THE UNIVERSITY OF CHICAGO

COMMITTEE ON GENETICS, GENOMICS & SYSTEMS BIOLOGY (GGSB)
Graduate Program Handbook

Molecular Biosciences Cluster
Biological Sciences Division

2018-2019 Academic Year
MISCELLANEOUS INFORMATION

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Recreation On & Near Campus

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Courses Available to GGSB Students: Computational Track

GGSB Students

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Empirical Track: Suggested Student Course Tracks

Computational Track: Suggested Student Course Tracks
### ACADEMIC CALENDAR

#### Autumn Quarter 2018

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<tr>
<th>Date</th>
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<tr>
<td>September 3</td>
<td>Labor Day</td>
</tr>
<tr>
<td>September 10-14</td>
<td>Prelim Examination Week</td>
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<tr>
<td>September 24-28</td>
<td>Orientation week</td>
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<tr>
<td>October 1</td>
<td>Autumn Quarter classes begin</td>
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<td>October 31</td>
<td>Dissertation Office Draft Deadline for Autumn 2018 graduation</td>
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<tr>
<td>Nov 9-10</td>
<td>Molecular Biosciences Retreat – Q Center – St. Charles, IL</td>
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<tr>
<td>November 16</td>
<td>Winter quarter rotation decisions due</td>
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<tr>
<td>November 16</td>
<td>Final Dissertation Submission Deadline Autumn 2018 graduation</td>
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<tr>
<td>November 22-23</td>
<td>Thanksgiving holiday observance</td>
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<tr>
<td>December 25</td>
<td>Autumn 2018 Quarter ends</td>
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#### Winter Quarter 2019

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<tr>
<td>January 7</td>
<td>Winter Quarter classes begin</td>
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<tr>
<td>January 21</td>
<td>Martin Luther King, Jr. Day observance</td>
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<tr>
<td>February 6</td>
<td>Dissertation Office Draft Deadline for Winter 2019 graduation</td>
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<td>February 6</td>
<td>Spring Quarter rotation decision due</td>
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<tr>
<td>February 22</td>
<td>Final Dissertation Submission Deadline Winter 2019 graduation</td>
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<tr>
<td>March 8</td>
<td>Thesis Advisory Committee members due (Second year students)</td>
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<tr>
<td>March 23</td>
<td>Winter Quarter ends</td>
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#### Spring Quarter 2019

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<th>Date</th>
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<tr>
<td>April 1</td>
<td>Spring Quarter classes begin</td>
</tr>
<tr>
<td>April 5</td>
<td>Thesis Advisory Committee members due (Second year students)</td>
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<tr>
<td>May 1</td>
<td>Dissertation Office Draft Deadline Spring 2019 graduation</td>
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<td>May 17</td>
<td>Summer Quarter rotation decision due (First year students)</td>
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<td>May 17</td>
<td>Final Dissertation Submission Deadline Spring 2019 graduation</td>
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<td>May 27</td>
<td>Memorial Day Holiday</td>
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<td>June 14</td>
<td>Divisional Academic Ceremony - Spring 2019</td>
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<td>June 15</td>
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<td>June 15</td>
<td>Spring Quarter ends</td>
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<td>May - June</td>
<td>Qualifying Exams held</td>
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#### Summer Quarter 2019

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<tr>
<td>June 24</td>
<td>Summer Quarter begins</td>
</tr>
<tr>
<td>July 4</td>
<td>Independence Day observance</td>
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<tr>
<td>August 31</td>
<td>Summer Quarter ends</td>
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COMMITTEE ON GENETICS, GENOMICS & SYSTEMS BIOLOGY ADMINISTRATION

CHAIR, GGSB
Marcelo Nobrega
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OTHER UNIVERSITY OFFICES
Main Number - University 773/702-1234
Main Number - Hospitals 773/702-1000
Campus Police (Call 123 from any University phone) 773/702-8181
University Voice Directory 773/702-1610
Student Health 773/702-4156
Student Counseling 773/702-9800
Student Disability Services 773/702-6000
Student Insurance 773/834-4543 (option #2)

COMMITTEE ON GENETICS, GENOMICS & SYSTEMS BIOLOGY WEBSITE: ggsb.uchicago.edu
PROGRAM OF STUDY IN BRIEF

The guidelines in this handbook are official policies of the Committee on Genetics, Genomics & Systems Biology (GGSB). Students and faculty of the Committee are expected to follow these policies. Students with questions not answered by this handbook are encouraged to contact the GGSB Graduate Program Administrator (Sue Levison at slevison@bsd.uchicago.edu Office: 773/702-2464 or Cell: 773/307-2237) or the Chair of GGSB, (Marcelo Nobrega - mnobrega@bsd.uchicago.edu or 773/834/7919).

First Year

The first year of graduate study is spent completing coursework, exploring research opportunities and performing laboratory rotations. Throughout their course of study, all students are registered as full-time (300 units) during the Autumn, Winter, Spring, and Summer quarters.

Graduate students in the Biological Sciences Division (BSD) are required to take 9 credits of coursework for their Ph.D. Most classes are completed within the first year. In addition to the course requirements, students are required to attend the Faculty Research Seminar Series (GENE 31900) to acquaint them with faculty research programs. This series is also referred to as “AllStars”. Students are also required to undertake short research projects in at least two different laboratories before beginning their dissertation research. These rotations are to be performed during the first academic year, one in the Winter or Spring and one Summer quarters. Winter and Spring rotations are for the duration of the quarter (10 weeks). Summer rotations are for 5 weeks. Students can opt to do a third rotation for the second 5 weeks of the Summer quarter.

All students are expected to attend the monthly Genetics Seminar Series starting from the Autumn of their first year and throughout their tenure in the program.

Second Year

Just prior to the start of the second year, in September, students take the Preliminary Examination as a first step towards candidacy for their Ph.D.

At the beginning of the second year, students also choose a Research Advisor. Under unusual circumstances (and with approval of the Curriculum/Student Affairs Committee), students are allowed to carry out a laboratory rotation during the Autumn quarter before choosing an advisor.

Once a Research Advisor is chosen, a Student Doctoral Committee is formed. The Curriculum/Student Affairs Committee (CSAC), in consultation with the student and the student’s advisor, appoints its members. The Student Doctoral Committee is comprised of the Research Advisor and three-four other faculty members, of which one will be appointed the Thesis Committee Chair. At least three of the four committee members must have a GGSB faculty appointment.

While most or all coursework will be completed in the first year, one course elective may be taken during the second year. If a student is interested in deferring more than one course beyond the first year, that student must petition the CSAC to receive approval.

Most of the second year is spent developing a research project and preparing the student to submit a written proposal for dissertation research. This proposal must be defended in front of the Student Doctoral Committee before the end of Spring quarter (which is known as the Qualifying Examination). Passing the Qualifying Examination permits the student to enter into candidacy for the Ph.D.

Starting in their second year, students are expected to attend and present at the Genetics Journal Club, where faculty and students review current research papers. Also in the second year, students are expected to attend the Genetics Work-in-Progress, where advanced students and Post Doc fellows give presentations.

Advanced Years

After passing the Qualifying Examination, students work full-time on thesis research while continuing to attend seminars, journal clubs, work-in-progress presentations, etc. Students are welcome to audit courses in which they have an interest with the approval of their PI.
Finally, each graduating student writes a dissertation describing his/her research, presents their work in a public seminar, and defends it before his/her Doctoral Committee members.

The dissertation research period should take approximately 12-16 quarters, with the total duration of coursework and research not to exceed 26 quarters.

**Evaluation**

GGSB expects each student throughout his/her term as a graduate student, to have numerous informal conversations with the Chair of GGSB, professors in their courses, their Research Advisor and (in later years) members of their Doctoral Committee. This allows students to obtain constructive advice and frequent appraisals of their progress.

Evaluation of each student's progress will take place each academic year. In the first and second years, the evaluation is based on the student's performance in courses, laboratory rotations and the Preliminary Examination. In later years, the Research Advisor and Doctoral Committee report to the CSAC on the student's dissertation research progress after the yearly meetings. If the CSAC is apprised of deficiencies in performance, the student will receive a letter describing those deficiencies along with suggestions as to how these deficiencies might be remedied.

**Steering/Curriculum Committee (SCC)**

The Steering/Curriculum Committee (SCC) makes all decisions regarding administrative policies for GGSB, reviews new GGSB faculty appointment applications. This faculty committee is responsible for advising all students during their first year of graduate study or until a Research Advisor has been chosen. Each student is assigned a member of the SCC to serve as temporary advisor during this time and to aid in selecting courses and arranging lab rotations. In addition, the SCC makes the final decisions on the granting of degrees and on the retention of students as degree candidates.

**Curriculum/Student Affairs Committee**

The Curriculum/Student Affairs Committee (CSAC) oversees the current curriculum and the development of new curriculum. This Committee conducts a quarterly review of each student's course. Members of the CSAC meet with first year students after each quarter to discuss any issues concerning the first year curriculum or other topics of concern. The GGSB Student Representatives are invited to present student concerns at the CSAC meetings as they arise.

**Graduate Program Administrator**

The Graduate Program Administrator, Sue Levison, provides assistance to students on a variety of questions and problems as they arise. The office is located in CLSC 1111. The office phone number is 773/702-2464; Cell phone is 773/307-2237 and e-mail address is slevison@bsd.uchicago.edu.

**REQUIREMENTS FOR THE Ph.D. DEGREE**

A Ph.D. candidate must fulfill certain formal coursework requirements, pass the Preliminary and Qualifying Examinations and present a satisfactory dissertation describing the results of original research.

The Committee expects a knowledge of and proficiency in genetics. This requirement will normally be met by fulfilling the formal coursework listed below, but detailed degree programs are flexible. Courses taken at other institutions, in other departments, or as part of the Medical School curriculum may substitute for genetics courses with approval of the CSAC.
Formal Coursework: Choice of Two GGSB Tracks: Empirical Track or Computational Track

To obtain a Ph.D. in the Division of Biological Sciences, nine graded courses are required as detailed below.

