Doctoral Advisor and/or Grant Writing instructor prior to submitting the proposal.

Timeline*:

- June 1: Submit proposal to research advisory committee
- June 21: Committee provides comments and requests a modified or a completely re-written version of the document
- July 14: Submit modified or re-written version of proposal
- Before third week of Fall semester: Defend proposal

*, if any of the stated dates falls on a weekend, the deadline is the first weekday afterwards

D. Proposal format

The proposal will follow an NIH R21 proposal format.

Exceptions from NIH format:

11 point/Arial/ 0.5 inch margins throughout.

Number pages at bottom and lines continuously in 6 point type

Double space instead of single space

Sections.

Abstract: One double spaced page

Specific Aims: 2 pages double spaced. Usually 2 but no more than 3 Specific Aims.

Narrative: 2-3 sentences on one page

Research Strategy: 12 pages double spaced including all figures, but not references. Research Strategy should be organized into the following sections:

- a) Significance
- b) Innovation
- c) Research Plan, including the following sections.
- d) Timetable (brief)
- e) Background (note: a general background can be given or a background can be included for each Specific Aim)
- f) Preliminary Results (note: preliminary results can be combined into one section or they can be included for each Specific Aim)

For each Specific Aim, describe hypotheses, rationale for choice of experimental plan, experimental plan, expected results and interpretations, pitfalls and alternative approaches, future directions.

References: No page limit, but usually <10 pages double spaced. Use Journal of Bacteriology or Journal of Virology (ASM) format.

E. Evaluation of the written proposal

For their evaluations of written proposals, committee members will be asked to consider the following questions:

1. Background and significance.
 - a. Has the student stated clearly the specific questions and hypotheses?
 - b. Does the student have a firm grasp of the research that has already been done that is relevant to his or her specific questions and hypotheses?
 - c. Has the student made clear how the proposed research will contribute toward answering the specific questions and testing the hypotheses that he or she has proposed?
2. Experimentation and interpretation.
 - a. Are the proposed experiments designed well?
 - b. Are these the experiments that the student ought to be doing?
 - c. Has the student considered and thoughtfully discussed different plausible outcomes of the experiments?
 - d. How well has the student related likely experimental results to the specific questions and hypotheses that the experiments were meant to address?
 - e. Is it likely that the proposed research will be completed within four years?

F. Outcomes of evaluation of written proposal

Each member of the advisory committee will provide written comments on the proposal. The chair of the committee will compile these comments and reach a consensus with the committee on the outcome.

The comments and the outcome will be shared with the student and their mentor. The chair must decide between the following three outcomes:

- a. **Accept.** The proposal is acceptable and the student may proceed to scheduling their oral defense.
- b. **Modify.** The proposal requires modification but students may proceed to scheduling their oral defense. The student should submit a revised proposal within 3 weeks. The revised proposal should be written so as to address the reviewers' comments and suggestions. The format and the length of the proposal must still conform to the guidelines for the original proposal. The revisions will be assessed as part of the rubric at the oral exam and so must be taken seriously.

In addition, the students revising the proposal should provide a concise point-by-point response to each comment made by all reviewers, similar to a response to reviewers when revising a research manuscript. There is no page limit to this document, however this document is not an opportunity to provide additional information that cannot fit in the proposal; the proposal must still stand on its own. This document is simply meant to summarize the changes made to the proposal and briefly explain any deviation from reviewer suggestions. Students are encouraged to seek advice from their advisors on how to concisely craft this document.

- c. **Reject.** The proposal is unacceptable. This will be considered as the first failed attempt at completing the thesis proposal exam. The student will have the option of completely rewriting their proposal. The re-written proposal should be submitted within 3 weeks.

G. Format of the Proposal Defense

The proposal defense will be conducted like a committee meeting except that there need not be any inclusion or discussion of an individual development plan. The committee and student will convene on the agreed-upon defense date. Prior to the defense, the student will be asked to step out of the room and the committee will confer on issues of greatest importance to be evaluated. At this point, the mentor will provide their assessment of the student to the committee as indicated on the rubric in Appendix E. The student will be invited to rejoin the committee and the student will present their proposal.

