TEXAS WOMAN'S
UNIVERSITY

STUDENT GUIDE TO GRADUATE PROGRAMS IN BIOLOGY

A Resource for Students in the Doctor of Philosophy in Molecular Biology, Master of Science in Biology, and the Professional Science Master in Biotechnology Degree Programs offered through the

Division of Biology

in the

School of the Sciences

of the

College of Arts and Sciences

at

Texas Woman's University

Mission for the Division of Biology, School of the Sciences, College of Arts and Sciences,
Texas Woman's University

A. Mission:

At the Texas Woman's University Division of Biology, our goal is to promote a thorough understanding of the processes of life, its evolution, and its diversity. We prepare students for careers or advanced graduate studies/professional training in the biological sciences.

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I. Overview

The Division of Biology at TWU offers graduate degrees in Biology, Biotechnology, and Molecular Biology. ***Biology*** is the science of life, and ***Biotechnology*** is the use of biological processes for applied industrial purposes that improve people's quality of life, such as the production of antibiotics, biofuels, pest-resistant crops, etc. ***Molecular biology*** is the discipline that studies mechanisms underlying the flow of genetic information, ranging from the one-dimensional sequence of nucleotides in DNA to the three-dimensional structures of proteins, as well as the processes involved in their formation, degradation, and regulation. Such knowledge is critical for understanding normal biological functions and for adapting or modifying them for useful purposes, such as treating or preventing disease arising from genetic or biochemical disorders. The rapid pace of conceptual and technological advances, coupled with the potential significance of new discoveries in modern biology, fits well with the University's overarching goals of expanding the domain of knowledge and cultivating engaged leaders and global citizens.

The major objectives of the graduate programs in the Division of Biology are to help students develop their creative potential and to prepare them for careers in research, teaching, and application in the biological sciences. Individual programs of study are designed to develop independent and critical thought as well as broad knowledge and technical skills, through formal and informal courses, laboratory experiences, seminars, and original research that forms the basis for the student's thesis or dissertation.

II. Degrees Offered

A. Doctor of Philosophy (Ph.D.) in Molecular Biology

The Ph.D. degree is the terminal degree for professional scientists who seek positions as Principal Investigators that design, execute, and direct independent research projects; Supervisory positions in research, industry, or clinical settings (e.g., managers, analysts, medical scientific liaisons); or other positions where a terminal degree is needed (e.g., scientific curation, instruction at non-research institutions, consulting). At TWU, the doctoral degree in Molecular Biology is a federated program of the Federation of North Texas Area Universities (the Federation). The three core institutions in the Federation are TWU, the University of North Texas, and Texas A&M University at Commerce. Students in the federated program may enroll at their home institution in courses offered at the other Federation institutions.

The heart of the Ph.D. training program is an original and creative research project that forms the basis of the doctoral dissertation. The intermediate attainment of a master's degree is not required but is possible during the path to completion of the Ph.D. (see below). Students complete a series of required advanced core courses during their first two years. A minimum of 90 credit hours (or 60 post-MS credit hours) is required. The specific course of study is decided in the first semester of enrollment in consultation with the Head of Research and Graduate Studies in Biology and is updated as necessary when the Advisory Committee is established

(later to be expanded into the Dissertation Committee). The Qualifying Examination (also known as the "quals") for the Ph.D. degree is typically undertaken near the beginning of the third year. For this exam, each student writes a 10-page research proposal and defends it before an examining committee. After successful completion of the Qualifying Examination, the student becomes a Candidate for the doctoral degree once the Graduate School receives and approves the Request for Admission to Candidacy Form. Thereafter, research progress is evaluated at least annually by the Committee. Typically, 5-7 years are required to complete the requirements for the Ph.D. degree, per standards of the field, but the degree should be completed within eight years of starting the program (see the TWU Graduate School policy).

B. Master of Science (M.S.) in Biology

The M.S. degree connotes evidence of advanced knowledge of the field and capability in performing biological research. Students who complete this degree are prepared for careers in government, industry, or teaching at the college level. The Division of Biology offers two types of M.S. degree programs: a thesis-based program, consisting of a minimum of 30 hours of coursework, research, a written thesis, and a final examination (Thesis defense); or a non-thesis-based program, consisting of a minimum of 30 hours of coursework, a written Professional Paper, and a final examination (Professional Paper Defense). For students intending to continue in the doctoral program, the writing of the thesis or professional paper and certifying final exam should occur during the student's second year in the program. The specific course of study is decided within the first semester of enrollment in consultation with the Head of Research and Graduate Studies in Biology and is updated as necessary when the Advisory Committee is established (three faculty members; chaired by the thesis or professional paper advisor) in the first year of study. Typically, at least two years are required to complete the requirements for the M.S. degree and may take three years (or longer in some cases) for some thesis-based degrees, depending on research progress.

C. Professional Science Master (P.S.M.) in Biotechnology

The M.S. in Biotechnology is a designated Professional Science Master (P.S.M.) degree. The program is distinctive in that it provides specialized training in both science and business to produce students with marketable skills that are in demand in the burgeoning biotechnology industry. The program consists of 30 hours of coursework and an internship experience with an approved industry partner. The specific course of study is decided within the first semester of enrollment in consultation with the Graduate Program Director. The P.S.M. degree can be completed in two years, or within one year through an accelerated program.

III. Elements of the Graduate Training Program

A. Doctoral Program in Molecular Biology

Students in the Ph.D. in Molecular Biology program complete both **coursework** and original biological research with defined **milestones**. Coursework includes required core classes,

Research Tools, weekly attendance at Journal Club and Seminar, and elective coursework. Milestones include a 1st year paper, a 2nd year paper, a Qualifying Exam, a Prospectus, a fourth-year Work-in-Progress (WIP) seminar presentation, and a written dissertation with oral defense. Milestones are evaluated by an advisory committee consisting of the faculty mentor plus additional faculty (see *Choosing an Advisory Committee* below). Students are required to schedule a yearly meeting with their committee, that can include the above milestones, until degree completion.

1. Choosing an Advisor (with optional Mini-Rotations Program)
   In the first semester of enrollment, the new graduate student should identify a member of the Biology Faculty that is also a full member of the Graduate Faculty who would agree to be the student's advisor [also referred to as mentor or Principal Investigator (PI)]. An **Advisor Selection Form** should be submitted by the end of the first semester of study.

   The student may choose to participate in our Mini-Rotations Program (using the **Mini-Rotations Selection Form;** includes further details on the program). During the 1st 2 weeks of the 1st semester of study, students will select up to 3 faculty with whom to do a 4-week long rotation each to aid in selecting an advisor.

2. Choosing an Advisory Committee
   Students should then select an initial advisory committee in consultation with their faculty advisor. For the first two milestones (1st year paper, 2nd year paper), the committee will consist of a total of three faculty members (two must be from the Division of Biology faculty) — the faculty advisor plus two additional faculty members. The student and advisor should consider faculty members whose research is in areas complementary to the student's chosen topic or who are likely to make helpful contributions based on their scientific knowledge and technical experience. It is the student's responsibility to contact faculty and request that they agree to serve on the advisory committee. An **Advisory Committee Selection Form** should be submitted early in the second semester of study and prior to the Preliminary Exam (1st year paper meeting).

   For the Qualifying Exam, normally taken within the third year in the program, the committee should be expanded to include a total of five faculty members — the original three members plus two additional faculty members. At least one member of the committee must be from outside the Division of Biology at TWU or outside the university and at least 3 members must be graduate faculty from the Division of Biology. The outside faculty member should agree to attend regular committee meetings. Committee members from institutions outside TWU must be approved by the Graduate School by assessment of a current curriculum vitae submitted by the advisor when they request the addition of the outside committee member. A **Doctoral Committee Selection Form** should be submitted following successful completion of the Pre-

Qualifying Exam (2nd year paper meeting) and prior to the Qualifying Exam (3rd year paper meeting; "quals"). Following the Qualifying Exam it is the students responsibility to submit the Request for Admission to Candidacy Form to the Graduate School.

It is generally expected that the members of the student's committees will remain the same throughout the program. In the event of retirement, health issues, or other unforeseen circumstances that lead to a faculty member being unable to participate in committee meetings, a suitable replacement may be chosen by the student with guidance from the advisor and/or Head of Research and Graduate Studies in Biology.

3. Coursework (A complete listing of all courses is found in Appendix A).

   a. *Core Courses.* The core course requirements for the Ph.D. in Molecular Biology are:

   - BIOL 6513 Molecular Biology
   - BIOL 6334 Advanced Cell Biology
   - BIOL 6734 Advanced Genetics
   - CHEM 5613 Advanced Biochemistry I

   b. *Research Tools.* In addition to the core courses, the Graduate School requires completion of two Research Tools. A "Tool" is a concentration of coursework (minimum of 6 credits) in an area that will aid the student's research. The most common tools for the Molecular Biology Program are the Research Methods tool and the Scientific Communication tool as noted below (students choose two of the three tools, taking the two courses within each tool). Other options may be available with approval from the faculty advisor and committee.

   i. Research Methods
   - BACT 6534 Advanced Molecular Techniques I (offered fall)
   - BACT 6544 Advanced Molecular Techniques II (offered spring; prerequisite BACT 6534)

   ii. Scientific Communication
   - BIOL 5293 Advanced Scientific Communication
   - BIOL 5123 Biostatistics (offered fall)

   iii. Statistics
   - MATH 5573 Statistical Methods I (offered fall)
   - MATH 5583 Statistical Methods II (offered spring)

   c. *Journal Club and Seminar.* These courses are standard in most graduate programs in biological sciences and enable students to develop communications skills. In addition to the core course and the research tools, Ph.D. in Molecular Biology students must complete a minimum of three enrollments in each course.

   - BIOL 5681 Seminar in Biology*

- BIOL 5611 Readings in Biology**

*Seminar in Biology is the weekly division seminar series. The seminar series provides opportunities to hear about current discoveries by leading scientists from around the nation and the world. When taking the course for credit, students must provide a written summary and critique of the seminar presentation. Students are expected to attend the seminar series on a regular basis (each fall and spring semester) and must take the course for credit three times before graduation. The students can be exempt from attending the seminar during the last semester of their dissertation writing.

**Readings in Biology is the weekly division journal club. The seminar series provides opportunities to hear about current literature as students present, discuss, and critique recent primary papers. When taking the course for credit, students must provide an oral presentation and critique of a recent primary article. It is generally advised that students not register for the course in their 1st semester of graduate work. Students are expected to attend journal club on a regular basis (each fall and spring semester) and must take the course for credit three times before graduation.

d. *Dissertation.* Students should be enrolled in Dissertation at two points during the graduate program, as noted below. Enrollment in three hours of dissertation is considered to be full time enrollment.