GGSB has two tracks, one “Empirical Track”, and the other “Computational Biology”. While the two tracks are united by the common goals of using genetic, genomic and systems biology approach to address important biological questions, the training focus is different. Training of the first track is more focused on experimental techniques, especially those quantitative in nature, while the second track builds computational skills of students. The curriculum of the two tracks, as a result, will be different, as outlined below.

**CHOICE #1: GGSB EMPIRICAL TRACK (4 REQUIRED COURSES AND 4 ELECTIVES)**

Suggested “tracks” for students interested in concentrating in the Empirical track have been developed by the CSAC. (Model Systems, Population Genetics, Human Genetics, Developmental Genetics, and Genomics & Systems Biology). A summary of the five suggested tracks is given in Appendix A. Students are required to consult with their assigned mentor prior to registration each quarter.

A total of four graded electives must be taken, one of which may be a reading course. The electives can be selected according to the student's interests and the availability of courses.

Additional questions about the curriculum should be directed to the Graduate Program Administrator or to the Chair of GGSB.

**Four [4] Required Courses:**
MGCB 31400: Genetic Analysis of Model Organisms (*Autumn*)
AND
HGEN 47300: Genomics and Systems Biology (*Spring*)

**Plus One [1] of the Following Two Courses:**
MGCB 31200: Molecular Biology I (*Winter*)
OR
MGCB 31300: Molecular Biology II (*Spring*)

**Plus One [1] of the Following Four Courses:**
ECEV 44000: Fundamentals of Molecular Evolution (*Autumn*)
OR
ECEV 35600: Principles of Population Genetics I (*Winter*)
OR
ECEV 35901: Evolutionary Genomics (*Spring – every other year*)
OR
HGEN 46900: Human Variation & Disease (*Spring*)

**Plus Two [2] Lab Rotations**
BSDG 40100 Non-Thesis Research: Biological Sciences. Laboratory rotation 1 – (10 weeks) (*Winter OR Spring*)
AND
BSDG 40100 Non-Thesis Research: Biological Sciences. Laboratory rotation – (5 weeks) (*Summer*)

BSDG 40102 Genetics: Lab Rotation 3. Laboratory rotation (*Optional*) (Second 5 weeks of quarter) (*Summer*)

**Empirical Track Course Electives [4 courses]:**
- Must take 4 courses (see list of approved electives).
- Students may petition the CSAC for approval of courses not listed in this handbook as “approved”.
- At least 3 of the 4 electives are to be taken before the Preliminary Exam.
- All 4 electives should be taken before the Qualifying Exam.
- One of the 4 elective courses may be taken pass/fail subject to CSAC approval.
- One of the electives may be a graded reading course (see guidelines for reading courses).
CHOICE #2: GGSB COMPUTATIONAL TRACK - 3 REQUIRED COURSES AND 3 CORE ELECTIVES AND 2 ADDITIONAL ELECTIVES

Suggested “tracks” for students interested in concentrating in the Computational Biology Track have been developed by the CSAC. (Population Genetics & Evolution, Statistical Genetics, Computational Genomics, and Computational Cell Biology) A summary of the four suggested tracks is given in Appendix B. Students are required to consult with their assigned mentor prior to registration each quarter.

Additional questions about the curriculum should be directed to the Graduate Program Administrator or to the Chair of GGSB.

Three [3] Required Courses in Computational Biology and Statistics:
STAT 24400 Statistical Theory and Methods I (Autumn)
AND
HGEN 48600 Fundamentals of Computational Biology: Models and Inference (Winter)
AND
HGEN 48800 Fundamentals of Computational Biology: Algorithms and Applications (Spring)

Plus Three [3] Core Elective Courses Chosen from the Following List:

HGEN 47000 Human Genetics I (Autumn)
OR
MGCB 31400 Genetic Analysis of Model Organisms (Autumn)
OR
HGEN 47100 Introductory Statistical Genetics (Winter)
OR
ECEV 35600 Principles of Population Genetics I (Winter)
OR
ECEV 31100 Evolution of Biological Molecules (Winter)
OR
BCMB 32200 Biophysics of Biomolecules (Spring)
OR
HGEN 46900 Human Variation and Disease (Spring)
OR
HGEN 47300 Genomics and Systems Biology (Spring)
OR
MGCB 32000 Quantitative Analysis of Biological Dynamics (Spring)

Plus Two [2] Additional Elective Courses Chosen From the Following List:

BIOS 20186 Fundamentals of Cell and Molecular Biology (Autumn)*
OR
STAT 34300 Applied Linear Statistical Methods (Autumn)
OR
STAT 37790 Topics in Statistical Machine Learning (Autumn)
OR
CMSC 37720 Computational Systems Biology (Autumn)
OR
STAT 30900 Mathematical Computation I — Matrix Computation (Autumn)
OR
ECEV 32000 Introduction to Scientific Computing for Biologists (Winter)
OR
BIOS 20187 Fundamentals of Genetics (Winter)*
OR
STAT 24500 Statistical Theory and Methods II (Winter)
OR
STAT 32950 Multivariate Statistical Analysis: Applications and Techniques (Winter)
OR
ECEV 42900 Theoretical Ecology (Winter)
OR
Computational Track Course Electives [5 courses]:
- Students may petition the CSAC for approval of courses not listed in this handbook as “approved”.
- At least 4 of the 5 electives are to be taken before the Preliminary Exam.
- All 5 electives should be taken before the Qualifying Exam.
- One of the 5 elective courses may be taken pass/fail subject to CSAC approval.

Plus Two Lab Rotations

BSDG 40100 Non-Thesis Research: Biological Sciences. Laboratory rotation 1 – (10 weeks) *(Winter OR Spring)*

**AND**

BSDG 40100 Non-Thesis Research: Biological Sciences. Laboratory rotation – (5 weeks) *(Summer)*

**Optional**

BSDG 40102 Genetics: Lab Rotation 3. Laboratory rotation *(Optional)* (Second 5 weeks of quarter) *(Summer)*

ADDITIONAL GGSB REQUIREMENTS FOR BOTH TRACKS:

**GENE 31800 Current Seminar Topics in Genetics**  This course will expose student to current research topics in genetics for the bi-monthly GGSB Invited Seminar Series.  *This is a required ½ credit course for all GGSB students and will be graded Pass/Fail.* *(Winter, Spring)*

ADDITIONAL DIVISIONAL REQUIREMENTS FOR BOTH GGSB TRACKS:

**GENE 31900 Introduction to Research (Allstars)**  Lectures on current research by departmental faculty and other invited speakers.  A required course for all first-year graduate students. *(Autumn)*

**BSDG 55100 Responsible, rigorous, and reproducible conduct of research: R3CL**  Required of all BSD first-year doctoral students.  The course is designed to stimulate thinking and facilitate discussion about the purpose and necessity of ethical conduct with respect to scientific and academic practices; to create personal awareness of the ethical dilemmas and choices that may be encountered in the course of a career in the sciences; to increase awareness and understanding of the importance of reproducible, rigorous, and transparent research; and to provide practical information regarding policies and procedures related to conduct in the Division of Biological Sciences at the University of Chicago. *(Winter)*

**MGCB 32100 Senior Graduate Ethics**  A second training in the ethical conduct of research is required for students still registered four years after their initial training.  Senior ethics training content is more closely aligned with research areas and so this training is coordinated by the individual graduate programs. *(Spring every other year)*

Students should note that several courses have prerequisites for enrollment, or require the consent of the instructor.  Students entering GGSB with advanced coursework at graduate level should inquire whether this coursework can substitute for required electives.

A student is required to do **two** laboratory rotations **before** selecting an advisor and laboratory to pursue a Ph.D. dissertation.

Students are expected to maintain a grade average of “B” or higher.  Students who fail to do so will be placed on academic probation with continuation in the program dependent upon improved performance.  Should a student receive a D or F in any course during any quarter, the student will be immediately placed on academic probation.
Students concluding their first year without a “B” average will be terminated from the program after Spring quarter unless otherwise recommended by the CSAC.

If a student fails to pass the Preliminary Examination or the Qualifying Examination, the student will be terminated by the end of the respective quarter, unless otherwise recommended by the members of the CSAC.

**Introduction to Research (AllStars)**

All first year students are required to participate in GENE 31900 - Introduction to Research (also known as “AllStars”), held in the Autumn quarter. This course is designed to provide incoming students with information on the variety of faculty research opportunities available. Three (3) faculty members from the Molecular Biosciences Cluster will present during each session. The sessions are held Tuesdays and Thursdays, 12:30 p.m. - 1:50 p.m. This course is required and is offered pass/fail. Students are required to attend 75% of the sessions for a passing grade.

**Scientific Ethics Courses**

**BSDG 55100 Responsible, rigorous, and reproducible conduct of research: R3CL** Required of all BSD first-year doctoral students. The course is designed to stimulate thinking and facilitate discussion about the purpose and necessity of ethical conduct with respect to scientific and academic practices; to create personal awareness of the ethical dilemmas and choices that may be encountered in the course of a career in the sciences; to increase awareness and understanding of the importance of reproducible, rigorous, and transparent research; and to provide practical information regarding policies and procedures related to conduct in the Division of Biological Sciences at the University of Chicago. (*Winter*)

**Senior Graduate Ethics (MGCB 32100)** A second training in the ethical conduct of research is required for students still registered four years after their initial training. Senior ethics training content is more closely aligned with research areas and so this training is coordinated by the individual graduate programs. (*Spring – every other year*).

**Prescribed Courses**

In some instances, a student's undergraduate training may not have prepared him/her for a required course. In such cases, the CSAC will prescribe an appropriate course or undergraduate courses if necessary. In such cases, the prescribed course can be counted as a graduate elective.

**Reading Courses**

All Reading Courses (GENE 39900) must be approved by the CSAC prior to registration. Every reading course must conform to the following requirements: 1) it must meet weekly, 2) the instructor must provide a syllabus for the course and an evaluation of the student's performance, both of which will become part of the student's file and 3) the student must submit a written paper.

**Laboratory Rotations**

Students undertake short research projects in at least two different laboratories before beginning their dissertation research. The purpose of the rotation is to expose the student to different research environments, broaden his/her acquaintance with useful laboratory techniques, and introduce him/her to the conceptual framework of experimental design.