The oral defense of the proposal will require the student to, (i), place their research in the appropriate context within the field, (ii), demonstrate excellent background knowledge, (iii), understand and defend the logic of experimental flow, (iv), demonstrate awareness of potential shortcomings in the proposal and provide alternative approaches, (v), think on their feet and engage in constructive scientific discussion with their committee. The Doctoral Advisor will be present during the oral defense but will remain silent. The chair or any other member of the committee is empowered to temporarily adjourn the meeting and ask the advisor to remain silent during the meeting. In extreme circumstances, the advisor will be asked to leave.

The committee may interrupt at any point to ask questions. The meeting will conclude when the committee is satisfied and the student will again be asked to leave the room. At this point, the advisor will also leave the room. The advisor will not provide their thoughts on the performance of the student during this defense. The committee will evaluate the student using the rubric included in Appendix E. The committee will confer and decide whether the student passes or fails. The student will be invited to rejoin the committee and the Prelim Committee Chair will inform the student of the outcome of the exam. The advisor will not be present in the room for this portion of the prelim. Instead, the advisor and the MGPD will be notified of the result by the Prelim Committee Chair. The rubric, which may be a combined document from the committee must be shared with the student, the advisor and the program director at this time.

H. Outcomes of Oral Examination

Students will be informed of the outcome of the examination after the oral examination. The committee must decide between the following two outcomes:

- a. **Pass.** The student's performance is adequate. If so, the student will have officially progressed to candidacy for a doctoral degree. The Prelim Committee Chair's responsibilities are now over and the chair of the Graduate Advisory Committee reverts to the Doctoral Advisor.
- b. **Fail. The student's performance is judged to be inadequate. This is considered to be one failed attempt at completing the thesis proposal exam.** If this is the student's first failed attempt, the student will be invited to retake the oral exam. The timing of this retake and a due date for a revised proposal, if deemed necessary, will be decided by the student's advisory committee in consultation with the student's mentor within 7 days of the failed exam. This information will be shared with both the student and the Microbiology graduate program director. The retake must be completed no later than the end of the 5th semester of study.

If a student has failed the thesis proposal exam two times (2 unacceptable written proposals, 1 unacceptable written proposal and 1 inadequate oral defense, or 2 inadequate oral defenses), they will be dismissed from the PhD program. If the student feels that the action of the Graduate Advisory Committee has been incorrect due to a procedural flaw in the examination process, the student may submit a written petition to the Microbiology Graduate Program Director and the Director of Graduate Studies.

APPENDIX D: PRELIM EXAM SCORESHEET

Written Prelim Evaluation Form

Student: _____

Score 9-10 Above Average

7-8 Average

Examiner: _____

3-6 Below Average

1-2 Poor

Paper #	Score	Comments
Total		

APPENDIX E: PROPOSAL DEFENSE RUBRIC

Student: _____ Score*: 9-10 Above average
 7-8: Average
 Examiners: _____ 3-6: Below average
 _____ 1-2: Poor

Criteria for evaluation	Score	Notes
Mentor's view of effort in lab and the quantity and quality of preliminary results collected#		
Has collected sufficient, interpretable preliminary data to support the stated hypothesis or goals§		
Sound knowledge of relevant literature including literature from the lab		
Clear statement of key questions and hypotheses		
If revision was required, properly addressed the committee's comments on the proposal		
Understands the methodology/techniques used or to be used		
Recognizes the importance of the proposed research		
Is able to work with the committee to accurately address questions		

* At the committee's discretion, a below average or poor ranking in any single category could result in a failure of the exam

#, Discussed by mentor and examination committee when student is not in the room

§, Determined independently from what the mentor thinks

Outcome: Pass/Fail

Comments:

