



# Georgia Institute of Technology

## HANDBOOK FOR BIOLOGY MAJORS

SCHOOL OF BIOLOGICAL SCIENCES



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## INTRODUCTION

The School of Biological Sciences has approximately 350 undergraduate majors, the largest enrollment of any of the majors in the College of Sciences. Biosciences faculty members, however, work hard to treat every student as a unique individual. Faculty and students together constitute a mutually supportive intellectual community. All biology majors are encouraged to know and to become known by their professors. The names, academic interests, and phone numbers of all faculty members are listed on the Biosciences website at [www.biosci.gatech.edu/people](http://www.biosci.gatech.edu/people).

This handbook is intended for the use of undergraduate students in the School of Biological Sciences. Its purpose is to provide information supplementary to that contained in the “General Catalog” ([www.catalog.gatech.edu](http://www.catalog.gatech.edu)) and the “Rules and Regulations” ([catalog.gatech.edu/rules/](http://catalog.gatech.edu/rules/)) in matters that pertain specifically to the School of Biological Sciences. The School of Biological Sciences website at [www.biosci.gatech.edu](http://www.biosci.gatech.edu) provides an additional resource. Information for registering for classes, advisor contact information, FAQ’s, etc., can be found on the Undergraduate Program page of the Biology web page at [www.biosci.gatech.edu/undergrad/undergraduate-current-students](http://www.biosci.gatech.edu/undergrad/undergraduate-current-students). This handbook and the Biology web pages are not intended to supersede the “General Catalog” or the “Rules and Regulations.” In the case of any conflicts, these latter documents will prevail.

## SCHOOL OF BIOLOGICAL SCIENCES ORGANIZATION

- I. **School Chair:** Dr. J. Todd Strelman, Professor, Room 2015 Engineered Biosystems Building. The Chair of the School of Biological Sciences is Dr. J. Todd Strelman, who is responsible for the overall operation of the School.
- II. **Associate Chair for Undergraduate Affairs:** Dr. Michael Goodisman, Cherry Emerson A110. The Associate Chair of Undergraduate Affairs works directly with the School of Biological Sciences Academic Office to ensure smooth operation of the Undergraduate Program.
- III. **Academic Office:**
  - Academic Advisors: Dr. Mirjana Brockett, 323 Cherry Emerson  
Dr. Linda Green, 474C Clough Commons  
Dr. Shana Kerr, A114 Cherry Emerson  
Dr. Chrissy Spencer, 474D Clough Commons
  - Academic Program Coordinator: Ms. Benita Black, 474E Clough Commons

The main functions of the Academic Office are to:

1. Organize undergraduate academic activities in the School.
2. Act as liaison to other schools and units on campus on matters relating to undergraduate education.
3. Coordinate an active and responsive academic advising program.
4. Provide advice and direction to students about academic programs and careers.

## THE LONG-TERM GOAL: EMPLOYMENT AND EDUCATION AFTER GRADUATION

**Job Placement:** The most frequently asked question is “What can I do with a B.S. in Biology?” You will be pleased to learn that there are excellent employment opportunities for those trained in the life sciences with a BS degree. The School of Biological Sciences assists students in obtaining internships during their time at Tech, and the Center for Career Discovery and Development ([careerdiscovery.gatech.edu](http://careerdiscovery.gatech.edu)) is also a great resource. Additional Biology resources are available on the School of Biological Sciences website at [biosci.gatech.edu/undergrad/career-links](http://biosci.gatech.edu/undergrad/career-links).

**Graduate School:** A degree in biology gives you flexibility to pursue diverse fields of study in graduate programs focusing on topics such as molecular biology, conservation biology, public health, engineering, business, or education.

**Professional School:** Georgia Tech biology graduates are regularly accepted into schools of medicine, dentistry, optometry, pharmacy, and veterinary medicine. To find out more about these and other pre-health options, contact the Pre-Health Advising Office and the School of Biological Sciences chapter of the American Medical Student Association (AMSA) premedical society.

## THE SHORT-TERM GOAL: B.S. DEGREE REQUIREMENTS

A Bachelor of Science in Biology requires a minimum of 122 credit hours. All courses must be taken for a letter grade, except for Free Electives which can include pass/fail courses. All letter grades of D and higher are accepted in the Biology degree.

### **Required Biology Core Courses**

BIOL 1511	Majors/Honors Biological Principles
BIOL 1521	Majors/Honors Intro to Organismal Biology
BIOL 2335 (or 2337)	General Ecology (or Honors)
BIOL 2344 (or 2354)	Genetics (or Honors)
BIOL 3450	Cell and Molecular Biology
BIOL 3600	Intro to Evolution
BIOL 4460	Communicating Biological Research

Two of these three labs: Ecology Lab (BIOL 2336 or 2338), Genetics Lab (BIOL 2345 or 2355), or Cell and Molecular Biology Lab (BIOL 3451) (each lab should be taken concurrently with the associated lecture course unless otherwise noted during registration).

### **Required Quantitative Biology Course**

One of the following:

BIOL 2400	Mathematical Models in Biology
BIOL 4150	Genomics & Applied Bioinformatics
BIOL 4401	Experimental Design & Statistical Methods

Other advanced quantitative courses may be appropriate depending on your interests and strengths. If you wish to enroll in a course other than BIOL 2400, BIOL 4401, or BIOL 4150 to fulfill your quantitative requirement, you must discuss with your advisor to obtain School of Biological Sciences approval.

### **Required Senior Research Experience**

One of the following:

BIOL 4590	Research Project Lab
BIOL 4690	Independent Research Project
BIOL 4910	Honors Research Thesis

### **Required Non-Biology Science Courses**

CHEM 1211K	Chemical Principles I
CHEM 1212K	Chemical Principles II
CHEM 2311	Organic Chem I, Principles (sections P and higher)
CHEM 2313 (or CHEM 2311)	Bio-Organic Chem (or Organic Chem II)
CHEM 2380	Synthesis Lab
MATH 1551	Differential Calculus
MATH 1553	Linear Algebra
MATH 1555 (or MATH 1552)	Integral Calculus for Life Sciences (or Integral Calc)
PHYS 2211	Intro Physics I for Life Sciences (section C)
PHYS 2212	Intro Physics II for Life Sciences (section C)

### **Biology Electives**

Students are required to complete 21 credits of Biology electives defined as follows: 12 "**depth**" credits must be courses with a "BIOL" prefix, excluding BIOL 4694-4699. Biology Elective courses that are cross-listed with other Schools are included in these 12 depth credits. The remaining 9 "**breadth**" credits can be selected from other BIOL 3XXX and higher courses, BIOL 4695, 4697, 4699, and the list of approved courses offered in other Schools (see Appendix). For Business Option students, a maximum of 6 credits of Business Option electives can be applied to the 9 breadth credits. For Research Options students, a maximum of 2 credits of LMC 4701 and 4702 can be applied to the 9 breadth credits. A maximum of 6 credits can be applied to the 9 breadth credits from each of BIOL 4695, 4697, 4699.

### **Humanities and Social Sciences Electives**

See "Core Curriculum," Information for Undergraduate Students on the Registrar's website (<http://www.catalog.gatech.edu/academics/undergraduate/core-curriculum/>) for approved courses and caveats. All students are required to take a total of 12 hours of Social Sciences and 6 hours of Humanities, in addition to ENGL 1101\* and 1102\*.

As part of the 12 hours of Social Sciences, all students are required to take one course from HIST 2111, HIST 2112, POL 1101, PUBP 3000, or INTA 1200 to satisfy state requirements regarding United States Perspectives.

### **Computing Requirement**

Students must complete CS 1301, CS 1315, CS 1371, or CS 13X1 (transfer course).

### **Wellness Requirement**

Georgia Tech requires students to complete APPH 1040 (formerly HPS 1040) or APPH 1050.

### **Free Electives**

The remaining 11 credits beyond those listed above are free electives, which may be taken for letter grade or pass/fail.

\* Timing: Students must complete a MATH course<sup>†</sup> and ENGL 1101 and 1102 courses within their first 30 credit hours as part of the required Communication and Quantitative Outcomes. After reaching 30 credit hours, a student must enroll in the next course necessary to make progress toward completing this requirement in every semester in which they take classes.

<sup>†</sup>Consult the registrar's website and your academic advisor for the exact MATH sequence required by the 30 credit hour mark.

## ACADEMIC ADVISING

### Advisors

Upon your arrival at Georgia Tech or when you declare Biology as your major, you will be assigned an academic advisor. Advisor assignments are by last name as follows:

<u>Last names beginning</u>	<u>Advisor</u>
A–F	Dr. Emily Weigel
G–L	Dr. Chrissy Spencer
M–R	Dr. Mirjana Brockett
S–Z	Dr. Shana Kerr

Your advisor is here to help you whenever you seek advice and to provide guidance about Georgia Tech regulations, undergraduate programs, and career opportunities. You are strongly urged to consult your advisor to plan and execute your program of study, to discuss career options, and to design an optimal map for achieving your goals. You may schedule a meeting with your advisors using the web-based appointment scheduling system at [gatech.gradesfirst.com](http://gatech.gradesfirst.com).

### Annual Advising Meeting

The Biology program recognizes that providing advising support for our undergraduates helps students succeed in effective course selection and career planning, which includes finding on-campus and off-campus research/internship opportunities, establishing a timeline for career planning, and exploring the range of options you have with a B.S. in Biology.

Therefore, Biology majors are required to attend an annual 15 minute advising meeting. The Annual Advising appointment is an opportunity to work one-on-one with your advisor to create a strong plan to achieve your academic and career goals.

Biology majors will receive an email invitation according to academic class standing: freshmen/sophomores in the Spring and juniors/seniors in the Fall. The email will give the scheduling deadline and detail what you need to bring to your advising appointment. Seniors will review their graduation status and discuss the Online Application for Graduation at this advising session. The online application for graduation deadline occurs at the end of the drop/add period in the student's final semester. Failure to schedule and attend your annual advising meeting may result in a registration hold being placed on your account.

### Midterm Progress Reports

At midterm, you may also be contacted by your advisor to check-in regarding your academic progress. Depending upon your Midterm Progress Report grades (provided for all 1000-2000 level courses), you may be invited to communicate by email or in person with your advisor to make an academic plan for the remainder of the semester. These meetings are to be taken seriously, and failure to respond may result in a registration hold being placed on your account.

### DegreeWorks

Students are able to and expected to monitor progress towards your degree requirements using DegreeWorks ([degreeworks.gatech.edu](http://degreeworks.gatech.edu)). Please take responsibility to monitor your progress and bring any discrepancies to the attention of your Academic Advisor. Discrepancies include missing transfer credits, courses listed in the incorrect category, or courses double-counted toward your degree. Advisors can work with Degree Certification to ensure that your courses are correctly attributed toward your degree. Should you wish to consider an alternative to a Biology major or a second major, the "What If" tool can be used to explore how progress towards degree completion is affected should you change or add majors.

## **B.S. DEGREE ENHANCEMENTS**

### **Bachelor of Science in Biology – Research Option**

The Research Option enables students to do 9 credit hours of supervised research with a Biological Sciences faculty member over multiple semesters. With faculty guidance, students write a brief proposal, perform independent, original research, and write a thesis about their work. The thesis is evaluated by two Biological Sciences faculty members. The first 6 credit hours of the research option are taken as BIOL 2699/4699 (research for credit) or BIOL 2698/4698 (research for pay). Students then take either BIOL 4690 (Independent Research Project; 3 hr) or BIOL 4910 (Honors Research Thesis; 3 hr) and two one credit-hour writing courses, LMC 4701 and 4702. These writing courses can be counted as Biology electives for students completing the Research Option. Note that LMC 4701 should be taken in the semester PRIOR to enrolling in BIOL 4910/4690. The student's research is presented in BIOL 4460 Communicating Biological Research. Completing this program gives students a "Research Option" designation on their transcripts. Students can consult the School of Biological Sciences (<http://biosci.gatech.edu/undergrad/bachelor-science-biology-research>) and the Undergraduate Research Opportunities Program for more details (<http://urop.gatech.edu/research-option>).