The distribution of course offerings makes it difficult for students to undertake rotations in the Autumn quarter of the first academic year. Therefore, rotations are performed in the Winter or Spring and Summer quarters. The Winter and Spring rotations (BSDG 40100 – Section 10) last 10 weeks to coincide with the academic quarter. The Summer rotation (BSDG 40100 – Section 10) lasts 5 weeks, when the student is able to devote full-time to research. Students wishing to do a third Summer rotation (BSDG 40102- Section 10) may request to do so during the second half of the Summer quarter.

Students arrange their own rotations, in consultation with their academic advisor by contacting potential mentors directly. **After the student and mentor have agreed on the time period for the rotation, the**
student must complete a Divisional Lab Rotation form, signed by the mentor, the students, the Graduate Program Administrator and the Chair of GGSB to confirm the arrangement.

Students should have their Spring quarter rotation arranged by February 1st. The Summer rotation(s) should be in place by May 1st.

Students who would like to rotate with someone who is not a member of the GGSB faculty should petition the CSAC for approval.

At the end of the rotation, the mentor will provide a written evaluation of the student's performance. The first two required rotations will be graded. Rotations, Non-Thesis Research, and Thesis Research carried out thereafter will be given a pass/fail. Please notify the Graduate Program Administrator once a Laboratory Advisor has been chosen.

Teaching Assistantships

The ability to teach and to communicate verbally are important skills for a successful research career. All students are required to serve as teaching assistants (TAs) for two quarters. This usually occurs during the second and third year and fourth years with the exact timing worked out between the student and their advisor. Students must have the TA requirement fulfilled prior to entering their fifth year. A course designed to train graduate students to be effective TAs can be taken in lieu of one of the two TAships. Responsibilities in this course include leading discussion groups, writing problem sets, and running laboratories. This course is offered every year in the Autumn Quarter only.

Preliminary/Qualifying Examinations

The Biological Sciences Division requires that "a general oral or written qualifying examination, separate from course examinations, must be passed by the student upon the major subject offered and such subordinate subjects as may be required by the Department concerned." In GGSB, this examination has two parts 1) the Preliminary Examination and 2) the Qualifying Examination. The examination procedures have been designed to ensure that preparing for the exams should be an educational experience for the student. Questions about these examinations that are not answered by the information that follows should be directed to the Graduate Program Administrator.

Preliminary Examination (Part I)

The objective of the Preliminary Examination (Part I) is to determine the strength of a student's general knowledge of genetics as well as his/her ability to synthesize an overview of research problems of active interest, based on the literature. The exam is typically taken in September following the student's first year.

Students must have completed the 4 required courses and at least three of the four elective courses to sit for the Preliminary Exam. Students also must have a "B" average or permission from the CSAC to take this exam.

For the Preliminary Exam, students will be given a set of questions and are expected to prepare responses to three of the questions. A starting point for references will be included with the Exam. Two weeks after receiving the questions, the student will be asked to present his/her answers orally for three questions.

The Preliminary Exam lasts for approximately two hours. Students are allowed to use books, reference materials, lecture and seminar notes to answer the questions. Students are also free to discuss the questions among themselves and with faculty. The format of the presentation should be a short lecture (approximately 10 minutes) designed to teach a generally knowledgeable group about the topic. The presentation should concisely review the pertinent background information, state the question being asked, and lay out an experimental plan (if applicable). Potential pitfalls and difficulties should be evaluated. Answers should not be read from a prepared text. However, one 5x8 note card and six PowerPoint slides for each question may be brought to the Exam. There will also be a board to write on. One of the purposes of the Preliminary Exam is to provide practice in oral presentations and discussion. The faculty will question the student further about the general subject of the presentation. There will be three examiners on each Preliminary Examining Committee from the GGSB faculty. The Preliminary Exam committee members are made public two days prior to the Exam.
Based upon the student's performance, the Preliminary Exam Committee recommends one of the following options:

A. Pass unconditionally.
B. Pass conditionally, with written answers to a question(s) required. Answers should be submitted within two weeks. The student will then meet again with the Exam Committee to defend his/her answers.
C. Pass conditionally, with further course work required in one or two areas.
D. Fail, with the recommendation that the student retake the exam within the quarter.
E. Fail, with the recommendation that the student leave the program.

The CSAC then meets to consider this recommendation, taking into account the student's overall academic performance as well as his/her performance on the Exam. If a student who fails the Exam is allowed to retake it, the Committee for the re-take will be selected by the CSAC in consultation with the Chair of the GGSB and will contain at least one member of the first Preliminary Examining Committee.

**The Qualifying Examination (Part II)**

The Qualifying Examination (Part II) evaluates a student's ability to propose and defend a doctoral thesis research plan. Upon successful completion of this Exam, the Qualifying Examining Committee becomes the student’s Doctoral Advisory Committee (i.e. Thesis Committee). A student must have the endorsement of his/her Research Advisor in order to sit for the Qualifying Examination. In the event that a Research Advisor declines to endorse a student for the Qualifying Exam, the Steering Committee will review the student’s record to determine if that student will be allowed to seek a new Research Advisor or be asked to leave the program.

Once the student chooses a Research Advisor, the student, in consultation with their Research Advisor, formulates a list of four or five prospective Qualifying Exam Committee members (including the student's advisor) and submits the list to the Graduate Program Administrator who will forward it on to the CSAC for their review and approval. This review is designed to help ensure that the proposed committee members are qualified and appropriate and, in keeping with the interdisciplinary nature of the program, the expertise of the members is broad-based. It is not uncommon for the CSAC to recommend the addition of a committee member to broaden the overall expertise of the committee. Final decisions on committee membership will be made by agreement between the CSAC, the Research Advisor, and the student.

In addition to approving the initial Doctoral Advisory Committee, the CSAC must also approve replacements when members of a Doctoral Committee resign. In the event that more than one member of a Doctoral Committee resigns, the Steering Committee will meet to consider the circumstances that led to these resignations and decide on an appropriate course of action. Possible courses of action include (but are not limited to) replacement of committee members, formation of a new Doctoral Committee or reconsideration of the student's qualifications for candidacy.

After the Qualifying Exam, the Qualifying Exam Committee members will continue to serve as the Doctoral Advisory Committee throughout the course of the student's doctoral research. This Doctoral Committee will be chaired by a member other than the student's Research Advisor. The function of the Doctoral Committee is to monitor the student's progress and to assist the student in the development of their dissertation research. For this reason, the choice of the members of the Doctoral Committee should be based on their knowledge and expertise in the area of the student's research. In the event the student chooses to work with a member of the faculty who does not have an appointment in the GGSB, the student must petition the Committee for approval. At least three members of the Doctoral Committee, including the Chair, must have faculty appointments in GGSB. It is important to note that the Qualifying Exam is not a thesis defense. It does not require preliminary results although, if available, they can be used. The exam tests the student's ability to:

1. Choose a topic, that is, formulate an important biological question;
2. Propose a coherent set of avenues to answer the question;
3. Summarize critically the current literature on that topic; and
4. Describe a series of experiments taking into account possible pitfalls and therefore alternative approaches.
The written proposal should be modeled after an NIH postdoctoral grant application which should consist of general and specific aims (no more than one page), background and significance (no more than three pages), methods of procedure and a description of your experimental approaches (no more than six pages). This is not a place for trivial experimental details. The recommended length of the proposal, including references and figures, is 10 pages.

Prior to submitting the written proposal to his/her Doctoral Committee, the advisor must approve the proposal for distribution. The written proposal should be submitted to the Graduate Program Administrator by the fifth week of the Spring quarter of the second year (see Calendar of Events for this year’s deadline). The student should practice presenting the oral exam prior to the final presentation at the Qualifying Exam. One example would be at the student’s lab meetings. The oral exam should be completed by the last week of the Spring quarter. It is the student’s responsibility to schedule their Qualifying Exam in a timely manner to ensure that the deadline is met. In the event that circumstances indicate a different schedule, or the student's Doctoral Committee is unable to meet prior to this time, the student must secure permission to postpone the Preliminary Examination from the CSAC. Once the student has fulfilled all course requirements and passed the Qualifying Examination, the student will be admitted into Candidacy for the degree of Ph.D.

**Annual Doctoral Committee Meetings**

All students are required to meet at least once a year with their Doctoral Committee and present a brief written report of their research as a basis for discussion. **This report must be submitted to all Doctoral Committee members and to the Graduate Program Administrator at least two weeks prior to the meeting.** An example of a written report can be found in the GGSB office. After the fourth year, a minimum of two meetings per year are required. At least three members of the Doctoral Committee must be present. These meetings help to ensure that students are making adequate progress toward the completion of their dissertation and to provide the student with a broader base of expertise on which to draw for help and advice. They also strengthen the student’s acquaintance with faculty other than their Research Advisor, providing a stronger basis for future letters of recommendation. When the Doctoral Committee approves it, the student may prepare their dissertation. Following each meeting, the Chair of the Doctoral Committee will prepare a written summary and send it to the student and the student's advisor for their approval and signature. The completed summary will then be given to the Graduate Program Administrator.

**Penultimate Meeting**

The Doctoral Committee should convene six months before a student expects to receive his/her degree to indicate their agreement that the student is nearing completion of their work and to arrange for subsequent approval that the student may begin writing their dissertation. In general, the mentor and other members of the Doctoral Advisory Committee should endeavor to minimize the possibility of an unsuccessful thesis defense via thoughtful and straightforward advice to the candidate. The Penultimate meeting is particularly important in this regard. Permission to write should not be granted if more than one member of the committee lacks confidence that the thesis will be acceptable. The written report from the penultimate meeting should contain a fairly detailed description of any additional work that needs to be completed prior to submission of the thesis. This list should be limited to a small number of minor items. If, in the judgment of the Doctoral Advisory Committee, substantial work is needed prior to the thesis defense, an additional meeting should be scheduled to review that work before permission to write is granted.

