

2015-2016

**THE GUIDE TO
GRADUATE
STUDY**

IN

THE DEPARTMENT OF
MOLECULAR, CELLULAR AND
DEVELOPMENTAL BIOLOGY

University of California
Santa Barbara
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GRADUATE PROGRAMS IN MCD BIOLOGY

The Department offers the Molecular, Cellular, and Developmental Biology (MCDB) Ph.D. and M.A. Programs. The policies, procedures and requirements pertaining to these programs are outlined in this Guide, which is updated yearly by the Graduate Committee.

Students may be admitted to M.A., M.A./Ph.D., or Ph.D. programs. Admission to the combined M.A./ Ph.D. program may be sought by applicants who wish to obtain both degrees, or such admission may be granted to applicants to a Ph.D. program when, in the judgment of the Admissions Committee, they may be expected to benefit from the implied, more deliberate rate of progress. Typically, the records of such applicants show certain gaps in preparation for graduate work. M.A./Ph.D. students may petition later that the M.A. requirement be dropped (see PETITIONS). Although the M.A. program provides two options -- Plan 1 (thesis) or Plan 2 (examination) - students are admitted initially, as a rule, only under Plan 2. Students may petition later for transfer to Plan 1 (see PETITIONS).

PROGRAM STAFF AND FACULTY

Staff Graduate Advisor

Mr. Anthony Galaviz serves as the Staff Graduate Advisor for the MCDB programs (Life Sciences Building, Room 3314; phone 893-8499; e-mail mcdb-gradadv@lifesci.ucsb.edu). The Staff Graduate Advisor provides administrative support for the graduate programs: (1) interprets policies and procedures for faculty and students; (2) advises students on admission, registration, fellowships, oral examination, petitions; (3) tracks academic and TA performance and makes recommendations to the Faculty Advisor on probation/dismissal; (4) first line of support to the Faculty Graduate Advisor and Graduate Committee; (5) assigns TA appointments and offsets fees; and (6) serves as liaison with the Graduate Division, Registrar and other campus departments. The Staff Advisor should be consulted regarding student status and academic progress.

Faculty Graduate Advisor

Dr. Kathy Foltz is the Faculty Graduate Advisor (Marine Biotech/bldg 555, room 3156; email kathy.foltz@lifesci.ucsb.edu). The Faculty Graduate Advisor represents the Graduate Division and serves to implement graduate program policies. The Advisor approves enrollment plans and petitions (leaves of absence, etc., see PETITIONS). The Advisor may refer matters to the appropriate MCDB committees or faculty.

Graduate Committee

The MCDB Graduate Committee Consists of the Faculty Graduate Advisor and three other faculty members, appointed by the department chair. One of these members serves as chair of admissions. The Graduate Committee acts on behalf of the program faculty in reviewing and implementing graduate program policies. The Committee may refer matters for consideration or action by the MCDB program faculty. The Committee makes decisions on admissions into, and transfers between, graduate programs; makes recommendations for University- or Department-administered fellowships and tuition grants, and awards certain traineeship funds available to the program. When acting to set policy regarding the allocation of traineeship funds, the Committee is expanded to include the Chair of the MCDB Department. A graduate student representative, selected by the graduate students, also serves on the committee as a consultant in matters not pertaining to admissions decisions or matters involving personal information of students.

Departmental Chair

Dr. Stephen Poole is Chair of the MCDB Department.

CURRICULAR AND GRADE REQUIREMENTS

Registration. *It is the student's responsibility to complete class registration for each quarter, when due, via registration with the online GOLD system.* (Late registration incurs a \$50 fee). Students who are associated with a research advisor are expected to consult with their research advisor prior to registration. All students are expected to inform the Staff Graduate Advisor of their registration plans and consult with the Staff Graduate Advisor regarding their progress toward meeting program requirements.

Undergraduate Preparation. Students in all programs are expected to have completed the following undergraduate courses (suitable UCSB equivalents are identified in parentheses):

One year of organic chemistry, with laboratory (Chemistry 130A-B-C and 6A-B-C)

One year of biochemistry/molecular biology (MCDB 108A-B-C);

Two quarters of genetics (MCDB 101A-B).

These courses are foundational preparation for the graduate core courses. Students may be admitted with deficiencies in their undergraduate preparation but they are expected to rectify these through the satisfactory completion of specified undergraduate courses during the first year of graduate study. *Course deficiencies will be identified on entrance, in consultation with the Faculty Graduate Advisor.* Such courses will earn no credit toward any unit requirement for a graduate degree.

Language Requirement. All graduate students are expected to demonstrate proficiency with English in all written examinations. Students whose native language is not English are required, as a matter of University policy, to complete a placement examination and courses in the "English for Multilingual Students" (EMS) program until they earn an exemption from further EMS course attendance. All prospective international Teaching Assistants (TAs) are required to take the TA Language Evaluation in order to be certified for sole classroom teaching responsibility. This evaluation is conducted by faculty of the English for Multilingual Students (EMS) Program and the examinee's department at the beginning of each quarter. It requires the prospective TA to give a brief oral presentation in English and respond to questions. Students may contact the EMS program assistant for further information. The Staff Graduate Advisor should be contacted for further details.

MASTERS PROGRAMS

It is expected that all MA students will be 'full time' students and register for at least 12 units each quarter.

Plan 1 (Thesis) Program Requirements: (1) a research thesis, (2) graduate core course modules (16 units), and (3) a minimum of 30 units (core modules and elective courses) of graduate coursework.

1. Students must receive an *average* of a B or better in the core course modules given each quarter and no grade lower than a "C" in a module.
2. Students must receive a B or better in each elective course (see Appendix I for pre-approved elective course list); courses outside the department may be substituted upon prior written approval of the Faculty Graduate Advisor.
3. Up to 4 units of literature courses (e.g., MCDB 261, 265, 266, 268, 595) may be counted toward the degree unit requirement. No more than one half of the units counted toward the degree can be comprised of MCDB 596 research coursework.
4. Certain graduate lecture courses in the Interdepartmental BMSE program may count as elective courses toward the degree (BMSE 201A, 204, 205B, 207, 215, 244, 247, 251).

All required graduate lecture courses are to be taken for a grade. Units in the following courses may not be counted towards the degree unit requirement: MCDB 260, 262, 263, 269, 500, 501, and 502. Students are required to sign up for the seminars: MCDB 260, 262, 263.

Plan 1 Core Lecture Course Modules

Course Code	Course Title	Units	Quarter
MCDB 235	Experimental Strategies in Molecular Genetics	1	F
BMSE 205A	Biochemical Techniques	1	F
MCDB 229	Protein Biochemistry	2	F
MCDB 220A	Chromosomes and Cell Cycle	2	W
MCDB 220B	Cytoskeleton and Membranes	2	W
MCDB 220C	Quantitative Approaches to Transcriptomics	2	W
MCDB 230	Gene Regulation	2	W
MCDB 223	Signal Transduction	2	S
MCDB 225	Development	2	S

Plan 2 (Examination) Program Requirements: (1) graduate core course modules (16 units), and (2) a minimum of 36 units (core modules and elective courses) of graduate coursework.