### **Bachelor of Science in Biology – Business Option**

The B.S. in Biology with a Business Option is a good fit for students interested in the business of biology, who intend to manage their own clinic or practice after professional school, or who may want to pursue an M.B.A. upon graduation. Students in the biology business option must complete 15 credits of approved coursework covering the principles of accounting, economics, and management. Two electives allow students to take advanced coursework in these areas, or to explore the legal, international, entrepreneurial, technological, or financial aspects of the business world. Six of the credit hours from the list of management (MGT) courses will fulfill requirements for Biology electives, and another 3 credit hours of management courses count as free electives. Additional courses within the Business Option may satisfy Social Science electives. Biology majors in this option must still fulfill the other requirements for the Biology undergraduate degree and should note that the MGT courses used as Biology electives reduce the approved Biology electives from outside Biology. Students interested in the Business Option should visit <http://www.biosci.gatech.edu/undergrad/business-option> for specific details on the courses available.

### **Bachelor of Science in Biology - International Plan**

Georgia Tech offers an International Plan through the Office of International Education (<http://www.internationalplan.gatech.edu/>). Successful completion of this plan earns students an International Plan designation on their Georgia Tech degree. The primary purpose of the plan is to offer a challenging and coherent academic program for students to develop global competence within the context of a Biology degree. The specific requirements of the International Plan can be found at <https://oie.gatech.edu/content/program-requirements>. Georgia Tech biology courses are taught in Australia/New Zealand (<http://www.pacific.gatech.edu/>) and Spain (<http://spainportugal2016.weebly.com/>) as part of the Study Abroad program. Other study abroad programs which offer courses relevant to Biology majors are described on the School of Biological Sciences website (<http://biosci.gatech.edu/undergrad/international-opportunities>). In addition, many biology courses are available through Georgia Tech partner universities abroad (<http://www.oie.gatech.edu/sa/programs/index.php>). Some of these universities teach biology courses in English, such as Hong Kong University, Tokyo Technological University, University of Victoria (New Zealand), National University of Singapore, University of Strathclyde (Scotland), and Bilkent University (Turkey).

## REGISTRATION

During Phase 1 and Phase 2 registration, you may begin registering for classes as soon as your time-ticket opens. Students are eligible to register for courses for which they have the prerequisite courses. Prerequisites are listed in the Catalog. To confirm how your courses fit into your degree requirements, check DegreeWorks after you register. If you have concerns about how your courses are attributed in DegreeWorks, please contact your academic advisor. The B.S. Biology degree can be completed in 8 semesters if you complete approximately 15 hours in each semester. This will often include one or two lab courses per semester.

### **Permits (Override Requests)**

For Biology courses, permits for *pre-requisite or class restriction overrides* should be requested from the faculty member teaching the course. Permit request forms for *Biology courses* are at <http://biosci.gatech.edu/undergrad/permits-and-registration>. Have the professor sign the form and return it to Ms. Benita Black in Clough 474E.

For non-biology courses, look on the department's website for their registration instructions. Some departments do permits by email, while others require that a request is submitted through the registration window in OSCAR. A full list of departmental contacts is available on the Registrar's Website (<http://www.registrar.gatech.edu/registration/oprequest.php>).

A *prerequisite override* is submitted by a student if the course instructor agrees that the student is prepared for the course without having taken the listed prerequisite courses – the instructor's signature is required in this case. In other cases, the registration software sometimes does not recognize legitimate prerequisite courses on a student's transcript, and may prevent them from registering for a course. In this case, no instructor's signature is required; instead submit a prerequisite override form to the appropriate department. For Biology courses, this is available at <http://biosci.gatech.edu/undergrad/permits-and-registration>; print and submit the form directly to Benita Black in Clough 474E. Be sure to include your contact information.

Permit requests should NOT be made by phone. Allow 1 business day for the form to be processed.

### **Waitlisting and Overloads**

Biology uses the Waitlist feature to assist our majors with course registration. The waitlist allows students who want to enroll in a full course to sign up on a virtual waitlist and sequentially offers a seat when another student drops. Because of this feature, we do not allow students to overload into our courses. If a section has no available seats, students will be able to register for the waitlist. Registering on a waitlist does not guarantee that you will receive a seat in the section. If seats become available, the system will automatically issue an email notification with permission to register to the next student on the waitlist. Notifications are only valid for a short time period (usually 12 hrs); after that time, the permission to register expires and the seat will be given to the next person on the waitlist. If you *require* a course in a specific semester for an on-time degree completion, you should waitlist and then contact your advisor for assistance.

The waitlist notifications will start once all time tickets are open. *If a section has a waitlist, the open seats are reserved for the people on top of the waitlist. Do not drop your current section unless you want to be waitlisted.* The waitlists will not be purged between registration phases, i.e. students that register on the waitlist for a section in Phase I will retain their spot on the list for Phase II. Check on the registrar's website for details of waitlist timing; typically, the last round of waitlist notifications will be issued at 5pm the day *before* registration closes. After 5pm, the waitlist is no longer functioning and all remaining open seats are first-come, first-served.

During Drop/Add week (the first week of classes), we suggest that you attend all classes that you are registered in *or waitlisted for* so that you do not fall behind. Important class material is covered during that first week.

### **Transfer Credit Options**

Transfer confirmation is a two-step process to determine whether: 1) Georgia Tech has an equivalent approved course and 2) that the transfer credit was taken before the student's last 36 hours at Georgia Tech.

First, confirm that a course will transfer using the transfer equivalency table on OSCAR ([https://oscar.gatech.edu/pls/bprod/wwsktrna.P\\_find\\_location](https://oscar.gatech.edu/pls/bprod/wwsktrna.P_find_location)). If the course is not listed, upload a course description and syllabus to <https://transfercredit.gatech.edu/index.php> for evaluation by the appropriate department. We suggest that you seek transfer credit approval *before* you take the course. In general, transfer Biology courses will be allowed as Biology electives if the course is a 3XXX or 4XXX level course from an accredited institution.

Second, be aware that students must complete the last 36 credit hours of their degree program in residence at Georgia Tech, the "36-hour rule." Note that Georgia Tech cross-enrollment, off-campus, and exchange programs are considered "in residence" for the 36-hour rule. Exceptions to the 36-hour rule may be granted by approval of a petition to the Institute Undergraduate Curriculum Committee; *however, approval of this type of petition is rare*. It is recommended to petition for an exception BEFORE violating the rule. Additionally, some medical schools only accept prerequisite courses taken at four-year institutions. While students may not receive transfer credit from a course taken at another institution when concurrently enrolled (e.g. in the same semester) at Georgia Tech, students are allowed to *cross-enroll* at other area schools through the ARCHE program. For additional information, refer to the ARCHE website at <http://www.registrar.gatech.edu/registration/cross/index.php> and consult with the ARCHE advisor at [crossregistration@registrar.gatech.edu](mailto:crossregistration@registrar.gatech.edu).

## ONLINE APPLICATION FOR GRADUATION (OAG)

In the semester *before* you intend to graduate, students submit an **Online Application for Graduation** by completing the steps below. Before you begin, please take note of the following instructions and deadlines. If the Business Option will be a component of the B.S. Biology degree, declare the Business Option through Oscar following these instructions ([www.degreeworks.gatech.edu/images/training/concentration\\_mgt.pdf](http://www.degreeworks.gatech.edu/images/training/concentration_mgt.pdf)).

### Instructions for the Online Application for Graduation (OAG)

1. Log into [degreeworks.gatech.edu](http://degreeworks.gatech.edu) and confirm that your courses are listed correctly under each Biology degree requirement. (For example, PHYS 2211 should fulfill Core Area D: Intro Physics I, not a Free Elective or a Fallthrough Course.)
2. Take careful note of the courses that you still lack to complete your degree. You must enroll in these courses in your final semester to complete your degree requirements.
3. If you see inconsistencies, email your advisor or schedule an appointment to clear up the errors. Once all errors are resolved, THEN proceed with step 2.
4. During the application window (see below), login to OSCAR and select: Student Services>Student Records>Apply to Graduate.
5. Confirm that your curriculum is listed as a B.S. in Biology. If you are completing a minor or an option, that must be listed as well. *If your curriculum is incorrect, stop immediately and contact Degree Certification (dc@lists.gatech.edu or 404-894-4150) for assistance.*
6. Select the radio button for your program. (If you have more than one major, you'll have to select one at a time and repeat the entire process for your second major.)
7. Select the graduation term in the drop down that will appear.
8. On the next screen, request any changes to your first or middle names to appear on your diploma. Please note that all requests will be reviewed by the Office of the Registrar and are subject to approval. If you would like to change your last name or make more significant changes to your diploma name, please contact the Office of the Registrar.
9. Confirm the address you would like to use as your diploma mailing address.
10. Review the summary of your application before clicking on "Submit Request."
11. At the confirmation screen, you will be redirected to an Exit Survey sponsored by the Office of Assessment. Please continue with the Exit Survey to complete your application.
12. Once you have applied, you will be able to view your Application and Graduation status in DegreeWorks near the top of your degree audit, under the section entitled "Student View." Upon applying you will be given an Application Status of "Active" and a Graduation Status of "Received, Pending Evaluation." You can continue to check your status throughout the semester, and work with your advisor to resolve any deficiencies in a timely manner.

## BACHELOR OF SCIENCE IN BIOLOGY 2016-2017 DEGREE REQUIREMENTS

FIRST YEAR-FALL	HOURS
GT 1000 FRESHMAN SEMINAR*	1
ENGL 1101 ENGLISH COMPOSITION I	3
MATH 1551 DIFFERENTIAL CALCULUS	2
BIOL 1511 (OR 1510) BIOLOGICAL PRINCIPLES	4
CHEM 1211K CHEMICAL PRINCIPLES I	4
<b>TOTAL SEMESTER HOURS</b>	<b>14</b>

SECOND YEAR-FALL	HOURS
BIOL 2335 ECOL, BIOL 2344 GENETICS, OR BIOL 2354 HONS. GENETICS <sup>2</sup>	3
BIOL 2336 ECOL LAB, BIOL 2345 GEN LAB, OR BIOL 2355 HONS. GEN LAB <sup>2</sup>	1
CHEM 2311 ORGANIC CHEMISTRY I	3
MATH 1553 LINEAR ALGEBRA	2
QUANTITATIVE BIOLOGY REQUIREMENT <sup>3</sup> or COMPUTING REQUIREMENT	3
HIST 2111 or 2112 or POL 1101 or PUBP 3000 or INTA 1200 (CONSTITUTION/HISTORY REQUIREMENT)	3
<b>TOTAL SEMESTER HOURS</b>	<b>14 or 15</b>

THIRD YEAR-FALL	HOURS
PHYS 2211 INTRODUCTORY PHYSICS I FOR LIFE SCIENCES	4
BIOL 3450 CELL & MOLECULAR BIOLOGY OR BIOL 3600 EVOLUTION	3
BIOLOGY ELECTIVE	3
HUM or SS ELECTIVE	3
FREE ELECTIVE	3
<b>TOTAL SEMESTER HOURS</b>	<b>16</b>

FOURTH YEAR-FALL	HOURS
BIOLOGY ELECTIVES	6
FREE ELECTIVE	3
HUM or SS ELECTIVE	3
SENIOR RESEARCH EXPERIENCE <sup>4</sup>	3
BIOL 4460 COMMUNICATING BIOLOGICAL RESEARCH	1
<b>TOTAL SEMESTER HOURS</b>	<b>16</b>

FIRST YEAR-SPRING	HOURS
ENGL 1102 ENGLISH COMPOSITION II	3
MATH 1555 CALCULUS FOR LIFE SCIENCES (OR MATH 1552 INTEGRAL CALCULUS)	4
BIOL 1521 (OR 1520) INTRODUCTION TO ORGANISMAL BIOLOGY <sup>1</sup>	4
CHEM 1212K CHEMICAL PRINCIPLES II	4
<b>TOTAL SEMESTER HOURS</b>	<b>15</b>

SECOND YEAR-SPRING	HOURS
BIOL 2344 GENETICS, BIOL 2335 OR BIOL 2337 HONORS ECOLOGY <sup>2</sup>	3
BIOL 2345 GENETICS LAB, BIOL 2336, OR BIOL 2338 HONS. ECOLOGY LAB <sup>2</sup>	1
CHEM 2313 BIO-ORGANIC CHEMISTRY (OR CHEM 2312 ORGANIC CHEMISTRY II)	3
CHEM 2380 SYNTHESIS LAB	2
QUANTITATIVE BIOLOGY REQUIREMENT <sup>3</sup> or COMPUTING REQUIREMENT	3
HUM or SS ELECTIVE	3
<b>TOTAL SEMESTER HOURS</b>	<b>14 or 15</b>

THIRD YEAR-SPRING	HOURS
PHYS 2212 INTRODUCTORY PHYSICS II FOR LIFE SCIENCES	4
BIOL 3450 CELL & MOLECULAR BIOLOGY OR BIOL 3600 EVOLUTION	3
BIOL 3451 CELL & MOLECULAR BIOL LAB <sup>2</sup>	1
BIOLOGY ELECTIVE	3
WELLNESS	2
HUM or SS ELECTIVE	3
<b>TOTAL SEMESTER HOURS</b>	<b>15 or 16</b>

FOURTH YEAR-SPRING	HOURS
BIOLOGY ELECTIVE	9
FREE ELECTIVE	5
HUM or SS ELECTIVES	3
<b>TOTAL SEMESTER HOURS</b>	<b>17</b>

**TOTAL DEGREE REQUIREMENT HOURS 122**

\*Not required for graduation, another free elective may be substituted

## Important notes

<sup>1</sup>4 credit hours of Biology elective may be substituted for BIOL 1521 if a score of 5 was achieved on the AP Biology test. A maximum of 1 of these credits may be BIOL 4697 or BIOL 4699. Please discuss this option with your advisor. It is important to note that substituting for BIOL 1520/1521 often results in a student needing to take more than a single Biology elective class, because most Biology electives are only 3 credit hours.