**Presentation of the Dissertation**

Each graduating student writes a dissertation describing his/her research. Following approval by the student’s advisor, the thesis must be delivered to the Doctoral Committee for a two-week reading period. At this stage, the thesis should be in near final form and not in a draft state. The student then presents the work in a public seminar, and defends it in front of their Doctoral Committee.

The University has strict rules concerning the preparation of the dissertation. Detailed information can be obtained from the Dissertation Office located on the first floor of the Regenstein Library, Room 100B, or from the Dissertation Office webpage https://www.lib.uchicago.edu/research/scholar/phd/, which has the most current information about upcoming deadlines, required forms, etc.
The Ph.D. dissertation should contain a description of the research performed. In addition, it must contain:

1. An introduction covering the scientific background of the project(s);
2. A discussion of the student's own results and their significance in the field; and
3. A summary of their work.

These should be separate sections of the thesis and written independently by the student. Published manuscripts may be included as chapters in the thesis, but separate Introduction, Discussion and Summary sections covering the entire thesis are still required. In cases where collaborative experiments are included in the thesis, the student must clearly indicate the specific contributions made by the individuals involved.

The final dissertation, together with a certificate of approval signed by the Committee Chair, must be submitted to the Dissertation Office no later than three weeks before the date of the convocation. The final Exam Committee consists of at least five faculty members, three of whom must be members of the student's Doctoral Committee and at least three of whom are members of the GGSB faculty.

1. Each member of the Thesis Defense Committee must vote "yes" or "no" on the defense form immediately following the defense (i.e. before leaving the room). Thesis Defense Committee members are not allowed to abstain from voting.
2. If more than one member of the Thesis Defense Committee votes “no” the student will be required to revise the thesis according to instructions provided by the Exam Committee and meet any additional conditions set by the CSAC within one week of the defense. The revised thesis must then be defended in a closed session with a committee consisting of at least one member of the original Thesis Defense Committee and at least one new member.
3. If, following the defense of the revised thesis, a candidate receives more than a single “no” vote from a committee member, the candidate will be denied the Ph.D.

**Master's Degrees – Transitional and Terminal**

The Committee on Genetics, Genomics & Systems Biology gives Transitional and Terminal MS degrees.

**Transitional Master's Degrees**

Upon completing all course requirements with a “B” average and successfully passing the Preliminary Examination GGSB students will receive a Transitional MS degrees. However, the Transitional MS Degree will only be issued once the student has successfully defended his/her thesis (not after qualifying exams).

**Terminal Master's Degrees**

For a student who decides not to complete his/her Ph.D. candidacy, or who loses Ph.D. candidacy status, but has completed all course requirements with a “B” average and has successfully passed the Preliminary Examination may be eligible for a Terminal Master’s degree. The Steering Committee makes final decisions with respect to the granting of Master’s degrees.

**GGSB Seminars & Club Meetings**

In addition to formal courses, there are many regularly scheduled research seminars that help keep students updated on new developments in genetics and related disciplines.

All students are required to attend the monthly Genetics Seminar Series. Students are also expected to attend the bimonthly Genetics Journal Club and the bimonthly Genetics Work-in-Progress Seminar.

The GGSB Seminar Series (required course for GGSB students), given by invited speakers, are held the bi-monthly on Tuesdays month during the academic year at 4:00 p.m. in CLSC 101. **GENE 31800 Current Seminar Topics in Genetics.** This course will expose student to current research topics in genetics for the bi-monthly GGSB Invited Seminar Series. This is a required ½ credit course for all GGSB students and will be graded Pass/Fail. (Winter, Spring)

The Genetics Journal Club meets twice a month on Thursdays during the academic year at noon. At each Journal Club meeting, one student and one faculty member present for discussion a recently published work in genetics.
The Genetics Work-in-Progress Seminar meets twice a month on Thursdays during the academic year at noon. The Genetics Work-in-Progress format is a one-hour meeting, which includes two ~20 minute research presentations from advanced students and/or post-docs from different labs, plus time after each presentation for a discussion.

The Graduate Program Administrator will send emails announcing GGSB seminars. Additional seminar information can be found on the GGSB website, the https://biosciences.uchicago.edu/current-students/groups website and the University of Chicago website.

FINANCIAL SUPPORT

The GGSB attempts to ensure that all students registered in the Ph.D. program are provided with adequate financial aid. Financial support is guaranteed to all incoming students for their first five years, subject to satisfactory academic performance. Support for subsequent years of study is subject to the student's satisfactory research progress as determined by the faculty sponsor, the program, and the Division of Biological Sciences.

Sources of Support

Students receive tuition plus a stipend. The various sources of support are:
- Divisional Funding
- Training Grants
- External Fellowships
- Research Assistantships

Payment of Stipend Checks

Divisional funding and NIH checks are paid in equal quarterly installments at the beginning of each quarter and cover the calendar year. Taxes are owed on, but not deducted, from these stipend checks (see section on “Taxes” below).

Research Assistant Type B (RA Type B) and Research Assistant Type A (RA Type A) students are paid on a bi-monthly basis. Taxes will be deducted from the RA Type-B checks.

NIH training grants pay for student health insurance, fees, and tuition without the student having to make separate payments. RA Type B and RA Type A students are responsible for paying their health insurance and fees from their salary each quarter. However, tuition is paid by the Division.

Taxes

Graduate student stipends are taxable by Illinois and the Federal government. Students on fellowships and NIH training grant support must calculate and pay estimated taxes several times a year.

The following IRS forms provide information on determining what portion of your stipend is taxable and when to pay taxes you owe: Tax Benefits for Education, PUB 970; US Tax Guide for Aliens, PUB 519 and US Tax Treaties, PUB 901. IRS form 520 provides information on determining what portion of your stipend is taxable and how and when to pay taxes you owe. These forms are available from the IRS. Regenstein Library also carries tax forms particularly after January 1st. For additional information see: http://www.irs.gov/Individuals/Students

Supplies and Research Expenses

In general, costs of research supplies and equipment are covered by grants or contracts held by the faculty member in whose laboratory you are working. Limited funds for supplies are available on training grants, and are disbursed on an annual pro-rated basis, directly to the laboratories in which trainees are working.
Travel to Scientific Meetings

Attendance at scientific meetings is an important part of the educational process. Should you wish to apply for support, check with the source of your funding, be it an agency, your Research Advisor or training grant. The GGSB is not able to provide financial support to students for scientific meetings. When making your request, please supply the following information: purpose of meeting and relevance to the research; title, place and time of the meeting; title and authors of paper being presented; and amount requested for travel, registration fees, food and lodging.

REGISTRATION

General Information

Approximately one week before the dates designated for registration, the Graduate Program Administrator will contact students via email informing them of the dates and times to register online. If a student does not register for their courses prior to the deadline, they will be charged a late registration fee of $100.

Special registration procedures have been established for the first year students in the Autumn quarter. During Orientation week, first year students will meet with the GGSB Chair and the Graduate Program Administrator to discuss procedures. The students will then meet individually with their assigned mentor to map out a program of study for the first year. If necessary, second year students also will meet with members of the CSAC to review their progress in the preceding year and to discuss further degree requirements.

Residency Status

All students are in one of three levels of residency, depending on the number of quarters they have been registered at the University. The three levels and the number of corresponding registration units are:

Scholastic Residence (SR)
Years 1-4

Advanced Residence (AR)
Years 5-12 - Students in SR and AR are eligible for all benefits associated with full time student status at the University, such as the student health plan, university housing, student loans and loan deferment.

Extended Residence (ER)
Years 12 and beyond - Students in ER are entitled to use of the library, email accounts, networked access, and faculty contact, but not to other benefits or facilities.

Leave of Absence

During Scholastic and Advanced Residence a student may, if necessary, apply for a Leave of Absence from the Ph.D. program to be approved by the GGSB Chair and the CSAC. Only students in good academic standing will be granted a Leave of Absence.

Pro-Forma Registration

Students in Advanced Residence, whose dissertation research requires residence away from Chicago, may register pro-forma. A fee of $259 per quarter is assessed, and keeps the student in full-time registration for purposes of reporting to outside agencies such as to defer student loans. Pro-forma status establishes a good faith relationship between the student and the University. The following regulations apply:
1. Pro-forma registration is approved for only one academic year at a time and the maximum pro-forma enrollment allowed is eight quarters
2. Applications for pro-forma registration must be approved in writing by the GGSB Chair, whose signature means that the student's work away from Chicago is recognized as essential to the dissertation. Normally, students applying for pro-forma status will have been admitted to candidacy and have had dissertation topics approved.
3. An applicant for renewal of pro-forma status must show the GGSB Chair that good use has been made...
of the time already spent "on location" and that additional time is essential to completing the original task. Renewals of pro-forma status must be approved by the Office of Graduate and Postdoctoral Affairs.

4. A student on pro-forma status may not be gainfully employed for more than 19 hours a week.

5. Pro-forma students may not use the facilities of the University or the time of its faculty, except for progress reports that may be required by the students' program.

6. The Registrar will certify that a pro-forma student is duly registered at the University to any agency requiring such certification.

7. The fact that a registration is pro-forma will be noted on the student's academic record.

8. Pro-forma registrations do not count toward satisfying a student's residence requirements toward a degree.

Visiting Non-Degree Students

Students who have moved to the University with their advisor but who are still registered at their home institution are given the status of Visiting Non-Degree Students. This gives them access to the libraries and to athletic facilities while they are completing their degrees.

MISCELLANEOUS INFORMATION

Student Representatives

GGSB students have student representatives to represent GGSB student concerns as needed at the quarterly Steering/Curriculum Committee meetings. At any time should a student representative have an agenda item for one of these meetings, they should contact the Graduate Program Administrator to add that item to the agenda for the next meeting. Each representative has a two year term, with one representative new each year, and the other tenured by one year. Each summer, once a representative’s two year term has expired, a new representative is appointed. The GGSB also has student representatives who participate in Molecular Biosciences Cluster events, such as Orientation, Retreat and Recruitment planning. These representatives are volunteers who are interested in participating and contributing to these events. The Student Representative will ask for volunteers each year. Students interested in becoming a student representative should contact the Graduate Program Administrator.

