## College of Biological Sciences

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The mission of the College of Biological Sciences (CBS) is to provide outstanding educational opportunities to undergraduate and advanced students and carry out world-class research in areas of modern biology from the molecular to the ecosystem level. To accomplish this mission, it is necessary to integrate a strong basic research program with both traditional and innovative classroom teaching and with intensive mentoring of students at all levels.

As part of its mission, the college is dedicated to providing basic biological science education and sharing expertise with students and colleagues in other disciplines at the University of Minnesota, such as agriculture, natural resources, engineering, health sciences, and liberal arts.

The college is committed to outreach to the general community and cooperation with other educational institutions. College members actively participate in the scientific community and in the leadership of professional organizations, and they contribute to the administration and governance of the University.

**Research and Teaching Facilities**

CBS has faculty and facilities on both Minneapolis and St. Paul campuses. The college is organized into the following departments: Biochemistry, Molecular Biology, and Biophysics; Ecology, Evolution, and Behavior; Genetics, Cell Biology, and Development; and Plant Biology. The Department of Microbiology and the Department of Neuroscience, both of which are housed in the Medical School, also function as CBS departments for undergraduate education. A description of departments and their major degree requirements may be found beginning on page 80.

In addition, CBS is responsible for the administration of several instructional programs, research institutes, shared-use laboratories, and an active field biology program with facilities at several locations around the state (see below). A complete list of faculty is provided in the Faculty and Administration section of this catalog.

**Albert Frenkel Reading Room**—The Reading Room, 406 Biological Sciences Center on the St. Paul campus, is open to all CBS students, faculty, and staff. It houses a small collection of journals and books on a range of biology topics, research ethics, and teaching and learning techniques and accepts donations of recent biology publications (612-624-7752).

**Biological Sciences Greenhouse**—On the St. Paul campus, the greenhouse is a teaching and research facility with standard bench space. Four landscaped rooms exhibit the flora of the tropics, subtropics, desert and aquatic regions (612-625-4788).

**Lake Itasca Forestry and Biological Station**—Situated at the headwaters of the Mississippi River in northern Minnesota, the field station is in an unparalleled ecological area where three great plant regions of the United States meet. These 50 square miles of protected forest provide unique opportunities for the study of varied ecosystems and of fauna and flora with southern, northern, and western origins. Diverse lakes and wetlands provide unusual field advantages for aquatic studies. Information about the highly popular summer biology offerings is in the Summer Term Catalog and at <http://genbiol.cssb.umn.edu/Itasca>. Reservations for and questions about the Itasca program should be addressed to the Itasca Biology Program, University of Minnesota, 220 Biological Sciences Center, 1445 Gortner Avenue, St. Paul MN 55108 (612-624-6743).

**Cedar Creek Natural History Area**—Within commuting distance of campus, Cedar Creek not only serves as the site of ecological and behavioral field research, but also provides unique opportunities for student projects and summer employment. For student opportunities, contact the Office of Student Services (612-624-9717) or the Cedar Creek Natural History Area program director (612-625-5743), or see the Web site at <http://genbiol.cssb.umn.edu/>.

**General Biology Program**—Located in 3-140 Molecular Cellular Biology on the Minneapolis campus, this program administers beginning biology courses for most University students, serving approximately 4,000 students per year. Students meet CBS’s finest instructors in these courses and enjoy personal attention in laboratory sections. For more than a decade, the program has premiered the use of digital technology in undergraduate education. Visit the Web site at <http://genbiol.cssb.umn.edu/> for more information or call 612-625-6636.

**Instructional Computing Centers**—Biology students have access to a well-equipped Macintosh plus Windows computing facility in 406 Biological Sciences Center, a Windows facility in 170 Ecology Building, and also in 2-124 Molecular and Cellular Biology Building. Another facility will be available on the Minneapolis Campus beginning fall, 2002. Priority in the computer centers is given to undergraduate classes and undergraduate students working on course-related materials. Students can use programs for word processing, graphing, drawing, or spreadsheets and can access many electronic databases and file servers around the world, as well as their own electronic mail service. Hours for each computing lab are posted on the lab doors.

**CBS Computing Services**—CBS Computing Services offers user support and serves more than 110 labs with advanced nucleic acid and peptide sequence analysis software. Molecular graphics facilities permit specialized research on the structure and function of DNA, RNA, and proteins (612-625-9284).