1. Students must receive an *average* of a B or better in the core course modules given each quarter and no grade lower than a "C" in a module.
2. Students must receive a B or better in each elective course (see Appendix I for pre-approved elective course list); courses outside the department may be substituted upon prior written approval of the Faculty Graduate Advisor.
3. Up to 4 units of literature courses (e.g., MCDB 261, 265, 266, 268, 595) may be counted toward the degree unit requirement. Up to 6 units of MCDB 596 research coursework may count toward the degree unit requirement.
4. Certain graduate lecture courses in the Interdepartmental BMSE program may count as elective courses toward the degree (BMSE 201A, 204, 205B, 207, 215, 244, 247, 251).
5. Upper-division undergraduate lecture courses may count toward the degree with the approval of the Faculty Graduate Advisor.

All required graduate lecture courses are to be taken for a grade. Units in the following courses may not be counted towards the degree unit requirement: MCDB 260, 262, 263, 269, 500, 501, and 502. Students are required to sign up for the seminars: MCDB 260, 262, 263.

Plan 2 Core Lecture Course Modules

Course Code	Course Title	Units	Quarter
MCDB 235	Experimental Strategies in Molecular Genetics	1	F
BMSE 205A	Biochemical Techniques	1	F
MCDB 229	Protein Biochemistry	2	F
MCDB 220A	Chromosomes and Cell Cycle	2	W
MCDB 220B	Cytoskeleton and Membranes	2	W
MCDB 220C	Quantitative Approaches to Transcriptomics	2	W
MCDB 230	Gene Regulation	2	W
MCDB 223	Signal Transduction	2	S
MCDB 225	Development	2	S
Electives	At least two additional MCDB graduate lecture courses (see Appendix I for list; others approved by petition).	Variable	F, W, S

M.A. Comprehensive Examination. The comprehensive examination for students enrolled in the M.A. Plan 2 (examination) program consists of completion of core modules with an *average* of a B or better in the core course modules given each quarter and no grade lower than a "C" in a module.

Teaching Assistantships. Students with Teaching Assistant (TA) appointments must also complete the appropriate TA orientation and techniques courses (MCDB 500 and 502; taken once, without degree credit).

When serving as a TA, students also should enroll in the TA practice course (MCDB 501) for the appropriate number of units (maximally 4 units for a 50% TA ship assignment; without degree credit).

Students must maintain a 3.0 or better GPA to qualify for a TA appointment. If the GPA falls below 3.0, the student may petition for an exception to be granted.

M.A. Emphasis in Pharmacology and Biotechnology. Students pursuing an M.A. in MCDB may petition to add an Emphasis in Pharmacology and Biotechnology. The curriculum for the Emphasis in Pharmacology and Biotechnology requires that students take the MCDB core courses (16 units total). Additional units of coursework should be taken from a selection of graduate courses chosen from the MCDB, Chemistry and Biochemistry and Psychology departments. The electives are grouped into three tracks, Molecular Biology and Cell Biology, Chemistry and Biochemistry, and Neurobiology and Behavior. The tracks have been established to reflect the three traditional areas of research in the field of pharmacology and biotechnology, and serve as a guideline for students to help shape their curriculum. To complete this emphasis, students must fulfill the following requirements:

I. Emphasis in Pharmacology and Biotechnology MCDB M.A. Plan 2 program (36 units)

The curriculum for the M.A. Plan 2 Emphasis in Pharmacology and Biotechnology requires 36 units total, distributed as outlined below: MCDB core courses (16 units), elective courses (14-15 units), research internship (4 units), and literature course (1-2 units).

1) Core courses

MCDB 220A-B-C, 223, 225, 229, 230, 235, and BMSE 205A (16 units)

2) Additional Units of Graduate Courses from Among the Following

Students take at least 8 units of electives in one of the tracks, and the remainder of the electives may be taken from among any of the tracks. The intention is to keep the choice of electives as flexible as possible and to allow students to explore different areas of pharmacology. Students who have not previously completed 8 units from the courses MCDB 126A-B-C-AL-BL are required to include at least 8 units from MCDB 226A-B-C-AL-BL in their electives. (14-15 units)

Track 1: Molecular and Cellular Biology

This track is designed to provide students with a background in cell biology and immunology that will equip them with the knowledge and skills needed to identify potential drug targets and to develop antibody-based therapeutics. Recommended courses for this track include: MCDB 203, 208AL, 222, 226A-B-C, 226AL-BL, 233, 245, 246, 247, 251, 252, 253, 293

Track 2: Chemistry and Biochemistry

The Chemistry and Biochemistry specialization will expose students to the biochemistry of living systems, enabling them to validate drug targets and understand issues relating to drug delivery. Recommended courses for the Chemistry and Biochemistry track include: BMSE 201A-B, 203, 204, 205B, 207, 250, 251, 252, CHEM 241, 243, 245, 246, 261, 262A-B

Track 3: Neurobiology and Behavior

The neurobiology track is focused on providing students with an understanding of neural processes at both the cellular and organismal level. Completion of electives within this area will enable students to design experiments to characterize the action of pharmaceutical agents that alter neural activity and behavior. MCDB 251, 252, 253. PSY 215, 219, 221A-B, 231, 235, 268, 269

3) Internship.

Internship in an industry or academic laboratory will give students an opportunity to gain research experience in an industry setting. The internship is expected to last for a minimum of 10-12 weeks, and is expected to be an independent research project under the supervision of an experienced researcher at the company or academic laboratory. A report by the student is due at the end of the term, describing the research project, and the outcome. The results of the project also should be communicated with a poster and/or PowerPoint presentation under the supervision of a graduate review committee. A short evaluation of the student's performance by his/her supervisor is to be included in the student's report. (4 units of MCDB 596)

4) Graduate literature course(s)

At least one literature class (1-2 units)

II. Emphasis in Pharmacology and Biotechnology MCDB M.A. Plan 1 (Thesis) program (30 units)

The numbers listed above coincide with the numbers below.