APPENDIX F: SUMMARY OF COURSEWORK NEEDED FOR MICROBIOLOGY MAJOR AND SUGGESTED ORDER

Course Requirements

The Microbiology program requires a total of 90 credit hours. Of these, 22.5 credit hours (21 credits if Responsible Conduct of Research workshop is taken to fulfill the Ethics requirement) come from the Core Program course work listed below. Most Advanced Courses are half-semester 1.5-credit hour courses in areas requested by students. Each student must also take Grant Writing and Research Ethics and Career Development courses. Students also typically do research rotations in three different labs during the first semester, after which they identify a lab in which to do their thesis research and form their advisory committee.

The courses that make up the 22.5 credit hours for the Microbiology major are indicated below. Other appropriate courses may be substituted in their place with permission from the Advisory Committee and the Microbiology Graduate Program Director. Any changes described here to course requirements can (but do not have to) apply retroactively.

Major Course Requirements

- * BIOL-M511 Molecular Biology of Prokaryotes (3.0 cr)
- *BIOL-M541 Virology and host responses (3.0 cr)
- *BIOL-M585 Microbial Genetics and pathogenesis (3.0 cr)
- BIOL-L523 Critical Analysis of Scientific Literature (1.5 cr)
- BIOL-Z620 Grant Writing (1.5 cr)
- BIOL-Z620 Ethics and Career Development (1.5 cr) or Responsible Conduct of Research workshops offered through the Offices of the Vice Provost for Graduate Education and Health Sciences, Research Compliance, and the Vice Provost for Research.
- BIOL-M500 Research rotations (3.0 cr)
- BIOL-L500 Independent study (3.0 cr)
- Elective Advanced Course work - Z620, one or more biochemistry course, one or more bioinformatics courses, or other relevant coursework (6.0 - 9.0 credits)

*Only one of these courses needs to be completed for the major

Suggested order

Fall year 1.

BIOL-L523 Critical Analysis of Scientific Literature (1.5 cr)

BIOL-M500 Research rotations (3.0 cr)

Elective Advanced Course work - Z620, one or more biochemistry course, one or more bioinformatics courses, or other relevant coursework to help. Electives may be taken to strengthen background (e.g., M550-Microbiology) to increase depth of knowledge. (3.0 – 6.0 credits)

Spring year 1

M541 Microbial pathogenesis and Virology (3.0 cr)*

M511 Molecular Biology of Prokaryotes (3.0 cr)*

(*Only one is required for the major but many students will take both to prepare for the preliminary exam)
Students looking to increase their background knowledge in virology might also consider M430-Virology.

Fall year 2

BIOL-L500 Independent study (3.0 cr)

Elective Advanced Course work - Z620, one or more biochemistry course, one or more bioinformatics courses, or other relevant coursework. Electives may be taken to strengthen background to increase depth of knowledge (3 - 6 credits)

Spring year 2

Z620 Grant Writing (1.5 cr)

L524 Ethics and Career Development (1.5 cr)¹

Elective coursework (flexible, can be taken at any time, usually after 2nd year)

Electives you might want to consider this coming year:

Z620 – Introduction to Genomics and Bioinformatics

M550 – Introductory Microbiology

M430 – Introductory Virology

M440 – Medical Microbiology: Lecture

M460 – Microbial Evolution

M480 – Microbial and Molecular Genetics

M511 – Molecular Biology of Prokaryotes

M525 – Microbial Physiology and Biochemistry

B511 – Biochemistry

Z620 - Med Microbio and Med Immunology

Z620 - Digital Imaging: Light Microscopy

Z620 - Quantitative Biodiversity

Z620 - Virus Fundamentals

L586 - Advanced Cell Biology

L500 - Independent Study

¹ This course may be substituted by ethics workshops offered by the University Graduate School and the Vice president of Research ethics. If so, the students require a total of 22.5 credit hours

Note that additional coursework toward a Minor needs to be completed. The number of credit hours required for each Minor can vary and is determined by the program administering the Minor. The same course cannot be counted toward a major and a minor.