**Developmental Biology Center**—The University has launched a major initiative in developmental biology, with researchers representing both basic and clinical sciences. Developmental biology identifies mechanisms whereby a single cell, the fertilized egg, develops into a complex multicellular organism containing millions of cells organized into characteristic patterns, with many different specialized functions. Developmental biology has become a central subject in biology and is of both medical and economic importance. The center serves as a resource for collaborative research and training (612-625-9429).
Institute of Human Genetics—The institute’s major objective is to develop an interdisciplinary approach to studying and applying new developments in human genetics. Research by its members is directed at understanding how genetics contributes to human biology. This institute’s programs include gene therapy, and molecular, neurobehavioral, clinical, and population genetics, as well as genetic counseling. For more information, call 624-8411 or visit the Web site at <www.ibg.med.umn.edu>.

Jane Goodall Institute’s Center for Primate Studies—This branch of the Jane Goodall Institute studies chimp behavior and houses all 38 years’ worth of Goodall’s records from Tanzania’s Gombe National Park. For more information, call 624-6714 or visit the Web site at <http://biosci.cbs.umn.edu/chimp/>.

Plant Molecular Genetics Institute—The institute fosters research in molecular biology and genetics of economically important plants and relevant model plant systems, develops genetic engineering methodologies for application to crop improvement, educates future plant biology researchers and teachers, maintains an interdisciplinary environment in which to explore and develop new ideas and experimental approaches in plant molecular biology, and provides a focus for external communication to aid recruitment and funding. Institute faculty members come from two colleges (Biological Sciences and Agricultural, Food and Environmental Sciences) and six departments (agronomy and plant genetics; biochemistry, molecular biology and biophysics; genetics, cell biology and development; horticultural science; plant biology; and plant pathology). The institute supports seminars and symposia on topics related to plant molecular biology and provides funds for speakers and visiting scientists (612-625-4718).

BioTechnology Institute BTI—The institute, established in 1985, brings together faculty from the College of Biological Sciences, the Institute of Technology, and the Medical School, for an interdisciplinary approach to biotechnology research in areas such as biocatalysis, biodegradation of hazardous waste, molecular evolution of proteins, and cell population biology. BTI also operates the Biotechnology Resource Center, a University-wide, shared-use facility that provides state-of-the-art equipment and expert staff for fermentation, animal cell cultures, expression of recombinant proteins, and large-scale separation of biological molecules. BTI promotes collaboration between University researchers and industry and is working to meet the increasing demand for students trained jointly in biological and engineering disciplines. For more information, call 612-624-6774 or visit the Web site at <http://biosci.cbs.umn.edu/bpti>.

High-Throughput Screening and Analysis Facility—In this facility, robots shuffle genes to find which of the thousands of recombinations produces the desired organisms. Several instruments are interfaced by a robot allowing high-throughput handling and analysis of thousands of samples per day. For more information, call 612-625-3782.

Imaging Center—A state-of-the-art facility for imaging of primarily biological specimens using light and electron optical methods with expertise centered on live cell imaging. Advanced digital imaging and analysis equipment is available for use. For more information, call 612-624-3454 or visit the Web site at <www.cbs.umn.edu/ic>.

Protein Expression and Purification Laboratory—This facility provides expertise in expression of proteins for structural, immunologic, and biochemical experiments. For more information, call 612-624-7246 or visit the Web site at <www.cbs.umn.edu/bpti/RPEL.html>.

Fermentation Process Development and Scale-up Laboratory—This facility offers process development, scale-up, and downstream processing for all types of fermentations allowing users to scale up microbial growth to industrial levels. For more information, call 612-624-6758 or visit the Web site at <www.biosci.cbs.umn.edu/bpti/brc>
Beginning College in Biological Sciences

If you’re about to begin college and think biology may be your area of interest, there are some important questions you need to consider. (If you’ve already completed one or two years of college work and are thinking of transferring to the University of Minnesota, see Transfer Admission in the General Information section of this catalog.)

How do I know if biology is a good choice for me?

Some students have always had an interest in biology. Others didn’t become hooked until they were inspired by a special teacher or course in high school. Some see biology as a step toward a career in medicine or preserving the environment. Yet others think they may have a strong interest, but want to learn more. If you fall into one of these categories and have a strong high school background in science and math, then read on.