<sup>2</sup>Only 2 of the 3 core labs are required: BIOL 2336/2338, BIOL 2345/2355, BIOL 3451.

<sup>3</sup>Quantitative Biology Requirement: choose one of the following: BIOL 2400 Mathematical Models in Biology, BIOL 4150 Genomics & Applied Bioinformatics, BIOL 4401 Experimental Design & Biostatistics.

<sup>4</sup>Senior Research Experience: choose one of the following: BIOL 4590 Research Project Lab, BIOL 4690 Independent Research Project, BIOL 4910 Honors Research Thesis. Senior Research Experience can be fulfilled in either fourth-year fall or spring semester.

## BIOLOGY MINOR

A minor in Biology is available to all *non*-biology majors. The minor is awarded by the registrar's office and appears on your transcript and diploma. The minor constitutes 15 credit hours of Biology (BIOL) courses, of which 9 hours must be at the 3000 level or higher and of which 3 hours can be Biology Special Topics courses and 3 hours can be either BIOL 4695, 4697, or 4699. Any section of a cross-listed Biology elective, such as APPH Anatomy and Physiology lecture courses, can be used toward the Biology minor. A maximum of 3 credit hours of transfer credit may be used to satisfy the course requirements for a minor. All courses counting toward the minor must be taken on a letter-grade basis with a grade of C or higher. Consult with your major and minor advisors to verify potential to use courses from the major field of study to satisfy the Biology minor, and that Core Area A-E courses are not used toward the minor. Students may not double-count courses towards more than one certificate or minor. Further information is available from your School of Biological Sciences advisor. To declare a minor in Biology, follow the instructions on the registrar's site: <http://www.registrar.gatech.edu/students/formlanding/changeminor.php>

## PHYSIOLOGY MINOR

A minor in Physiology is available to all GT students, *including* Biology majors. The Physiology minor consists of 8 credits of required courses and an additional 7 credits of electives. The required coursework includes APPH/BIOL 3753, APPH 3754, APPH/BIOL 3755, and APPH 3756. For biology majors, APPH/BIOL 3753 and 3755 may be counted in **depth** or **breadth** electives, all remaining APPH courses can be counted in **breadth** electives. In addition to the required 8 credit hours, an additional 7 credit hours of elective courses from the list here (<http://biosci.gatech.edu/undergrad/minor-physiology>) complete the minor. A minimum of 4 of these elective credits must be APPH courses, and a maximum of 3 ch may be APPH 4699. All courses counting toward the minor must be taken on a letter-grade basis with a grade of C or higher. Consult with your major and minor advisors to verify potential to use courses from the major field of study to satisfy the Physiology minor, and that Core Area A-E courses are not used toward the minor. Students may not double-count courses towards more than one certificate or minor. Further information is available from your School of

Biological Sciences advisor. To declare a minor in Physiology, follow the instructions on the registrar's site: <http://www.registrar.gatech.edu/students/formlanding/changeminor.php>

## BIOLOGICAL SCIENCES CERTIFICATES

Certificate programs in Biological Sciences are available to students from any major, *including* Biology majors. Certificates are awarded by the School of Biological Sciences and do not appear on the transcript or diploma. Each certificate requires 12 credit hours of approved courses from that certificate's list, at least 9 of which must be at the 3000 level or higher. All courses counting toward the certificate must be taken on a letter-grade basis. Major electives can be counted toward certificates, but courses required by name and number in a student's major program of study will not be counted toward certificates. While students may complete more than one certificate, they may not double-count courses towards more than one certificate or minor.

### Certificates for Non-Biology Majors

For non-majors, additional courses that can count towards any of the certificates (except the Physiology certificate) are: BIOL 1510/1511, BIOL 1520/1521, BIOL 2335/2337, BIOL 2344/2345, BIOL 3450 as long as these courses are not required for their major program of study, with the restrictions that

- 1) only up to 3 credits of courses at the 1xxx-2xxx level can be used
- 2) at least 9 credits of BIOL coursework are required for each certificate. Any section of a cross-listed Biology elective, such as APPH Anatomy and Physiology lecture courses, can be attributed as Biology courses toward the Biology certificates for non-majors.

Further information is available here <http://biosci.gatech.edu/undergrad/biology-certificates> and from School of Biological Sciences advisors.

To declare a certificate in Biology, select 12 credits that correspond to the desired certificate from the list of approved courses at <http://biosci.gatech.edu/undergrad/biology-certificates>. Two weeks prior to the end of your final semester, complete and submit the certificate application form at [http://biosci.gatech.edu/sites/default/files/images/biology\\_certificate\\_application\\_12.1.15.pdf](http://biosci.gatech.edu/sites/default/files/images/biology_certificate_application_12.1.15.pdf)

### Certificates offered through the School of Biological Sciences

#### 1) Biomedical Science

APPH/BIOL 3751	Human Anatomy and Physiology
APPH/BIOL 3753	Anatomy
APPH/BIOL 3754	Anatomy Lab
APPH/BIOL 3755	Human Physiology
APPH/BIOL 3756	Physiology Lab
BIOL 4015	Cancer Bio/Tech
BIOL 4105	Macromolecular Modeling
BIOL 4150	Genomics & Applied Bioinformatics
BIOL 4340	Medical Microbiology
BIOL 4401	Experimental Design and Statistical Methods
BIOL 4464	Developmental Biology
BIOL 4480	Evolutionary Developmental Biology
BIOL 4545	Human Genetics
BIOL 4570	Immunology and Immunochemistry
BIOL 4607	Molecular Biology of Microbes: Disease, Nature, and Biotechnology

BIOL 4650	Bioethics
BIOL 4668	Eukaryotic Molecular Genetics
BIOL 4752	Introduction to Neuroscience
BIOL 4801	Special Topics: Bioethics Advanced Reading
BIOL 4801, BIOL 4803	Special Topics: Epigenetics
BIOL 4802	Special Topics: Drug Discovery
BIOL 4803	Special Topics: Virology
BIOL 4803	Special Topics: RNA Biology and Biotechnology
BIOL 4803	Special Topics: Biological Basis of Public Health
BIOL 4803	Special Topics: Health, Genes & Society

BMED 3100	Systems Physiology
BMED 3110	Quant Engr Physio Lab I
BMED 4400	Neuroengineering
BMED 4500	Cell and Tissue Engineering Lab
BMED 4570	Diagnostic Imaging Physics
BMED/CHEM/CHBE 4765	Drug design, development and delivery
LCC 2300	Intro Biomedicine & Culture
LCC 3318	Biomedicine & Culture
PSYC 3020	Biopsychology

## 2) Biomolecular Technology

BIOL 3380	Microbiology
BIOL 3381	Microbiology Lab
BIOL 4012	Protein Biology
BIOL 4105	Macromolecular Modeling
BIOL 4150	Genomics
BIOL 4225	Molecular Evolution
BIOL 4440	Plant Physiology
BIOL 4746	Signaling Molecules
BIOL 4478	Biophysics
BIOL 4607	Molecular Biology of Microbes: Disease, Nature, and Biotechnology
BIOL 4608	Prokaryotic Molecular Genetics
BIOL 4668	Eukaryotic Molecular Genetics
BIOL 4802	Special Topics: Drug Discovery
BIOL 4803	Special Topics: Environmental Microbial Genomics
BIOL 4801, BIOL 4803	Special Topics: Epigenetics
BIOL 4803	Special Topics: Molecular Basis of Neurodegeneration
BIOL 4803	RNA Biology and Biotechnology
BMED/CHEM/CHBE 4765	Drug design, development and delivery
CHEM 3511	Survey of Biochemistry
CHEM 4511	Biochemistry I
CHEM 4512	Biochemistry II
CHEM 4521	Biophysical Chemistry
CHEM 4803	Special Topics: Macromolecular Structure
CHBE 4760	Biocatalysis

## 3) Computational & Quantitative Biology

BIOL 2400	Mathematical Models in Biology
BIOL 4105	Macromolecular Modeling
BIOL 4150	Genomics
BIOL 4225	Molecular Evolution
BIOL 4401	Experimental Design and Statistical Methods
BIOL 4422	Theoretical Ecology

BIOL 4755	Mathematical Biology
BMED 4477	Bio Networks & Genomics
BIOL 4803	Special Topics: Computational Systems Biology
BIOL 4803	Special Topics: Programming in Biological and Health Sciences
BIOL 4803	Special Topics: Human Population Genomics
CS 4400	Introduction to Database Systems
CS 4710	Intro to Computing Concepts in Bioinformatics
MATH 3012	Applied Combinatorics
MATH 3215	Probability & Statistics
MATH 4022	Introduction to Graph Theory
CEE/ISYE/MATH 3770	Statistics & Applications

#### 4) Environmental Science

BIOL 2100	Biogeography of New Zealand
BIOL 3100	Ecology and Evolution of Australia
BIOL 3300	Tropical Ecology
BIOL 3380	Introductory Microbiology
BIOL 3381	Introductory Microbiology Lab
BIOL 4101	Sensory Ecology
BIOL 4221	Biological Oceanography
BIOL 4410	Microbial Ecology
BIOL 4417	Marine Ecology
BIOL 4418	Microbial Physiology
BIOL 4422	Theoretical Ecology
BIOL 4428	Population Dynamics
BIOL 4440	Plant Physiology
BIOL 4446	Animal Physiology
BIOL 4471	Behavior Biology
BIOL 4620	Aquatic Chemical Ecology
BIOL 4802	Special Topics: Community Ecology
BIOL 4803	Special Topics: Population Biology
BIOL 4803	Special Topics: Environmental Microbial Genomics
BIOL 4803	Special Topics: Urban Ecology
BIOL 4803	Special Topics: Conservation Biology
BIOL 4803	Special Topics: Microbial Symbiosis
BIOL 4803	Special Topics: Biology of Terrestrial Vertebrates
BIOL 4803	Special Topics: Mediterranean Ecology
BIOL 4803	Special Topics: Biology in a Changing Environment
CEE 2300	Environmental Engineering Principles
CEE 3340	Environmental Engineering Laboratory
CEE 4300	Environmental Engineering Systems
CEE 4620	Environmental Impact Assessment
CHEM/EAS 4740	Atmospheric Chemistry
EAS 1600	Intro Environmental Science
EAS 1601	Habitable Planet
EAS 2420	Environmental Measures
EAS 2600	Earth Processes
EAS 2602	Earth Through Time
EAS 4110	Resources, Energy & the Environment
EAS 4300	Oceanography
EAS 4350	Paleoclimate & Paleoceanography
EAS 4410	Climate & Global Change
EAS 4602	Biogeochemical Cycles

### 5) Marine Science

BIOL 4221	Biological Oceanography
BIOL 4410	Microbial Ecology
BIOL 4417	Marine Ecology
BIOL 4446	Animal Physiology
BIOL 4620	Aquatic Chemical Ecology
CEE 3040	Fluid Mechanics
CEE 4225	Coastal Engineering
EAS 3620	Geochemistry
EAS 4300	Oceanography
EAS 4350	Paleoclimatology and Paleoceanography
EAS 4602	Biogeochemical cycles
NS 2323	Navigation

### 6) Biologically Inspired Design

All students must take BIOL/ISyE/MSE/ME 4740-Bio-Inspired Design. In addition students will take an additional 9 credit hours of courses selected from the following list

APPH/BIOL 3753 Anatomy  
APPH/BIOL 3755 Human Physiology  
BIOL 4440 Plant Physiology  
BIOL 4464 Developmental Biology  
BIOL 4478 Biophysics  
BIOL 4101 Sensory Ecology  
BIOL 4446 Animal Physiology  
BIOL 4471 Behavior Biology  
BIOL 4752 Introduction to Neuroscience  
BIOL 4803 Special Topics: Urban Ecology  
BIOL 4803 Special Topics: Vertebrate Biology  
BIO/MSE 4802 Special Topics: Bioinspired Materials Design  
ARCH 4411 Introduction to visual arts: Drawing on nature  
BMED 3100 Systems Physiology  
BMED 3110 Quant Engr Physio Lab  
BMED 4400 Neuroengineering Fund  
BMED 4500 Cell and Tissue Engineering Lab  
BMED 4752 Introduction to Neuroscience  
AE/CHE/ME/BMED 4757 Biofluid Mechanics  
AE/CHE/ME/BMED 4758 Biosolid Mechanics  
CEE 3040 Fluid Mechanics  
ME/MSE 4790 Materials Selection and Design

### 7) Integrative Biology

12 credits chosen from courses represented in at least four of certificates 1–6 listed above.