Annual GGSB Symposium

The GGSB hosts an Annual Symposium at The University of Chicago. Each year a timely new topic is chosen to provide the Genetics community an opportunity to hear a speakers' expertise in a particular area of Genetics. This highly renowned event draws speakers from around the globe as well as a large crowd from the Chicagoland area. All GGSB students are expected to attend. There is a luncheon prior to the Symposium, where GGSB students are given the rare opportunity to interact one-on-one with the speakers over lunch. A reception follows the afternoon talks, where students are given additional opportunities to interact with the featured speakers.

Molecular Biosciences Retreat

The Molecular Biosciences Retreat provides an opportunity for students, post-docs, and faculty to meet in a pleasant, informal setting to learn about the various research programs of the various research laboratories. The program consists of several sessions of presentations by students and post-docs. Each session is chaired by a faculty member. There is also a poster session. The Retreat is held annually, usually in early November.

John Crerar Library

The John Crerar Library (5730 S. Ellis Avenue, 773-702-7715) combines the University collections in biological sciences, medicine, and the physical sciences. Users with valid University of Chicago ID have access to all floors and stack areas during library hours. The library is adjacent to the Cummings Life Science Center and is connected by tunnel to Cummings, the Kovler Viral Oncology building, the Gordon Center for Integrative Science, and the Medical Center.
The first floor of Crerar contains the major service units. The Circulation Desk (773-702-7409) is located to the left of the entrance atrium. Reserve materials for all science courses except math, computer science, and statistics are held at the Circulation Desk, as well as a permanent reserve collection of current medical textbooks and frequently used science periodicals. The Science Reference Department (773-702-7715) is located to the right of the atrium entrance, together with the science microforms.

The website for the University of Chicago Libraries is www.lib.uchicago.edu.

ID & Privileges Office

The ID & Network Privileges Office, located in the lobby of Regenstein Library (1100 E. 57th Street), is a joint venture between the Library and IT services. They offer a variety of services to the University community. Their main services include: UChicago Cards, Library access and privileges, CNetID account assistance, Library lockers, Passport photos and International Student or Teacher Identity Cards.

Bursar's Office

The Bursar's Office, located at 6030 S. Ellis Avenue, 2nd floor and is open to the public weekdays from 9:00 a.m. to 4:00 p.m. The University Cashier (In-Person Cash and Check Payments) is located at 5525 S. Ellis (55th and Ellis Parking Structure). Students may contact the follow Bursar’s Office number for information:

Tuition Inquiries & Bursar Restrictions: 773/702-7086
Other Information: 773/702-8000
For additional information go to: http://bursar.uchicago.edu/

Student Health Services & University Student Health Insurance Plan (USHIP)

Student Health Services provides health care to all registered students in the University. It is funded by a mandatory quarterly student health fee. Payment of this fee allows the student access to the University's student health services. Some specialized and emergency care is not covered, nor does the fee include the cost of outside referrals, laboratory tests, and hospitalizations.

In addition to participation in Student Health Services, all students are REQUIRED to carry a health insurance plan (either university student health insurance or comparable insurance) to cover the costs of hospitalization, outpatient diagnostic and surgical procedures, laboratory tests and catastrophic illness. Charges for university insurance are assessed for each of three quarters (Fall, Spring, Winter); there is no charge for coverage for the Summer Quarter. More information about the university insurance can be found on the web, http://studenthealth.uchicago.edu/page/student-health-insurance-0

For detailed information about the 2018-2019 University Student Health Insurance Plan (USHIP) please see their website at https://wellness.uchicago.edu/student-insurance/u-ship/

Students with comparable group insurance coverage through a parent, spouse, or their own policy may request that participation in the university program be waived. However, they must cover the cost of alternative health insurance out of their own pocket.

The Student Health Service (SHS) is located at 860 E. 59 Street, Suite R100. Hours are 8:00 a.m. to 6:00 p.m., Monday-Thursday, and 8:00 a.m. to 5:00 p.m. on Friday. Saturday, SHS is in DCAM, Suite 3B, 8:00 a.m. to 11:00 a.m. Please note that there are no walk-ins, so you must make an appointment. If you need emergency medical advice after SHS business hours, or if you need emergency medical advice during business hours or want to review an acute medical problem, contact the Nurse Advice Line at 702-1915. The nurse can provide time-saving advice and assistance and help you to determine if you need immediate medical treatment. For other services and phone numbers, please visit the SHS website at http://healthcare.uchicago.edu

The Student Counseling Service is located at 5737 S. University Avenue, and is open from 8:30 a.m. to 5:00 p.m., Monday through Friday. It specializes in diagnostic evaluation, psychotherapy and emergency services for all students, as well as services for students who are experiencing difficulties in studying and learning and difficulty in managing time commitments. For an evaluation, outside referral, or assignment to a therapist call
702-9800 to schedule an appointment. Emergencies are taken immediately during regular hours. During evenings and weekends, a therapist is available by calling 702-3625. For all services and phone numbers, please go to the SCS at http://counseling.uchicago.edu

**Student Disability Services**

To ensure the intellectual richness of research and education, the University of Chicago seeks to provide an environment conducive to learning, teaching, working, and conducting research that values the diversity of its community. The University strives to be supportive of the academic, personal, and work-related needs of each individual and is committed to facilitating the full participation of students with a disability in the life of the University.

Student Disability Services works to provide resources, support, and accommodations for all students with disabilities and works to remove physical and attitudinal barriers, which may prevent their full participation in the University community.

For general questions about accommodations for University classes, programs or activities, please contact us at: 773-702-6000, or disabilities@uchicago.edu.

**Computing Facilities**

Information Technology Services (IT Services) runs computing facilities in Regenstein (A level) The facilities provide access to a variety of up-to-date computing equipment. For additional information see their website https://itservices.uchicago.edu/welcome/students.

**Copying, Printing & Scanning**

Copy, print, and scan stations are located in the Crerar and Regenstein libraries. The cost varies from 10 to 30 cents, and a Chicago Card, University of Chicago library card, or UChicago Copy Card is required; no machine takes cash. Cards may be purchased from automated dispensers located on the first floors of Crerar and Regenstein. See their website at: http://printing.uchicago.edu/ for additional information.

**Transportation & Parking**

You may obtain an assigned parking space on campus by paying a monthly fee. Information about current fees and how to apply for a parking assignment is available for students. For information see their website at http://safety-security.uchicago.edu/transportation/

For Chicago area public transportation bus routes, maps and schedules (CTA, Metra, Pace, and other transportation options), as well as on-campus parking information visit the University of Chicago Department of Safety and Security website at: http://safety-security.uchicago.edu/transportation/

**Chicago Transit Authority (CTA)**

The Chicago Transit Authority (CTA) is the public transportation system for the Chicago area. A copy of the CTA bus schedules, routes, maps and fare options can be obtained by visiting the CTA website at http://www.transitchicago.com or by calling 1-888-YOURCTA. You may also to pick up schedule, route information and purchase CTA transit cards in the Regenstein Library at the Chicago Card, Library & Network Privileges Office JRL 100F.

**UGo NightRide Shuttles**

The University of Chicago provides a comprehensive nighttime shuttle service to the entire campus community on a fixed schedule along highly used routes. The goal of NightRide is to provide safe, timely, and reliable transportation during late-night hours to students, faculty, and staff throughout campus and the Hyde Park neighborhood.

Shuttles run approximately every 20 to 30 minutes throughout the evening. The routes cover the campus core as well as the Hyde Park community. Riders are able to access a shuttle within one to two blocks of
nearly every building on campus. Routes are designed with specific University destinations in mind to make travelling around campus easy. All University of Chicago College Housing residence halls are designated as a destination stop.

Shuttles leave their hub area approximately every 15-30 minutes. To track the movements of the shuttles, check the TransLoc system on a mobile app and on display monitors in the lobbies of some campus buildings. TransLoc provides the most up-to-date information of all NightRide shuttle locations, arrival times, and pertinent route announcements.

Riders must present their valid UChicago ID or UC Medicine ID to ride the shuttles.

For detailed information see the Safety and Security Transportation NightRide Program website at: http://safety-security.uchicago.edu/services/ugo_nightride_shuttles/

Divvy Bikes

Divvy is Chicago’s bike sharing system with 4,000 bikes and 400 stations across the city. Intended to provide Chicagoans with an additional transportation option for getting around the city, Divvy is fun, easy, and affordable. For additional information and to become a member go to their website at: http://divvybikes.com/

Recreation On & Near Campus

There are two main student centers. The Reynolds Club, located at 57th Street and University Avenue, includes the Hutchinson Commons, home of the largest food court on campus, with a wide variety of fast food restaurants, and the C-Shop, which stocks coffee and pastries; the North Lounge; ATM’s; as well as a variety of recreation rooms. For additional information and to find out more about student life see their website at: http://leadership.uchicago.edu/.

The Gerald Ratner Athletics Center is a 15,000-square foot, state-of-the-art, athletic and recreational facility. With its fitness center, gymnasiums, dance studios, classrooms, 50-meter swimming pool, and more, it is designed to support the university’s various sports teams as well as the fitness needs of other users. Graduate students receive membership for free. During the academic year, the Ratner Center is open from 6:00 a.m. to 12:00 midnight on weekdays and Sundays, and from 8:00 a.m. to 9:00 p.m. on Saturdays. For additional information about this facility visit their website.
http://athletics.uchicago.edu/facilities/facilities-ratnercenter.htm

Ida Noyes Hall, on 59th Street between Woodlawn and Kimbark, was modeled after an English manor house. It houses the Max Palevsky Cinema, a 500-seat theater in which Doc Films screens movies every night of the academic year. For more information about Doc Films visit http://docfilms.uchicago.edu. Ida Noyes also contains The Pub, Ida’s Café (soups, salads, and hot entrees), the office of Career Advancement and the University of Chicago independent student newspaper office, the Chicago Maroon.

Chicago at Large

Chicago is a fantastic city for cultural pursuits including museums, music, theatre, and dining out. The Chicago Symphony Orchestra, the Lyric Opera, jazz and blues clubs, The Goodman Theater, and off-loop theatres are all excellent. Both inexpensive ethnic restaurants and expensive special-occasion restaurants abound.