- BIOL 6983 Dissertation (Prospectus):
  Students enroll in this course while they are writing their Prospectus. **All required coursework must be completed and the Qualifying Exam passed before a student may enroll in BIOL 6983.** The **Request for Admission to Candidacy Form** must be submitted and approved by the Graduate School prior to registering for BIOL 6983. May be taken up to two times (6 credit hours total) if needed.

  Students must submit the Prospectus to the Committee a minimum of two weeks prior to the date of the Prospectus meeting. Following a successful defense of the Prospectus, the student must submit the final prospectus to the Graduate School. The student will then return to taking Research in Molecular Biology courses (BIOL 6821, BIOL 6823, BIOL 6831, BIOL 6833) until the student has been cleared by the Dissertation Committee to enroll in BIOL 6993.

- BIOL 6993 Dissertation (Final Dissertation):
  Students enroll in this course while they are writing their final dissertation document. **Students must gain the approval of their Committee before**

enrolling in this course. The student should convene a Committee Meeting to present all the results of their research to the committee members (known as the Results Meeting). At the Results Meeting, the methods and results chapter(s) should be presented (written and oral) as a complete story with publication-quality figures and rigorous statistical analysis. If the committee finds the body of work insufficient or the quality of the data presented to be unacceptable, then the student may be asked to complete additional experiments or analyses before approval to enroll in BIOL 6993 is granted. Based on the Results Meeting, a student's committee may recommend that the student meet with the committee prior to the defense for the purpose of reviewing and providing feedback on a draft of the dissertation (called a Document Meeting). If this meeting is required, students will prepare a complete draft of the dissertation and submit it to their research committee two weeks prior to the meeting.

Once the student has been cleared by the committee to complete the dissertation document, students will write their final Dissertation document, detailing the results of their doctoral research. Ultimately, the work will be presented in a public seminar called the Dissertation Defense, to also include a closed meeting of the Dissertation Committee where the student will defend the work to the committee. The student should complete the Dissertation document and share it with the committee a minimum of two weeks prior to the Dissertation Defense. Students must be enrolled in BIOL 6993 Dissertation in order to hold their dissertation defense. May be taken up to four times (12 credit hours total) if needed. Committee approval is required for the first enrollment only. It is the responsibility of the student to frequently refer to the Graduate School website for Degree Completion and Graduation Deadlines per semester. All students are required to complete the **Student Exit Form** found at PIR.TWU.edu before their last day at TWU.

i. Grading for BIOL 6983 and BIOL 6993: The possible grades for Dissertation are:

- CR — credit
- PR — progress
- LP — lack of adequate progress
- NP — no progress

Students enrolled in BIOL 6983 will receive a grade of CR if they: 1) successfully defend the Prospectus; 2) submit their Prospectus to Graduate School; and 3) receive approval for the Prospectus from the graduate school.

If a student makes adequate progress (e.g., is actively working on the Prospectus, but does not submit the Prospectus and obtain approval notification from the Graduate School), they will receive a grade of PR (progress). The student would receive a grade of CR for the enrollment in BIOL 6983 and this course will be applied to the degree. Please note that a grade of PR/LP/NP will not count toward degree hours on the transcript (but will count towards the max 99 credit hours for in state tuition) until the faculty has submitted a Change of Grade Form to the Registrar to change the grade to a CR.

For BIOL 6993, students who are making satisfactory progress toward completion of the written dissertation may be awarded a grade of PR, if they are actively writing and have not completed the dissertation. Because students can enroll in BIOL 6993 a maximum of four times, they can receive a grade of PR for the first three even without completion of the dissertation, if the faculty advisor confirms there has been adequate progress toward completion. ***In cases where there is little or no progress, grades of LP or NP will be assigned. A student who receives three grades of LP or NP will be disqualified from the program. Please note that students who receive a grade of LP or NP are expected to make an appointment with their advisor and develop a course of action towards degree completion.*** If the dissertation is not completed and defended during the fourth enrollment in BIOL 6993, the student will receive a grade of either PR, LP, or NP depending on their level of progress and will be required to obtain permission from the School of the Sciences Director to enroll in BIOL 6993 again. Upon successful completion and defense of the dissertation, the grade will be converted to CR. Students are encouraged to complete the dissertation within 1–3 semesters of enrollment in BIOL 6993. No more than twelve credits total of BIOL 6993 may be applied to the doctoral degree.

e. *Elective Coursework*

A minimum of 90 hours is required for the Ph.D. in Molecular Biology. In addition to the above requirements, students may choose other elective courses (by recommendation and in consultation with their committee) or register for research credit. Research credits should be taken at the 5000 level during the first two years (30 hours) of the program, then 6000 level research hours should be taken thereafter. Courses may include, but are not limited to:

- BIOL 5033 Advanced Science in the Secondary Classroom
- BIOL 5123 Biostatistics (unless counted as Tool)
- BIOL 5293 Advanced Scientific Communication (unless counted as Tool)

- BIOL 5333 Advanced Pathophysiology
- BIOL 5503 Research Methods
- BIOL 5543 Genome Editing and Medical Ethics
- BIOL 5643 Neuroscience
- BIOL 5663 Biology of Cancer
- BIOL 5801 Biological Research
- BIOL 5803 Biological Research
- BIOL 5881 Biological Research
- BIOL 5883 Biological Research
- BIOL 5903 Special Topics[#]
- BIOL 5973 Professional Paper
- BIOL 6843 Health Care Genetics
- BIOL 6821 Research in Molecular Biology
- BIOL 6823 Research in Molecular Biology
- BIOL 6831 Research in Molecular Biology
- BIOL 6833 Research in Molecular Biology
- BIOL 6903 Special Topics[#]
- CHEM 5623 Advanced Biochemistry II

[#]Special Topics courses cover emerging issues or specialized content not represented in the main curriculum. Past special topics have included: Electron Microscopy, Genome Editing and Medical Ethics, Immunology, Plant Ecophysiology, Programming for the Biologist, and Signal Transduction.

f. *Sample Schedule of Coursework and Milestones for the Ph.D. Molecular Biology Program:*

Special Considerations to note:

(1) this is only one possible degree plan and there are many options available depending on the individual student's needs, goals, experience, etc. Students should consult with the faculty advisor, committee, and the Head of Research and Graduate Studies in Biology to determine an appropriate degree plan.
(2) 60 hours post-M.S. is required to earn the Ph.D. in Molecular Biology and a maximum of 99 credit hours is allowed for in-state tuition and a GA/GTA/GRA position. Excessive hours in BIOL 6993 (12 hrs. max) will not count as hours towards degree.

Sample Degree Plan for the Ph.D. in Molecular Biology

Year	Fall	Spring	Summer	Credits
1	BIOL 6513 Molecular Biology BACT 6534 Adv Mol Tech I BIOL 5681 Seminar *Mini-Rotations Program (optional)* *Forms Due! Mini-Rotation Form & Advisor Selection Form*	BIOL 6334 Adv Cell Biology BACT 6544 Adv Mol Tech II BIOL 5801 Research *Preliminary Exam (1st year paper)* *Forms Due! Advisory Committee Selection Form & Annual Student Performance Evaluation*	BIOL 5803 Research BIOL 5883 Research *Complete Preliminary Exams if needed*	**23**
2	CHEM 5613 Adv Biochem BIOL 5293 Adv Sci Comm BIOL 5611 Journal Club	BIOL 6734 Adv Genetics BIOL 5611 Journal Club BIOL 5681 Seminar *Pre-Qualifying Exam (2nd Year Paper)* *Forms Due! Annual Student Performance Evaluation*	BIOL 5803 BIOL 5883 OR BIOL 5973 Pro Paper *Forms Due! Certificate of Completion (for MS Pro Paper)*	**39-42**
3	BIOL 6831 Research BIOL 5123 Biostatistics BIOL 5611 Journal Club BIOL 5681 Seminar *Complete Qualifying Exam (3rd year paper)* *Forms Due! Dissertation Committee Form & Annual Student Performance Evaluation & Admission to Candidacy Form*	BIOL 6983 Dissertation (Prospectus) *Add BIOL 6823 if took BIOL 5973 last summer *Defend & Submit Prospectus* *Forms Due! Annual Student Performance Evaluation & Prospectus Cover Sheet*	BIOL 6823 BIOL 6833 Research *Complete Prospectus if needed*	**57**
4	BIOL 6823 Research BIOL 6833 Research	BIOL 6823 Research BIOL 6833 Research *Work-in-Progress (WIP) Seminar* *Forms Due! Annual Student Performance Evaluation*	BIOL 6823 Res BIOL 6833 Res	**75**
5	BIOL 6823 Research BIOL 6833 Research	BIOL 6823 Research BIOL 6833 Research *Results Meeting* *Forms Due! Annual Student Performance Evaluation*	BIOL 6993 Dissertation *Complete and defend Dissertation* *Forms Due! Certificate of Completion for Dissertation*	**90**
6	(BIOL 6993 Dissertation) *(Complete and defend dissertation)*	(BIOL 6993) *(Complete and defend dissertation)*	(BIOL 6993) *(Complete and defend dissertation)*	**(99)** *Max hrs. reached*

4. Milestones

These are program requirements that may not be tied to a specific course but measure proficiency with skills like reading and understanding primary literature, synthesizing original ideas and testable hypotheses, designing controlled experiments, and written and oral communications. Milestones are evaluated by a committee consisting of the faculty mentor plus additional faculty. The student is responsible for scheduling committee meetings and work with the Biology office to schedule a meeting space. Students should expect to give faculty a 30-day advance notice and several day/time options to determine availability (Doodle Poll and When2meet are recommended free scheduling tools). Students should be registered when completing each milestone and are encouraged to complete milestones during the Fall and Spring semesters (avoid trying to convene committee meetings during winter break and June/July). An Annual Student Progress Evaluation should be submitted following each committee meeting and milestone attempt.

The milestones for the Ph.D. in Molecular Biology are listed here and described in further detail on the following pages:

- Preliminary Exam (1st year paper)
- Pre-Qualifying Exam (2nd year paper)
- Qualifying Exam and Prospectus (3rd year paper)
- Work-in-Progress (WIP) Seminar Presentation (4th year)
- Dissertation Results Meeting (5th year)
- Dissertation Defense (5–6th year)

a. Preliminary Exam (1st year paper)

The goal of this activity is to help the student attain a strong grasp of the current literature on their chosen research topic and to help develop scientific writing skills. The student will produce a short literature review describing the current state of the field and identifying potential gaps to be filled with the thesis/dissertation research. The preliminary exam consists of both the written paper, which should be submitted to the committee a minimum of two weeks prior to the scheduled Preliminary Exam meeting, and an oral presentation. During the meeting, the student will demonstrate knowledge of the primary literature and ability to identify possible research directions with a brief presentation and by answering questions posed by the committee.