- 1) Core courses (16 units): same as Plan 2 program
- 2) Elective courses (7-13 units): same as Plan 2 except that students are required to take a minimum of 7 units from among the tracks
- 3) Thesis research (up to 6 units MCDB 596 may be counted towards the degree)
- 4) Graduate literature course: (1 unit)

DOCTORAL PROGRAM

Brief Outline of MCDB Ph.D. Program (see Appendix II for Projected Learning Outcomes)

- **Year One**
 - ❑ Quarterly lab rotations (FWS)
 - ❑ Take MCDB core lecture courses and electives (FWS; see below)
 - ❑ Two literature seminar courses (student presentation of literature); outside seminar speaker courses (FWS) (see below)
 - ❑ TA Orientation/Techniques courses (MCDB 500 & 502)
 - ❑ MCDB 221 (Spring Quarter)
 - ❑ Decide on a dissertation advisor/laboratory by end of Spring Quarter
 - ❑ Non-CA residents are expected to CHANGE THEIR RESIDENCY STATUS to CA before classes start in Fall quarter—this needs to be submitted ASAP upon arrival in California
- **Year Two**
 - ❑ Finish any required coursework
 - ❑ Enrollment in seminar (FWS) and two literature courses
 - ❑ Take Prelim Off-topic Proposition Exam (Fall quarter)
 - ❑ Form Dissertation Committee
- **Year Three**
 - ❑ Continue enrollment in seminar (FWS) and literature courses
 - Two literature courses per year until advanced to candidacy (if advanced by end of Winter quarter, only 1 is required during third year, if advanced by end of Spring quarter, 2 are required during the third year).
 - ❑ Advancement to Candidacy
 - Submit dissertation proposal to committee, formal meeting with Dissertation Committee to present proposal
 - Advancement to candidacy upon positive evaluation by Dissertation Committee and satisfactory completion of all required coursework
- **Subsequent Years**
 - ❑ Continue enrollment in seminar courses (FWS)
 - ❑ If necessary, complete 2 quarter teaching requirement
 - ❑ Meet with dissertation committee at least once per year to evaluate progress
 - Submit short report to Graduate Program Assistant regarding the meeting
 - The committee must convene and approve the final research plan (typically 3-12 months) before defense of the dissertation.
- **Completion of Doctoral Degree**
 - ❑ Confirm all course work and teaching requirements for PhD degree are met
 - ❑ Prepare and file doctoral dissertation; enroll in MCDB 599 (instead of MCDB 596)
 - ❑ Present final defense/seminar

Required Courses for Doctoral Degree (taken *prior* to advancement to candidacy)

Ph.D. Core Lecture Course Modules

Course Code	Course Title	Units	Quarter
MCDB 235	Experimental Strategies in Molecular Genetics	1	F
BMSE 205A	Biochemical Techniques	1	F
MCDB 229	Protein Biochemistry	2	F
MCDB 220A	Chromosomes and Cell Cycle	2	W
MCDB 220B	The Cytoskeleton	2	W
MCDB 220C	Quantitative Approaches to Transcriptomics	2	W
MCDB 230	Gene Regulation	2	W
MCDB 223	Signal Transduction	2	S
MCDB 225	Development	2	S

Other Required Lecture Courses

Course Code	Course Title	Units	Quarter
MCDB 221	Preparation and Evaluation of Research Proposals	2	S
Electives	At least one additional graduate lecture course of the 200 series (see Appendix I for list; others approved by petition).	≥ 3	Variable

Required Seminar Courses (excluding laboratory group meetings)

Course Code	Course Title	Units	Quarter
MCDB 260	Research Seminar in MCDB (faculty speaker)	1	F, W, S
MCDB 262	Research Progress in MCDB (student speaker)	1	F, W, S
MCDB 263	Research Seminar in MCDB (outside speaker)	1	F, W, S
Electives	Two graduate literature courses each year until advancement to Ph.D. candidacy (MCDB 261, 265, 266, 268, 595)	Variable	F, W, S

1. Students must receive a minimum of 30 units (core course modules (16 units), elective courses, research units, and literature units) of graduate coursework in the department.
 2. Students must receive an *average* of a B or better in the core course modules given each quarter and no grade lower than a "C" in a module.
 3. Students must receive a B or better in each elective course (see Appendix I for pre-approved elective course list); courses outside the department may be substituted upon prior written approval of the Faculty Graduate Advisor.
 4. Lab rotation consists of 3 units of MCDB 596 (directed research) per quarter. In subsequent quarters, students are expected to enroll in MCDB 596, but no more than one half of the units counted toward the degree can be comprised of MCDB 596.
- All required graduate lecture courses are to be taken for a grade. Units in the following courses may not be counted towards the unit degree requirement: MCDB 260, 262, 263, 269, 500, 501, and 502.

It is expected that all Ph.D. students be enrolled as 'full time' students and earn a minimum of 12 course units each quarter, and that most of the course requirements (see below) will be completed during the first year of graduate study. All course requirements must be completed prior to advancement to candidacy.

Teaching Requirements. Departmental TA orientation/practice/technique courses (MCDB 500, 501, 502); two quarters of TA service being a degree requirement.

Academic Standards. Ph.D. students should generally register for lecture courses, literature courses, and research units for letter grades rather than S/U. In all programs, students are expected to maintain a minimum cumulative grade point average of 3.0. Failure to maintain this

average will cause the student to be placed on academic probation (according to the policy of the Graduate Division) and may lead, in extreme cases, to dismissal from the program. Also, Research and Teaching Assistants should meet the GPA standard of 3.0. Students admitted with undergraduate deficiencies must complete all required undergraduate courses, with a letter grade of B or better, during the first year of study. Students in the Ph.D. programs must receive an *average* of a B or better in all core course modules given each quarter and no grade lower than a "C" in a module, in addition to receiving a B or better in all other coursework.

Failure to meet minimum grade standards will cause the student's record to be reviewed by the Graduate Committee. Fellowship support is awarded on the basis of excellence and may be jeopardized by poor academic performance. In cases of poor academic performance, the Graduate Committee may prescribe appropriate remedial action or, in extreme cases, recommend dismissal from the program to the program faculty. The program faculty must approve a dismissal recommendation before it is submitted to the Graduate Division. The Faculty Graduate Advisor will inform a student of any decision affecting the student's status (see also PERIODIC EVALUATION OF STUDENT PROGRESS AND STATUS).

Laboratory Rotations. All entering graduate students in the MCDB Doctoral program (including M.A./Ph.D. program) who are supported wholly or in part by institutional funds (including University fellowships, teaching assistantships, traineeships, etc.) are expected to complete three one-quarter long laboratory rotations during their first year of study. For first-year students supported entirely by faculty research grants, the three rotations are not mandatory, but are highly recommended.

Laboratory rotations serve two purposes: 1) students learn first-hand about research efforts in several different areas, thus broadening a student's research perspective; and 2) they allow students and mentors to "match up" so a research advisor may be selected. Each laboratory rotation consists of 3 units of MCDB 596 under the instruction of the appropriate faculty member. Although, in principle, this translates into a minimum commitment of 15 hours per week in the research laboratory, research is the core of a doctoral training and it is assumed that students will devote much more than this to their research efforts during rotations. Grades will be assigned according to the Satisfactory - Unsatisfactory (S/U) grading system, on the basis of a laboratory meeting presentation or a written summary of the student's laboratory experience, at the faculty member's discretion.