APPENDIX G: COMMITTEE MEETING REQUIREMENT AND PROCEDURE

- Critical in-depth analyses, discussion of data, and plans for the overall research project are crucial for the development of any research program. Both preparation for the meetings and thoughtful feedback by committee members help students to: 1) avoid or minimize the pursuit of unproductive lines of investigation; 2) produce careful and thorough studies; and, 3) think critically and creatively about interpretations and possible future directions.
- Each student must have at least one committee meeting each academic year starting in the 2nd year of graduate school.
- For each student, the first meeting must occur before the end of the Fall semester in the 2nd year of the program.
- Students will write and defend their thesis proposal in the summer between year 2 and 3 of graduate school. Defense of the thesis proposal can count as a committee meeting. This meeting will occur over the summer between 2nd and 3rd year and must be completed before the start of the Fall semester of the 3rd year. Please refer to instructions for preliminary exam for details.

How to schedule committee meeting

1. Email to identify a range of weeks that your committee members are available BEFORE sending a specific poll (e.g., WhenIsGood, Doodle)
2. Pick one week that is open for all members (including the PI) and send a poll. WhenIsGood is usually better to identify overlapping availability. Alternatively, use a Doodle poll with two-hour time slots. If a common time is not available, try another week later in the semester
3. Once date/time is set, reserve a room (and projector if needed) and email the entire committee the final date/time/place

How to prepare for committee meeting

1. Complete your IDP document and meet with your advisor to discuss this document. Edit as needed following this discussion. The student does not need to complete an IDP before they meet with the committee to defend their thesis proposal.
2. Write a pre-committee meeting report
 - i. Limit: 2 pages of text. You should include key figures and references and these do not count toward the page limit.
 - ii. Label your PDF file: NAME_pre-committee meeting report_YEAR
 - iii. The document should include introduction, data and future directions.
 - iv. It is expected that as a student progresses through graduate school, preliminary evidence presented early in his or her career will be replaced by data.
 - v. At the 4th year committee meeting, if the student has not already submitted or published a first-author paper, the student should be prepared to discuss a plan for submission of a manuscript.
 - vi. If the committee meeting is a 6-month meeting, where the student is proposing that the committee will give them approval to schedule a defense of their doctoral

dissertation, the report to the committee will be more detailed. Here, the student should submit an outline of their dissertation document including subsections to be included in Introduction and Discussion sections and the Data chapters to be included. Because, submission of at least one Data chapter is required to schedule a defense, it is expected that at this point, the punchline of the paper is known and there is a defined plan to complete the remaining figures without the need for new assay development and excessive troubleshooting.

3. This report should be shared with your mentor at least 7 days prior to the meeting, edited as needed, and sent to the committee at least 3 days prior to the meeting.
4. Prepare a presentation with an outline similar to your report.
5. Depending on your mentor's preference, you should practice your presentation with your peers in the laboratory, senior members of the laboratory, or your mentor.

What to do after committee meeting

1. Summarize committee comments in post-committee meeting document
 - a. Limit: 1 page
 - b. Your report should include a short 3-4 sentence summary of progress you reported and indicate difficulties encountered. Include what key suggestions were made by your committee.
 - c. Label your PDF file: NAME_post-committee meeting report_YEAR
 - d. Get report approved by your advisor
2. Send post-committee meeting report to your advisor, your committee, and the graduate office.
3. Complete [Google form](#) for committee meeting to help graduate program director and graduate advisor track whether you had your required annual committee and if you completed an IDP each year.

APPENDIX H: PROGRAMMATIC REQUIREMENTS FOR MICROBIOLOGY PHD DEGREE

A doctoral degree in Microbiology is earned by scholarly productivity and is not simply an award to students for completing a number of years in graduate school. As part of their training, students should gain both breadth and depth in field of Microbiology (as evidenced by passing both phases of the preliminary exam), conduct research, answer important scientific questions, and should learn how to communicate their science (with presentations at local talks, conferences, and in written form with manuscripts). To ensure that a uniform standard is met, we have set minimal criteria that each student must attain.