The student and faculty mentor will select a general topic for investigation. The topic should align with the dissertation project plans and be within the interests and capabilities of the advisor's existing research program. It should encompass sufficient literature to allow the student to synthesize the relevant background and

identify scientific questions that have yet to be answered. The student will meet with the assigned faculty advisor at least three times during the semester:

1. During the first week of the semester, the research topic will be identified, and the faculty mentor will provide guidance on how to conduct a literature search and read scientific papers. Committee membership should also be discussed at this time, and the student should then invite two additional faculty members to serve on her or his committee.
2. At the end of the first month in the semester, the student will submit an outline of her or his literature review paper and a list of references consulted up to that point in time. The faculty member will provide constructive criticism and guidance for improving the work.
3. At the end of the second month in the semester, the student will submit a rough draft of the literature review paper with a bibliography to the advising faculty member, who will again provide guidance and critical feedback.

At the end of the semester and at least two weeks prior to the scheduled presentation, the student will submit the completed document (electronic or hard copy), which should be a succinct review of the literature that identifies 1–3 scientific research questions raised during the literature review. The literature review paper should be 5-7 pages total, not including references or figures (which are highly encouraged and should be in an addendum) formatted with 1" margins, 12 pt. Font, and having line spacing of 1.5-2 lines. The document should include page numbers. The paper should be carefully proofread and be free of spelling and grammatical errors before submitting it to the advisory committee.

The student will give a 10–15-minute presentation on their first year paper, which may include PowerPoint slides. The presentation and document will be assessed by the Advisory Committee of three Biology faculty. The committee will rate the document as acceptable or unacceptable based on the divisional rubric for assessing presentation (rubrics are included in Appendix 2 of this document). The student may be given the option to resubmit the document in the case of an unacceptable rating. If the first-year paper is not deemed acceptable by the committee after three attempts, the student may be dismissed from the program (see below — Policies pertaining to completion of program milestones). Students can expect this meeting to take approximately 1 hour. The student is responsible for scheduling committee meetings and work with the biology office to schedule a meeting space.

Pre-Qualifying Exam (2nd Year Paper)

The purpose of this milestone is for the student to expand their literature review (1st year paper) to include 2–3 original specific aims with basic experimental design. The

goal is for the student to gain experience identifying methods that can be used to answer scientific questions. The proposed aims should provide new knowledge to the field and should be developed and conceived by the student. Students should not use faculty grant proposals or copy previously published experiments to design their experiments. Adjusting known methods to address the proposed experiments is acceptable. This document will serve as the foundation for the proposal to be defended as part of the Qualifying Exam and the Prospectus.

The 2nd year paper is a 8–10-page written proposal (not including references or figures, which are highly encouraged and should be in an addendum) that contains both a literature review and proposed experiments (with 2–3 specific aims). It should be formatted in the style of a grant proposal (such as to the National Institutes of Health or the National Science Foundation) and include sections such as Specific Aims, Background and Significance, Innovation and Approach (experimental design), and some Potential Pitfalls and Alternatives. It should be formatted with 1" margins, 12 pt. font, have a line spacing of 1.5-2 lines, and include page numbers. As with the 1st year paper, the student may discuss their ideas with the faculty mentor to gain critical feedback, but the work should be the based on the student's own thoughts and ideas. For a proposal with three aims, for example, it is expected that Specific Aim 1 is developed with the faculty mentor, Specific Aim 2 developed largely by the mentee, and Specific Aim 3 developed rather independently of the faculty member to illustrate to the committee growth in scientific thought. Specifically, students may seek feedback from their faculty mentor when they are developing their ideas, after producing an outline with a list of references consulted to that point, and after an initial draft of the document.

The student will provide the advisory committee with an electronic or hard copy of the written document two weeks in advance of the Pre-Qualifying Exam meeting. At the meeting, the student will give a 20-25-minute oral presentation on the proposed research which may include PowerPoint slides, and the student will answer questions from committee members. The committee will rate the document and oral presentation as acceptable or not acceptable using the rubrics for presentations (included in Appendix 2 of this document). The student may be given the option to resubmit the document in the case of an unacceptable rating. If the 2nd year paper is not deemed acceptable by the committee after three attempts, the student may be dismissed from the program (see below — Policies pertaining to completion of program milestones). Students can expect this meeting to take approximately 2 hours.

Students may elect to have the M.S. in Biology conferred as an intermediate milestone on the way to the Ph.D. in Molecular Biology. The M.S. in Biology (Professional Paper) may be awarded with successful completion of the Pre-

Qualifying Exam (the 2nd year paper will serve as the Professional Paper) and 30 hours of coursework that includes BIOL 5973 Professional Paper, BIOL 6513 Molecular Biology, and two semesters each of BIOL 5611 and BIOL 5681. The track to awarding of the M.S. degree is included as an option in the degree plan table depicted above. Students who wish to receive the M.S. degree must apply for graduation and submit the required Graduate School paperwork (Certificate of Completion form).

b. *Qualifying Exam and Prospectus*

This milestone consists of two parts: a written **Qualifying Research Proposal** (which will serve as the basis for the *Prospectus*) and an **Oral Qualifying Exam**. To advance to Candidacy, students must propose a well-rationalized research project in the format of a grant proposal that demonstrates application of knowledge obtained from their coursework thus far. The proposal must also display comprehensive knowledge in their research area. It should be developed from the 2nd Year paper, considering feedback from the Advisory Committee, and contain the student's original thoughts and ideas. The written proposal should be formatted according to the Prospectus Formatting and Submission Guide. Specifically, the proposal should be 8–10 pages in length (excluding figures and references which are highly encouraged and should be in an addendum) formatted with 1" margins, 12 pt. font, double spaced, with page numbers, and should include the following:

- Background & Rationale
- Hypothesis and Specific Aims
- Experimental Design
- Possible Outcomes and Interpretations (including alternative hypotheses and approaches)
- Potential Pitfalls (include strategies to mitigate risk)
- Implications and Significance of proposed work

The student will provide the Dissertation Committee with a copy of the proposal at least two weeks in advance of the Qualifying Exam meeting. The paper should be carefully proofread and be free of spelling and grammatical errors. For the Oral Qualifying Exam, students will give a brief, 20–25-minute PowerPoint presentation describing their Qualifying Research Proposal, and answer questions that require the student to apply their knowledge in the core areas of Molecular Biology, Cell Biology, and Genetics, and in their specialized research area. Students may present some Preliminary Data in their presentation. However, this should not resemble a Results meeting. The presentation should focus on the proposed experimentation. Students may solicit feedback from their advisor on one draft of their Qualifying Exam paper and PowerPoint presentation prior to submitting the paper to the

committee and giving the presentation. Students can expect this meeting to take approximately 2 hours.

To be eligible to take the Qualifying Exam, a graduate student must have completed all required courses including both research tools and be in good standing (GPA= 3.0 or higher). The Qualifying Exam may be taken while the student is enrolled in their final semester of required coursework. Upon successful completion of the Qualifying Exam, the student must apply for candidacy by submitting the Request for Admission to Candidacy Form to the Graduate School. The form must be submitted to and approved by the Graduate School before the student can enroll in BIOL 6983 Dissertation. Students who do not pass either or both the oral and written parts of the Qualifying Exam may have a second attempt to be attempted no later than the next semester of enrollment. Should the student fail to pass either section of the exam on the second attempt, they will be removed from the doctoral program.

After passing the Qualifying Exam, the student will enroll in BIOL 6983 Dissertation, and work closely with the faculty mentor to make edits recommended by the committee to transition the Qualifying Research Proposal to the Prospectus and to submit it to the Graduate School. The student will email the prospectus, *with changes highlighted*, to the committee no later than the Graduate School's posted Thesis/Dissertation Submission Deadline. The student will provide the committee a minimum of 5 business days to review and respond; any committee member may call a meeting and lack of response will be taken as approval of the student and advisor to complete and submit the Prospectus to the Graduate School. In cases where significant changes (as determined by the student, advisor, or any committee member) between the qualifying exam document and the prospectus were required during the Qualifying Exam, or have occurred later during the editing, the committee may request an additional meeting to discuss the Prospectus where the student will give a brief, 15–20-minute PowerPoint presentation describing their Prospectus. If the Prospectus is not submitted to the Graduate School by the end of the semester, then the student will again register for BIOL 6983 for the following semester. The student may take BIOL 6983 two times, but the student should be aware that this may be a setback in completing their degree plan within 5-6 years.

The final Prospectus should be submitted with the Prospectus Cover Sheet along with documentation of successful completion of Responsible Conduct in Research training and approval to work with animal or human subjects, if appropriate. After acknowledgement from the Graduate School that the candidacy and prospectus have been approved, the student is considered a Candidate for the Ph.D. in Molecular Biology and can proceed to completion of their doctoral research.

c. Work-in-Progress (WIP) Seminar Presentation

Approximately one year after the Qualifying Exam (ideally in the 4th year of graduate study), the student will complete a public presentation of their doctoral research in the Division's weekly seminar series. Students should contact the faculty member coordinating seminar in advance to identify available dates and ensure a majority of the committee members are available to attend. The presentation should utilize PowerPoint slides and outline the project goals, provide background and a rationale for the studies, describe the results obtained to date, and discuss additional planned experiments or directions for the project. Students are expected to dress and behave professionally in their presentation and interaction with the audience.