First year students are expected to rotate in MCDB faculty members' labs. Exceptions will be considered on an ad hoc basis, and must be requested in writing at least one month in advance. Financial support to rotate in a non-MCDB lab will be determined in consultation with the graduate committee and the sponsoring faculty member.

The Staff and Faculty Graduate Advisors, in consultation with the faculty, will be responsible for assigning students to particular laboratories each quarter. Incoming students are expected to submit to the Staff Graduate Advisor their laboratory preferences in the form of a rank-ordered list of three or four names. These lists should be submitted the week before classes start for fall rotations, and no later than the last week of fall and winter classes for winter and spring rotations. Students should meet with faculty with whom they are interested in doing laboratory rotations prior to submitting their rotation requests.

During the spring quarter, Ph.D. students should initiate discussions with prospective mentors about joining their research groups for their dissertation research. All students are normally expected to decide on their doctoral research mentor by the end of their first academic year.

Ph.D. PRELIMINARY EXAMINATION

Ph.D. students must complete a preliminary examination consisting of a written research proposition followed by an oral defense of the proposition.

Examination Objectives. The aim of the Preliminary Examination is to evaluate student progress following the first year of graduate study. It is important that students have achieved specific goals that will enable them to be successful in their Ph.D. studies. These goals include:

1. Acquiring a strong foundation of knowledge in relevant disciplines.
2. Acquiring critical thinking and analysis skills vital to the basic principles of research, including the ability to develop scientific hypotheses, design experiments, and evaluate scientific outcomes
3. Acquiring skills in scientific communication, writing and presentation.

Together these skills serve as a foundation for dissertation research in which the student develops increasing independence and responsibility for the design, implementation, and analysis of their research project.

Examination date. The preliminary exam period **occurs during the first few weeks of fall quarter of the 2nd year of study, as outlined below.**

First day (Mon) of F Qtr	Beginning of exam period - journal articles made available
Wed of 1 st week of F Qtr	Final date to choose article (the earlier the better)
Wed 3 rd week of F Qtr	Written proposition due
4 th week of F Qtr	Oral exams (tentative dates)

The student must have rectified any deficiencies in their undergraduate preparation and have completed the first year core courses. Elective course requirements need not be completed before taking the exam. In the event that a student must re-take a first-year course, the preliminary exam will be deferred for up to one year until the required course work has been passed. Such deferred preliminary exams will be administered the quarter following completion of the courses.

Examination Committee. The examination committee will consist of three MCDB faculty members who are selected by the Graduate Advisor and will not include the research mentor.

Format of the Examination. The student will be evaluated on their ability to 1) critically analyze a published research paper, and 2) develop a research proposition with hypothesis and experimental aims that extend the findings reported in the manuscript. The critique/proposition will be submitted as a written document that then will be orally presented and defended to the Exam Committee.

At the beginning of the quarter, candidates will be provided with a list of specific issues of scientific journals and/or individual articles from which they will select one paper as the basis for their presentation. Candidates will forward their selection to the Graduate Advisor for approval, and will be notified shortly thereafter of the suitability of the chosen paper. If not suitable, the candidate must select another paper, which must be approved by the Graduate Advisor. Both the article and the proposition must be focused on a topic unrelated to the student's own dissertation project and different from that prepared for the MCDB Proposal Preparation class (MCDB 221). *As an expectation of ethical conduct, a student may not choose a paper that they have previously analyzed for a journal club, class or lab meeting, or one that has been analyzed at a class that they have attended.*

The exam is comprised of written and oral components. In the first half of each, the student will critically evaluate the chosen article. For the second half of the exam, students will propose a hypothesis based on the findings from the manuscript and other relevant studies in the field. They will then develop two aims for a proposal of their own to test their hypothesis. Students should emphasize development of the hypothesis, the experimental strategies devised to test the hypothesis, and interpretation of the potential outcomes.

Submission of the Proposition. Four complete paper copies of the written proposition and a PDF formatted electronic version of the paper being critiqued and the proposition must be submitted to the Staff Graduate Advisor by the proposition due date. Students who have detected a flaw in their already submitted proposition should not submit written amendments, but may discuss any revisions at the oral exam.

Written Proposition Format and Content. The written proposition is to consist of the sections described below. The proposition must be typewritten in 12 point font with 0.75 inch margins on all sides, top and bottom. Sections 1, 5 & 6 should be single-spaced; while Sections 2, 3 & 4 must be 1.5x spaced (~33 lines per page). The total length of sections 2, 3 & 4 must not exceed 8 written pages. Failure to adhere to these guidelines may result in the return of the proposal to the student.

Section 1 – Title Page and Abstract (1 page). The title page should contain:

- a) a descriptive title of the proposition
- b) the general topic area of the proposition (e.g., molecular dynamics of the cytoskeleton, plant development, mechanism of enzyme action)
- c) the name of the student's research advisor
- d) a one-paragraph description of the student's anticipated dissertation topic or research problem (even if only tentatively identifiable at the time).
- e) Abstract – the proposal abstract may not exceed 250 words. It should include background information, significance of the problem to be investigated, the hypothesis to be investigated and the general approach to be used.

Section 2 – Journal Article Critique (~3½ pages). The critique should include a concise description of the significance of the field including relevant background material and the current status of the field. Students are expected to research the topic of the paper and include a clear description of the most important previous work in the literature. The article critique should emphasize the authors' hypothesis, the principle findings of the authors, and evaluation of the authors' conclusions. The student should assess the data themselves, not merely re-state the authors' interpretation of the data, and critique it in the context of other published studies in the field. Throughout, the candidate should critically analyze the paper—were the conclusions justified by the data? Are there alternative interpretations of the data? Did the authors do the right experiments and the correct controls? How do the results compare to other studies?

Finally, the student should make a compelling argument for the direction they are proposing for further studies. A hypothesis for the proposition should be developed, and specific data that support the hypothesis of the proposition should be outlined. The rationale behind the proposed experimental approach should be described and the significance of the expected results should be discussed. All statements must be documented with references.

Section 3 – Specific Aims (~½ page). The Aims should comprise a very short paragraph describing the overall goals of the proposed research, with minimal redundancy with the Critique/Background section, followed by 2 specific aims of the proposal, which should be listed and described. Each specific aim should include a 2-3 sentence description.

Section 4 – Research Design (~4 pages). The research plan should be clearly laid out, including a description of the types of proposed experiments, their purpose and the

underlying techniques and methods to be used. The emphasis should be on experimental approach and design, with minimal description of methodological details.