Chicago Area Festivals, Exhibits and Special Events Websites

For information on outdoor concerts, cultural and neighborhood festivals, art fairs and other special events in the Chicagoland area visit the following websites:

The Chicago Convention and Tourism Bureau: www.choosechicago.com

University of Chicago Campus Events: http://event.uchicago.edu/maincampus/
University of Chicago Student Events: https://studentactivities.uchicago.edu/

Special Events Management: www.chicagoevents.com

The Chicago Park District: http://www.chicagoparkdistrict.com


Metromix: http://chicago.metromix.com/

The Chicago Tribune: www.chicagotribune.com/entertainment

The Chicago Sun Times: http://www.suntimes.com/index.html

The Chicago Reader: http://www.chicagoreader.com

Chicago Magazine: http://www.chicagomag.com


The Magnificent Mile: http://www.themagnificentmile.com/

The Promontory: http://promontorychicago.com/

Ravinia: http://www.ravinia.org

The Chicago Symphony Orchestra: https://cso.org/

Chicago Architecture Center: http://www.architecture.org/

Chicago Detours: http://www.chicagodetours.com/

The Museum of Broadcast Communications: http://www.museum.tv/index.htm

The Museum of Science and Industry: http://www.msichicago.org

The Field Museum: http://www.fieldmuseum.org

The International Museum of Surgical Science: https://imss.org/

The Alder Planetarium: http://www.adlerplanetarium.org

John G. Shedd Aquarium: http://www.sheddaquarium.org

The Art Institute: http://www.artic.edu

Kohl’s Children Museum: http://www.kohlchildrensmuseum.org


Lincoln Park Zoo: http://www.lpzoom

Brookfield Zoo: http://www.brookfieldzoo.org

Navy Pier: http://www.navypier.com

Broadway in Chicago: http://www.broadwayinchicago.com

The League of Chicago Theatres: http://www.chicagoplays.com
The Goodman Theatre: http://www.goodmantheatre.org/
The Looking Glass Theatre: https://lookingglasstheatre.org/
Theater Wit: http://www.theaterwit.org/
The Second City: http://www.secondcity.com/
Steppenwolf Theatre: http://www.steppenwolf.org
The Chicago Botanic Gardens: http://www.chicago-botanic.org
The Morton Arboretum: http://www.mortonarb.org
Chicago Public Library: http://www.chipublib.org/
Chicago Sport and Social Club: http://www.chicagosportandsocialclub.com/
Chicago Athlete: http://www.mychicagoathlete.com/
Fleet Feet Sports: http://www.fleetfeetchicago.com
Divvy Bikes – Bike Sharing System: http://divvybikes.com/
Illinois State Parks: https://www.dnr.illinois.gov/recreation/Pages/default.aspx
Starved Rock State Park: http://www.starvedrockstatepark.org/
Indiana State Parks: http://www.in.gov/dnr/parklake/
Indiana Dunes: http://www.indianadunes.com/
Wisconsin State Parks: http://dnr.wi.gov/topic/parks/
Wisconsin Bike Trails: http://dnr.wi.gov/topic/parks/activities/bike.html
EMPIRICAL TRACK - COURSES AVAILABLE TO GGSB STUDENTS

For detailed information on course time schedules visit:
The Academic Information System: Class Search


FOUR [4] REQUIRED COURSES IN GENETICS:

MGCB 31400  Genetics Analysis of Model Organisms. Fundamental principles of genetics discussed in the context of current approaches to mapping and functional characterization of genes. The relative strengths and weaknesses of leading model organisms are emphasized via problem-solving and critical reading of original literature. Autumn.

AND

HGEN 47300  Genomics and Systems Biology. This lecture course explores technologies for high-throughput collection of genomic-scale data, including sequencing, genotyping, gene expression profiling, and assays of copy number variation, protein expression and protein-protein interaction. In addition, the course will cover study design and statistical analysis of large data sets, as well as how data from different sources can be used to understand regulatory networks, i.e., systems. Statistical tools that will be introduced include linear models, likelihood-based inference, supervised and unsupervised learning techniques, methods for assessing quality of data, hidden Markov models, and controlling for false discovery rates in large data sets. Readings will be drawn from the primary literature. Evaluation will be based primarily on problem sets. Spring.

Plus one [1] of the following two courses:

MGCB 31200  Molecular Biology I. Nucleic acid structure and DNA topology; methodology; nucleic-acid protein interactions; mechanisms and regulation of transcription in eubacteria, and of replication in eubacteria and eukaryotes; mechanisms of genome and plasmid segregation in eubacteria Winter.

OR

MGCB 31300  Molecular Biology II. The content of this course will cover the mechanisms and regulation of eukaryotic gene expression at the transcriptional and post-transcriptional levels. Our goal is to explore research frontiers and evolving methodologies. Rather than focusing on the elemental aspects of a topic, the lectures and discussions highlight the most significant recent developments, their implications and future directions. Spring.

Plus one [1] of the following four courses:

ECEV 44000  Fundamentals of Molecular Evolution. Covers major theories that form the foundation for understanding evolutionary forces governing molecular variation and divergence and genome organization. It explores the evolutionary assembly of genes, the origin of novel gene function, the population genetics of repetitive DNA variation, and the evolution of multi-gene families. Winter.

OR

ECEV 35600  Principles of Population Genetics I. Examines the basic theoretical principles of population genetics, and their application to the study of variation and evolution in natural populations. Topics include selection, mutation, random genetic drift, quantitative genetics, molecular evolution and variation, the evolution of selfish genetic systems, and human evolution. Spring.

OR

ECEV 35901  Evolutionary Genomics. This course is a summary and analysis for the investigation of genomic evolution, a rapidly growing area in molecular evolution as a consequence of genomic studies in recent years. We will lecture basic tools and conceptual progresses in the field, including molecular clock, codon usages, new gene evolution and evolution related to sex reproduction and behavior genetics. We will discuss all major issues in the area, adaptive evolution of genomes, gene orders, codon evolution, intron evolutions, gene transfer, transposable elements, and Structure and variation in prokaryotic genomes. One debate will be organized, where students will have opportunity to practice how to express their ideas articulately. Spring (every other year

OR

HGEN 46900  Human Variation and Disease. This course focuses on principles of population and evolutionary
genetics and complex trait mapping as they apply to humans. It will include the discussion of genetic variation and disease mapping data. Spring.

**GRADED LAB ROTATIONS TO BE TAKEN IN WINTER, SPRING & SUMMER QUARTERS:**

BSDG 40100 Non-Thesis Research: Biological Sciences. Laboratory rotation – (10 weeks) Winter, Spring

BSDG 40100 Non-Thesis Research: Biological Sciences. Laboratory rotation – (5 weeks) Summer.

BSDG 40102 Non-Thesis Research: Biological Sciences. Third Laboratory rotation (Optional) (Second 5 weeks of quarter) Summer.

**ADDITIONAL GGSB REQUIREMENT:**

GENE 31800 Current Seminar Topics in Genetics. This course will expose student to current research topics in genetics for the bi-monthly GGSB Invited Seminar Series. This is a required ½ credit course for all GGSB students and will be graded Pass/Fail. Winter, Spring

**ADDITIONAL DIVISIONAL REQUIREMENTS:**

GENE 31900 Introduction to Research (Allstars) Lectures on current research by departmental faculty and other invited speakers. A required course for all first-year graduate students. Autumn, Winter.

BSDG 55100 Responsible, rigorous, and reproducible conduct of research: R3CL Required of all BSD first-year doctoral students. The course is designed to stimulate thinking and facilitate discussion about the purpose and necessity of ethical conduct with respect to scientific and academic practices; to create personal awareness of the ethical dilemmas and choices that may be encountered in the course of a career in the sciences; to increase awareness and understanding of the importance of reproducible, rigorous, and transparent research; and to provide practical information regarding policies and procedures related to conduct in the Division of Biological Sciences at the University of Chicago. (Winter)

MGCB 32100 Senior Graduate Ethics A second training in the ethical conduct of research is required for students still registered four years after their initial training. Senior ethics training content is more closely aligned with research areas and so this training is coordinated by the individual graduate programs. Spring.

**FOUR [4] ELECTIVE COURSES CHOSEN FROM THE FOLLOWING LIST:**
(Students may petition the Curriculum & Student Affairs Committee for approval of courses not listed below)

**Genetics:**

GENE 39900 Readings in Genetics. A course designed by a student and faculty member. All reading courses must be approved by the Curriculum/Student Affairs Committee prior to registration. See page 9 for our policy on reading courses. Autumn, Winter, Spring, Summer.

**Biochemistry & Molecular Biology:**

BCMB 30400 Protein Fundamentals. The course covers the physical-chemical phenomena that define protein structure and function. Topics include: the principles of protein folding, molecular motion and molecular recognition; protein evolution, design and engineering; enzyme catalysis; regulation of protein function and molecular machines; proteomics and systems biology. Autumn.

BCMB 30600 Nucleic Acid Structure and Function. This course focuses on the biochemistry of nucleic acids. Topics include nucleic acid structure, folding, and chemistry, protein-nucleic acid interactions, non-coding RNAs, and the enzymology of key processes such as DNA replication, repair and recombination. A special emphasis is placed on primary literature. Prereq: Courses in Biochemistry, molecular biology and organic chemistry. Autumn.
Developmental Biology:

DVBI 33850 Evolution and Development.
The course will provide a developmental perspective on animal body plans in phylogenetic context. The course will start with a few lectures, accompanied by reading assignments. Students will be required to present a selected research topic that fits the broader goal of the course and will be asked to submit a referenced written version of it after their oral presentation. Grading will be based on their presentation (oral and written) as well as their contributions to class discussions. Autumn

DVBI 36200 Stem Cells and Regeneration.
The course will focus on the basic biology of stem cells and regeneration, highlighting biomedically relevant findings that have the potential to translate to the clinic. We will cover embryonic and induced pluripotent stem cells, as well as adult stem cells from a variety of systems, both invertebrate and vertebrates. Autumn.