Is biology a good choice right now? Do biology careers look promising for the future?

Biology is playing an increasingly important role in health, agriculture, the environment, the economy, and society in general, thanks to advances such as the sequencing of the human genome and development of new biotechnologies. New career opportunities in the biotechnology industry, government, and education are emerging all the time. There has never been a better time to earn a degree in biology.

The University of Minnesota is a research university. What does this mean for undergraduates?

It means that many faculty are engaged in federally sponsored research, which gives undergraduates a multitude of opportunities to gain research experience working with faculty in laboratories.

Do all students have the opportunity to be involved in research?

Most students participate in research, choosing from opportunities in basic sciences, medicine, dentistry, pharmacy, veterinary medicine, agriculture, and natural resources. Hands-on experience in a laboratory or in the field is an essential part of the educational experience in CBS. Research experiences help students gain admission to competitive graduate programs, and many employers require candidates to have research or internship experience.

The University has a College of Biological Sciences rather than just a department. What does this mean for students?

As a college, CBS has a much larger faculty, more varied course offerings, and more services for biology students. Services include an honors program; research, internship and study abroad opportunities; and a Career Center.

What if I'm not sure I want to major in biology? If I choose CBS now, will I have problems if I change my major later?

No. All lower division students take general education courses, including biology. If you change your major later, you will not be at a disadvantage when you transfer to another college. But if you are undecided and considering several options, the College of Liberal Arts is a good place to explore a variety of interests.

Admission

Students may enter CBS at the beginning of their freshman, sophomore, junior, or senior year. For those students who choose to begin at another institution or even in a different college at the University, transfer into CBS is welcome at any point in the undergraduate program. CBS faculty and staff can help students select appropriate coursework for transferring to the college. During the freshman and sophomore years, students should plan to complete, at least, the beginning English composition course, mathematics, general chemistry, and general biology. Most students take organic chemistry during their sophomore year, thereby allowing ample time for major coursework and research experience.

Requirements

Freshmen Admission Requirements

For official and up-to-date information about the University's admissions policies, procedures, and deadlines, please see the latest edition of the Undergraduate Application Booklet available from the Office of Admissions or online at <http://admissions.tc.umn.edu>.

Admission requirements for students transferring from other University of Minnesota colleges:

1. A 2.00 GPA and grades of at least C- in the following:
   a. General biology (Biol 1009 or 1001)
   b. General chemistry (Chem 1021 and 1022)
   c. Calculus (Math 1271 and 1272 or 1281 and 1282)
2. Courses must be complete at the time of application, with the following exception: students with a GPA of 3.00 or higher may be admitted with one course in progress.

Admission requirements for transfer students with other previous college experience

Students applying for admission to CBS with previous college experience elsewhere must have the following:

• Minimum GPA of 2.50 in previous college coursework
• At least C- in General Biology 1009 or 1001 or equivalent; General Chemistry 1021 or equivalent; and Calculus 1271 or 1281 or equivalent
• Evidence of consistent academic success in other college coursework
  Courses must be complete at the time of application, with the following exception: students with a GPA of 3.00 or higher may be admitted with one course in progress.

For more information on transfer course equivalencies, visit <http://admissions.tc.umn.edu/inside/transfercredit_03.html>. For course equivalencies in chemistry, math, and physics, go to <http://www.it.umn.edu/admissions/equiv/index.html>.

Applications to the University of Minnesota, Twin Cities may be requested from the Office of Admissions (612-625-2008 or, toll free in the United States, 1-800-752-1000).

For more information, contact the Office of Student Services (612-624-9717).
Orientation

Before classes begin, freshmen and transfer students are invited to attend a New Student Program/Orientation. The program acquaints students with the campus and provides information about CBS and the University. Students spend part of the session with an adviser who helps them plan their undergraduate program. Participation in orientation is required.

Freshmen attend a series of programs and seminars throughout the first year to fully acquaint them with CBS faculty, staff, and students and inform them about special opportunities for biology students.

Transfer students also attend a CBS orientation/reception during the first week of the semester. Information is presented about research and internship opportunities, as well as information critical to preparing for a profession in the biological sciences.