### 8) Physiology

All students must take APPH/BIOL 3753 Fundamentals of Anatomy and APPH/BIOL 3755 Human Physiology. A minimum of 3 credits must be from the approved APPH courses below, and a maximum of 3 credits may be from the optional non-APPH courses below. Contact Dr. Mindy Millard-Stafford, (404) 894-6274, for questions about the Physiology certificate.

APPH courses (minimum 3 hours)  
APPH 2500 – Introduction to Sport Science  
APPH 3000 – Survey of Medicine  
APPH 3500 - Nutrition and Health  
APPH 3754 – Laboratory in Human Anatomy

APPH 3756 – Laboratory in Human Physiology  
APPH 4100 - Exercise Physiology  
APPH 4200 - Kinesiology  
APPH 4400 – Human Neuroanatomy  
APPH 4600 - Muscle Structure & Plasticity  
APPH 3801-2-3 – Special Topics  
APPH 3901-2-3 – Special Problem  
APPH 2698-4699 Undergraduate Research

Optional non-APPH courses (maximum 3 hours)

BIOL 3450 – Cell Molecular Biology (Note Biology majors cannot count BIOL 3450 toward the Physiology certificate)  
BIOL 3451 – Cell Molecular Biology Lab (Note Biology majors cannot count BIOL 3451 toward the Physiology certificate if it is being used to fulfill the Biology core lab requirement)  
BIOL 4446 – Animal Physiology  
BIOL 4464 – Developmental Biology  
BMED 3100 – Systems Physiology  
ECE 4781 - Biomedical Instrumentation  
LMC 3318 – Biomedicine and Culture  
ME 4757 - Biofluid Mechanic  
ME 4758 - Biosolid Mechanics  
PSYC 2230 - Abnormal Psychology  
PSYC 3020 - Biopsychology  
PSYC 4100 - Behavioral Pharmacology

## COMMON MINORS AND NON-BIOLOGICAL SCIENCES CERTIFICATES FOR BIOLOGY MAJORS

Biology undergraduates can partake in several non-biology minors that help expand the scope of the B.S in Biology undergraduate degree. The most common minors are:

**Biomedical Engineering –**

[http://acad.bme.gatech.edu/undergraduate/program\\_ugrad\\_minor.php](http://acad.bme.gatech.edu/undergraduate/program_ugrad_minor.php)

**Chemistry and Biochemistry –**

<http://www.chemistry.gatech.edu/academics/minors>

**Climate Change -**

[http://www.eas.gatech.edu/academics/minors/Climate\\_Change\\_Minor](http://www.eas.gatech.edu/academics/minors/Climate_Change_Minor)

**Energy Systems –**

<http://www.catalog.gatech.edu/programs/minor-energy-systems/#programofstudy-trackforbiologystudents>

**Environmental Chemistry –**

[http://www.eas.gatech.edu/academics/minors/Environmental\\_Chemistry\\_Minor](http://www.eas.gatech.edu/academics/minors/Environmental_Chemistry_Minor)

**Environmental Science –**

[http://www.eas.gatech.edu/academics/minors/Environmental\\_Science\\_Minor](http://www.eas.gatech.edu/academics/minors/Environmental_Science_Minor)

**Health, Medicine, and Society –**

<http://www.hsoc.gatech.edu/undergraduate/minors/hms>

**Language Studies –**

<http://www.modlangs.gatech.edu/degrees/minors>

**Leadership Studies –**

<http://leadership.gatech.edu/content/minor-leadership-studies-0>

**Ocean Sciences –**

[http://www.eas.gatech.edu/academics/minors/Ocean\\_Sciences\\_Minor](http://www.eas.gatech.edu/academics/minors/Ocean_Sciences_Minor)

**Science, Technology, and Society –**

<http://www.hsoc.gatech.edu/undergraduate/minors/sts>

**Psychology (Minor and Certificates) –**

<http://www.psychology.gatech.edu/minor-psychology-0>

<http://www.psychology.gatech.edu/certificates-psychology>

## UNIVERSITY RESOURCES

**Tutoring:** Georgia Tech offers many excellent opportunities to seek help in your courses. The Center for Academic Success on the second floor of Clough Commons offers 1-to-1 tutoring in most subjects as well as hosting Commons Tutoring for Chemistry, Computer Science, Math, and Physics. OMED, LAP, and the CommLab also have links from their website at <http://www.success.gatech.edu/tutoring>. Many of these programs keep late hours and operate in convenient locations, such as the Freshman Residence Halls and the Chapin Building (OMED).

**Counseling Center:** At some point you will encounter a challenge in academics, in your personal/social life, or involving a career choice. If it would help to have a professional counselor to whom you can talk, you can contact the Counseling Center about your concerns. Their services are described on the website: <http://www.counseling.gatech.edu/>. Many of their services are free to students, including individual and group consultations.

**Career Planning:** Georgia Tech's Center for Career Discovery and Development provides the following resources and programs to help students explore, select and pursue a meaningful career: career counseling, majors fair, seminars, resume & job search assistance, practice interviews, a career library, and coordination with campus recruiting. You can find more information at <http://www.career.gatech.edu/>.

**Office of Disability Services:** The Office of Disability Services serves any Georgia Tech student who has a documented, qualifying disability. Staff members serve as full-time advocates for students with disabilities, and they can assist in the process to document a disability. Their role is to ensure that all students have physical and programmatic access to all college programs, thereby enhancing their interactions in all activities of the campus community. See <http://disabilityservices.gatech.edu/> for more information.

## THE INSTITUTE'S COOPERATIVE AND INTERNSHIP PROGRAMS

Cooperative Education, or "Co-op," is a unique partnership among employers, students and the university whereby students work in paid, planned and supervised work experiences in business, industry, education, and government while earning academic credit. Georgia Tech's Cooperative Education Program (<http://www.coop.gatech.edu/>) is a five-year academic program in which students alternate semesters as a full-time student with semesters of full-time work. In addition to providing experiences outside of academia, the Co-op program can provide the student with full-time research work within a Georgia Tech faculty member's lab if the faculty member is agreeable.

Biology majors participating in the Co-op program must plan course schedules very carefully, since courses required for a degree in Biology may not always be offered during the at-school semester. This will be more of a problem when the at-school semester occurs during the summer semester.

The Undergraduate Professional Internship (UPI) Program (<http://www.gtip.gatech.edu/>) provides practical work experience in a professional setting, on-campus or off-campus, related to the student's field of study. Internships are a partnership among students, employers, and the Georgia Institute of Technology. Internships are single-semester, paid, major-related work experiences designed to help students understand the "real world" applications of their academic studies. Opportunities are available during summer, fall, and spring semesters and require a commitment of full-time employment for a minimum of 18 weeks during the spring and fall semesters or 12 weeks during the summer semester. To contact the UPI office, email [intern@dopp.gatech.edu](mailto:intern@dopp.gatech.edu).

## THE SCHOOL OF BIOLOGICAL SCIENCES' INTERNSHIP PROGRAM

The School of Biological Sciences has created an internship program specifically for Biology majors. In 2016-2017, approximately twenty internship positions are available for current Biology undergraduates. These opportunities are with local government, academia, and industry groups and will provide each intern with direct, hands-on experience in how a Biology degree can be used to obtain employment upon graduation. Current partnerships exist with the CDC, Georgia Tech's Environmental Health and Safety, the Army Defense Forensic Science Center, GTRI Occupational Safety and Health Programs, Zoo Atlanta, local biotechnology companies, and Sustainable Aquatics. Students can apply through the Biology Advising Tsquare site, and new opportunities will be advertised as they become available. Check the weekly Biology Advising Update email for recent announcements. For questions about the internship positions, contact Dr. Terry Snell ([terry.snell@biology.gatech.edu](mailto:terry.snell@biology.gatech.edu)). These internships are for pay or for credit, as detailed below.

**Internships for credit:** To receive course credit for an internship experience, you must be involved in authentic job-related training in a biological or biologically-related organization, and not primarily performing administrative and managerial duties. Freshmen and sophomores register for BIOL 2695, which can count as free elective hours. Juniors and seniors register for BIOL 4695. Students may elect to complete the internship for letter grade, pass/fail, or audit. BIOL 4695 taken for a letter grade may count toward up to 6 credits of your breadth electives. Additional BIOL 4695 credits count as free electives. Contact the internship coordinator, Dr. Terry Snell, to seek approval for an unpaid biology internship you have obtained and receive a permit to register for BIOL 2695/4695.

**Internships for pay:** BIOL 2694 and 4694 correspond to paid internships and are audit only. As with internships for credit, you must be involved in an authentic job-related training experience in a biological or biologically-related organization, and not simply providing services that are only distantly related to career goals. You should register for BIOL 2698 if a freshman or sophomore, or 4698 if a junior or senior. Contact the internship coordinator, Dr. Terry Snell, to seek approval for a paid biology internship you have obtained and receive a permit to register for BIOL 2694/4694.

## AWARDS IN THE SCHOOL OF BIOLOGICAL SCIENCES

Every spring semester, the faculty gives several undergraduate awards in Biology. These awards are presented to students demonstrating excellent academic achievement, initiative, and/or service. Some of the awards were designated by donors for students entering specific areas of study. Nominations for awards will be solicited by Biology faculty and students will also be invited to self-nominate in the spring semester.

**Biology Faculty Award:** An award to a senior majoring in Biology who has demonstrated outstanding scholastic achievement, meritorious character, and significant contributions to the School. The award consists of a monetary award and the student's name engraved on a plaque permanently displayed in the School of Biological Sciences office.

**Williams-Walls Award:** An award to senior female biology or psychology majors who have a grade point average of 3.5 or higher and who have applied to graduate school for advanced education. The award honors the memory of Frederick Alton Williams, father of the founder of Applied Biology, Inc. The award consists of a monetary award and the student's name engraved on a plaque permanently displayed in the School of Biological Sciences office.

**Cherry L. Emerson Research Award:** This award is given annually to a junior or senior in the School of Biological Sciences in recognition of a significant contribution to science through their undergraduate research. To apply for the award, the student must submit a research manuscript in the format of the journal to which it is likely to be submitted (or has already been submitted/published) to the School of Biological Sciences and a detailed letter of support from the research mentor. The award consists of a monetary award, a personal plaque, and the student's name on a plaque permanently displayed in the School of Biological Sciences office. This award is named in honor of two members of the Emerson legacy at Georgia Tech: Cherry L. Emerson, Sr. and Cherry L. Emerson, Jr.