Students are strongly encouraged to deliver at least one practice presentation to their faculty mentor and/or lab group prior to the public presentation. PowerPoint slides should be reviewed for logical progression, grammar and spelling, consistent use of font style and size, appropriate labels on graphs, scale bars on micrographs, statistics as appropriate, and other details that convey a professional and polished scientific presentation. Following the public seminar, the student will meet with the advisory committee to solicit feedback and constructive criticism, answer questions, decide whether additional experiments are needed, and discuss potential for publication.

d. Results Meeting

To be cleared to enroll in BIOL 6993 to defend the dissertation, students must convene the Dissertation Committee to present the results of the dissertation research that has been completed. This milestone consists of two parts:

i. Written presentation in the format of the dissertation methods and results section(s) of their research as a complete story with publication-quality figures and rigorous statistical analysis. Written introductions and discussions are not required for the results meeting, but Methods and Results, including data presentation and analysis, are required.
ii. Oral presentation and discussion of the results

The Results meeting is a closed meeting with the committee and is separate from the WIP Seminar Presentation but could occur directly following the WIP presentation. The Results (including methods) section of their Dissertation should be sent to the Dissertation Committee one week prior to the scheduled Results meeting. The written document should follow the guidelines and requirements of the graduate school for dissertation (see below section e for details and links). The committee will determine whether the body of work is sufficient and either approve progression to completion of the dissertation and enrollment in BIOL 6993 or make

specific recommendations for additional experiments or analyses. The student should plan for the Results meeting to take 2-3 hours.

e. *Dissertation (enrollment in BIOL 6993)*

The final requirement for the Ph.D. in Molecular Biology is a dissertation that clearly and effectively describes the outcome of the student's original work. Approval from the Dissertation Committee is required before a student may enroll in BIOL 6993. This milestone consists of three parts:

iii. A written document with data figures and references
iv. A public oral presentation
v. An oral examination by the advisory committee

Students can expect the Dissertation Defense to take approximately 3 hours (includes both the public and closed sessions of the defense). Students are responsible for carefully formatting the dissertation according to the Graduate School Dissertation Technical Manual prior to submission. Students are encouraged to review the Graduate School's YouTube Channel for video tutorials. There are two options for the Dissertation format. The student, together with the mentor and committee, may elect to format the Dissertation in the traditional dissertation format using the "Basic Technical Manual" or may use the "Multi-Article Dissertation Technical Manual" whereby the Dissertation chapters are works that were previously published in scholarly journals or submitted to/being prepared for submission to an identified scholarly journal. The guidelines for the journal's formatting guidelines (e.g., *Cell Press*, *Journal of Immunology* instructions for authors) must be submitted to the Graduate School with the Dissertation to facilitate review by the Graduate Reader/Editor. Dissertations that use multiple formatting styles that are not Multi-Article Dissertations or are not accompanied by a set of formatting guidelines will require revision and will not be approved by the Graduate School. Students can direct questions to the Graduate Reader to ensure proper formatting of the Dissertation prior to submitting the final version to the Graduate School. Please note that the Graduate Reader will not review the entire document but will address specific questions when asked in a timely manner (typically not within one month of the deadline). After submission, the dissertation will be reviewed by the Graduate Reader/Editor, who will provide a list of revisions to be made to the student and their advisor.

The student should send the complete and correctly formatted written dissertation document with figures and references to the Dissertation Committee a minimum of three weeks before the dissertation defense. In accordance with Graduate School guidelines, a reasonably complete draft of the dissertation must be submitted to the Academic Component Administrator six weeks before the intended graduation date.

If a draft is not submitted by the deadline, the student must submit a Graduation Rollover Application to have the degree conferred the following semester. Students must be registered for BIOL 6993 in the semester in which they graduate. **It is the responsibility of the student to frequently refer to the Graduate School website for Degree Completion and Graduation Deadlines per semester.** All students are required to complete the **Student Exit Form** found at PIR.TWU.edu before their last day at TWU.

f. Policies pertaining to completion of program milestones

Efficient progress through the doctoral program requires students to complete each milestone in the required timeframe. This means that the Preliminary Exam should be completed in the second semester of the first year; the Pre-Qualifying Exam should be completed in the second semester of the second year; the Qualifying Exam should be completed in the first semester of the third year; the Prospectus should be submitted in the second semester of the 3rd year; and the WIP Seminar should occur in the fourth year. The Dissertation should be written and defended in a timely manner upon completion of the research objectives outlined in the Prospectus. Because in some cases students enroll in specific courses for these milestones, failure to complete the milestones will be reflected in course grades. When students are adequately progressing through the milestone but not yet completed the milestone, a grade of PR will be given which will then be changed to CR upon milestone completion. Should students fail to make adequate progress on the milestone, they will receive a grade of LP or NP in the course and be required to re-enroll in the course in the next semester. Should the student receive a LP or NP grade a second time for the course associated with any milestone, they will be placed on academic probation, and required to re-enroll in the course. A third grade of LP or NP will result in dismissal from the program. A student's Committee may issue disciplinary statements to the student should they fail to pass milestones that are not associated with a course grade, and these will be documented in the student's file. Should a student receive two warnings that they have missed a milestone, they will be notified that their continuation in the program is in jeopardy and failure to meet a milestone a third time may result in their dismissal from the program. Please note milestones are set to guide students through the program in 5-6 years. Failure to meet milestones will result in lengthening the time to degree completion.

B. The Master of Science (M.S.) in Biology Programs

Students in the M.S. in Biology program complete required coursework and a capstone paper. There are two options for the M.S. in Biology degree: a thesis-based program with original research thesis (M.S. in Biology Research Option), or a coursework-based program with a

professional paper (M.S. in Biology Professional Paper). Coursework for both programs must include either BIOL 6513 Molecular Biology or BIOL 6334 Advanced Cell Biology plus additional semester credit hours of courses chosen with an advisory committee to fit the needs of the student. All M.S. students must enroll in BIOL 5611 Readings in biology (Journal Club) and BIOL 5681 Seminar a minimum of two times. All candidates for master's degrees must pass a final oral examination administered by the student's Advisory Committee. The Advisory Committee for a master's degree should be composed of three graduate faculty that have obtained at least a master's degree. Should it benefit the student to have a member of the committee from outside the Division, that member's name and curriculum vitae should be submitted to the Graduate School for approval. A student should identify a faculty advisor for their committee during the first semester in the program and determine the other members of the committee in consultation with the chosen faculty advisor.

The student is responsible for scheduling committee meetings and should expect to give faculty a 30-day advance notice and several day/time options to determine availability (Doodle Poll and When2meet are recommended free scheduling tools). Students must be registered in at least a 1-hour course when completing each milestone and are encouraged to complete milestones during the Fall and Spring semesters (avoid trying to convene committee meetings during winter break and June/July). An Annual Student Progress Evaluation should be submitted following each committee meeting and milestone attempt.

1. Master of Science in Biology Thesis (Research Option)

   A minimum of 30 semester credit hours is required for completion of the M.S. in Biology Research Option. In the first semester of enrollment, the new graduate student should identify a member of the Biology Faculty that is also a full member of the Graduate Faculty who agrees to be the student's advisor [also referred to as mentor or Principal Investigator (PI)]. The student may choose to participate in our Mini-Rotations Program (using the **Mini-Rotations Selection Form**) and select 3 faculty with whom to do an informal rotation to aid in selecting an advisor and being selected by the advisor. An **Advisor Selection Form** should be submitted by the end of the first semester of study. The student will also defend a research prospectus, which is a plan for the research project, during the 2nd year (and takes the place of the 2nd year paper for MS Thesis students). The student should register for BIOL 5983 Thesis (Prospectus) while writing the prospectus, and BIOL 5993 Thesis (Defense)in the final semester of study. Students will write an M.S. thesis detailing their research project and defend it to their Advisory Committee composed of the research mentor (as Chair) and two other faculty members, typically in the Division of Biology.

   Milestones for obtaining the M.S. in Biology Thesis (Research Option) are like those for the early doctoral program. Master's students produce a 1st year paper following the same guidelines, procedures, and expectations described for first year doctoral students

in section III.A.4.a of this handbook, Preliminary Exam (1st year paper). Following the 1st year paper, the student will work closely with the faculty mentor and make edits recommended by the committee to transition the 1st year paper to the Prospectus (which takes the place of the 2nd year paper for MS Thesis students) and to submit to the Graduate School within the 2nd year. The student will provide the Advisory Committee with a copy of the prospectus at least two weeks in advance of the meeting, where the student will give a brief, 15–20-minute PowerPoint presentation describing their Prospectus. The paper should be carefully proofread and be free of spelling and grammatical errors. The student should enroll in BIOL 5983 Thesis to complete and submit the Prospectus to the Graduate School. The final Prospectus should be formatted according to the Prospectus Formatting & Submission Guide and submitted with the Prospectus Cover Sheet along with documentation of successful completion of Responsible Conduct in Research training and approval to work with animal or human subjects, if appropriate. If the Prospectus is not submitted to the Graduate School by the end of the semester, then the student will again register for BIOL 5983 for the following semester. The student may take BIOL 5983 two times, but the student should be aware that this may be a setback in completing their degree plan within 2-3 years. Once the Prospectus is approved, the student may register for Biological Research (BIOL 5801, 5803, 5881, 5883) as they conduct the proposed experiments. In the last semester, the student enrolls in BIOL 5993 Thesis and writes and defends the thesis. All students are required to complete the **Student Exit Form** found at PIR.TWU.edu before their last day at TWU.

The Master's Thesis will describe the results of original research conducted by the student. It should contain an Introduction, Methods, Results, Discussion, and References and follow the Graduate School formatting requirements using the Basic Technical Manual. As noted above, the student must provide the committee members with the thesis document at least three weeks in advance of the Defense meeting (or Pre-Qualifying Exam meeting if the student is continuing to a Ph.D.), during which the student will give a 20–40-minute oral presentation and answer questions from committee members.

a. MS Thesis Option: Core Requirements, Research, and Electives:

Code	Title	SCHs
BIOL 6513 OR BIOL 6334	Molecular Biology OR Advanced Cell Biology	3 OR 4
BIOL 5611	Readings in Biology (must be taken twice)	2
BIOL 5681	Biology Seminar (must be taken twice)	2
BIOL 5983	Thesis (Prospectus)	3
BIOL 5993	Thesis (Written Master's Thesis and Oral Defense)	3

	Electives (e.g., CHEM 5613, BIOL 5033, 5333, 5903, 5293) or research courses (BIOL 5801, 5803, 5881, 5883) as approved by committee	16–17
	Total SCHs	**30**

b. Sample Schedule and Timeline for M.S. in Biology Thesis Option:

Note that this is only one possible degree plan and there are many options available depending on the individual student's needs, goals, experience, etc. Students should consult with the faculty advisor, committee, and the Head of Research and Graduate Studies in Biology to determine an appropriate degree plan. Excessive hours in BIOL 5993 (12 hrs. max) will not count towards degree.

Sample Degree Plan for the M.S. in Molecular Biology Thesis

Year	Fall	Spring	Summer	Credits
1	BIOL 6513 Molecular Bio CHEM 5613 Adv Biochem *Mini-Rotations Program (optional)* *Forms Due! Mini-Rotation Form & Advisor Selection Form*	BIOL 6334 Adv Cell Bio BIOL 5611 Journal Club BIOL 5681 Seminar *Preliminary Exam (1st year paper)* *Forms Due! Advisory Committee Selection Form & Annual Student Performance Evaluation*	BIOL 5983 Thesis (Prospectus) *Defend & Submit Prospectus* *Forms Due! Annual Student Performance Evaluation & Prospectus Cover Sheet*	**15**
2	BIOL 5883 BIOL 5801 BIOL 5611 BIOL 5681 *Complete Prospectus milestone if needed*	BIOL 5803 BIOL 5883	BIOL 5993 Thesis *Complete and defend Thesis* *Forms Due! Certificate of Completion for Thesis*	**30**
3	(BIOL 5993 Thesis) *Complete and defend thesis if needed*	(BIOL 5993 Thesis) *Complete and defend thesis if needed*	(BIOL 5993 Thesis) *Complete and defend dissertation if needed*	**(39)**

2. Master of Science in Biology Professional Paper Option

A minimum of 30 semester credit hours is required. This degree plan is suggested for those who wish to pursue a career in teaching, health sciences, business, or other non-research scientific fields. In the first semester of enrollment, the new graduate student should identify a member of the Biology Faculty that is also a full member of the Graduate Faculty who agrees to be the student's advisor [also referred to as mentor or Principal Investigator (PI)]. The student may choose to participate in our Mini-Rotations Program (using the **Mini-Rotations Selection Form**) and select 3 faculty with whom to

do an informal rotation to aid in selecting an advisor. An **Advisor Selection Form** should be submitted by the end of the first semester of study. All students must complete 30 semester hours of coursework determined in consultation with the advisor (may include up to 6 credit hours of Research in Biology if appropriate). Electives may include chemistry, math, or education courses. Students pursuing the Ph.D. in Molecular Biology may choose to complete the M.S. Professional Paper requirements as part of the coursework toward the doctoral degree.