Attention should be given to ensure that the aims and the possible experimental outcomes relate to the hypothesis that is proposed. In developing the proposed research plan, students should consider anticipated results and their interpretation to permit unambiguous conclusions regarding alternative hypotheses or models that are being examined. Positive and negative control experiments, possible difficulties and alternative approaches should be discussed.

Excessive experimental detail should be avoided, but the student should be prepared to discuss technical details during the oral defense of the proposition. The proposal should not include buffer composition, minute details of plasmid constructs, routine lab methods, etc. The emphasis should be on experimental design as opposed to a description of methodology.

The principal experiments should be generally described in the sequence in which they might be carried out. A flow chart may be included in an Appendix; also, the use of appropriate figures (e.g. a protein's domain structure) is encouraged.

Section 5 – Literature Cited (no page limit). A complete list of citations should be included. Each reference should be cited by number (as opposed to [author, year], for example) and must contain the full list of authors, year, the title of the paper, journal, volume and inclusive page numbers.

Section 6 – Appendix (optional; 1-2 pages). An appendix of figures/tables is permissible (4-6 figures/tables maximum). Legends must be included with all figures/tables.

Consultation on the Proposition. The purpose of the exam is to evaluate the student's ability to analyze, formulate and defend an experimental research plan. While discussion with other students, post-docs and/or faculty members is allowed and encouraged throughout the process, the final research plan must represent ideas originating from the student and the written version of the research proposal must be the **unaided** product of the student. The written proposal may not be circulated to anyone prior to its submission. However, after the proposition has been submitted, the student may enlist the help of a group of graduate students and postdocs to give a 'mock exam' to aid the student's preparation for the oral exam.

Oral Defense of Proposition. The student is expected to have a solid intellectual understanding of the research paper and of the proposition. The background should be understood fully: the student should know who the major contributors have been and should be able to critically evaluate their contributions. The student also should be able to discuss the significance of the proposal and will be expected to defend the rationale for the proposed experimental approach. The student will be expected to draw on other, relevant areas of knowledge. Precedents for the approach and the conceptual and theoretical basis for all proposed techniques should be understood.

The student also must be able to demonstrate a thorough understanding of basic knowledge relevant to the proposed research. The defense of the proposition is expected to be conducted with emphasis on the proposal itself; students should expect questions regarding basic biochemical and molecular biological principles in areas relevant to their proposal. Examination committees will assume that the student's preparedness in the broad field of molecular, cellular, and developmental biology will be commensurate with the successful completion of relevant course requirements.

The oral presentation should be a "chalk talk" at the white board, and students should be prepared to make effective use of the board. Electronic media, visuals, or handouts are not allowed. However, students may bring the manuscript being discussed, and all members of the examination committee will have access to the manuscript. The Candidate should expect that

the members of the Committee have critically evaluated the manuscript prior to the exam. The student should be prepared for interruptions to their presentation and questions throughout the exam. The oral examinations are ~1.5 hours in length.

Evaluation of Oral Examination. Immediately after the oral exam the Examination Committee will review the student's examination performance and decide whether the candidate has performed at or above the level expected of a student entering the second year of Ph.D. studies. Evaluation is based on a combination of criteria including background knowledge in the discipline, critical thinking, development of hypotheses, design of experiments, interpretation of results, understanding research methods, and clarity of presentation. The student's research advisor will then join the meeting of the Examination Committee in order to participate as a consultant in the final decision regarding the outcome of the examination. The Examination Committee will make the final decision regarding the outcome (Pass or Not-Pass) of the exam. In either case, the committee may specify that additional courses be taken. All such imposed requirements must be completed to the satisfaction of the Examination Committee prior to the assessment by the Dissertation Committee for advancement of the student to candidacy. The Examination Committee will inform the student about the outcome of the examination as soon as possible. A written summary and any advice from the committee may be provided to the student by the Examination Committee chair.

Repetition of Proposition Examination. A student who does not pass the proposition examination will be permitted to repeat the examination once, unless the student's progress in the laboratory, in course work, or in the remediation of course and language deficiencies, is also unsatisfactory. The second attempt must be made by the end of fall quarter of the 3rd year of graduate study. If the exam has not been completed by that time or if the student does not pass a second attempt, he/she will be dismissed from the Ph.D. program and automatically placed in the Master's program.

DISSERTATION COMMITTEE & ANNUAL COMMITTEE MEETINGS

During the 2nd year of graduate study, each student forms a Dissertation Committee, and is required to meet annually with their committee starting in their 2nd year. The Advancement to Candidacy assessment will take place at the committee meeting in the 3rd year of graduate study.

The Dissertation Committee consists of four members with the student's advisor as Chair (see Graduate Division guidelines for the nomination of members of the Dissertation Committee: <https://www.graddiv.ucsb.edu/handbook/doctoraldegree requirements.aspx#doctoralc>). These committees are formally appointed by the Dean of the Graduate Division, upon nomination by the MCDB Department Chair. Typically, the committee's tentative membership will emerge from a discussion between the student and the research advisor. Of course, the consent of the proposed committee members must be secured before the committee slate is submitted for nomination.

The annual committee meetings are intended to evaluate the research accomplished and to refine goals and expectations. The purpose of these meetings is to help students plan their research, provide effective feedback and support, and to help students stay on track to make normal progress toward their Ph.D. degree. The student is expected to communicate their research progress and chart a course for the next steps in the research plan. The Committee should provide informative feedback and mentoring for the student, highlight strengths and weaknesses of the studies, and help to provide a roadmap for future work.

The precise format of the meeting will be up to the Dissertation Committee, the advisor and the student. Typically the committee will expect the student to provide a short written report of their research progress and plan (~3 pages) prior to each annual meeting. The report should contain:

- A discussion of any changes in goals, specific aims, or experimental design
- A concise description of studies conducted, the results obtained, and their significance to the field (negative results or technical problems also should be described).
- Specific objectives for the coming year

Depending on committee preference, a copy of a computer presentation by the student addressing these topics may be submitted in lieu of all or part of this report.

Following each annual meeting, the student will send a brief synopsis of the meeting to each committee member summarizing agreed-upon steps for the upcoming year. The synopsis and research progress report also should be forwarded to the Faculty and Staff Graduate Advisors. If the Dissertation Committee does not approve the annual research plan, the committee can dissolve itself, and if so, the student will be subject to dismissal from the doctoral program on the grounds that the student has not shown satisfactory progress toward the degree. In this case, the research mentor is responsible for communicating to the Staff and Faculty Graduate Advisors the outcome of the meeting. In the last year of graduate study, the Dissertation Committee must convene and approve the final research plan (typically 3-12 months) before defense of the dissertation.

ADVANCEMENT TO CANDIDACY

The goal of the Advancement to Candidacy assessment is for the student to demonstrate that she/he has developed a viable dissertation project, and has achieved the independence and skills to successfully complete the project. Advancement to Candidacy will occur following a positive review by the student's Dissertation Committee. The appraisal will take place during the 3rd year of study at a formal meeting with the Dissertation Committee. The advisor, as chair of the committee, attends the meeting, but is expected to play a back-seat role in the presentation of the project, and to resist the temptation to answer questions that are directed to the student.