**John H. Ridley Award:** An award to a junior in the School of Biological Sciences who plans to apply to medical or dental school, and who has demonstrated outstanding scholastic achievement and interest in research. The award consists of a monetary award and is intended to support the recipient's academic and research interests in the senior year.

### ACTIVITIES IN THE SCHOOL OF BIOLOGICAL SCIENCES

Biology undergraduates engage in several extracurricular clubs and activities. More information can be found at <http://biosci.gatech.edu/undergrad/undergraduate-organizations>

**Biology Student Advisory Committee (BSAC):** BSAC (<http://jacketpages.gatech.edu/organizations/view/28269>) is a student organization open to any biology major. The purpose of this organization is to provide student recommendations on curriculum, advising or any other issue relevant to undergraduate students to the School of Biological Sciences administration. BSAC also facilitates student-faculty interaction by co-sponsoring yearly picnics and poster sessions. Faculty Advisor: Dr. Linda Green ([linda.green@biology.gatech.edu](mailto:linda.green@biology.gatech.edu)).

**Beta Beta Beta (Tri-Beta):** Tri-Beta (<http://jacketpages.gatech.edu/organizations/view/28026>), the national biology honor society, is dedicated to improving the understanding and appreciation of biological study and extending human knowledge through scientific research. Full membership is restricted to students with a GPA of at least 3.0 in their biology courses and completion of at least one biology course beyond introductory biology. Associate membership is available to all students. Members enjoy a variety of activities including social gatherings and field trips, as well as the national quarterly newsletter. National once-in-a-lifetime membership dues are \$45 and \$35 (full and associate membership, respectively), in addition to local dues of \$10 per year. Faculty Advisor: Dr. Jeannette Yen ([jeannette.yen@biology.gatech.edu](mailto:jeannette.yen@biology.gatech.edu)).

**American Medical Student Association (AMSA):** AMSA is a student-governed organization committed to the concerns of students who hope to become physicians. AMSA has a national membership of about 28,000, composed of premedical and medical students, interns and medical residents. The Georgia Tech chapter of AMSA (<http://www.gtamsa.org/>) meets every two to three weeks throughout the school year. Guest speakers include campus premedical advisors, regional medical school admissions officers, and representatives of MCAT preparation firms. Students from the GT AMSA chapter attend regional and national AMSA meetings. Dues: \$20 annually. Faculty Advisor: Dr. Mirjana Brockett ([mirjana.brockett@biology.gatech.edu](mailto:mirjana.brockett@biology.gatech.edu)).

**American Red Cross Club (AARC):** AARC helps students gain leadership experience through service to the university community and the community-at-large. The GT AARC chapter (<http://www.redcross.gtorg.gatech.edu/>) plans all the blood drives on campus, organizes a GT-led national blood drive project on 9/11 of each year, hosts monthly CPR/First Aid classes for

GT students, and plans numerous service events on and off campus. Faculty Advisor: Dr. Shana Kerr ([shana.kerr@biology.gatech.edu](mailto:shana.kerr@biology.gatech.edu))

**American Society for Microbiology (ASM) Georgia Tech chapter:** The GA Tech ASM chapter (<http://www.asm.gatg.org.gatech.edu/>) is a student group promoting the field of microbiology as both a study and a career. The group fosters interaction between students and faculty interested in microbiology, awareness of career opportunities in microbiology, and intellectual curiosity related to the field. Sponsored Meetings and events occur monthly. Past events include visits by guest microbiologists from Georgia Tech, the CDC, and Emory; screening of movie related to microbiology; “Microbiology Jeopardy” night; and outreach opportunities at local K-12 institutions. Students also have opportunities to attend regional and national ASM meetings. Faculty Advisor: Dr. Brian Hammer ([brian.hammer@biology.gatech.edu](mailto:brian.hammer@biology.gatech.edu)).

**Pre-Veterinary Medical Association (PVMA):** The PVMA (<http://jacketpages.gatech.edu/organizations/view/28293>) is open to students interested in pursuing a career in veterinary medicine. The PVMA provides a network of academic and professional support, as well as a fun environment to connect with fellow students interested in similar goals. We host speakers from admissions boards of Veterinary schools, tour the Georgia Aquarium and Zoo Atlanta (behind the scenes), as well as put on fundraisers and bake sales for local animal shelters. Faculty Advisor: Dr. Chrissy Spencer ([chrissy.spencer@biology.gatech.edu](mailto:chrissy.spencer@biology.gatech.edu)).

**GT Junior STEM:** Junior STEM (<http://jacketpages.gatech.edu/organizations/view/44746>) is an organization that aims to encourage and facilitate student involvement in Science, Technology, Engineering, and Math (STEM) initiatives to promote and increase the retention of underrepresented and underserved minorities in STEM careers. Through local outreach to K-12 students, Junior STEM seeks to garner greater interest in the STEM field through promotion and establishment of Science Olympiad teams (and other STEM-focused organizations) as well as hosting presentations and demonstrations to enhance scientific learning among students where the general interest in science has fallen significantly. For more information, please contact: [sbd.gatech@gmail.com](mailto:sbd.gatech@gmail.com) Faculty Advisors: Dr. Shana Kerr ([shana.kerr@biology.gatech.edu](mailto:shana.kerr@biology.gatech.edu)) and Dr. Keith Oden ([keith.oden@cos.gatech.edu](mailto:keith.oden@cos.gatech.edu)).

## UNDERGRADUATE TEACHING IN THE SCHOOL OF BIOLOGICAL SCIENCES

The School of Biological Sciences offers positions for part-time work as laboratory or lecture teaching assistants in the fall and spring semesters. These positions have several requirements and are competitive. Applicants should have already taken at Georgia Tech the course they will teach and received an A or B, they must be at ease in front of a class, and they must submit an application for the position. A student will enroll in two teaching preparatory courses, BIOL 4697 and CETL 2000 BIO, in their first semester as a teaching assistant. BIOL 4697 counts as a biology breadth elective. An experienced undergraduate TA can apply for paid teaching assistant positions (BIOL 4696) when they are available. Students may use a maximum of 6 credits of BIOL 4697 towards their breadth electives. Each semester of teaching corresponds to a different course assignment. Applications are solicited during Phase I registration for the subsequent semester assignment. To apply, contact Dr. Chrissy Spencer ([chrissy.spencer@biology.gatech.edu](mailto:chrissy.spencer@biology.gatech.edu)).

## UNDERGRADUATE RESEARCH IN THE SCHOOL OF BIOLOGICAL SCIENCES

Research in the School of Biological Sciences is integrative, but with four general areas of focus: ecology, evolution, and behavior (<http://biosci.gatech.edu/research/ecology-evolution->

[and-behavior](http://biosci.gatech.edu/research/molecular-and-cell-biology)); molecular and cell biology (<http://biosci.gatech.edu/research/molecular-and-cell-biology>); integrative physiology (<http://biosci.gatech.edu/research/integrative-physiology>) and computational biology and bioinformatics (<http://biosci.gatech.edu/research/computational-biology-and-bioinformatics>).

Research is the most fulfilling scientific experience for many undergraduates and it increases career options after graduation. Working independently on your own research project teaches you the true nature of scientific investigation. You will learn scientific approaches, fundamental techniques, and how to work effectively in a research environment. Undergraduate research also provides you with experiences that make your résumé stand out. See <http://biosci.gatech.edu/undergrad/undergraduate-research> and the information below for details.

**Research for credit:** To receive course credit for conducting research, you must be involved in a biology-related, research project and not simply providing services that are only distantly related to research goals (e.g., washing glassware or preparing media). Freshmen and sophomores register for BIOL 2699, which can count as free elective hours. Juniors and seniors not taking part in their Senior Research Experience (see below) register for BIOL 4699. However, juniors or seniors completing their Senior Research Experience register for BIOL 4690 or 4910. BIOL 4699, 4690, and 4910 can count towards a Biology major's program of study; up to 6 credits of breadth electives can be BIOL 4699. Additional BIOL 4699 credits count as free electives. Your faculty mentor must provide permission for you to register for any of the research classes by emailing Benita Black (include student name and GT ID#). Each credit hour registered represents approximately 3 hours per week of research effort for a semester.

**Research for pay:** In some cases, you can be paid to conduct research-related activities. As with research for credit, you must be involved in a biology-related research project, and not simply providing services that are only distantly related to research goals. Current pay rates are ~\$10-12/hr depending on experience. After you and your faculty member agree to the terms, you must visit the Biology finance office to complete appropriate paperwork to get paid. You will then be responsible for completing bi-weekly timesheets that your faculty mentor signs. You should register for BIOL 2698 if a freshman or sophomore, or 4698 if a junior or senior. Although these are audit-only, no-credit courses that do not count towards your program of study, they allow you to document your paid research experience on your transcript. Your faculty mentor must provide permission for you to register by emailing Benita Black (include student name and GT ID#).

**Research as a volunteer:** You may volunteer to conduct research-related activities. These arrangements are informal and the work can be negotiated between you and your faculty advisor. You must fill out the Georgia Tech Agreement for Volunteer Services form available from the Biology office to officially recognize the volunteer relationship.

**Research for credit or pay outside of the School of Biological Sciences:** You can conduct research in other Schools within Georgia Tech or even in institutions outside of Georgia Tech, and obtain credit for BIOL 2698, 2699, 4690, 4698, or 4699 (BIOL 4910 can only be taken with a School of Biological Sciences faculty member who holds a major or minor, but not courtesy-only, appointment in Biology). In this case, you have to have an official co-supervisor within Biology who will serve as the instructor of record (and second reader in the case of BIOL 4690). Note that a co-supervisor is not needed if your faculty mentor has a minor or courtesy appointment within the School of Biological Sciences.

To conduct research outside the School of Biological Sciences, you should first get approval from the primary research faculty mentor (e.g. in Psychology, Emory University). Your research

mentor needs to be a PhD or MD level scientist, preferably in a group leader-like role (not a postdoc, etc). To obtain approval for this research to count for BIOL course credit, you must then provide the Biology co-supervisor a description of the research they will be doing, the name of the primary research mentor, and the department or institution of the research mentor. Your primary research mentor must email the School of Biological Sciences Associate Chair for Undergraduate Affairs saying that they are willing to serve as a research mentor, follow the Biology syllabus for the course in question, and provide the final grade to the Biosciences co-supervisor. If appropriate, the School of Biological Sciences Associate Chair for Undergraduate Affairs will approve the project for credit or pay.

**Senior Research Experience:** All Biology majors complete a capstone “Senior Research Experience” consisting of one of the following courses: BIOL 4590, 4690, or 4910. BIOL 4690 and 4910 are conducted under the supervision of a faculty member in the research laboratory. BIOL 4590 is taught by Biology faculty members each semester in various areas of Biology chosen by the faculty teaching the course. The syllabi for these courses available from the School of Biological Sciences website or the course mentors or professors. In addition, the student must take BIOL 4460 the same semester as 4590, or if the student is enroll in 4690 or 4910, BIOL 4460 may be taken the same semester *or* the semester after 4690 or 4910. Note that if 4460 is taken after BIOL 4690 or 4910, it will require permission to register, which the Undergraduate Coordinator can provide.

**The Research Option:** With faculty guidance, you write a brief proposal, perform independent and original research, and write a thesis about your work. This plan requires that you conduct 9 credit hours of supervised research over multiple semesters. The first 6 credit hours are taken by any combination of BIOL 2698, 2699, 4698, or 4699. You then take either BIOL 4690 or 4910 in your final semester of research. In addition, you must take two one credit-hour writing courses, LCC 4701 and LCC 4702. These writing courses can be counted as Biology breadth electives. You should take LCC 4701 and LCC 4702 in the semester prior to and during the semester you are enrolled in BIOL 4690 or 4910, respectively. For example, you might take 3 credits of BIOL 4699 in the spring, 3 credits of BIOL 4698 and LCC 4701 in the fall, and then BIOL 4910 and LCC 4702 in the next spring. Completing the Research Option gives you a “Research Option” designation on you transcripts. You must fill out the Research Intent Form with the UROP office to pursue the Research Option. See the School of Biological Sciences (<http://biosci.gatech.edu/undergrad/bachelor-science-biology-research>) and the UROP Research Option website for more information (<http://undergradresearch.gatech.edu/research-option>)

**President’s Undergraduate Research Awards (PURA):** The Undergraduate Research Opportunities Program funds undergraduate research. The awards can be made for student salaries (\$1500 max), travel expenses (\$1000 max), or supplies. You must also be registered for BIOL 2698, 2699, 4698, 4699, 4690, or 4910 when you have a PURA. More details about applying for a PURA award can be found here: <http://uop.gatech.edu/content/presidents-undergraduate-research-awards> .