Committee members are tasked with the responsibility of ensuring that the following criteria are met before students schedule a defense of their doctoral dissertation. Students must:

1. Complete required coursework (refer to Microbiology handbook for the year you started in the PhD program) and maintain a GPA of 3.2
2. Complete requirements for selected minor
3. Pass phase I and II of the Microbiology prelims
4. Serve as an Associate Instructor (AI) for a minimum of one semester and receive a satisfactory performance evaluation
5. Complete an Individual Development Plan (IDP) prior to their first committee meeting in the 2nd year of the program. The student should continue to update their IDP prior to meeting with their committee each year after they have passed phase II of the Microbiology prelim.
6. Hold a committee meeting each year (First meeting is Fall of year 2 and at least once each academic year in subsequent years)
7. Present their research progress to the microbiology faculty and students (e.g. a Microphiles presentation) at least once by the end of year 4 in the program. This presentation should be greater than 30 min in length.
8. Present their research as a poster or talk at a regional, national, or international conference. Presentation at the Microbiology retreat is not sufficient to fulfill this requirement.
9. Hold a 6-month meeting and obtain approval from the committee to schedule a dissertation defense.
10. Publish or submit at least one first author primary research paper before doctoral dissertation is submitted to the committee.
11. Beyond these general expectations, the specific components of each dissertation will be determined by the candidate, their mentor and the dissertation committee.

*Note that reaching these standards does not guarantee that a student will be allowed to defend. We expect that most students will exceed these requirements.

Explanations for requirements 3-9 are below:

Preliminary exams:

The Preliminary Exam serves to distinguish students who have successfully made the transition from purely academic study to independent learning, are adequately prepared for research, and are making adequate progress toward a thesis. The two phases of prelims in biology test both the breadth and depth of the student's knowledge in Microbiology.

Teaching requirement:

Learning to teach others is an important part of graduate training. Thus, each student must teach (by serving as Associate instructor) at least one semester during his/her graduate career. The student should take this task seriously, work with the instructor effectively, and earn at least a satisfactory evaluation for their teaching. In addition, it is expected that graduate students participate in the research training of other students and personnel in their laboratories.

Individual Development Plan (IDP):

An IDP provides a template to identify annual academic and scientific goals and progress, professional development needs, and career objectives for graduate students. In addition, the IDP serves as a vehicle for communication between the graduate student and his or her mentor (PI).

Yearly Committee meeting:

Critical in-depth analyses, discussion of data, and plans for the overall research project are crucial for the development of any research program. Both preparation for the meetings and thoughtful feedback by committee members help students to: 1) avoid or minimize the pursuit of unproductive lines of investigation; 2) produce careful and thorough studies; and, 3) think critically and creatively about interpretations and possible future directions.

Presentation to the Microbiology Program:

A venue such as the Microphiles series allows student to gain experience practicing their presentation skills, including answering questions. Moreover, since the audience is fairly diverse, students can learn how to present to a broad audience. Finally, this forum offers opportunities for the student to receive feedback and suggestions from Microbiologists (faculty, staff, and students) that do not serve on the students' advisory committee.

Presentation at a regional, national, or international scientific meeting:

Presentation at a major scientific meeting is an important part of a student's training. It helps help familiarize students with the research in their field and meet other researchers. It is also an opportunity for the student to learn how to talk about and defend their research to a professional scientific audience. The networking opportunities at such meetings will increase opportunities for the student to transition to the next phase of their scientific career.

Publication requirement:

Publication of a first-author paper indicates that a student is capable of solving a biological problem and is able to take a study to completion. It is also important to consider that the stated single publication requirement is a minimal programmatic bar for the Ph.D., and a strong doctoral career will consist of greater levels of productivity. It is expected that most dissertation documents will contain a minimum of three major data chapters, each of which will constitute a publishable unit of research.