DVBI 36400 Developmental Mechanisms. This course provides an overview of the fundamental questions of developmental biology, with particular emphasis on the genetic, molecular and cell biological experiments that have been employed to reach mechanistic answers to these questions. Topics covered will include formation of the primary body axes, the role of local signaling interactions in regulating cell fate and proliferation, the cellular basis of morphogenesis, and stem cells. Winter.

DVBI 35600 Vertebrate Development. This advanced-level course combines lectures, student presentations, and discussion sections. It covers major topics in the developmental biology of vertebrate embryos (e.g., gastrulation, segmentation, nervous system development, limb patterning, organogenesis). The course makes extensive use of the current primary literature and emphasizes experimental approaches including embryology, genetics, and molecular genetics. Spring.

DVBI 36100 Plant Development and Molecular Genetics. Genetic approaches to central problems in plant development will be discussed. Emphasis will be placed on embryonic pattern formation, meristem structure and function, reproduction, and the role of hormones and environmental signals in development. Lectures will be drawn from the current literature; experimental approaches (genetic, cell biological, biochemical) used to discern developmental mechanisms will be emphasized. Graduate students will present a research proposal in oral and written form; undergraduate students will present and analyze data from the primary literature, and will be responsible for a final paper. Spring.

Ecology & Evolution:

ECEV 32500 Evolutionary Aspects of Gene Regulation. This advanced level course focuses on reading and participation. Each meeting period is dedicated to a new Topic, several of which make up a Module. Typical modules are: transcription factors and cis-regulatory elements, functional consequences of regulatory changes and RNAi as an alternative mechanism of gene regulation. Students present and discuss several papers from the primary literature during this course. Autumn.

ECEV 35800 Classics of Evolutionary Genetics. Major classic papers in evolutionary genetics that had great impact on the development of the field are reviewed. Spring.

Human Genetics:

HGEN 47000 Human Genetics I. This course covers classical and modern approaches to studying cytogenetic, Mendelian, and complex human diseases. Topics include chromosome biology, human gene discovery for single gene and complex diseases, non-Mendelian inheritance, mouse models of human disease, cancer genetics, and human population genetics. The format includes lectures and student presentations. Autumn.

HGEN 47100 Introductory Statistical Genetics. This course focuses on genetic models for complex human disorders and quantitative traits. Topics covered also include linkage and linkage disequilibrium mapping genetic models for complex traits, and the explicit and implicit assumptions of such models. Winter.
HGEN 47400 Introduction to Probability and Statistics for Geneticists. This course is an introduction to basic probability theory and statistical methods useful for people who intend to do research in genetics or a similar scientific field. Topics include random variable and probability distributions, descriptive statistics, hypothesis testing and parameter estimation. Problem sets and tests will include both solving problems analytically and analysis of data using the R statistical computing environment. Autumn.

Molecular Genetics & Cell Biology:

MGCB 31300 Molecular Biology II. The content of this course will cover the mechanisms and regulation of eukaryotic gene expression at the transcriptional and post-transcriptional levels. Our goal is to explore research frontiers and evolving methodologies. Rather than focusing on the elemental aspects of a topic, the lectures and discussions highlight the most significant recent developments, their implications and future directions. Spring.

MGCB 31500 Genetic Mechanisms
Advanced coverage of mechanisms involved in promoting genome stability and genome evolution. A variety of experimental systems are explored from bacteriophage to humans. Topics include the genetics and biochemistry of DNA repair, homologous and site-specific recombination, transposition and genome rearrangement. Two of three weekly meetings are lecture and the third student led discussion of recent papers from the primary literature. The course emphasizes experimental design and interpretation of primary data. Spring.

MGCB 31600 Cell Biology I. Eukaryotic protein traffic and related topics, including molecular motors and cytoskeletal dynamics, organelle architecture and biogenesis, protein translocation and sorting, compartmentalization in the secretory pathway, endocytosis and exocytosis, and mechanisms and regulation of membrane fusion. Autumn.

MGCB 31700 Cellular Biology II. This course covers the mechanisms with which cells execute fundamental behaviors. Topics include signal transduction, cell cycle progression, cell growth, cell death, cancer biology, cytoskeletal polymers and motors, cell motility, cytoskeletal diseases, and cell polarity. Each lecture will conclude with a dissection of primary literature with input from the students. Students will write and present two short research proposals, providing excellent preparation for preliminary exams. Cell Bio I 31600 is not a prerequisite Winter.

MGCB 32900 Plant Development and Molecular Genetics. Growth, differentiation and development in plants at the organismal, cellular, and molecular level. The regulatory function of environmental factors, hormones and phytochrome on gene expression and the possible evolutionary relationships will be studied. The molecular genetic advances in Arabidopsis and maize are a central feature of the course. Spring.

Cell Physiology:

CPHY 35000 Systems Biology, Self-Assembly & Complexity. The unifying theme of the course is Systems Biology, Self-Assembly and Complexity, covering a wide range of forward-looking topics where exploiting the approaches of chemistry, physics, computer science, statistics, and mathematics will be necessary to gain key insights into biological mysteries. Topics will be as broad as nucleic acid structure and function at the nano- and meso-scales, determinants of protein-nucleic acid interaction specificity, finding short sequence needles in genome-size haystacks, sequencing and mining genomes and even speculations on the chemical origins of life. Spring.

Computer Science:

CMSC 37720 Computational Systems Biology. Introductory concepts of systems biology, computational methods for analysis, reconstruction, visualization, modeling and simulation of complex cellular networks including biochemical pathways for metabolism, regulation and signaling. Students will have the opportunity to explore systems of their own choosing and will participate in developing algorithms and tools for comparative genomic analysis, metabolic pathway construction, stoichiometric analysis, flux analysis, metabolic modeling
and cell simulation. A particular focus of the course will be on furthering our understanding of the computer science challenges in the engineering of prokaryotic organisms. The course requires written assignments, programming assignments and a final course project. Autumn.

Statistics:

STAT 22000 Statistic Methods and Applications. Statistics 22000 provides an introduction to how statisticians think about describing data, data collection and research design, probability and randomness, and inference from a sample to a population. Autumn, Winter, and Spring.

STAT 23400 Statistical Models/Method. This course presents basic ideas of probability theory and statistics and will provide a broad background in statistical methodology and exposure to probability models and the statistical concepts underlying the methodology. Probability is developed for the purpose of modeling outcome of random phenomena. Random variables and their expectations are studied; including means and variances of linear combinations, and an introduction to conditional expectation. Binomia, Poisson, normal and other standard probability distributions are considered. Some probability models are studied mathematically and others via simulation on a computer. Sampling distributions and related statistical methods are explored mathematically, studied via simulation and illustrated on data. Statistical methods for describing data and making inferences based on samples from populations are presented. Methods include, but are not limited to, inference for means and variances for one- and two-sample problems, correlation and simple linear regression. Graphical and numerical data descriptions are used for exploration, communication of results, and comparing mathematical consequences of probability models and data. Mathematics is employed to the level of univariate calculus and is less demanding than that required by STAT 24400. Autumn, Winter.

STAT 22600 Analysis of Qualitative Data. This is an introduction to the theory and applications of statistical methods for investigating the relationships among discrete variables. The course will present methods for analyzing categorical data, standard methods for contingency tables such as odds ratios, tests of independence and various measures of association, generalized linear models for binary data and count data, logistic regression for binomial data, loglinear models for Poisson data. The statistical techniques discussed will be presented by many real examples involving both physical and social science data. PQ: Statistics 22000 or equivalent. It is expected that the students have a good understanding of basic descriptive statistics such as means, variances and expectation, of the inferential notions of estimate, confidence intervals and significance or hypothesis testing. Familiarity with one statistical package, e.g. Stata, Sas, Splus, Spss, Minitab and ability to access Web sites and to download files from the Web are required. Winter.


STAT 35500 – Statistical Genetics. This is an advanced course in statistical genetics. Prerequisites are Human Genetics 47100 and Statistics 24400 and 24500. Students who do not meet the prerequisites may enroll on a P/NP basis with consent of the instructor. Prerequisites are either Human Genetics 47100 or statistics preparation at the level of Statistics 24400 and 24500. This is a discussion course and student presentations will
be required. Topics vary and may include, but are not limited to, statistical problems in linkage mapping, association mapping, map construction, and genetic models for complex traits. *Spring.*
GGSB COMPUTATIONAL TRACK - COURSES
For detailed information on course time schedules visit:
The Academic Information System: Class Search


THREE [3] REQUIRED COURSES IN GENETICS:


AND

HGEN 48600 Fundamentals of Computational Biology: Models and Inference. Note: Course description coming soon. Winter

AND

HGEN 48800 Fundamentals of Computational Biology: Algorithms and Applications Note: Course description coming soon. Spring

GRADED LAB ROTATIONS TO BE TAKEN IN WINTER, SPRING & SUMMER QUARTERS:

BSDG 40100 Non-Thesis Research: Biological Sciences. Laboratory rotation – (10 weeks) Winter, Spring

BSDG 40100 Non-Thesis Research: Biological Sciences. Laboratory rotation – (5 weeks) Summer.

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MGCB 32100 Senior Graduate Ethics A second training in the ethical conduct of research is required for students still registered four years after their initial training. Senior ethics training content is more closely aligned with research areas and so this training is coordinated by the individual graduate programs. Spring.

Plus Three [3] Core Elective Courses Chosen from the Following List)
HGEN 47000  Human Genetics I. This course covers classical and modern approaches to studying cytogenetic, Mendelian, and complex human diseases. Topics include chromosome biology, human gene discovery for single gene and complex diseases, non-Mendelian inheritance, mouse models of human disease, cancer genetics, and human population genetics. The format includes lectures and student presentations. Autumn.

OR

MGCB 31400  Genetics Analysis of Model Organisms. Fundamental principles of genetics discussed in the context of current approaches to mapping and functional characterization of genes. The relative strengths and weaknesses of leading model organisms are emphasized via problem-solving and critical reading of original literature. Autumn.

OR

HGEN 47100  Introductory Statistical Genetics. This course focuses on genetic models for complex human disorders and quantitative traits. Topics covered also include linkage and linkage disequilibrium mapping genetic models for complex traits, and the explicit and implicit assumptions of such models. Winter.