Milestones for obtaining the M.S. in Biology Professional Paper are similar to those for the early doctoral program. Master's students produce a 1st year paper following the same guidelines, procedures, and expectations described for first year doctoral students in section III.A.4.a of this handbook, Preliminary Exam (1st year paper). The student continues to enroll in courses as advised by their committee and enrolls in BIOL 5973 Professional Paper (which serves as the 2nd year paper for MS Professional Paper students) in their final semester in the master's program. All students are required to complete the **Student Exit Form** found at PIR.TWU.edu before their last day at TWU.

The Master's Professional Paper is essentially the 2nd year paper described under the Ph.D. in Molecular Biology milestones section. The paper is written in the format of a grant proposal (such as to the National Institutes of Health) and should be 8-10 pages in length (not including references). It should contain background information and a rationale for the proposed studies, as well as specific aims and proposed experiments. While the proposed experiments may not be carried out, the exercise demonstrates the student's ability to comprehend the literature and synthesize original ideas. The student, with the approval of the Advisory Committee and the Head of Research and Graduate Studies in Biology, may adjust the content on a case-by-case basis if the formatting requirements are met and agreed upon prior to the defense. The Professional Paper should be formatted with 1" margins, 12 pt. font, and double spaced. The document should be provided to the committee two weeks in advance of the Defense of the Professional Paper (equivalent to the Pre-Qualifying Exam meeting if the student is continuing to the Ph.D.), during which the student will give a 20-25-minute oral presentation and answer questions from committee members.

a. M.S. in Biology Professional Paper: Core Requirements, Research, and Electives:

Code	Title	SCHs
BIOL 6513 OR BIOL 6534	Molecular Biology OR Advanced Cell Biology	3 OR 4
BIOL 5611	Readings in Biology (must be taken twice)	2
BIOL 5681	Biology Seminar (must be taken twice)	2
BIOL 5973	Professional Paper (written paper and oral defense)	3

	Electives (e.g., CHEM 5613, BIOL 5033, 5333, 5903, 5293) or research (BIOL 5801, 5803, 5881, 5883) as approved by committee.	19-20
	Total SCHs	**30**

b. Sample Schedule and Timeline for M.S. in Biology Professional Paper Option

Note that this is only one possible degree plan and there are many options available depending on the individual student's needs, goals, experience, etc. Students should consult with the faculty advisor, committee, and the Head of Research and Graduate Studies in Biology to determine an appropriate degree plan. If the M.S. Professional Paper is being earned along the way to the Ph.D., then the student should follow the sample degree plan for the Ph.D.

Sample Degree Plan for the M.S. in Molecular Biology Professional Paper

Year	Fall	Spring	Summer	Credits
1	BIOL 6513 Molecular Biol CHEM 5613 Adv Biochem *Mini-Rotations Program (optional) Forms Due! Mini-Rotation Form & Advisor Selection Form*	BIOL 5903 Special Topics BIOL 5681 Seminar BIOL 5801 Research *Preliminary Exam (1st year paper) Forms Due! Advisory Committee Selection Form & Annual Student Performance Evaluation*	BIOL 5333 Adv Patho BIOL 5613 Readings *Writing Professional Paper*	**17**
2	BIOL 5293 Adv Sci Comm BIOL 5611 Journal Club BIOL 5681 Seminar *Writing Professional Paper*	BIOL 5033 Adv Sci in the Classroom BIOL 5611 Journal Club BIOL 5681 Seminar *Writing Professional Paper*	BIOL 5973 *Defend Professional Paper Forms Due! Certificate of Completion for Thesis*	**30**

3. Professional Science Master (P.S.M.) in Biotechnology

The P.S.M. Biotechnology program is a 30-credit hour interdisciplinary program that integrates scientific and business aspects of biotechnology. The program is designed for students who enjoy science, have an interest in business, and want to apply that knowledge working in industry. Our streamlined curriculum is designed with a strong foundation in molecular biology, technology, and business to create a comprehensive program that provides graduates with marketable skills and industry experience and prepares them for careers in industry. As part of the curriculum, students are required to complete an internship in the biotechnology industry with a minimum of 300 working hours. Once the P.S.M. program is completed, students interested in continuing their education can apply to the Ph.D. in Molecular Biology.

a. P.S.M. in Biotechnology: Core Requirements (12 Biology SCHs, 9 Business SCHs), and Electives (9 SCHs):

Code	Title	SCHs
Biology		
BIOL 6513	Molecular Biology	3
BIOL 5503	Research Methods (Advanced Methods in Biology)	3
BIOL 5681	Seminar in Biology	1
	Electives (e.g., BIOL 5293, 5333, 5543, 5903, 6334, 6843, BACT 6534, 6544 CHEM 5613, 5623)	9
Business		
BUS 5013	Foundations in Business	3
BUS 5933	Business Ethics and Legal Environment	3
BUS 5923 MKT 5133	Global Business OR Marketing Management (Choose one)	3
Professional Development		
BIOL 5711	Biotech Internship Seminar (taken twice)	2
BIOL 5953	Internship	3
	Total SCHs	**30**

b. Sample Schedule and Timeline for M.S. in Biotechnology†

Year	Fall	Spring	Summer	Credits
1	BIOL 5543 BIOL 5711 BUS 5013	BIOL 5503 BIOL 5711 BIOL 5293	BIOL 5953	**17**
2	BIOL 6513 BIOL 5681 BUS 5933	BIOL 5333 BUS 5923		**13**
			Total SCHs	**30**

† Note that this is only one possible degree plan and there are many options available depending on the individual student's needs, goals, experience, etc. Students should consult with the Program Director to determine an appropriate degree plan.

IV. Graduate Assistantships

A. University Supported Assistantships

The University provides a limited number of Graduate Assistantships (GAs), Graduate Teaching Assistantships (GTAs), and Graduate Research Assistantships (GRAs) for qualified students [students must be enrolled full-time (at least 5 credit hours) and in good academic standing]. Detailed rules and regulations on stipends can be found in the **TWU Graduate Catalogue** and in students can refer to the Grad School's **Graduate Assistantships Fact Sheet**. Stipends vary

according to assignment and educational level of the applicant. Students who enter the graduate program with a bachelor's degree are paid at the Master's rate until they become a candidate for the doctoral degree or accumulate 30 hours of graduate credit, at which point the student will be paid at the Doctoral Rate. Students with M.S. degrees from accredited U.S. or international institutions recognized by the TWU Graduate School, will be paid at the Doctoral Rate upon entry into the graduate program if they are directly enrolled in the doctoral program. These rates may change, please refer to the **Graduate School Graduate Assistantships** website for current pay scale information. Graduate Assistantships are part-time positions and restricted to a max of 20 hours per week (0.50 full time equivalency or FTE), as the student is expected to spend the other 20 hours a week on their coursework and research or professional paper development towards attaining the degree. Students on GA/GTA/GRA assignments should not have, and in some circumstances may be prohibited from having, additional jobs outside the University.

Students in the M.S. program are eligible for a maximum of three years of support as a Graduate Assistant. Students in the doctoral program may receive a maximum of six years of support as a Graduate Assistant. Graduate assistantships are available only to students who are registered for a minimum of 5 credit hours and the student qualifies for in-state tuition. The exception to this rule is students who are enrolled in professional paper, thesis, or dissertation (BIOL 5973, BIOL 5983, BIOL 5993, BIOL 6983, BIOL 6993). For students enrolled in any of these specific courses, three credits are considered full time, and the student is eligible for 0.50 FTE employment. During the summer, students may choose to register for 3 credit hours and be paid up to 0.49 FTE if they have had a scholarship that academic year or if they already qualify for in state tuition as a Texas resident.

Graduate Assistants (GAs) in the Biology Division typically work in support of laboratory or lecture classes. GAs who work in support of laboratory classes generally report to a Clinical Faculty member and assist in the preparation of materials, such as solutions and media, cleaning the lab, replenishing supplies between lab sections, and other routine tasks as assigned. GAs who works in support of lecture classes (>60 students) generally report directly to the course instructor and assist with copying, distributing, and proctoring exams, grading quizzes or homework, recording grades, and other routine tasks as assigned. Students will have the opportunity to provide preferences in course placements (without guarantees) using the GA Interests Form through the Head of Research and Graduate Studies in Biology.

Graduate Teaching Assistants (GTAs) generally teach undergraduate laboratory courses. A student must complete a minimum of 18 hours of graduate coursework in Biology to qualify as a GTA. For international students, minimum scores (as defined by the Graduate School) on the TOEFL or IETLS requirements must also be met. GTAs generally work as part of a team of instructors for a given laboratory course and report to the Clinical Faculty member who oversees that course. Students will have the opportunity to provide preferences in course

placements (without guarantees) using the GA Interests Form through the Head of Research and Graduate Studies in Biology.

Graduate Research Assistants or Associates (GRAs) are paid a stipend to complete research that supports the overall research program of the faculty mentor; typically supported by an external grant. GRAs report directly to the faculty mentor. Faculty with an external grant may elect to pay experienced doctoral students at the higher pay rate (up to 0.5 FTE) set for Graduate Research Associates (via grant budgeting with the Office of Research and Sponsored Programs).

A student holding an assistantship at TWU may not hold an assistantship at any other college or university concurrently. A student may hold only one 0.5 full time equivalent (FTE) assistantship, which may include multiple assignments, at TWU at any time. Assistantships are not guaranteed, and students who receive poor performance evaluations from their supervisor will not be offered additional employment.

B. Competitive Divisional Graduate Research Assistantship Awards (GRAAs)

There are limited GA positions in the summer due to decreased offering of courses that use graduate assistant support. The division employs some students in GTA or GA positions to help run these courses, and some faculty members have obtained grant funding to support GRAs throughout the academic year and/or summer. To provide some opportunity for assistantship funding, the Division of Biology offers funding [derived from the Indirect Costs (IDC) funds the Division receives from external grants] for a few Graduate Research Assistantship Awards (GRAAs) to cover the summer pay of graduate students in the M.S. Biology Thesis Option or Ph.D. in Molecular Biology programs.