## Summary of Biology Research Courses

Syllabi are available at <http://biosci.gatech.edu/undergrad/undergraduate-courses-syllabi-descriptions>.

BIOL 2698 – Research Assistantship: Independent research conducted under the guidance of a faculty member. 1-12 credit hours. Audit-only class, does not incur tuition charges.

BIOL 2699 – Undergraduate Research: Independent research conducted under the guidance of a faculty member. 1-12 credit hours. Grade given directly by faculty mentor.

BIOL 4460 – Communicating Biological Research: Senior students present seminars on recent research topics based on their own research experience and/or literature research. 1 credit hour. Biol 4590, 4690 or 4910 are prerequisites with concurrency - one of these courses must be taken before or in the same term as Biol 4460. Grade given by faculty teaching the class.

BIOL 4590 – Research Project Lab: Experience in designing, implementing, and communicating a biology research project, and practical training in modern approaches for biological research. 3 credit hours. Prerequisites: BIOL 1510. Grade given directly by faculty teaching the class.

BIOL 4690 – Independent Research Project: Independent research with proposal and manuscript writing, conducted with the guidance of a faculty member. 3 credit hours. Prerequisites: 1 credit hour of BIOL 2698 or 2699 or 4698 or 4699. Faculty may accept a student without the 1 credit hour prerequisite at their discretion by signing a prerequisite override form for the student. Students must complete the “Independent Research Project” form available from the website, and deliver this form to the instructor of record for BIOL 4690 to receive a permit. Letter grade is sent by the faculty mentor to the instructor of record of BIOL 4690.

BIOL 4698 – Research Assistantship: Independent research conducted under the guidance of a faculty member. 1-12 credit hours. Audit-only course, does not incur tuition charges.

BIOL 4699 – Undergraduate Research: Independent research conducted under the guidance of a faculty member. 1-12 credit hours. Grade given directly by research advisor.

BIOL 4910 – Honors Research Thesis: Writing and submission of a proposal and manuscript (thesis) describing independent research with a biology faculty member. Prerequisites: Students must have a GPA > 3.0 and have taken 1 credit hour of BIOL 2698 or 2699 or 4698 or 4699. Faculty may accept a student without the 1 credit hour prerequisite at their discretion by signing a prerequisite override form for the student. Students must get permission to register for BIOL 4910. Letter grade is sent by the faculty mentor to the instructor of record of BIOL 4910 for the semester in question.

### **The following are some suggestions for getting involved in research.**

1) Earn good grades and make yourself known to your professors. Undergraduate research is competitive and you are more likely to be accepted with the faculty member of your choice if you have a strong record of academic excellence.

2) Choose an area of biology that you find interesting and corresponds to one of the areas of faculty expertise here at Georgia Tech. One of the best ways to determine the areas of biology in which you are most interested is to reflect upon the courses you have taken, identifying those that you most enjoyed. Then think about how these courses fit in with your career goals - for example, are you seeking a career in medicine, the biotech industry or in environmental protection? Within these or other areas, it is best to identify the faculty member whose research program most closely fits your interests. You can read about faculty research interests and ongoing projects at

[http://www.biosci.gatech.edu/people?field\\_last\\_name\\_value=&field\\_job\\_category\\_tid=19](http://www.biosci.gatech.edu/people?field_last_name_value=&field_job_category_tid=19).

Recent publications of most biology faculty are listed on faculty members' web pages.

3) After identifying faculty members, tell them about your interest in research and ask to meet with them to discuss their current research projects and your potential participation beginning in a specific semester. At this point it is important to emphasize why you think that an undergraduate research project would be a valuable experience for you and why you would be a good choice for the faculty member. Undergraduate research is a learning opportunity for students AND enables student to make unique contributions to science. So don't forget that you need to think about how your work will benefit other scientists and our understanding of biology in general, not just how you will benefit.

4) Do not be discouraged if the first professor tells you no. There are many reasons why faculty may not want to take on more undergraduate researchers. The most common is that their lab is full and space and equipment are limited, or they may be over-committed with committee assignments or teaching duties. Your chances of being invited to join a research group are better if you get to know a professor. Take their classes and show an interest in their work. If you are courteously persistent and demonstrate success in your coursework, an opportunity is likely to come your way.

Students who have conducted research in faculty labs feel that it has enhanced their degree and often redirected their career plans. In their own words:

"I believe that the undergraduate research experience that I have gained has been an invaluable rite of passage into becoming an independent, critical thinking scientist. My experience has also been crucial in helping develop a relatively specific set of research interests that I will pursue in graduate school in the fall."

"Participating in undergraduate research has been one of the best decisions that I could have made during my years at Georgia Tech. More than just doing the experiments, I have enjoyed working with the people. The day-to-day mentoring process is what has helped me more than anything else. I was fortunate enough to work directly with an advisor and numerous graduate students, all of whom took the time to help me develop into a successful scientist."

"I started doing research as a minor activity, however it quickly became more than that. By my junior year the hours that I worked in lab took highest priority on my academic schedule. The research that I was doing was the link between my classes, my future career options and the real world. Working in lab integrated knowledge from all of my classes, and the critical thinking skills that I employed every day in lab were skills that I took to the classroom and to other aspects of my non-academic life."

"Because of the multidisciplinary nature of my research, I was really able to grasp the application of biology much more than I could have from a lecture or lab course. I also gained confidence in my public presentation skills because so much of doing research is presenting and defending it. It encompasses reading numerous journals and articles, running experiments, analyzing results, presenting, getting feedback, hopefully getting published, and having something to be proud of when your research is complete."

## OBTAINING LETTERS OF RECOMMENDATION

To get a job or to get into graduate or professional school, you will need letters of recommendation from the faculty. A letter of recommendation can point out features of your record, habits, or personality that are important in hiring and admission decisions. They can help you get a job or admission to graduate or professional program when your grades are not as high as those of other candidates.

Faculty members are more willing to write recommendation letters and can write stronger letters if they know you well. The most common way to get to know faculty is to do research in their lab or to take an interactive, small course with them. You will likely need at least three letters of reference, so start developing relationships with faculty as soon as possible.

### *Content of Strong Letters*

To be valuable, the letter must contain information that is not available elsewhere in your written record. The writer should be able to comment on your work ethic, ability to solve problems, creativity, reliability, accuracy, receptiveness to coaching, ability to work independently, and ability to work cooperatively with colleagues.

Medical School Letter of Evaluation (LOE) guidelines request the writer to explain the unique contributions of the student as well as provide an assessment and evidence of the following competencies:

1. Thinking & Reasoning, including Critical Thinking, Quantitative Reasoning, Scientific Inquiry, and Written Communication
2. Science, including Living Systems and Human Behavior
3. Interpersonal, including Service Orientation, Social Skills, Cultural Competence, Teamwork, and Oral Communication
4. Intrapersonal, including Ethical Responsibility to Self and Others, Reliability and Dependability, Resilience and Adaptability, Capacity for Improvement

The letter also should contain details to justify the recommendation. A simple statement that you are a good or smart person is almost meaningless unless it is accompanied by factual information to back up that claim. A lack of details suggests that the writer does not have such evidence and/or does not know much about you.

The reference letter should not be a mere recitation of your good points. No one is perfect, and any attempt to paint you that way will trigger justified doubts in the mind of the reader. It is reasonable for the letter to point out that your record has some weakness, and then to point out how you have overcome the weakness. This converts the negative point into a positive one.

### *Requesting a letter*

First, you should start preparing now for the day when you will need the letter. Get to know at least three professors and encourage them to get to know you. You can do this several ways: Visit with them for at least 30 minutes each semester in office hours or through an event such as Take-a-Prof to lunch, participate at a high level in their courses (especially those with small class sizes and lots of discussion), or do research in their lab. However you do it, invest the time that is necessary. Only after the professor really gets to know you will he or she be able to write a persuasive letter for you.

Second, you should ask the letter writer if he or she is able to write a good letter. If they hedge in any way, thank them and go elsewhere.

Third, if they feel that they can write a good letter, ask them if they can meet whatever deadline

you have. Again, if they hedge, go elsewhere. A good letter that remains unwritten or unsent is no letter at all. Always check back with the letter writer a few days before the letter is due at its destination.

### *The Student's Role*

Most importantly, try to be the kind of person about whom a good letter can easily be written.

It is your job to identify appropriate letter writers, and you should start early in your career to cultivate relationships with them. Ask professors and other students to recommend reliable people. Don't be afraid to reject the ones who do not seem promising.

When the time comes to request the letter, give the writer sufficient advanced notice (at least 2-4 weeks) and all of the materials that helps them do a good job: a copy of your résumé and details of the program you are applying for. Since faculty members usually have many students asking for reference letters, you should present them with a typed list of the email addresses, or typed, addressed envelopes that contain the correct postage. If he or she cannot write the letter in a timely manner, take that as a message to find someone else.

Finally, waiving your right of access to the letter is a signal that you trust the writer. If you do not trust the writer, you should not ask him or her for a letter in the first place.

## **PROBLEMS WITH A PROFESSOR**

There may come a time when you get upset with a professor. When this happens you should understand two things: 1) conflicts may occur when people work closely together, and 2) there is usually a satisfactory way to resolve the conflict.

As a student you will develop a working relationship with the faculty of Georgia Tech. This relationship is not symmetrical, because faculty members evaluate your performance and decide about your grades. That system is not likely to change, probably for very good reasons. After all, professors have already demonstrated their advanced academic qualifications, and you came to Tech to learn some of the things that they know.

Any relationship that is emotionally and intellectually close, especially an asymmetrical one, may generate stresses. Therefore, we need to anticipate them and find a way to deal with them. The solution you find will almost certainly be imperfect, but there is no reason that it need be unsatisfactory. The more unrealistic your initial expectations are, the more imperfect the solution will be to you. So, start out with this dose of reality; *most problems can be solved, but you may have to compromise*. Talk to your professor about the problem. If you are not satisfied with the result, talk to your advisor and if you still need help, consult the Associate Chair for the Undergraduate Program.

If you wish to pursue a formal grievance procedure, you should consult the Georgia Tech Registrar's website at <http://www.catalog.gatech.edu/rules/20/>.

## **ADVICE FOR STUDENTS**

Take advantage of everything Tech and Atlanta have to offer by getting involved. A great way to meet people is through intramurals, fraternities and sororities, and the Student Government Association (SGA). SGA publishes a Student Handbook of Campus Organizations that includes all of the on-campus organizations. You should have received one in your FASET packet, but they are also available in the SGA office in the Student Services Building. If you have an artistic side, you can fulfill your creative urges with many of the classes offered in the "Options Guide",

available in the Student Center Box Office. Some of the activities available are ceramics, pottery, salsa lessons, piano lessons, photography, and drawing classes.

There are many fun things to do and see in Atlanta. The Georgia Aquarium, High Museum of Art, Stone Mountain, Zoo Atlanta, Atlanta Botanical Garden, Fernbank Natural History Museum, and the World of Coca-Cola are definitely worth the entry fees. Six Flags and White Water are fun theme parks in the area. The Robert Ferst Center for the Arts, the Atlanta Symphony Orchestra, the Fox Theater, the Atlanta Ballet, and the Shakespeare Tavern offer something for everyone. Information and discount tickets are available for activities around town at the Student Center Box Office on the second floor of the Student Center. Experience the numerous restaurants and theaters around Atlanta, and take your student ID; many places offer student discounts. There are many free publications, such as "*Creative Loafing*" magazine, that detail up and coming events in Atlanta, or you can check in the Access Atlanta section of the *Atlanta Journal-Constitution*.

Good time management is the key. Do not schedule so many classes that you do not have time for friends and relaxation. On the other hand, if you schedule only two classes per semester because you want to hang out with your new friends, you will probably never graduate. The right mix will be a balance of work and leisure so that you get good grades, yet thoroughly enjoy yourself. By getting involved and trying new activities, you will soon find your niche. The most successful students have developed good time management skills to include both work and leisure activities.