OR

ECEV 35600  Principles of Population Genetics I. Examines the basic theoretical principles of population genetics, and their application to the study of variation and evolution in natural populations. Topics include selection, mutation, random genetic drift, quantitative genetics, molecular evolution and variation, the evolution of selfish genetic systems, and human evolution. Spring.

OR

ECEV 31100 Evolution of Biological Molecules. The course connects evolutionary changes imprinted in genes and genomes with the structure, function and behavior of the encoded protein and RNA molecules. Central themes are the mechanisms and dynamics by which molecular structure and function evolve, how protein/ RNA architecture shapes evolutionary trajectories, and how patterns in present-day sequence can be interpreted to reveal the interplay data of evolutionary history and molecular properties. Core concepts in macromolecule biochemistry (folding and stability of proteins and RNA, structure-function relationships, kinetics, catalysis) and molecular evolution (selection, mutation, drift, epistasis, effective population size, phylogenetics) will be taught, and the interplay between them explored. Winter.

OR

BCMB 32200 Biophysics of Biomolecules. This course covers the properties of proteins, RNA, and DNA, as well as their interactions. We emphasize the interplay between structure, thermodynamics, folding, and function at the molecular level. Topics include cooperativity, linked equilibrium, hydrogen exchange, electrostatics, diffusion, and binding. Spring.

OR

HGEN 46900 Human Variation and Disease. This course focuses on principles of population and evolutionary genetics and complex trait mapping as they apply to humans. It will include the discussion of genetic variation and disease mapping data. Spring.

OR

HGEN 47300  Genomics and Systems Biology. This lecture course explores technologies for high-throughput collection of genomic-scale data, including sequencing, genotyping, gene expression profiling, and assays of copy number variation, protein expression and protein-protein interaction. In addition, the course will cover study design and statistical analysis of large data sets, as well as how data from different sources can be used to understand regulatory networks, i.e., systems. Statistical tools that will be introduced include linear models, likelihood-based inference, supervised and unsupervised learning techniques, methods for assessing quality of data, hidden Markov models, and controlling for false discovery rates in large data sets. Readings will be drawn from the primary literature. Evaluation will be based primarily on problem sets. Spring.

OR

MGCB 32000 Quantitative Analysis of Biological Dynamics. This course covers quantitative approaches to understanding biological organization and dynamics at molecular, sub-cellular and cellular levels. A key emphasis is on the use of simple mathematical models to gain insights into complex biological dynamics. We also will cover modern approaches to quantitative imaging and image analysis, and methods for comparing models to experimental data. A series of weekly computer labs will introduce students to scientific programming using Matlab and exercise basic concepts covered in the lectures. Spring.

Plus Two [2] Additional Elective Courses Chosen From the Following List:
BIOS 20186 Fundamentals of Cell and Molecular Biology. This course is an introduction to molecular and cellular biology that emphasizes the unity of cellular processes amongst all living organisms. Topics are the structure, function, and synthesis of nucleic acids and protein; structure and function of cell organelles and extracellular matrices; energetics; cell cycle; cells in tissues and cell-signaling; temporal organization and regulation of metabolism; regulation of gene expression; and altered cell functions in disease states. (Autumn)

OR

STAT 34300 Applied Linear Statistical Methods This course introduces the theory, methods, and applications of fitting and interpreting multiple regression models. Topics include the examination of residuals, the transformation of data, strategies and criteria for the selection of a regression equation, nonlinear models, biases due to excluded variables and measurement error, and the use and interpretation of computer package regression programs. The theoretical basis of the methods, the relation to linear algebra, and the effects of violations of assumptions are studied. Techniques discussed are illustrated by examples involving both physical and social sciences data. Autumn

OR

STAT 37790 Topics in Statistical Machine Learning "Topics in Statistical Machine Learning" is a second graduate level course in machine learning, assuming students have had previous exposure to machine learning and statistical theory. The emphasis of the course is on statistical methodology, learning theory, and algorithms for large-scale, high dimensional data. The selection of topics is influenced by recent research results, and students can take the course in more than one quarter. Autumn

OR

CMSC 37720 Computational Systems Biology. Introductory concepts of systems biology, computational methods for analysis, reconstruction, visualization, modeling and simulation of complex cellular networks including biochemical pathways for metabolism, regulation and signaling. Students will have the opportunity to explore systems of their own choosing and will participate in developing algorithms and tools for comparative genomic analysis, metabolic pathway construction, stoichiometric analysis, flux analysis, metabolic modeling and cell simulation. A particular focus of the course will be on furthering our understanding of the computer science challenges in the engineering of prokaryotic organisms. The course requires written assignments, programming assignments and a final course project. Autumn

OR

ECEV 32000 Introduction to Scientific Computing for Biologists The course will cover basic concepts in computing for an audience of biology graduate students. The students will receive basic training in the use of version control systems, databases and regular expressions. They will learn how to program in python and R and how to use R to produce publication-grade figures for their manuscripts, and how to typeset scientific manuscripts and theses using LaTeX. All the examples and exercises will be biologically motivated and will make use of real data. The approach will be hands-on, with lecturing followed by exercises in class. Winter

OR

STAT 30900. Mathematical Computation I — Matrix Computation This is an introductory course on numerical linear algebra, which is quite different from linear algebra. We will be much less interested in algebraic results that follow from axiomatic definitions of fields and vector spaces but much more interested in analytic results that hold only over the real and complex fields. The main objects of interest are real- or complex-valued matrices, which may come from differential operators, integral transforms, bilinear and quadratic forms, boundary and coboundary maps, Markov chains, correlations, DNA microarray measurements, movie ratings by viewers, friendship relations in social networks, etc. Numerical linear algebra provides the mathematical and algorithmic tools for analyzing these matrices. Topics covered: basic matrix decompositions LU, QR, SVD; Gaussian elimination and LU/LDU decompositions; backward error analysis, Gram-Schmidt orthogonalization and QR/complete orthogonal decompositions; solving linear systems, least squares, and total least squares problem; low-rank matrix approximations and matrix completion. We shall also include a brief overview of stationary and Krylov subspace iterative methods; eigenvalue and singular value problems; and sparse linear algebra. Autumn

OR

BIOS 20187 Fundamentals of Genetics. The goal of this course is to integrate recent developments in molecular genetics and the human genome project into the structure of classical genetics. Topics include Mendelian inheritance, linkage, tetrad analysis, DNA polymorphisms, human genome, chromosome aberrations and their molecular analysis, bacterial and virus genetics, regulatory mechanisms, DNA cloning, mechanism of mutation and recombination, and transposable elements. Winter
STAT 24500  **Statistical Theory and Methods II.** Principles and techniques of statistics with emphasis on the analysis of experimental data. First quarter: Discrete and continuous probability distributions, transformation of random variables; principles of inference including Bayesian inference, maximum likelihood estimation, hypothesis testing, likelihood-ratio tests, multinomial distributions and chi-square tests. Second quarter: Multivariate normal distributions and transformations, Poison processes, data analysis, t-tests, confidence intervals, analysis of variance and regression analysis. *Autumn, Winter.*

OR

STAT 32950  **Multivariate Statistical Analysis: Applications and Techniques** This course focuses on applications and techniques for analysis of multivariate and high dimensional data. Beginning subjects cover principal component analysis, factor model, canonical correlation, multi-dimensional scaling, discriminant analysis, clustering, and common techniques of dimension reduction. Further topics on statistical learning for high dimensional data and complex structures include penalized regression models (LASSO, ridge, elastic net), sparse PCA, independent component analysis, Gaussian mixture model, and Expectation-Maximization methods. Theoretical derivations will be presented with emphasis on motivations, applications, and hands-on data analysis. *Winter*

OR

ECEV 42900  **Theoretical Ecology** A lecture course on the empirical and theoretical approaches to the study of natural populations, including field methodologies and quantitative approaches. Includes computer assignments. *Winter*

OR

STAT 24610  **Pattern Recognition** This course treats statistical models and methods for pattern recognition and machine learning. Topics include a review of the multivariate normal distribution, graphical models, computational methods for inference in graphical models in particular the EM algorithm for mixture models and HMM’s, and the sum-product algorithm. Linear discriminative analysis and other discriminative methods, such as decision trees and SVM’s are covered as well. *(Spring)*

OR

STAT 30210  **Bayesian Analysis and Principles of Statistics** This course continues the development of Mathematical Statistics, with an emphasis on Bayesian analysis and underlying principles of inference. Topics include Bayesian Inference and Computation, Frequentist Inference and interpretation of p values and confidence intervals, Decision theory, admissibility and Stein’s paradox, the Likelihood principle, Exchangeability and De Finetti’s theorem, hierarchical modelling, multiple comparisons and False Discovery Rates. The mathematical level will generally be at that of an easy advanced calculus course. We will assume familiarity with standard statistical distributions (e.g., Normal, Poisson, Binomial, Exponential), with the laws of probability, expectation, conditional expectation, etc., and exposure to common statistical concepts such as p values and confidence intervals. Familiarity with the R statistical language will also be expected, and homework assignments will include programming problems in R. *(Spring)*

OR

STAT 35500 –  **Statistical Genetics.** This is an advanced course in statistical genetics. Prerequisites are Human Genetics 47100 and Statistics 24400 and 24500. Students who do not meet the prerequisites may enroll on a P/NP basis with consent of the instructor. Prerequisites are either Human Genetics 47100 or statistics preparation at the level of Statistics 24400 and 24500. This is a discussion course and student presentations will be required. Topics vary and may include, but are not limited to, statistical problems in linkage mapping, association mapping, map construction, and genetic models for complex traits. *(Spring)*

OR

STAT 37710  **Machine Learning.** This course provides hands-on experience with a range of contemporary machine learning algorithms, as well as an introduction to the theoretical aspects of the subject. Topics covered include: the PAC framework, Bayesian learning, graphical models, clustering, dimensionality reduction, kernel methods including SVMs, matrix completion, neural networks, and an introduction to statistical learning theory. *(Spring)*
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