To apply, students will write a short research proposal of no more than two pages and describe the product that they will produce because of the funding (a form is circulated by email and due each Spring). Students are encouraged to develop proposals that will lead to fellowship funding from the federal government or a private foundation. Applications are evaluated by the Assistantships & Course Releases Committee.

V. Graduate Program Policies

A. University-wide Graduate Policies

University policies, definitions, and appeal/grievance procedures regarding student conduct, academic dishonesty, non-discrimination, and sexual harassment are available in the TWU Student Handbook. Student responsibilities, academic review and appeals, and grade requirements are available in the Graduate Catalog.

B. Divisional Policies and Expectations

1. Transfer Credit Policy

According to Graduate School policy, no credit is automatically awarded for courses by transfer into a TWU graduate program and requests to transfer credit can only be submitted once the student has successfully completed 9 hours of coursework at TWU. Students may enroll as non-degree seeking students to take graduate coursework for a maximum of 12 credits to be transferred into a degree program. Per the graduate school, students in master's programs may transfer a maximum of 6 hours and students in doctoral program may transfer in a maximum of 12 hours and the courses must have been completed within the last six years. For graduate programs in the Division of Biology, students may petition the Head of Research and Graduate Studies in Biology for credit for didactic courses taken at other graduate institutions. There will be no transfer credit awarded for research-based courses, journal club (BIOL 5611), seminar (BIOL 5681), or life experience. **Transfer credit may be used to substitute for no more than one of the core courses.** Upon acceptance into a Biology graduate program, a student seeking credit by transfer will request this in written communication to the Head of Research and Graduate Studies in Biology. The student will supply a detailed syllabus of the course for which they seek credit along with evidence that the mentor and advisory committee approve of the courses requesting to be transferred in. The Graduate Admissions & Curriculum Committee will determine whether transfer credit and/or course substitutions will be granted to the student.

2. Professional Ethics

Graduate students are expected to strive for the highest standards of academic quality and research integrity in all scholarly activities. All students enrolled in graduate programs offered through the Division of Biology are expected to behave ethically and professionally in (a) personal and professional interactions, (b) in laboratory work and utilizing divisional resources and equipment, (c) performing duties as a Graduate Assistant (refer to the GA Rights and Responsibilities), (d) in professional presentations, research conduct, and in preparing manuscripts for publication in professional journals, and (f) in applications being prepared and submitted to granting agencies. Specific expectations in each of these areas is described below. Students are utilizing and engaging with Biology resources, including physical, personnel, and intellectual resources, while conducting research with a faculty mentor; the research outcomes belong to the Principal Investigator/mentor and TWU.

a. Personal and Professional Interactions

The integrity of science depends on all members of the community interacting respectfully and professionally. All communications with other students, staff, faculty, lab coordinators, directors, and other members of the university community

are expected to be conducted with respect and all parties should refrain from personal insults, profanity, derogatory comments, and comments that are divisive or discriminatory. Students are expected to behave collegially and respectfully, and toxic behavior such as aggressive or threatening behavior directed at others will not be tolerated. This applies to in-person conversations, phone calls, emails, texts, or any other form of communication. Biology graduate students are expected to present themselves professionally in interacting with the members of the profession and the community. This includes wearing appropriate attire in the research and teaching laboratories and wearing professional attire during presentations and when interacting with other scientists in professional settings. Misconduct may result in severe sanctions including reporting an incident to the Office of Civility and Community Standards, dismissal from the program, and in some cases, civil or criminal charges.

b. *Laboratory work*

Students may not begin working in a research or teaching lab until relevant safety training, including responsible conduct of research, chemical safety, biosafety, hazardous materials, in-person safety training, and other relevant training (e.g., working with research animals, human subjects/tissues, and/or recombinant DNA) has been successfully completed. New students should initiate the training process by going to the **Pioneer Instruments for Research (PIR) General Training** site. Some training requires refresher training, which students must complete in a timely manner when requested or access to research resources will be revoked. While working in a research or teaching lab, students should always wear appropriate personal protective equipment (PPE) for the experiment being performed. Students should determine the appropriate PPE prior to initiating an experiment through consulting the Safety Data Sheets for any chemicals with which they will be working. Anyone working in a research or teaching laboratory on campus should be wearing a lab coat and appropriate clothing to cover the skin. Hair should be tied back and loose jewelry and clothing that could be caught in equipment should be avoided. Appropriate footwear should always be worn in the lab. Shoes should be closed toe and cover the feet. Sandals are not allowed in the lab. Lab coats and gloves should not be worn outside the lab in common areas.

Students should only use equipment for which they have received appropriate training. Many pieces of equipment are extensively used in the division and require that students reserve time for using that piece of equipment. Students should be respectful of other members of the community and only reserve equipment for the time they need, begin using the equipment on time, and do not exceed the time for which they reserved the equipment. Many pieces of equipment can be reserved through the divisional Google calendars. Students gain access to these calendars

following appropriate training on the pieces of equipment. When use of the equipment and workspace is completed, the student must thoroughly clean the work area for the next user to maintain cleanliness and safety of the workspace. Should the equipment not be functioning as expected, the malfunction should be reported as soon as possible. Please refer to the **Shared Instrument Guidelines** posted on the PIR website.

Students who violate lab safety procedures endanger themselves and others. Students who fail to follow safety guidelines will be issues a warning for the first offense. In the event of a second offense, the student will be required to complete safety training again. In the event of a third offense, the student may be dismissed from the program.

c. *Professional Presentations, Research Conduct, and Publications*

As stated above, students are expected to conduct themselves professionally in interacting with the research community. This includes following all ethical standards for analyzing and presenting data and authorship. Scientists must use the highest ethical standards in preparing reports of their experiments. Failure to follow these ethical standards may result in charges of scientific misconduct. Specifically, misconduct can result from fabrication, falsification, or plagiarism. Fabrication is the addition of data points that were not derived through experimentation (making up the data). Falsification is altering and/or concealing (covering up) data to misrepresent the results of the experiments. Plagiarism results from not properly crediting sources of the information in presentations or publications, and often results in students presenting others work as their own. Any scientific misconduct may result in severe sanctions including dismissal from the program and/or criminal charges. Student researchers are also expected to follow authorship conventions as detailed in professional journals and in the discipline (see the recommendation of the International Committee of Medical Journal Editors for example). Any author on a publication or presentation should have had substantial input into the work, beyond providing technical assistance, and should have read and approved the manuscript before it is submitted for publication. Students should consult with their advisor on her or his policies for authorship inclusion and order.

d. *Use of AI Tools in Scholarly Work*

The use of generative Artificial Intelligence (AI) tools in the process of writing and presenting scholarly works (including but not limited to Professional Papers, Theses, Dissertations, 1st/2nd/3rd year milestone papers, publications, etc.) must always take place will full transparency. If you intend to use AI tools, you must work with your advisor in advance to agree on how any generative AI tools will be used. Any scholarly work that includes AI generated materials must include a clear and

complete description and citation of any generative AI tools used and specifically how they were used.

e. *Consequences for Violating Policies*

Repercussions from violating TWU or Division of Biology policies fall on a continuum from minor to extremely dangerous and expensive. Thus, sanctions also range from minor (apology requests, safety retraining) to severe (immediate dismissal from the program, criminal charges). Sanctions may be defined and applied by Advisors, Supervisors (Clinical Faculty overseeing lab courses or instrumentation), or Program Leadership (Academic Component Administrator, Division Heads). Any sanction to be issued to a student will be done in writing using the Infraction Form with notification to the Academic Component Administrator or the Division Head. Consistent with TWU policies, any student may appeal a sanction in writing within 10 business days of them receiving the sanction. The person issuing the sanction has 10 days to respond to the appeal in writing. All appeals will be evaluated by the Division Resolution Committee and decisions will be communicated to involved parties within 10 business days of the committee receiving the appeal. Please note that minor infractions are cumulative, and a history of minor infractions can lead to a more severe sanction. If there is reasonable cause to believe that a violation of university policy has occurred, the incident will be reported to the TWU Office of Civility and Community Standards. As TWU students, graduate students in the Division of Biology have the right to complain or file an appeal against a sanction as defined by the institutional policies on complaints and appeals. Details are located under Academic Affairs Administrative Complaints & Appeals.

C. Institutional Assessment and Program Evaluation

Each graduate program is routinely assessed according to student learning outcomes (SLOs) the faculty of the Division of Biology have deemed as important learning outcomes for each of the graduate programs offered in the Division. For the Doctor of Philosophy degree in Molecular Biology, the following SLOs are used to assess students' mastery of the content and processes covered in courses taken as part of the requirements for obtaining the degree. M.S. and Ph.D. students are assessed in presentations for first 1st and second 2nd year papers, and the Qualifying Exam. The journal club course (BIOL 5611) oral presentation and both written and oral presentations of the thesis/professional paper/dissertation are assessed using the assessment rubrics that are included in Appendix 2. SLOs for the doctoral program include:

- **SLO 1**: Accurately synthesize new knowledge based on advanced molecular biological concepts.
- **SLO 2**: Effectively critique current scientific literature.
- **SLO 3**: Successfully defend an independently developed research project.

The overarching goal for the M.S. in Biology Research Option and the M.S. in Biology Professional Paper programs is to prepare students for technical, academic, or supervisory careers that require advanced knowledge of biological processes. The SLOs for the M.S. in Biology programs include:

- **SLO 1**: Accurately integrate knowledge of advanced biological concepts into discipline-specific scientific design.
- **SLO 2**: Critically evaluate current scientific literature.
- **SLO 3**: Successfully defend an original scholarly project.

The Professional Science Master (P.S.M.) program in Biology is designed to better position students for careers in the biotechnology arena by educating them at the interface between Biology and Business. Thus, students receive instruction in both areas and engage in an intensive internship in a biotechnology company or academic laboratory. The SLOs for the P.S.M. program include:

- **SLO 1**: Effectively propose potential technical solutions to modern biological problems or human health challenges.
- **SLO 2**: Successfully integrate scientific knowledge and professional business concepts, principles, and ethics in the biotechnology sector.
- **SLO 3**: Compose effective written summaries and oral presentations that convey basic and applied scientific principles appropriate for an industry setting.

Appendix 1: List of All Courses

Core courses

M.S. choose BIOL 6513 or BIOL 6334; P.S.M. choose BIOL 6513; others serve as electives

BIOL 6513 Molecular Biology
BIOL 6334 Advanced Cell Biology
BIOL 6734 Advanced Genetics
CHEM 5613 Advanced Biochemistry I

Core courses specific to the P.S.M.