Undergraduate Programs

Students choose CBS because it has high quality programs offered by professors who are recognized in their fields. As students begin planning for a specific career, they should supplement their coursework with research experiences and internships to further develop their skills and prepare for their chosen professions. Students may explore biology career interests through the Biology Colloquium, freshman seminars, a broad selection of course offerings, and special programs offered through the CBS Career Center, including Biol 2001—Careers in Biology.

The CBS bachelor of science degree program is composed of four essential elements. Each is important in preparing students to be leaders in their chosen professions in an increasingly complex and interdisciplinary world.

I. Liberal Education—A liberal education gives students a broad perspective that strengthens judgment and critical thinking skills. It enables students to seek:

• communication and critical thinking skills;

• understanding of the ways scientists contribute to knowledge;

• historical and philosophical perspective on the nature of students' own lives and the world in which they live;

• and appreciation of the creative insights into life and nature provided by literature and the arts.

To help achieve these goals, the University requires all students to distribute a portion of their coursework in areas of study outside of those most directly linked to their specialized interests in science.

II. Physical Sciences and Mathematics—The biological sciences rely heavily on the tools of mathematics and physical science. Organisms consist of molecules that obey the rules of physics and chemistry; these rules are often stated using mathematics. Modern biologists in the field and in the laboratory must be able to use fundamental principles of mathematics, chemistry, and physics to appreciate living organisms at all levels from molecules to ecosystems.

Mathematics is a tool that underlies all of science. It permits the description of the kinetics of reactions occurring in organisms, is used to model population growth and distribution, and forms a basis for statistical analysis of data.

Chemistry is the study of molecules and their interactions. Phenomena such as nerve impulses, the exchange of gases in respiration, water balance, and the conversion of food energy to useful work by organisms require an understanding of chemistry. Organisms are composed of organic molecules. An understanding of these molecules and their reactive groups is essential to an understanding of biological phenomena such as metabolism, gene function, and nutrient cycling in ecosystems.

Physics includes the study of atoms and their interactions, mechanics, heat, sound, electricity and magnetism, and the properties of light. The laws of physics are important for our understanding of photosynthesis, blood and air flow, mutations, and energy pyramids in ecosystems. Also, the instruments and techniques used by biologists require a basic understanding of physics.

III. Biology Core Curriculum—Specialists will always be important in biology, but today there is a growing need for people whose understanding ranges across the disciplines of biology. Students are introduced to diverse aspects of biology by completing a set of core courses. Some courses introduce students to various kinds of organisms—animals, plants, and microorganisms. Biochemistry introduces students to organic compounds of importance to organisms, to enzyme-catalyzed reactions, and to metabolic pathways involved in the synthesis or catabolism of macromolecules. Cell biology provides an in depth analysis of cellular structure and function. Genetics examines the mechanisms of heredity, including both molecular genetics and population genetics. Ecology, evolution, and behavior introduces students to populations, evolution, and the behavior of animals.

IV. Specialization in the Major—Students may choose to major in biology, which offers a variety of electives, or a departmental major (biochemistry; ecology, evolution, and behavior; genetics, cell biology and development; microbiology; neuroscience; plant biology; or the new interdisciplinary biology, society, and environment). These majors each have required courses specified by the department. In addition, most students will plan to complete a research project in their area of interest. Each department offers credit for Directed Study (4993 and 4793W) and Directed Research (4994 and 4794W).

Recommended Related Coursework

The University offers a variety of life sciences courses in addition to those offered by CBS. These elective courses may be found in a number of areas, including agronomy and plant genetics (Agro), animal science (AnSe), anthropology (Anth), biophysics (BPhy), chemical engineering (ChEn), chemistry (Chem), computer science (CSci), entomology (Ent), fisheries and wildlife (FW), food science and nutrition (FScN), forest resources (FR), geology (Geo), history of medicine and science (HMEd, HSci), horticultural science (Hort), laboratory medicine (LaMP), mathematics (Math), natural resources and environmental studies (NRES), pharmacology (Phcl), philosophy (Phil), physics (Phys), physiology (Physl), plant pathology (PPla), psychology (Psy), public health (PHHD), soil science (Soil), statistics (Stat), veterinary biology (VB), and veterinary pathobiology (VPB).