APPENDIX I: PROCEDURE FOR SCHEDULING AND DEFENDING DOCTORAL DISSERTATION.

1. Identify a date where your entire advisory committee will be available for your dissertation defense. This must be done before your defense is announced by the University Graduate School (UGS). It is best to start this process as soon as the committee agrees that you are ready to write and defend your thesis (*i.e.* immediately after the 6-month meeting)
2. Ensure that a room is available both for your dissertation defense public talk and the post-presentation defense to the committee. When possible, Microbiology students should schedule their public defense talk during a regularly scheduled research presentation such as “Microphiles” which is held on Fridays at 12:40 PM.
3. UGS requires that your dissertation defense announcement is made through them at least 30 days in advance. The procedure to make this announcement is described [here](#).
4. The UGS has specific requirements for formatting your dissertation document. The student should carefully read and follow [these](#) instructions.
5. The student should discuss with their mentor an acceptable timeline for providing a draft of the dissertation document.
6. The student should submit a draft of the dissertation document to their mentor for reviewing and editing at least 60 days prior to defense. It is the responsibility of both the student and mentor to meet this deadline. In many cases, the advisor will request that the dissertation be submitted to them chapter by chapter.
7. The mentor should submit an approved dissertation document to the entire committee at least 30 days prior to defense (note that this deadline is a UGS deadline and a committee member reserves the right to refuse to be present for your defense if this deadline is not met). The student should be cc'd this email.
8. The student will not be allowed to defend without timely submission of a complete dissertation document.
9. Defend your thesis.
10. Incorporate corrections and suggestions provided by the committee, if this has not been done prior to the defense.
11. Obtain signatures on cover page
12. Submit dissertation to UGS using the procedure described [here](#).

APPENDIX J: FORMAT FOR DOCTORAL DISSERTATION FOR MICROBIOLOGY PHD

Each doctoral dissertation must meet the formatting [requirements](#) set by the University Graduate School (UGS). Keeping these requirements in place, each Microbiology graduate student writing their doctoral dissertation should include these sections in their dissertation.

1. Title Page
2. Acceptance Page
3. Abstract
4. Table of Contents
5. Introduction

This chapter should present an overview of the field in a way that sets up the rationale for the students' thesis research. Recommended length for this section is ~12 pages of double spaced text. The background should be appropriately referenced.

6. Data Chapters

As indicated in the minimal requirements documents, each doctoral dissertation must contain at least one data chapter that contains research that is ideally, already published or at least submitted as a first author publication by the student. We expect that most doctoral dissertations will contain at least three data chapters, each of which will equate to a publication in the immediate or near term.

Each data section should contain a short introduction, materials and methods (sufficiently detailed to be useful to future laboratory members), results, discussion and references. All data chapters should contain publication quality images and figure legends.

If the student includes data from a submitted, in press, or published manuscript that also contains work performed by other laboratory members or members of collaborating laboratories, the student should clearly state how they contributed to the study (i.e., indicate which experiments were done by the student, whether the student contributed to the writing, analyses, etc).

7. Conclusions and future directions

This chapter summarizes the contribution of a student's work. This section should discuss how their contribution changed the field and impacted the line of study. It should identify new questions that were raised by their contribution. Finally, future directions that are of interest and can be pursued by other members of the laboratory should be identified and approaches that may be taken to pursue these directions should be discussed. Recommended length for this section is ~10 pages of double spaced text. The section should be appropriately referenced.

8. Appendices

If the student has obtained data that are interesting and potentially useful to the laboratory but are too preliminary or do not pertain to the main subject of the doctoral dissertation, they may be included in this section using the format of the other data chapters.