Be sure to check the Biology Advising Tsquare website frequently for summer jobs, seminars, and research opportunities. You should attend several Biology seminars (advertised on the School of Biological Sciences webpage) before your senior year to get a feel for what is expected when you present your research in Senior Seminar and for what kinds of research careers are available to biologists. Usually you will find that the students with the highest grades are the ones who attend class every day, sit in the front rows and ask questions, and study well in advance of tests.

The key to a successful career as a Biology student at Georgia Tech is hard work, focus, good time management, and networking with as many people as possible to create important contacts for the future.

## BIOLOGY COURSE LISTINGS

**All prerequisite courses require a D unless otherwise specified.**

### **BIOL 1510 - Biological Principles**

An introduction to the basic principles of modern biology, including biomacromolecules, bioenergetics, cell structure, genetics, homeostasis, evolution, and ecological relationships. 4.000 Credit hours, 3.000 Lecture hours, 3.000 Lab hours

### **BIOL 1511 - Honors Biological Principles**

An advanced introduction to the principles of modern biology, including biomacromolecules, bioenergetics, cell structure, genetics, homeostasis, evolution, and ecological relationships. For all Biology majors.

4.000 Credit hours, 3.000 Lecture hours, 3.000 Lab hours

### **BIOL 1520 - Intro to Organismal Biology**

An introduction to biology at the organ and organismal levels, with emphasis on physiological processes and integration of growth and development.

4.000 Credit hours, 3.000 Lecture hours, 3.000 Lab hours

### **BIOL 1521 - Honors Organismal Biology**

Introduction to biology at the organ and organismal levels, with emphasis on biodiversity, physiological processes, and integration of growth, reproduction and development. For all Biology majors.

4.000 Credit hours, 3.000 Lecture hours, 3.000 Lab hours

### **BIOL 2100 – Biogeography - New Zealand**

Introduction to theory of island biogeography focused on New Zealand's geological history and unique biota.

3.000 Credit hours, 3.000 Lecture hours

### **BIOL 2335 - General Ecology**

Introduction to ecological processes at individual, population, and community levels that occur in plant, animal, and microbial taxa, and their relevance to current environmental problems.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 1510 or BIOL 1511

### **BIOL 2336 - General Ecology Lab**

The companion laboratory for BIOL 2335 (Ecology). This course stresses understanding ecological concepts through a combination of lab and field experiments, and computer simulations. 0

1.000 Credit hours, 0.000 Lecture hours, 3.000 Lab hours

Corequisites: BIOL 2335

Prerequisites: BIOL 1510 or BIOL 1511

### **BIOL 2337 - Honors Ecology**

A problem-based learning course in ecology. Student teams will do research and solve challenges typically faced by ecologists and environmental scientists.

3.000 Credit hours, 3.000 Lecture hours

Corequisites: BIOL 2338

Prerequisites: BIOL 1510 Minimum Grade of B or BIOL 1511 Minimum Grade of B

### **BIOL 2338 - Honors Ecology Lab**

Companion course to Honors Ecology. Student teams will explore solutions to ecological challenges using experiments and mathematical models.

1.000 Credit hours, 0.000 Lecture hours, 3.000 Lab hours

Prerequisites: BIOL 1510 Minimum Grade of B or BIOL 1511 Minimum Grade of B

### **BIOL 2344 - Genetics**

Mendelian and molecular genetics; principles of inheritance, gene structure and function, foundations of recombinant DNA technology, genetic basis of variation and evolution.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 1510 or BIOL 1511

### **BIOL 2345 - Genetics Laboratory**

A laboratory course in the fundamental techniques of genetic analysis.

1.000 Credit hours, 0.000 Lecture hours, 3.000 Lab hours

Corequisites: BIOL 2344

Prerequisites: BIOL 1510 or BIOL 1511

### **BIOL 2354 - Honors Genetics**

A comprehensive genetics course incorporating discussions of primary literature. Topics include molecular genetics and gene action, transfer systems and mapping, cytological, quantitative and population genetics.

3.000 Credit hours, 3.000 Lecture hours

Corequisites: BIOL 2355

Prerequisites: BIOL 1510 Minimum Grade of B or BIOL 1511 Minimum Grade of B

### **BIOL 2355 - Honors Genetics Lab**

Hands-on introduction to practical techniques, critical thinking, and important concepts in genetics. Students carry out laboratory experiments that explore transmission, population, and molecular genetics.

1.000 Credit hours, 0.000 Lecture hours, 3.000 Lab hours

Corequisites: BIOL 2354

Prerequisites: BIOL 1510 Minimum Grade of B or BIOL 1511 Minimum Grade of B

### **BIOL 2400 - Math Models in Biology**

Introductory probability and deterministic models in biology, including discrete and continuous probability distributions and dynamic models from molecular and cellular biology to ecology and epidemiology.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: (MATH 1553 and either MATH 1555 or MATH 1522) and (BIOL 1510 or BIOL 1511)

### **BIOL 2698 - Research Assistantship**

Independent research conducted under the guidance of a faculty member.

1.000 TO 12.000 Credit hours, 1.000 TO 12.000 Lecture hours

### **BIOL 2699 - Undergraduate Research**

Independent research conducted under the guidance of a faculty member.

1.000 TO 12.000 Credit hours, 1.000 TO 12.000 Lecture hours

### **BIOL 280X - Special Topics**

This designation enables the School of Biological Sciences to provide new lecture courses dealing with areas of current interest in biological sciences.

X Credit hours, X Lecture hours

**BIOL 290X - Special Problems**

Research problems in biology under the supervision of a faculty member.  
1.000 TO 21.000 Credit hours, 1.000 TO 21.000 Lecture hours

**BIOL 3100 – Ecology & Evolution - Australia**

Evolution and ecology of Australian ecosystems, including rainforests, open woodlands, coastal habitats; conservation of endangered ecosystems. Earns Biology technical credit. Research project required.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 2100

**BIOL 3300 - Tropical Ecology**

Ecological processes in the tropics including community organizations, biotic interactions, biodiversity, coevolution. Students perform research projects in rain forest, cloud forest, and seashore.

0.000 OR 3.000 Credit hours, 0.000 OR 1.000 Lecture hours, 0.000 OR 6.000 Lab hours

Prerequisites: BIOL 1510 or BIOL 1511

**BIOL 3380 - Intro Microbiology**

Basic biology of bacteria, fungi, algae, and viruses, with emphasis on bacteriology.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: (BIOL 1510 or BIOL 1511) and CHEM 1212K

**BIOL 3381 - Intro Microbiology Lab**

Fundamental laboratory techniques in microbiology.

1.000 Credit hours, 0.000 Lecture hours, 3.000 Lab hours

Corequisites: BIOL 3380

Prerequisites: (BIOL 1510 or BIOL 1511) and CHEM 1212K

**BIOL 3450 - Cell Molecular Biology**

An introduction to the structure and function of cells and their organelles with emphasis on eukaryotic cellular and molecular processes.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: (BIOL 1510 or BIOL 1511) and (CHEM 2311 or CHEM 1315)

**BIOL 3451 - Cell Molecular Biology Lab**

An introduction to experimental methods of cell and molecular biology research that will cover some fundamental topics of cell biology.

0.000 OR 1.000 Credit hours, 0.000 Lecture hours, 0.000 OR 3.000 Lab hours

Corequisites: BIOL 3450

Prerequisites: (BIOL 1510 or BIOL 1511) and (CHEM 2311 or CHEM 1315)

**BIOL 3600 - Intro Evolutionary Biology**

Comprehensive introduction to evolutionary biology. Includes focus on processes (natural selection, genetic drift) and resulting patterns (genome organization, phylogeny) illustrated with prokaryote and eukaryote examples.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 2344 or BIOL 2354 or BIOL 2335 or BIOL 2337

**BIOL 3753 – Human Anatomy**

Detailed study of human body structures using a regional and systems approach. Emphasis is placed on structural relationships and the integration of body systems. **Note:** Credit cannot be awarded for both APPH/BIOL 3751 and APPH/BIOL 3753.

3.000 Credit hours, 3.000 Lecture hours. Crosslisted with APPH 3753.

Prerequisites: BIOL 1520 or BIOL 1521 or CHEM 1211K or CHEM 1310

### **APPH 3754 - Anatomy Lab**

A detailed hands-on study of human structure using high-resolution models, specialized specimens and dissection of selected mammalian organs and tissues.

1.000 Credit hours, 0.000 Lecture hours, 3.000 Lab hours

Prerequisites with concurrency: APPH 3753 or BIOL 3753

### **BIOL 3755 - Human Physiology**

Students will explore the function and adaptation of the human body emphasizing neuromuscular, cardio-respiratory, gastrointestinal, endocrine, and urinary systems to maintain homeostasis and human health. Crosslisted with APPH 3755. **Note:** Credit cannot be awarded for both APPH/BIOL 3751 and APPH/BIOL 3755.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: APPH 3753 or BIOL 3753

### **APPH 3756 - Physiology Lab**

A laboratory application of concepts in Physiology, providing hands-on experience focusing primarily on non-invasive human experiments supplemented with in vitro tissues experiments.

1.000 Credit hours, 3.000 Lab hours

Prerequisites with concurrency: APPH 3755 or BIOL 3755

### **BIOL 4012 - Protein Biology**

Biological view of proteins, including: protein biosynthesis, processing, modifications, folding, trafficking, interactions, degradation, natural and directed evolution, protein assembly diseases, amyloids, prions and protein-based inheritance.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 1510 or BIOL 1511

### **BIOL 4015 - Cancer Biology & Technology**

This course covers basic concepts of cancer biology and new technologies that are being developed to understand, detect, treat, and prevent cancer.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 1510 or BIOL 1511 or BIOL 1520 or BIOL 1521 or CHEM 1310 or CHEM 1211K or CHEM 1212K or PHYS 2211 or PHYS 2212 or EAS 1600 or EAS 1601 or EAS 2600

### **BIOL 4101 - Sensory Ecology**

A quantitative analyses of communication channels and information acquisition involving visual, auditory, mechanosensory, and olfactory modalities across a range of species and habitats.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 2335 or BIOL 2337

### **BIOL 4105 - Macromolecular Modeling**

Principles and practices in the use of molecular mechanics methods (minimization; molecular dynamics) to study structure-function relationships in biological macromolecules.

4.000 Credit hours, 4.000 Lecture hours

### **BIOL 4150 – Genomics & Applied Bioinformatics**

Retrieval and analysis of biological sequence, gene expression, and proteomics data from public databases and other sources; applying standard bioinformatics tools to investigate biological questions.

0.000 OR 3.000 Credit hours, 0.000 OR 2.000 Lecture hours, 0.000 OR 3.000 Lab hours

Prerequisites: BIOL 2344 or BIOL 2354 and (CS 1321 or CS 1371 or CS 1301 or CS 1315)

### **BIOL 4221 - Biological Oceanography**

An introduction to the major biological processes in the ocean including primary production, elemental cycling, food webs, and fisheries.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 1510 or BIOL 1511

### **BIOL 4225 - Molecular Evolution**

Evolutionary processes at molecular level, organizations of genomes and genetic systems. Students will read and present up-to-date research articles in various topics in molecular evolution.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 2344 or BIOL 2354

### **BIOL 4340 - Medical Microbiology**

Advanced study of bacteria, protozoa, fungi, and viruses that cause human diseases; emphasis on epidemiology, mechanisms of disease causation, prevention, and treatment.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 3380

### **BIOL 4401 - Experimental Design & Statistical Methods**

Introductory course on experimental design, hypothesis testing and basic statistical techniques commonly applied in biological research. Exercises based on computer statistical software packages.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: (MATH 1553 and either MATH 1555 or MATH 1522) and (BIOL 1510 or BIOL 1511)

### **BIOL 4410 - Microbial Ecology**

Advanced studies of microbial ecosystems, the specific roles of bacteria in maintaining ecological balance, and the evolution of the ecosystem in response to changing environments.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 3380

### **BIOL 4417 - Marine Ecology**

An overview of the physical forces and biotic interactions structuring marine communities and of the major threats to these communities.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 2335 or BIOL 2337

### **BIOL 4418 - Microbial Physiology**

Study of the physiology of growth and metabolic activities of microorganisms.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 3380

### **BIOL 4422 - Theoretical Ecology**

Theoretical foundations of ecology, from the population to the community and ecosystem levels.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: MATH 2403 or BIOL 2400

**BIOL 4428 - Population Dynamics**

Ecological factors that affect dynamics, regulation, and evolution of natural populations, with an emphasis on the connections with mathematical models, genetics, and ecology.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 2335 or BIOL 2337

**BIOL 4440 - Plant Physiology**

Chemical transformation in photosynthesis, photophysiology and water relationships, organic nutrition and effects of hormones on growth and development of plants.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 1510 or BIOL 1511 and BIOL 1520 or BIOL 1521

**BIOL 4446 - Animal Physiology**

Systems physiology including nerves, muscles, kidney, digestion, circulation, endocrinology, reproduction, and respiration.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 3450

**BIOL 4460 – Communicating Biological Research**

Students learn to convey the importance of research findings in the biological sciences and to critically evaluate research results through discussions and scientific presentations.