Graduate Programs

Graduate study at the University is coordinated and administered by the Graduate School. For information about general policies regarding admission requirements, registration procedures, financial aid, and requirements for graduate degrees, see the Graduate School Catalog. Application materials may be obtained from CBS department offices.

Questions regarding specific bioscience programs should be addressed to the director of graduate studies in the appropriate program area.

(area code 612)

Biochemistry, Molecular Biology, and Biophysics—Anath Das, 624-3239, and Michel Sanders, 624-9637

Conservation Biology—Francesca Cuthbert, 624-1756

Ecology, Evolution, and Behavior—Donald N. Alstad, 624-6748

Genetic Counseling—Bonnie LeRoy, 624-7193

Microbial Engineering—Michael Sadowsky, 625-1722
Honors Program

The goal of the honors program is to provide a special learning community of motivated students and faculty. The CBS honors program consists of two parts. The freshman-sophomore program offers honors courses, a CBS honors colloquium and co-curricular activities that allow students to interact with faculty and explore various research frontiers. Students who complete the freshman-sophomore part of the program earn a sophomore honors certificate and a special notation on their transcript. Students who maintain a strong academic record in their first two years of college may participate in the second part of the honors program. The nucleus of the junior-senior honors program is a directed research experience. Students also participate in the CBS honors seminar, which provides exposure to the breadth of biological inquiry and promotes interactions among the honors students. The honors experience culminates in a written thesis and a research presentation at the Life Sciences Undergraduate Research Symposium. Students who complete the junior-senior part of the honors program graduate with a “Latin” (e.g. *cum laude*) honors degree.

**Honors Program Admission**—Entering freshmen apply to the honors program when they apply to the University by completing the *Application for Scholarships and Honors Programs*. Forms are available in the Admissions Office, and online at <http://admissions.tc.umn.edu>. For entering freshmen, admission to the honors program is based on achievements in high school, standardized test scores, and an essay.

Admission to the second stage of the honors program is based on grades earned during the first two years of college. Students are encouraged to apply soon after they have completed 60 credits, and must be registered for a minimum of two semesters after being accepted into the program to fulfill the requirements for graduation with honors (see below). Applicants should have a 3.50 minimum GPA. Admission to the freshman-sophomore honors program is not a prerequisite for admission into the junior-senior honors program. Application forms are available in 223 Snyder Hall.

**Sophomore Honors Certificate**—To earn a certificate and transcript notation signifying completion of the freshman-sophomore honors program, students must satisfy the following requirements within the first two years at the University of Minnesota:

1. One freshman seminar during the first year
2. Biol 2960H—Honors Colloquium: Explorations in the Biological Sciences during the second year
3. Two additional honors courses
4. Maintain a minimum GPA of 3.50

**Directed Research**—This provides students with research experience to obtain new information about the biological system under investigation. Honors program participants should select a research adviser from the college faculty and start on a project early in their junior year or as soon thereafter as possible. Participation in at least two semesters (6 credits) of directed research is required; students may register in BioC 4794W/4994, EEB 4794W/4994, GCD 4794W/4994, MicB 4794W/4994, NSc 4794W/4994, or PBio 4794W/4994. Students who participated in the Undergraduate Life Sciences Summer Research Program or who received Undergraduate Research Opportunities Program grants may petition to use this work to fulfill up to three of the six research credits. An honors thesis, summarizing the research and written in the style of a publishable manuscript, is required. The thesis must be approved by the faculty member supervising the research and by two other faculty (at least one of whom must be from CBS), chosen with college approval.

**Honors Seminar**—Honors program graduates must participate in two semesters of Biol 3960—Honors Seminar. In fall semester, the seminar is a forum to discuss special topics focused on a theme of general relevance to all biologists. In spring semester, seniors nearing completion of their directed research projects must present summaries of their project results. Students must take a seminar in the fall and follow that with a seminar in the spring semester preceding graduation. They also are encouraged to enroll in the spring semester seminar before the senior year.