9. Student CV.

APPENDIX K: RESOURCES FOR STUDENTS

Department resources

Katie LaPadula/Tracy Bradley/Chelsea Silverman

- For almost all questions about academics and AI stuff, especially see Katie

James ‘Jake’ McKinlay

- Microbiology Graduate Program Director

Heather Reynolds

- Biology Director of Graduate Studies

John Patton

- Microbiology Section Associate Chair

Your faculty mentor

- If you aren’t connecting with the one you were ‘assigned’, find someone else informally. However, keep in mind that your thesis advisor likely expects to be your mentor.
- Find multiple faculty mentors, especially helpful when choosing your thesis committee

Your graduate student mentor

- Ask questions, hang out, make lots of friends; good for advice, protocols, reagents, etc.
- Note: after your first year, there are fewer and fewer options to meet other students

Microbiology Graduate Student Association (MGSA)

- Contact mgsa.iub@gmail.com to get connected

Establishing your support group

Graduate Student life at IU

<http://www.indiana.edu/~gradlife/>

Women in Science

<https://beinvolved.indiana.edu/organization/WinSIU>

Society for the Advancement of Chicano/Latino and Native American Scientists:

<http://www.indiana.edu/~sacnas/>

La Casa Latino Cultural Center

<https://lacasa.indiana.edu/>

Neal Marshall Black Culture Center

<https://blackculture.indiana.edu/>

LGBTQ+ Cultural Center

<https://lgbtq.indiana.edu/>

When times are extra-tough

Counseling and Psychological Services (CAPS)

- <http://healthcenter.indiana.edu/counseling/index.shtml>

Sexual Assault Crisis Service _____

<http://stopsexualviolence.iu.edu>

Student Advocates Office

<https://studentaffairs.indiana.edu/student-advocates/>

Writing/Funding

Grad Grants Office

- <http://www.indiana.edu/~gradgrnt/>
- Training to navigate grants.gov
- Tips on searching for your own funding (in and after grad school)

National Science Foundation Pre-doctoral Graduate Fellowships

- <http://www.nsfgrfp.org/>
- Early deadlines (November of your first year) mean you should apply right away

National Institutes of Health Pre-doctoral Graduate Fellowships

- <https://researchtraining.nih.gov/programs/fellowships/f31>
- Eligible to apply once you join a lab, the earlier you start the better

Department of Energy, Office of Science, Graduate Fellowship Program

- <https://science.osti.gov/wdts/scgsr>

Other Professional Development

Career Services

- <https://cdc.indiana.edu/>

Center for Innovative Teaching and Learning

- <https://citl.indiana.edu>

Expectations of Training Faculty: Microbiology Graduate Program

The primary privilege of being a Training Faculty Member as part of the Microbiology Graduate Program is to participate in the training and mentoring of Microbiology Graduate Students. This training and mentoring includes interaction with students during recruitment, if the students are applying to Microbiology, hosting rotation students during their first year, as well as placement of students in Training Faculty laboratories.

Expectations of Microbiology Training Faculty

Training faculty are expected to:

- have an active research program that is deemed consistent with the training goals of Microbiology and/or adds to the strengths of the program.
- have an active grant or other funds, or reasonable expectation to obtain an active grant, to support students financially should they join their laboratory. We expect training faculty to support their students through a variety of ways including RA-ships, supporting travel to conferences, funding their research, providing financial support during the summer, and covering publication costs.
- help graduate students complete PhD and graduate in a timely manner (usually within 6 years) and help students apply for and secure extramural fellowships.
- be willing to serve on prelim committees and graduate advisory committees for students within the program.
- participate actively in the Microbiology seminar series and weekly training seminars (MicroPhiles).
- engage in service to the section, as needed, and as audited by the section associate chair.
- have a good record of retention and graduation of students, as evaluated by the DGS, GPD, and the Graduate Program Recruitment Committee.

Training faculty shall retain their appointment as long as they are fulfilling their obligations to the section and remaining in good standing. Otherwise, such faculty must be reappointed by majority vote of the faculty section.