1.000 Credit hours, 1.000 Lecture hours

Prerequisites: BIOL 4590 or BIOL 4690 or BIOL 4910

**BIOL 4464 - Developmental Biology**

Investigations of cell differentiation and development using the tools of molecular genetics and cell biology.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: (BIOL 2344 or BIOL 2354) and BIOL 3450

**BIOL 4471 - Behavior Biology**

An introduction to the study of the principles of behavior of all kinds of organisms, from microbes to mammals.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 1510 or BIOL 1511 or BIOL 1520 or BIOL 1521

**BIOL 4478 - Biophysics**

Biophysical aspects of nucleic acids, proteins, and their interactions.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: PHYS 2211 and (BIOL 2344 or BIOL 2354 or BIOL 3450)

**BIOL 4480 – Evolutionary Developmental Biology**

This course teaches students how the process of development from embryo to adult impacts evolutionary diversity and human health.

2.000 Credit hours, 2.000 Lecture hours

Prerequisites: BIOL 1510 or BIOL 1511

**BIOL 4545 - Human Genetics**

Introduction to the genetics and evolution of complex human traits, focusing on contemporary approaches to understanding susceptibility to malignant, metabolic, immune and psychological diseases.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: Undergraduate Semester level BIOL 2344 or BIOL 2345

### **BIOL 4570 - Immunology & Immunochemistry**

A survey of modern immunology and its applications.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 3450 and (BIOL 2344 or BIOL 2354)

### **BIOL 4590 - Research Project Lab**

Experience in designing, implementing, and communicating a biology research project, and practical training in modern approaches for biological research.

0.000 OR 3.000 Credit hours, 0.000 OR 1.000 Lecture hours, 0.000 OR 6.000 Lab hours

Corequisites: BIOL 4460

Prerequisites: BIOL 1510

### **BIOL 4607 - Molecular Biology of Microbes: Disease, Nature, and Biotechnology**

Molecular genetics of bacteria with an emphasis on experimental approaches, regulatory mechanisms in disease-causing and environmental bacteria, and biotechnology applications derived from microbes. Credit not allowed for both BIOL 4607 and BIOL 4608.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 1510 or BIOL 1511

### **BIOL 4608 - Prokaryotic Molecular Genetics**

The molecular genetics of bacteria and their viruses, with emphasis in the organization, replication, expression, transfer and experimental manipulation of prokaryotic genes and genomes. Credit not allowed for both BIOL 4220 and BIOL 4608.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 2344 or BIOL 2354

### **BIOL 4620 - Aquatic Chemical Ecology**

Focuses on understanding the chemical mechanisms of aquatic signaling and the cascading effects on population regulation, community organization, and ecosystem function.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 2335 or BIOL 2337

### **BIOL 4650 - Bioethics**

This course will examine the process of scientific inquiry and the ethical implications of research in the biological sciences.

2.000 Credit hours, 2.000 Lecture hours

Prerequisites: BIOL 1510 or BIOL 1511

### **BIOL 4668 - Eukaryotic Mol Genetics**

Topics in molecular genetics, including genetic engineering techniques, gene expression and regulation, genetic structure, stability and evolution, with emphasis on eukaryotic organisms.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 2344 or BIOL 2354

### **BIOL 4690 - Independent Research Project**

Independent research with proposal and manuscript writing, conducted with the guidance of a faculty member.

3.000 Credit hours, 0.000 Lecture hours, 9.000 Lab hours

Prerequisites: BIOL 2698 or BIOL 2699 or BIOL 4698 or BIOL 4699

**BIOL 4694 - Intern Assistantship**

Biology Undergraduate Internship for pay for juniors and seniors, by permit only. The internship experience must be at a unit or agency approved by the School of Biological Sciences. AUDIT ONLY.

1.000 to 21.000 Credit hours

**BIOL 4695 – Undergraduate Internship**

Biology Undergraduate Internship for credit for juniors and seniors, by permit only. The internship experience must be at a unit or agency approved by the School of Biological Sciences.

1.000 to 21.000 Credit hours

**BIOL 4696 - Biology Teaching Assistant**

Biology teaching assistantship for pay under the guidance of a faculty member. Permit only. AUDIT ONLY.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: CETL 2000

**BIOL 4697 - Biology Undergraduate Teaching**

An introduction to teaching biology for undergraduate teaching assistants, with a focus on effective teaching active engagement of students, and development of innovative classroom activities. Permit only.

0.000 OR 3.000 Credit hours, 0.000 OR 1.000 Lecture hours, 0.000 OR 6.000 Lab hours

Prerequisites: CETL 2000

**BIOL 4698 - Research Assistantship**

Independent research conducted under the guidance of a faculty member. AUDIT ONLY.

1.000 TO 12.000 Credit hours, 1.000 TO 12.000 Lecture hours

**BIOL 4699 - Undergraduate Research**

Independent research conducted under the guidance of a faculty member.

1.000 TO 12.000 Credit hours, 1.000 TO 12.000 Lecture hours

**BIOL 4740 - Bio-Inspired Design**

We examine evolutionary adaptation as a source for engineering design inspiration, utilizing principles of scaling, adaptability, and robust multifunctionality that characterize biological systems.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 1520 or BIOL 1521 or BIOL 3600 or BMED 3100 or PHYS 2211

**BIOL 4746 - Signaling Molecules**

The diversity of chemical signals between organisms and their structural specifications will be presented along with chemical and biological methods for isolating signaling molecules.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 1510 or BIOL 1511 and CHEM 2311

**BIOL 4752 - Intro Neuroscience**

Goals are to understand the components of the nervous system and their functional interactions, and appreciate the complexity of higher order brain functions and pathways. Crosslisted with BMED 4752.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: BIOL 3450 or BMED 3160

**BIOL 4755 - Mathematical Biology**

An introduction to practical applications of mathematical models to help unravel the underlying mechanisms involved in biological processes. Crosslisted with MATH 4755.

3.000 Credit hours, 3.000 Lecture hours

Prerequisites: MATH 2403 or BIOL 2400

**BIOL 480X - Special Topics**

This designation enables the School of Biological Sciences to provide new lecture courses dealing with areas of current interest in biological science.

X Credit hours, X Lecture hours

**BIOL 490X - Special Problems**

Research problem in biology under supervision of a faculty member. To be offered any term with credit to be arranged. Seven hours (four hours technical electives + three hours free elective) are the maximum credits allowed toward the Bachelor of Science in Biology degree.

1.000 TO 21.000 Credit hours, 1.000 TO 21.000 Lecture hours

**BIOL 4910 - Honors Research Thesis**

Writing and submission of an Undergraduate Research Thesis describing research accomplishments with a biology faculty member.

3.000 Credit hours, 0.000 Lecture hours, 9.000 Lab hours

Prerequisites: BIOL 2698 or BIOL 2699 or BIOL 4698 or BIOL 4699

**NON-BIOLOGY COURSES THAT ARE APPROVED FOR BIOLOGY BREADTH ELECTIVES  
(9 credits maximum)**

**LMC:**

LMC 4701 Undergraduate Research Proposal Writing  
LMC 4702 Undergraduate Research Thesis Writing

**All APPH 3XXX and higher courses EXCEPT:**

APPH 3300 Health Promotion  
APPH 3901-3904 Special Problems  
APPH 4698 Research Assistantship

**All BMED 3XXX and higher courses EXCEPT:**

BMED 4698 Research Assistantship  
BMED 4699 Undergraduate Research  
BMED 4900-4903 Special Problems

**All CHEM 3XXX and higher courses EXCEPT:**

CHEM 4601 Chemistry Seminar  
CHEM 4698 Research Assistantship  
CHEM 4699 Undergraduate Research  
CHEM 4901- 4903 Special Problems in Chemistry

**All EAS 3XXX and higher courses EXCEPT:**

EAS 4651 Practical Internship  
EAS 4698 Research Assistantship  
EAS 4699 Undergraduate Research  
EAS 4900 Special Problems

**All MATH 2XXX and higher courses EXCEPT:**

MATH 2698 Research Assistantship  
MATH 2699 Undergraduate Research  
MATH 4080 Senior Project I  
MATH 4090 Senior Project II  
MATH 4698 Research Assistantship  
MATH 4699 Undergraduate Research  
MATH 4999 Special Problems

**All PHYS 3XXX and higher courses EXCEPT:**

PHYS 4601 Senior Seminar I  
PHYS 4602 Senior Seminar II  
PHYS 4698 Research Assistantship  
PHYS 4699 Undergraduate Research

**All PSYC 3XXX and higher EXCEPT:**

PSYC 4600 Senior Thesis I  
PSYC 4601 Senior Thesis II  
PSYC 4698 Research Assistantship  
PSYC 4699 Undergraduate Research  
PSYC 4900-4910 Special Problems

**STUDENT/ADVISOR WORK SHEET**  
2016-2017

Student Name: \_\_\_\_\_ ID number: \_\_\_\_\_

<b>A. General Biology (Required)</b>	<b>Credits</b>	<b>✓</b>	<b>C. Other Required Courses</b>	<b>Credits</b>	<b>✓</b>
Biol 1511 (or 1510) Biol Princ	4		Chem 1211K Chem Princ I	4	
Biol 1521 (or 1520) Organ Bio	4		Chem 1212K Chem Princ II	4	
Biol 2335 or 2337 Ecology	3		Math 1551 Differential Calculus	2	
Biol 2344 or 2354 Genetics	3		Math 1555 (or1552) Integral Calc	4	
Biol 3600 Evolution	3		Math 1553 Linear Algebra	4	
Biol 3450 Cell & Molecular Bio	3		Chem 2311 Organic Chem I	3	
Biol 4460 Comm Biol Research	1		Chem 2313 (or 2312) Bio-Organic Chem	3	
<b>Choose 2 from:</b>			Chem 2380 Synthesis Lab	2	
Biol 2336 or 2338 Ecology Lab	1		Phys 2211 Physics I	4	
Biol 2345 or 2355 Genetics Lab	1		Phys 2212 Physics II	4	
Biol 3451 Cell & Molec Bio Lab	1		CS 1301 or 1315 or 1371	3	
<b>Choose 1 from:</b>			APPH 1040 or 1050 Wellness	2	
Biol 2400 Math Models Bio	3		<b>Total</b>	<b>37</b>	
Biol 4150 Genomics & App Binf	3				
Biol 4401 Exp Des and Stat	3				
			<b>D.-E. Social Sciences/Humanities</b>	<b>Credits</b>	<b>✓</b>
			History/Political Science	3	
			Social Science	3	
<b>Choose 1 from:</b>			Social Science	3	
Biol 4590 Research Project Lab	3		Social Science	3	
Biol 4690 Ind. Research Proj	3		<b>Total</b>	<b>12</b>	
Biol 4910 Honors Res Thesis	3				
<b>Total</b>	<b>29</b>		English 1101	3	
			English 1102	3	
			Humanities	3	
<b>B. Biology Electives (21 hrs req)</b>	<b>Credits</b>	<b>✓</b>	Humanities	3	
			<b>Total</b>	<b>12</b>	
			<b>F. Free Electives</b>	<b>Credits</b>	<b>✓</b>
			GT1000 (recommended)	1	
			<b>Total</b>	<b>11</b>	
<b>Total</b>	<b>21</b>		<b>Total for Graduation</b>	<b>122</b>	