**Graduation With Honors**—Participation in the honors program is required for graduation with the traditional honors designations *cum laude*, *magna cum laude*, and *summa cum laude*. In addition to the requirements for graduation, candidates for graduation with honors must complete

1. at least 40 credits in upper division courses (3xxx-5xxx) at the University of Minnesota, Twin Cities, including two semesters of honors registration.
2. two semesters (6 credits) of directed research, the results of which are to be reported in an acceptable honors thesis.
3. two CBS honors seminars (Biol 3960H), one of which must be completed during fall semester and the other during the last spring semester in residence.
4. one additional honors opportunity, which may be selected from
   a. an additional semester (2 credits) of participation in directed research.
   b. an upper division honors seminar offered by the CLA Honors Division.
   c. an upper division honors course (3xxx-5xxx).
   d. an 8xxx course (seniors only; requires permission).
5. the last 60 credits of A-F registration with the minimum GPAs specified below:

   *cum laude*: 3.50 minimum GPA  
   *magna cum laude*: 3.66 minimum GPA  
   *summa cum laude*: 3.75 minimum GPA

Grades of F and N, which carry no grade points, are included in the computation of the CBS honors GPA. If a portion of the last 60 credits completed has been transferred from another institution, the proportion of residence credits with grades of A must at least equal the proportion of transfer credits with grades of A.

**For More Information**—Once admitted, students should feel free to discuss questions with an Office of Student Services adviser or honors program staff in 223 Snyder Hall.
Graduation Requirements
To earn a B.S. degree from CBS, students must complete at least 120 credits with grades of A, B, C, or S. Grades of D or D+ are not accepted in any of the math, chemistry, physics or biological sciences courses used to meet requirements for the major.

Course Requirements

English Communication Skills—See Writing Requirement under Liberal Education Requirements on page 31 of this catalog.

Foreign Language—Either two high school years or one college year of study of a single foreign language or demonstration of equivalent proficiency satisfactory to the appropriate language department.

Liberal Education—The University’s liberal education diversified core, designated themes, and writing skills curriculum is required for all students completing a degree program on the Twin Cities campus. (See page 31 of this catalog.) Mathematics and science coursework required of CBS students ordinarily satisfies the minimum University requirements for physical and biological sciences and mathematical thinking.

Physical Sciences and Mathematics—CBS majors require at least one year of calculus, one year of physics, and chemistry through organic chemistry. See specific requirements included with the description of each major beginning on page 80.

Biological Sciences—Each major has a defined list of required courses in general and organismal biology, and components of the biology core curriculum. Requirements are listed with each major beginning on page 80.

Advising
The size and diversity of the University offers unlimited opportunities for students to explore and develop their academic, professional, and personal interests.

Both current and prospective students are well-served by the advising services, resources, and programs provided by CBS’s faculty and Office of Student Services. CBS students are assigned to a faculty adviser in their particular area of interest. In addition, Office of Student Services staff members are available by appointment for students to discuss student concerns. Summarized below are the types of advising services available through a combination of faculty and professional advising.

The Office of Student Services performs a variety of other essential functions in the college, including admission, student orientation and registration, academic progress review, and degree certification.

Prospective Student Activities
Admission counseling
Career transitions
Prospective student information
High school and community college visits
College tours
Summer science program
Visit days
Welcome fair

New Student Advising
Orientation
New student reception
Course planning
Freshman seminars and special events
Exploration of life sciences majors
Campus resource information

Developmental Advising
Intellectual and personal growth
Career directions
Goal setting
Clarifying values
Decision making
Refining skills
Developing leadership

Peer Advising/Networking
Honors
Biology Colloquium
Biological Sciences Student Association
CBS club activities
Alumni society
Mentor programs
Biology House

Major and Faculty Advising
Program planning
Career exploration/planning
Internship Program
Undergraduate research
Seminars
Preparation for graduate and professional school programs

Program Planning—This annual, shared planning activity should form the basis of an ongoing relationship between the faculty adviser and student. The importance of the relationship between faculty adviser and student cannot be overemphasized. Students will find it useful to consult their advisers to discuss progress in specific courses, obtain information about graduate study, plan internships, or arrange to work with faculty in laboratory and field settings.

Special Learning Opportunities and Resources
Students are encouraged to explore the full scope of learning experiences available, including those beyond the required curriculum. Many students plan projects they carry out under faculty supervision in research laboratories and in the field. Some students participate in off-campus internships in private industry, government agencies, and the nonprofit sector. Other students seek employment as undergraduate teaching and research assistants or museum tour guides. Most departments offer special seminars for undergraduates.