The emphasis of the candidacy meeting is intended to be discussion and defense of the student's dissertation proposal. It is expected that the experimental design of this project will be developed by the student in close consultation with the mentor. The student also is encouraged to discuss their project with members of their Dissertation Committee, with fellow students and postdocs, through presentations of their project at group meetings, and writing of extramural fellowship applications.

Prior to the candidacy appraisal, the student should prepare a written proposal describing the dissertation project, and submit copies to the Committee and the Staff Graduate Advisor. The proposal should include background and significance, the specific aims of the project, an outline of experiments, both planned and completed, and references. The total length should be ~8 pages maximum (excluding references), 1.5x spaced

The meeting typically will include a presentation by the student summarizing the scientific background for the project, their hypothesis, aims, the work that they have accomplished and the research directions they have planned. Students should plan to discuss the significance of their studies and defend the rationale for their approach. Students are expected to demonstrate proficiency in the background literature relevant to the field in which they are carrying out research and to present a defensible dissertation proposal together with the general experimental approaches to be used. In addition, the student should be able to think incisively and critically about experimental approaches, including recognizing potential difficulties with experimental approaches, identifying possible solutions for how to overcome them, and developing a reasonable timetable. The format of the meeting is at the discretion of the

Dissertation Committee, and usually will include a computer/projector presentation by the student, accompanied by questions and discussion with the Committee.

In the case of a passing evaluation, the Dissertation Committee will complete and sign the form recommending Advancement to Candidacy. If the Committee imposes any special requirements, the recommendation for Advancement to Candidacy will not be completed until such requirements have been met. (Filing for Advancement to Candidacy requires payment of a fee, but has a number of advantages including remission of some of a student's educational fees and eligibility for student travel awards from the Academic Senate).

PERIODIC EVALUATION OF STUDENT PROGRESS AND STATUS

Monitoring Progress of Students after Advancement to Candidacy. Following Advancement to Candidacy, students will continue to meet at least once a year with their Dissertation Committee. [These meetings should be scheduled to occur during the academic quarters](#) - students wishing to meet during Summer should consult well in advance with the members of their dissertation committee..

The performance of all graduate students will be reviewed and evaluated at least once each year by the Graduate Committee. The Graduate Committee in consultation with the Research Advisor will review problematic cases. These reviews and evaluations will focus, as applicable, on the student's 1) progress and ability in the laboratory, 2) progress and performance in courses, 3) progress toward the remedy of course and language deficiencies, and 4) performance on Ph.D. proposition examination and Advancement to Candidacy evaluation.

The Faculty Graduate Advisor, as necessary, will advise students upon completion of their first year regarding their performance. Advice to other students will be given, as appropriate, on the student's progression toward the desired degree after review by the appropriate program faculty. Such advice may include particular recommendations, notice of specific requirements as a consequence of certain deficiencies, or dismissal from the program. However, no recommendation will be made to the Graduate Division that a student be dismissed from the program without the endorsement of the Graduate Committee.

PRESENTATION OF STUDENT RESEARCH

Students who have advanced to candidacy are expected to present a yearly seminar in MCDB 262 (Friday Noon Seminar) describing their research accomplishments and goals, and to present a poster describing their work at the annual MCDB Research Retreat. Students also are encouraged to present their work at national and international meetings and conferences. Applications for funding to support travel to conferences may be made through the UCSB Graduate Division and through the MCDB department.

DOCTORAL DISSERTATION AND MASTERS THESIS

The capstone of graduate research is the dissertation, for Ph.D. candidates, and the thesis, for M.A. (Plan 1) candidates. By the completion of their studies, students will produce a written dissertation or thesis that should represent substantial new contributions to the biological sciences. The research underlying the dissertation or thesis must be conducted under the mentorship of a faculty member, the research advisor. Before the end of their first graduate year, students are urged to begin informal consultations with faculty members regarding the possibility of joining one or another faculty-led research group. The initiative for these consultations must be the student's. Faculty members welcome such initiatives and students should not perceive such consultations, especially early ones, to carry an implied commitment to the eventual establishment of a student-mentor relationship. This relationship must be

established by mutual consent and should be established only after thoughtful consideration of the several potential possibilities for research in an area of interest to the student. Such possibilities may be discovered through direct conversations with faculty members (and their graduate students and postdoctoral associates) and through formal laboratory rotations. In any case, it is understood that even a 'commitment' may be tentative and may be broken if experience does not sufficiently match the expectations of the student or faculty member.

The research advisor serves as the Chair of the student's Dissertation Committee, which is to be formed as described above. Committee members may be consulted at any time during the research phase of the student's graduate study at the discretion of the student or the committee chair. Also, committee members may inquire on their own initiative into the student's progress. An annual meeting of the student with the Dissertation Committee is required in any case. **In the last year of graduate study, the Dissertation Committee must convene and approve the final research plan (typically 3-12 months) before defense of the dissertation.**

A principal function of the Dissertation or Thesis Committee is to critically read and ultimately approve the dissertation or thesis. ***The dissertation should be carefully reviewed by the faculty advisor, and be in excellent shape before going to the committee.*** A 'clean' dissertation or thesis draft that has already received the mentor's approval then is submitted to members of the committee whose critical review may aid the student in the completion of the final product. It is the student's responsibility to ascertain that committee members will be available for reading the dissertation or thesis in a timely fashion. ***The dissertation must be given to committee members at least two weeks prior to the PhD defense seminar*** to allow sufficient time for the completion of this task. Students must advise the appropriate Staff Graduate Advisor and all members of their committees of their intent to file a dissertation or a thesis by the end of the second week of the quarter in which they intend to file.

All Ph.D. candidates must present a formally announced research seminar. After the dissertation seminar, the candidate and Dissertation Committee will convene privately for an oral defense of the dissertation. It is the student's responsibility to make the necessary arrangements for the seminar presentation, with the assistance of the Staff Graduate Advisor.

PETITIONS

As a rule, students may petition for leaves of absence, inter-program transfers, or regarding certain degree requirements. In most cases, petitions must be made on special forms to be obtained from the Staff Graduate Advisor. If a student is formally associated with a research advisor, this advisor must signify approval of any petition by signature. Finally, the Faculty Graduate Advisor must sign petitions before they can be submitted to the Graduate Division for action.

Leave of Absence. All students are expected to be 'continuously registered' unless the Dean of the Graduate Division approves a leave 'under special circumstances'. Special limitations apply to students who are not U.S. citizens: they may not apply for a leave of absence unless all of their course and residency requirements have been met or, in case of students in Ph.D. programs, unless they have been advanced to candidacy.