BIOL 5503 Research Methods
BIOL 5953 Internship
BUS 5013 Foundations in Business
BUS 5933 Business Ethics and Legal Environment
BUS 5923 Global Business OR MKT 5133 Marketing Management

Journal Club

BIOL 5611 Readings in Biology (required 2x for M.S. and 3x for Ph.D.)

Seminar

BIOL 5681 Seminar in Biology (required 2x for M.S. and 3x for Ph.D.)
BIOL 5711 Biotechnology Internship (required 1x for P.S.M.)

Tools (12 hours required for Ph.D.)

BACT 6534 Advanced Molecular Techniques I (fall only)
BACT 6544 Advanced Molecular Techniques II (spring only; prerequisite BACT 6534)
BIOL 5123 Biostatistics (fall only)
BIOL 5293 Advanced Scientific Communication
BIOL 5801 Biological Research
BIOL 5803 Biological Research
BIOL 5881 Biological Research
BIOL 5883 Biological Research
MATH 5573 Statistical Methods I
MATH 5583 Statistical Methods II
CSCI 5893 Statistical Packages II
BIOL 5903 Programming for the Biologist

Research courses (for M.S. and Ph.D.)

BIOL 5801 Biological Research
BIOL 5803 Biological Research
BIOL 5881 Biological Research

BIOL 5883 Biological Research
BIOL 6831 Research in Molecular Biology
BIOL 6833 Research in Molecular Biology
BIOL 6881 Research in Molecular Biology
BIOL 6883 Research in Molecular Biology

Capstone courses (for M.S. and Ph.D.)

BIOL 5973 Professional Paper
BIOL 6983 Dissertation (Prospectus)
BIOL 6993 Dissertation (Final Dissertation)

Electives

BIOL 5033 Advanced Science in the Secondary Classroom (not counted towards P.S.M.)
BIOL 5123 Biostatistics (unless counted as Tool; not counted towards P.S.M.)
BIOL 5293 Advanced Scientific Communication (unless counted as Tool)
BIOL 5333 Advanced Pathophysiology
BIOL 5503 Research Methods (required course for P.S.M)
BIOL 5543 Genome Editing and Medical Ethics
BIOL 5643 Neuroscience
BIOL 5663 Biology of Cancer
BIOL 5903 Special Topics[#]
BIOL 6843 Health Care Genetics
BIOL 6903 Special Topics[#] (not counted towards P.S.M.)
CHEM 5623 Advanced Biochemistry II

[#]Special Topics courses cover emerging issues or specialized content not represented in the main curriculum. Past special topics have included: Electron Microscopy, Immunology, Plant Ecophysiology, Programming for the Biologist, and Signal Transduction.

Appendix 2 Divisional Rubrics

As part of Institutional Assessment, and to evaluate the graduate programs in the Division of Biology, faculty will fill out divisional rubrics that assess student mastery of the content presented in the graduate program in which they are enrolled. The rubrics assess the extent to which students understand and can use important biological and molecular biological concepts, and their skill in presenting their results in oral and written forms. Oral presentations will be assessed when the students present in the journal club course, when they are presenting data during the defense of their professional paper, master's thesis, or doctoral dissertation, and within their final written document (professional paper, master's thesis, or doctoral dissertation). The rubrics that will be used include the following.

A. Rubric for Journal Club Presentations (1 page)

   This rubric will be used to assess presentation skills for students critically reviewing a published paper that they present in the journal club course. It is also used to provide feedback on the 1st year paper for all students, and the 2nd year paper for students in the Ph.D. program.

B. Rubric for Oral Presentations (1 page)

   This rubric will be used to assess student presentations at the time of the defense of the Professional Paper, Master's Thesis, or Doctoral Dissertation. The rubric assesses attainment of the Student Learning Outcome (SLOs) that the Division of Biology has determined students should master during attainment of the Master of Science in Biology of Doctor of Philosophy in Molecular Biology degrees.

C. Rubric for Written Documents (3 pages)

   This rubric is used to assess both master's theses and doctoral dissertations according to the SLOs that the Division of Biology uses to assess their graduate programs.

Presenter's Name:_____**Semester:** _____ **Type of Presentation: Journal Club Presentation**

Rubric for Oral and POSTER PRESENTATIONS (ADAPTED FROM TEXAS BRANCH ASM POSTER RUBRIC)

For each of the categories, assign a score of 1 through 5. Enter scores in the rightmost column.

FOCUS: CONTENT						
Evaluation Categories	**5 Outstanding**	**4 Very Good**	**3 Good**	**2 Acceptable**	**1 Unacceptable**	**Score**
*How well were the **central issue**(s) identified?*	Clear, concise, **engaging,** and thought provoking	Clear and concise	**Reasonably** clear	**Incomplete or unfocused**	No clear statement offered	Thesis
*How well **organized** was the presentation and was there proper citation?*	**Exceptional** organization, very easy to follow despite complexity or out of the presenter's area; all material **properly cited.**	Presented in logical & interesting ways; easy to follow, not oversimplified; **most material properly cited**.	Ideas presented in logical sequence; **reasonably easy** to follow; some material cited.	Evidence of **some organization** but not in an optimal order; difficult to follow; some material cited.	No clear information sequence; very difficult to follow; material not cited.	Organization
*How well was **evidence** invoked to support the work's main claims?*	**Well chosen**, detailed, **rich; very compelling**; **opposing** evidence/ alternative explanations considered & refuted	**Well chosen & detailed;** connection between argument & evidence is clear; alternative evidence/ interpretations considered	Evidence used to support the central claim(s) was well chosen with **some of detail**	Some evidence presented, but **insufficient** or not clearly supportive of the main claim(s)	No appropriate evidence was presented to support the central claim(s)	Evidence
*How well did the work draw **conclusions**?*	**Synthesizes**; brings closure; conveys real implications; suggests **new perspectives**	Synthesizes the work; brings closure; **alludes** to broader implications	**Some synthesis** but does not address implications	Conclusions are **restatement**s of previous statement(s)/ results	No apparent conclusions; no discussion of implications	Conclusions
How critical was the analysis	Presenter **identified problems** with methods / conclusions and offered **alternative methods** and; discussed potential difficulties (if present) with the overall conclusions	Presenter **noted potential difficulties** (if present) in authors methods/procedures and **offered alternatives** but **essentially accepted** the conclusions	Presenter **identified** potential difficulties (if present) in methods but offered **no alternatives;** conclusions were accepted as stated	Presenter **offered criticisms** for **minor** issues in the document but did not focus on the overall picture.	Presenter did not provide any criticism of the methods or conclusions	Critical Analysis
FOCUS: DELIVERY						
*How well did the author use the **poster or slides** for laying out info?*	Perfectly laid out; figures easy to read and appropriate to convey the story; **highly polished work**	Well laid out; **graphics add value** and impact; no redundancies	Sometimes **a bit too crowded** or sparse; **not all graphics/ figures add value**; minor redundancies	Generally too crowded or too sparse; graphics **lack clear value**; several redundancies	Poster or most slides are extremely crowded or sparse; no graphics, too small to read	Space / Layout
*How **clear** and **error-free** was the presentation?*	**Exceptionally lucid** and well written work; error free	**Clear and coherent text**; error-free	**Mostly clear**, with few lapses; one or minor typos / errors	**Some unclear** / ungrammatical passages; a few typos/ errors	Many unclear or ungrammatical passages; many typos or misstatements	Clarity / Mechanics
*How **professional** was the presenter?*	**Exceptionally** relaxed, confident, and poised, excellent use of terminology	Relaxed, confident, and poised, appropriate terminology	**Reasonably** relaxed /confident; recovered from minor lapses, good pacing	**Somewhat relaxed**; lapses in appropriate terminology, sometimes excessive speed	Seemingly ill-at-ease; high use of inappropriate terminology and mispronunciations Excessive speed	Confidence
*Overall, how well did the presentation **engage** audience?*	Exceptionally	Consistently	Moderately	Minimally	Not at all	Engagement
*How well did the presenter **respond** to questions?*	**Excellent,** concise, accurate answers to all questions	**Strong accurate answers** to majority of questions	Answered **most** questions adequately	**Attempted to answer** questions, reasonably accurate	Unable to accurately answer questions	Response
***Future** Implications*	**Excellent** proposal of future directions/experiments, thoughtful and thought provoking	**Strong** proposal of good further experiments, indicating thought	**Could/did propose** reasonable experiments when prodded	**Proposed few,** basic or obvious experiments. Re-iterated future directions from the paper only	Future implications not addressed at all, Unable to propose further experiments	Future

Rubric for Oral Examinations (oral defense or oral portion of comprehensive exam)

ADAPTED FROM ASSOCIATION OF AMERICAN COLLEGES AND UNIVERSITIES

For each of the categories, assign a score of 1 through 5. Enter scores in the rightmost column.

Evaluation Component	5 Outstanding	4 Very Good	3 Good	2 Acceptable	1 Unacceptable	Score	NA
KNOWLEDGE OF CELL AND MOLECULAR BIOLOGY (SLO1)							
Cell and molecular structure and function	Correctly answers **every** question with illustrations and examples	Correctly answers **most** questions with illustrations and examples	Correctly answers **most questions** with **some illustrations** and examples	Correctly answers **some** questions but **without** illustrations and examples	Fails to correctly answer any questions		
Control and regulation of biological functions	Correctly answers **every** question with relevant illustrations and examples	Correctly answers **most** questions with relevant illustrations and examples	Correctly answers **most questions** with **some illustrations** and examples	Correctly answers **some** questions but **without** illustrations and examples	Fails to correctly answer any questions		
Cellular and molecular interactions between organisms and their environments	Correctly answers **every** question with illustrations and examples	Correctly answers **most** questions with illustrations and examples	Correctly answers **most questions** with **some illustrations** and examples	Correctly answers **some** questions but **without** illustrations and examples	Fails to correctly answer any questions		
KNOWLEDGE in SPECIFIC SUBDISCIPLINE (SLO1)	Correctly answers **every** question with relevant illustrations and examples	Correctly answers **most** questions with relevant illustrations and examples	Correctly answers **most questions** with **some illustrations** and examples	Correctly answers **some** questions but **without** illustrations and examples	Fails to correctly answer any questions		
USES CORRECT NOMENCLATURE TO ANSWER QUESTIONS (SLO2)	Shows **sophistication** in use of language; exhibits knowledge of **proper terminology/**nomenclature	Exhibits **knowledge** of proper terminology/ Nomenclature	Needs **assistance** in recall of some nomenclature but has **good understanding**	Needs **assistance** in proper use of terminology but has **some understanding**	Does not understand or use proper terminology		
EVIDENCE OF ANALYTICAL REASONING (SLO2)	Shows evidence of ability to **logically develop** an answer to **all** questions and project beyond the information provided	Can **derive** the answer to **all** questions but does **not follow a logical** progression toward the answer; **can project beyond** the information provided	Can derive the answer to **most** questions; does **not follow a logica**l progression toward the answer; can project beyond the information provided	Can derive the answer to **some** questions; does not follow a logical progression toward the answer; **cannot project beyond** the information provided	Shows evidence only of repetition of memorized information		
COMMUNICATION ABILITY (SLO2)	Language choices are **imaginative, compelling**, and **enhance** the effectiveness of the answer	Language choices and **thoughtful** and generally **appropriate** for the answer	Language choices are **mundane** and commonplace but **appropriate** for the answer	Language choices are **mundane** and commonplace but **sometimes inappropriate** for the answer	Language choices are commonplace and in appropriate for the answer		
ORGANIZATION (SLO2)	Response to questions is **clearly organized** with **logical** transition; **clear** communication to audience	Response to questions is **sometimes fragmented** but **generally** with logical transition; **clear** communication to audience	Response to questions is **sometimes fragmented without logical** progression but mostly understandable to the audience	Response to questions is **often fragmented**, without logical progression; but mostly understandable to the audience	Response to questions is fragmented; no logical sequence; not clear to audience		
IDENTIFICATION OF PROPER PROCEDURES/ TECHNIQUES	Presenter **consistently** identified and/or understood **proper use** and **significance** of biological techniques. Presenter could **consistently design** appropriate experiments.	Presenter **generally** identified and/or understood **proper use** and **significance** of biological techniques. Presenter could **usually design** appropriate experiments.	Presenter **often** identified but **occasionally misunderstood** proper use and significance of biological techniques; could **sometime** design experiments	Presenter **occasionally** identified but sometimes **misunderstood** proper use and significance biological techniques; could **occasionally** design experiments.	Presenter could not identify and did not understand proper use and meaning of biological techniques; could not design appropriate experiments		