Biology Colloquium (Biol 1020)—This unique course, organized and run by students, is recommended for those who wish to explore the various fields and career alternatives in the biological sciences. Offered each semester, the course gives students the chance to interact with biology faculty and students with similar interests. The colloquium offers both large group seminars, featuring prominent scientists discussing their research programs, and small group tours to research facilities on and off campus, such as the Raptor Rehabilitation Center, the Wolf Center, or behind-the-scenes at the Minnesota Zoo. In addition, students are encouraged to begin exploring their own interests through participation in a research project. Colloquium student leaders help students find projects that fit their interests and allow them to earn University credit.

Socially, colloquium students always find time for fun, whether on a field trip or studying together in the colloquium student room. A popular social event is the weekend field trip to the Itasca Biological Station near the headwaters of the Mississippi. Upper division biology majors gain important leadership and communication experience as colloquium leaders.
Freshman Seminars—These are small classes, taught by the University’s finest faculty. Students explore exciting ideas and concepts and also learn more about the University and the wide range of services available.

Multicultural Affairs—CBS seeks to increase the number of students of color who enroll in and successfully complete its courses and majors. The college provides students of color with mathematics and science tutors, faculty mentors, and research experiences. The coordinator for recruitment and retention is available to work with individual students or groups of students in exploring potential interests in biology, provide academic assistance, identify employment opportunities, and alternative sources of financial aid, assist in leadership development, and help overcome barriers to educational success. For more information, contact John S. Anderson, 123 Snyder Hall (612-625-8752).

Internship Program—Offered by the CBS Career Center, the Internship Program provides experiential education information and opportunities to students year-round, specializing in biology-related internships, community service opportunities, and study-travel internships. Experiential learning programs promote academic and professional competence, skills development, career exploration, personal growth, and social responsibility through student involvement in structured work situations. CBS promotes excellence among University students by helping them integrate their classroom study with practical learning experience in the academic, public, and private sectors. Participating in the internship program allows students interested in biology to begin career exploration and planning early in their academic careers.

Previous students have studied marine biology at marine institutes and local facilities, gained laboratory experience in private industry, learned forensic science techniques in a criminal identification lab, and studied health care policy in Kenya, to name a few projects. Organizations sponsoring internship opportunities include educational institutions, government agencies, businesses, and nonprofit organizations. Both paid and volunteer positions are available throughout the year and some offer course credit. The CBS Alumni Society provides stipends each year for students who participate in unpaid internships. Students with specific interests may design their own internship and Career Center staff will help them find a sponsoring organization. Students can earn credit for a structured professional learning experience through registration in Biol 3610—Internship: Professional Experience in Biological Sciences.

Undergraduate Research—Each spring an Undergraduate Research Symposium is held to recognize the accomplishments of undergraduates participating in life sciences research projects. Students do research work largely on their own and at their own pace, supervised by a University faculty or staff member.

Students may choose to earn academic credit for their research experiences, or they may wish to apply for special grants that provide a research stipend. CBS students are able to apply for financial support for their research activities through the University’s Undergraduate Research Opportunities Program (See Undergraduate Research in the General Information section of this catalog). The CBS Career Center maintains a research topic database to help students find interesting research projects in laboratories throughout the University.

Scholarships

Students are encouraged to apply for both need- and merit-based CBS scholarships. Information and scholarship applications are available at <http://cbs.umn.edu/honors> or by calling Student Services at 612-624-9717.

International Programs

CBS students recognize the need to prepare themselves to be citizens of a multicultural society, a global economy, and an increasingly interdependent world. The college encourages them to enhance their education by taking advantage of international programs sponsored by the University.

The college also encourages study abroad for language acquisition or culture learning. The resulting credits can be used as general electives or, in some cases, to satisfy liberal education requirements. The University sponsors or cosponsors a broad range of intensive short-term language programs and area studies programs.

The two types of study abroad that best lend themselves to study in the biological sciences are field study and integrated classroom study.

For more information, see Study Abroad in the General Information section of this catalog.

Career Information

Biology encompasses many fields of study and appeals to students with diverse interests. Career opportunities are equally broad. While students might be drawn to some majors because of their direct application to jobs, most students select a major in the biological sciences because it is the subject they most enjoy learning about. Happily, they will discover that their career choices are limited only by their imagination, individual interests, and acquired skills.