Adding the M.A. Program by Ph.D. Program Students. After formal admission to Ph.D. candidacy, students in a Ph.D. program may petition for a retroactive admission to an M.A. program and award of the M.A. degree Plan 2 (examination) with a minimum of 36 total units. The Faculty Graduate Advisor will act on such petitions.

Transfers Between Graduate Programs. Students may petition for transfer between Plan 1 (thesis) and Plan 2 (examination) of the Masters program, or between the MCDB and the BMSE programs. Students contemplating such transfers should first seek information regarding the

procedure from the Staff Graduate Advisor, and regarding the academic implications from the Faculty Graduate Advisor. In all cases, the student's petition should contain a concise justification for the transfer. Such petitions will be evaluated in terms of the same criteria and by the same procedures that apply to original admissions to the program into which the student seeks entry.

Transfers between Plan 1 and Plan 2 of the Masters program. Since admission into the Masters program occurs, as a rule, under Plan 2 (examination), any transfer between the two plans would typically occur from Plan 2 into Plan 1. A student seeking such a transfer should have made satisfactory progress in course work. In addition, the student's prospective research advisor must provide written support for the petition and affirm willingness to serve as the student's M.A. Thesis Committee chair.

Transfers from M.A. to Ph.D. programs. [UCSB Graduate Division policy on this matter has changed, effective Fall Quarter, 2015. The information here may change subject to final approval by UCSB Graduate Division.](#)

Students admitted to M.A. programs may apply to the Ph.D. program, under exceptional circumstances and on the basis of compelling justification. Typically, a student will have identified a faculty research adviser and enter directly into the laboratory upon admission to the PhD program. In consultation with the research faculty adviser and the Faculty Graduate Adviser, the student should plan to apply during the normal cycle (late Fall quarter) in order to be considered for admission into the PhD program and for relevant fellowships. The Graduate Admissions Committee will act upon the application, and admission will be based on the same criteria applied to applications from all other entering Ph.D. students. Successful entry into the Ph.D. programs will also depend on satisfactory progress in all graduate courses and a written letter of support by the Principal Investigator.

Dropping the M.A. Program by M.A./Ph.D. Program Students -- Students admitted to the M.A./Ph.D. program are expected to successfully complete the course requirements for the M.A. degree. Continuation in the Ph.D. program will be contingent upon the successful completion of the Ph.D. preliminary examination, as outlined above, and a letter of support from the student's mentor.

After a minimum of two quarters of graduate study, students originally admitted to the M.A./Ph.D. program may petition to drop the M.A. requirement on the basis of satisfactory progress in 'core' graduate courses and the written support of at least one faculty member. The Faculty Graduate Advisor following review by the Graduate Admissions Committee will act upon such petitions.

Transfers from Ph.D. to M.A. programs. A student in the Ph.D. program may petition for the M.A. degree instead of the Ph.D. degree. Such a petition should contain clear justification and be supported by at least one faculty member best acquainted with the student's progress in the Ph.D. program. In some cases, when a student's progress in a Ph.D. program is marginal or unsatisfactory, the student may be recommended for a terminal M.A. degree.

Transfers between MCDB and BMSE Ph.D. programs. Petitions of this nature should be made with justification and be supported in writing by at least one faculty member familiar with the student's academic performance and laboratory progress, if applicable. The Graduate Committee will act on the petition. If it is approved, the student should consult the Faculty Graduate Advisor without delay regarding program requirements. If the Committee is inclined to deny the petition, it will consult with any faculty members who support the petition and may consult also with the appropriate program faculty body before making its final decision.

FINANCIAL AID

Every effort is made to provide financial support to students in good standing in the MCDB graduate program. In the allocation of financial aid, students in good standing in the Ph.D. program are given preference. It is the student's responsibility to observe application deadlines and requirements thoroughly. Students are urged to keep informed regarding opportunities for financial aid. Eligible first year students are encouraged to apply for extramural pre-doctoral fellowships from the National Science Foundation, the American Cancer Society, and the Howard Hughes Medical Institute, and other opportunities for which they may be eligible. The office of the Staff Graduate Advisor and the office of the Graduate Division should be considered as the primary information sources.

University Scholarships or Fellowships are usually awarded in conjunction with admission to a Ph.D. program. The Graduate Admissions Committee makes recommendations for such awards. Limited number of university fellowships through the UCSB Graduate Division may be available for continuing students who have advanced to candidacy, and students should consult the Grad Division web site and the Staff Graduate Advisor for application deadlines (typically March).

Fellowships are also awarded on the basis of excellence in conjunction with admission to a Ph.D. program. Also, in exceptional cases of funding emergencies, some awards may be made to continuing students in response to an application by a student, supported by the student's research advisor.

Non-Resident Tuition during the first year of study is typically awarded in conjunction with admission to a Ph.D. program. It is the responsibility of first year out-of-state students to establish California residency before their second year of study. Payment of non-resident tuition by Ph.D. students after their first year may be required for non-U.S. citizens. As a matter of University policy, students appointed to Graduate Student Researcher (GSR) positions receive payment of their fees and California-resident tuition by the extramural grant that supports their GSR.

Employment through GSR positions is expected to provide the principal support of Ph.D. students, particularly after their first graduate year. Students should apply for such support directly to their research advisors.

Students in their second and third year of study are encouraged to apply for extramural pre-doctoral fellowships from relevant funding agencies (e.g. NIH, American Heart Association). Such fellowships typically support 2-3 years of stipend and fees, and are a prestigious addition to a student's graduate accomplishments.

Teaching Assistantships are allocated, upon proper application, to newly entering students and continuing students by the Staff Graduate Advisor and MCDB Vice Chair. Students should consult with their mentors about their needs for TA support in the coming year. The application deadline for Teaching Assistantships in the Department of MCDB is June for the coming academic year.

Appendix I

Pre-approved Graduate Elective Lecture Courses

Please note that courses of less than 3 units are pre-approved to satisfy the elective requirement only if they are combined with other pre-approved courses for a total of at least 3 units.

- 203. Cell Biology (4)
- 212. Molecular Virology (5)
- 220D. Experimental Cytology and Digital Imaging (4)
- 226A. Basic Pharmacology (4)
- 226B. Basic Pharmacology: Molecular Pharmacology (4)
- 226C. Basic Pharmacology: Principles and Chemotherapy (4)
- 231. General Microbiology (4)
- 232. Bacterial Pathogenesis (3)
- 233. Molecular and Cellular Immunobiology (3)
- 238. Angiogenesis in Health and Disease (2)
- 245. Post-translational Protein Processing (4)
- 246. Stem Cell Biology in Health and Disease (4)
- 247. Social Dimensions of Stem Cell Research (4)
- 251. Neurobiology I. Cellular Organization and Biophysics of the Nervous System (4)
- 252. Neurobiology II. Molecular and Cellular Neurobiology (4)
- 253. Neurobiology III. Developmental Neurobiology (4)
- 293. Computational Methods in Biochemistry-Molecular Biology (1)

Course electives listed above are pre-approved. In addition, BMSE 201A, 204, 205B, 207, 215, 244, 247, and 251 are pre-approved as electives. If there are graduate courses within MCDB or outside of MCDB that are more relevant to your needs/research interest, you may petition to have those approved. All petitions must provide a statement regarding the relevance of the proposed elective to your needs/research interests. Please submit all petitions to the Staff Graduate Advisor, who will forward them to the MCDB Graduate Committee for review.