Rubric for Written Examinations (for written part of dissertation, thesis, professional paper, literature review of qualifying exam)

ADAPTED FROM ASSOCIATION OF AMERICAN COLLEGES AND UNIVERSITIES

For each of the categories, assign a score of 1 through 5. Enter scores in the rightmost column.

For Literature Review of Qualifying Exam and Introduction for Thesis/Dissertation — SLO2 for M.S./Ph.D. The introduction/literature review will be used twice for two different purposes for Ph.D. — for literature review on qualifying exam and for introduction/background for dissertation **for literature review.**

Component	5 Outstanding	4 Very Good	3 Good	2 Acceptable	1 Unacceptable	Score	Not applicable
Introduction /Literature Review							
Evidence	Current, comprehensive, complete; shows **superior discrimination** between relevant and nonrelevant material; shows evaluative knowledge of the primary literature; **critically evaluates** opinions of experts	Current and complete; shows **some discrimination** between relevant and nonrelevant material; shows knowledge of the primary literature; **evaluates some** opinions of experts	Current but **not comprehensive**; shows **little discrimination** between relevant and nonrelevant material; shows some knowledge of much of the primary literature; **accepts most** opinions of experts	Current but **incomplete;** shows **little discrimination** between relevant and nonrelevant material; shows some knowledge of some of the primary literature; **accepts opinions** of experts	Hastily prepared; limited in scope; neither current nor complete; shows no evaluative discrimination between relevant and nonrelevant material; shows little knowledge the primary literature; does not critically evaluate opinions of experts		Evidence
Theme/rationale	Question/theme is **clear**; develops a **concrete rationale** for the question; guides the reader **directly** to the theme/hypothesis	Question/theme is **clear**; develops a **reasonable rationale** for the question; reader can **discern** theme/hypothesis	Question/theme is **present**; rationale for the question **available** but difficult to follow; does **not guide** the reader directly to the theme/hypothesis	Question/theme is **present** but rationale is **not appropriate**; does **not clearly direct** reader to the theme/hypothesis	No theme/question; no rationale for the project		Theme/ rationale
Synthesis	Provides a **focused synthesis** of the literature; shows **excellent relationship** between the literature and the question	Provides a **mostly focused** synthesis of the literature but **some fragmentation**; shows relationship between the literature and the question	Provides a **modest synthesis** of the literature; relationship between the literature and the question is present and **is partially developed**	Provides **some synthesis** of the literature; relationship between the literature and the question **is present** but not developed	Literature is fragmented; no synthesis		Synthesis
Organization	Organized **clearly** with **appropriate transitions** across sections; cohesive organization	Organization **good** but **without clear transitions** across sections; mostly cohesive organization	Contains all the required sections but has **no transition** between sections; organized but **not cohesive**	Contains all required sections but **organization is unclear;** no transitions across sections; poor organization	Poor organization; no connection across sections		Organization
Writing Style	Uses **excellent** grammar, punctuation, and spelling; choice of language **enhances effectiveness** of the document; language is appropriate to the goal of the document	Uses **good** grammar, punctuation, and spelling; choice of language is appropriate and professional and **enhances effectiveness** of the document	Uses **good** grammar, punctuation, and spelling; choice of language is **appropriate** but does **not enhance** the goal of the document.	Uses **good grammar**, but some punctuation, and/or spelling errors; choice of language **is adequate**	Appears hastily prepared; multiple spelling, punctuation and/or grammar errors; language inappropriate or unprofessional; distracts from the content of the document.		Language/ Writing style

Rubric for Written Examinations (for written part of dissertation, thesis, professional paper, literature review of qualifying exam)

ADAPTED FROM ASSOCIATION OF AMERICAN COLLEGES AND UNIVERSITIES

For each of the categories, assign a score of 1 through 5. Enter scores in the rightmost column.

For Written Results from Thesis/Dissertation — SLO3: effectively communicate scientific results

Methods/Results	5 Outstanding	4 Very Good	3 Good	2 Acceptable	1 Unacceptable	Score	Not applicable
Experimental Design	Appropriate, **inventive, clear**; describes procedures in detail, precisely describing how data were collected and handled; attention to **relevant detail**; has good controls; applies new methods or comes up with **novel approach**	Appropriate procedures; described **in detail**, always **sufficient** for replication; good controls;	Appropriate procedures; described in detail; **sometimes sufficient** for replication; good controls;	Appropriate procedures; described in **minimal detail;** insufficient for replication; missing some controls but **data can still stand;**	Omits important information; insufficient detail; inappropriate design; no controls		Design
Execution of procedures	Shows evidence of **rigorous** data collection; **superb data quality**	Shows evidence of **good data** collection procedures; **excellent** data quality	Shows evidence of **acceptable data** collection procedures; **good data quality**	**Evidences minimally acceptable** data collection procedures; data quality occasionally **inconsistent**	Evidences sloppy data collection; much data of low quality		Execution
Handling of Data	Shows **novel insight;** always accurately **organizes data into patterns;** always **connects** patterns to hypotheses	**Consistently organizes** data into patterns; **most of the patterns** are connected to hypotheses	**Consistently** organizes data; **some data** organized into patterns; **some patterns** are connected to hypotheses	**Consistently** organizes data, though **not necessarily in patterns**; data **connected to hypotheses** but **rarely** in patterns	Shows little insight; data not organized; misses patterns in data; no connection to hypotheses		Data Handling
Analysis of Data	Done **rigorously**; **strong** statistical foundation for the analysis; **creative analytical** methods; demonstrates **excellent** understanding of statistical analysis.	**Accurate** statistical application based on **good** statistical foundation; demonstrates understanding of statistical analysis.	Accurate use of statistics; **acceptable** understanding of statistical foundation	Statistical tools used but with only **modest understanding** of statistical foundation	No analysis or use of inappropriate statistical tools		Analysis
Data Presentation	**Unambiguous** and clearly presented figures and graphs; shows **creativity** in presentation	**Unambiguous** and clearly presented figures and graphs.	**Acceptable** figures and graphs; clearly presented.	**Acceptable** figures and graphs but **not clearly** presented.	Hastily prepared; poorly presented figures and graphs; ambiguous.		Presentation

Rubric for Written Examinations (for written part of dissertation, thesis, professional paper, literature review of qualifying exam)

ADAPTED FROM ASSOCIATION OF AMERICAN COLLEGES AND UNIVERSITIES

For each of the categories, assign a score of 1 though 5. Enter scores in the rightmost column.

For SLO3 for thesis/dissertation: effectively interpret and communicate scientific results

Discussion	5 Outstanding	4 Very Good	3 Good	2 Acceptable	1 Unacceptable	Score	
Conclusions	All conclusions are **extremely clear, succinct, and complete**	Conclusions are **clear,** succinct, and complete	Conclusions are **mostly clea**r, succinct, and complete	Conclusions are **often unclear**; **not** succinct	Conclusions are not clear; not succinct; not complete		Conclusions
Interpretation	Can back up **all interpretation** with valid results; does not claim findings that are not evident from the data	Can back up **most interpretation** with valid results; does not claim findings that are not evident from the data	Can back up most interpretation with valid results but **some interpretations speculative**; does not claim findings that are not evident from the data	Can back up **most interpretation** with valid results; but some interpretation is **speculative**	Cannot back up all interpretation with valid results; claims findings that are not evident from the data		Interpretation
Synthesis /Understanding	Synthesizes and integrates **all data**; student **clearly understands** the data and their implications;	Synthesizes and integrates **most data**; student clearly **understands most** of the data and their implications;	Synthesizes and integrates **some** of the data; student understands most of the data but **not all their implications**;	Student **understands most** of the data but not all their implications; synthesizes information to a **small degree**.	Student does not understands the data or their implications;		Synthesis
Integration with current knowledge	**Excellent** use of citations and **thorough integration** of findings with the current literature	**Good** use of citations and **integration** of findings with the current literature	Good use of citations and **adequate integration** of findings with some of the current literature	**Adequate** use of citations but **minimal integration** of findings with the current literature	Improper use of citations and fails to integrate findings with the current literature		Integration with literature
Extrapolation and global significance	Shows insight into the question and **extrapolates** to future questions; shows evidence of significance beyond the specific research field; discussed **broader impact;** says something about the **societal importance** of what it means to the world at large.	Shows insight into the question and **extrapolates** to future questions; shows **evidence** of **significance beyond** the specific research field;	Shows insight into the question and extrapolates to future questions; shows **some evidence** of s**ignificance** beyond the specific research field;	Shows some insight into the question and extrapolates to future questions; shows **little evidence of significance** beyond the specific research field;	Shows no insight into the question; shows no evidence of significance beyond the specific research field; ~~did~~ does not discuss the broader impact or the societal importance of what it means to the world at large.		Global Significance
Limitations	Discusses the l**imitations** of the project and how these limitations moderate conclusions; **offers solutions**	Discusses the limitations of the project and how these limitations moderate conclusions; does **not offer solutions**	**Some discussion** of the limitations of the project and how these limitations moderate conclusions; **does not offer** solutions	**Modest discussion** of the limitations of the project and **does not offer solutions**	No discussion of the limitations of the project		Limitations