Note that if a graduate course is listed concurrently with an undergraduate course, then a student may not take the graduate course (e.g. MCDB 203) for credit if she/he has previously completed the undergraduate course (e.g. MCDB 103).

Appendix II

MCDB Graduate Program Projected Learning Outcomes

MCDB MA-Plan I (thesis) Program Learning Outcomes

Core Knowledge:

- Students will be able to demonstrate a broad knowledge of modern molecular and cellular biology, including areas outside of their specific research specialty.
- Students will be able to demonstrate mastery of at least one area of the molecular biosciences relevant to their thesis topic.

Research Methods and Analysis:

- Students will be able to design and conduct a well-controlled and hypothesis-driven experiment.
- Students will be able to collect, analyze, and present original research data.
- Students will be able to critically analyze published research reports in their area of expertise.
- Students will understand new research methods and analytical approaches.

Pedagogy:

- Students will develop the ability to communicate (in English) technical material to audiences ranging from general to specialized
- *Students will demonstrate skills for mentoring undergraduate students in the context of a discussion or laboratory section.**
- *Students will be able to critically assess the quality of undergraduate exams and writing assignments.*
- *Students will be able to make a technical presentation on both their own research and on published studies.*

Scholarly Communications:

- Students will be able to write effectively (in English) at the levels found in relevant peer-reviewed journals, conference proceedings, posters and other written formats.
- Students will be able to produce graphics of their own research for peer-reviewed publication.
- Students will be able to write critical summaries of published research articles.
- *Students will be able to prepare and present oral presentations of both their own research and published studies of other researchers.*

Professionalism:

- Students will understand and demonstrate the importance of effective communication in the molecular biosciences.
- Students will appreciate and demonstrate the cooperative and collaborative nature of research in the molecular biosciences.
- Students will demonstrate an understanding of the importance of research honesty and professional ethics and conduct themselves in an ethical manner in all aspects of their scientific careers.
- Students will have a thorough knowledge of different career options.
- *Students will contribute to professional societies in their areas of specialization.*

Independent research:

- Students will develop and conduct a creative, independent research project in the area of molecular, cellular or developmental biology that meets high standards of conceptual, experimental and methodological scientific rigor.

- Students will complete original research studies that are comparable in scope and format to an article that appears in leading peer-reviewed venues in the field of molecular, cellular and developmental biology.

MCDB MA-Plan II (exam) Program Learning Outcomes

Core Knowledge:

- Students will be able to demonstrate a broad knowledge of modern molecular, cellular and developmental biology

Research Methods and Analysis:

- *Students will be able to design and conduct a well-controlled and hypothesis-driven experiment.**
- *Students will be able to collect, analyze, and present original research data.*
- Students will be able to critically analyze published research reports in their area of expertise.

Pedagogy:

- Students will develop the ability to communicate (in English) technical material to audiences ranging from general to specialized
- *Students will demonstrate skills for mentoring undergraduate students in the context of a discussion or laboratory section.*
- *Students will be able to critically assess the quality of undergraduate exams and writing assignments.*
- *Students will be able to make a technical presentation on both their own research and on published studies.*

Scholarly Communications:

- Students will be able to write effectively (in English) at the levels found in relevant peer-reviewed journals, conference proceedings, posters and other written formats.
- Students will be able to write critical summaries of published research articles.
- *Students will be able to produce graphics of their own research for peer-reviewed publication.*
- *Students will be able to prepare and present oral presentations of both their own research and published studies of other researchers.*

Professionalism:

- Students will understand and demonstrate the importance of effective communication in the molecular biosciences.
- Students will appreciate the cooperative and collaborative nature of research in the molecular biosciences.
- Students will demonstrate an understanding of the importance of research honesty and professional ethics and conduct themselves in an ethical manner in all aspects of their scientific careers.
- Students will have a thorough knowledge of different career options.
- *Students will contribute to professional societies in the molecular biosciences.*

Independent research:

- *Students will develop and conduct a creative, independent research project in the area of molecular, cellular or developmental biology that meets high standards of conceptual, experimental and methodological scientific rigor.*

**Items listed in italics are considered desirable outcomes but are not required for degree completion.*

MCDB Ph.D. Program Learning Outcomes

Core Knowledge:

- Students will be able to demonstrate a broad knowledge of modern molecular and cellular biology, including areas outside of their specific research specialty.
- Students will be able to demonstrate mastery of at least one select area of the molecular biosciences relevant to their dissertation topic.

Research Methods and Analysis:

- Students will be able to design and conduct a well-controlled and hypothesis-driven experiment.
- Students will be able to collect, analyze, and present original research data.
- Students will be able to critically analyze published research reports in their area of expertise.
- Students will understand new research methods and analytical approaches.

Pedagogy:

- Students will develop the ability to communicate (in English) technical material to audiences ranging from general to specialized
- Students will demonstrate skills for mentoring undergraduate students in the context of a discussion or laboratory section.
- Students will be able to critically assess the quality of undergraduate exams and writing assignments.
- Students will be able to make a technical presentation on both their own research and on published studies.

Scholarly Communications:

- Students will be able to write effectively (in English) at the levels found in relevant peer-reviewed journals, conference proceedings, posters and other written formats.
- Students will be able to produce graphics of their own research for peer-reviewed publication.
- Students will be able to write critical summaries of published research articles.
- Students will be able to prepare and present oral presentations of both their own research and published studies of other researchers.

Professionalism:

- Students will understand and demonstrate the importance of effective communication in the molecular biosciences.
- Students will appreciate and demonstrate the cooperative and collaborative nature of research in the molecular biosciences.
- Students will demonstrate an understanding of the importance of research honesty and professional ethics and conduct themselves in an ethical manner in all aspects of their scientific careers.
- Students will have a thorough knowledge of different career options.
- Students will contribute to professional societies in their areas of specialization.

Independent research:

- Students will develop and conduct a creative, independent research project in the area of molecular, cellular or developmental biology that meets high standards of conceptual, experimental and methodological scientific rigor.
- Students will complete original research studies that are comparable in scope and format to articles that appear in leading peer-reviewed venues in the field of molecular, cellular and developmental biology.