Many students study biology to prepare for professional training in the health sciences. Because entry requirements for the health sciences generally include similar courses to those required in CBS (mathematics, chemistry, physics, and biology), a bioscience major provides a good foundation for these fields of study. In fact, nearly a third of CBS graduates each year choose to continue their education in health fields including medicine, dentistry, pharmacy, veterinary medicine, and public health.

CBS students beginning full-time employment immediately following graduation frequently take research scientist and laboratory technician positions. Others pursue an array of occupations requiring a liberal education and bachelor’s degree, from business fields (e.g., sales, quality control, communications) to public service (e.g., environmental control or regulatory affairs, public education). CBS graduates have been very successful in gaining employment in their chosen professional fields, even at times when the market was limited and competitive. Right now, given the importance of biology in so many aspects of U.S. society and economy, the market for CBS graduates is very strong. Biologists are clearly in demand as advances in biotechnology create opportunities in health care, environmental science, and teaching the next generation of biologists. Employers have come to realize that the University is a good place to find well-trained biologists.
Some students combine their training in the biological sciences with other fields, such as engineering, graphic arts, law, business, or computer technology. Those graduates who choose to continue their study are regularly admitted to high-quality or highly ranked graduate schools and professional programs.

Nearly half of CBS graduates elect to pursue advanced study immediately after earning the B.S. degree (about 20 percent are admitted to professional schools and 20 percent enter graduate programs); the percentage of each graduating class that pursues advanced training had increased over time. Details about follow-up studies of graduates are available on request in 223 Snyder Hall.

**Career Center**—The CBS Career Center helps students explore the varied career options available to CBS graduates. Undergraduates are encouraged to consult with Career Center staff early to investigate careers, learn about career preparation, and begin to make decisions. The center provides extensive career and employer information, and connections to professionals in many fields of interest. Contacts made through the Internship Program, annual Career and Internship Fair, and CBS Career Network ensure that students make well-informed career decisions. Career Center staff also offer an annual course, Biol 2001—Careers in Biology, to help students in their career choices.

As graduation approaches, the center assists students in applying to graduate schools and professional health sciences programs. For those choosing to enter the job market directly, the center helps develop job search skills (including résumé writing and interviewing) and provides placement assistance in the form of job listings and a résumé distribution service. For more information, visit the center’s Web site at [www.cbs.umn.edu/career](http://www.cbs.umn.edu/career).

Students interested in teaching biology at the secondary level should consult the College of Education and Human Development for information about the curriculum.

**Student Organizations**

**Achieving Excellence in Mathematics and Science (AEIMS)**—All life sciences majors are encouraged to participate in AEIMS with students from other sciences, mathematics, and engineering. The club was established to ensure full participation of students from groups currently underrepresented in science and to foster interaction among diverse life sciences students and faculty. AEIMS activities include monthly issue-oriented meetings, organized community service projects, group study sessions, and social events. For more information, contact Dr. Annie Baldwin (612-626-1055).

**Biochemistry Club**—This club strengthens ties between biochemistry students and faculty, provides personalized career guidance, helps undergraduates identify biochemistry labs for directed research, and helps students keep abreast of advances in biochemistry. For more information, contact the Office of Student Services (612-624-9717) or the Department of Biochemistry, Molecular Biology, and Biophysics (612-624-7755).

**Biological Sciences Alumni Society (BSAS)**—BSAS is a professional association for graduates that fosters relationships among alumni, students, faculty, and the community. Enhancing student opportunities is a top priority. Toward that end, BSAS sponsors scholarships, research and internship grants, and a mentor program. Additionally, alumni worked with the CBS Career Center to develop the Career Network, an innovative program that enables students and graduates to explore career options. For more information, contact Emily Johnston, alumni relations coordinator, 612-624-4770 or ejohnsto@cbs.umn.edu, or stop by room 123 in Snyder Hall. BSAS welcomes the opportunity to get to know future alumni.

**Biological Sciences Student Association (BSSA)**—Through BSSA, biology undergraduates can take on leadership roles in the college. BSSA plans educational and social activities throughout the year and invites all University biology students to attend its meetings and events. BSSA is a major contributor to Biology Week. Involvement in the association is an excellent way to meet faculty and students. For more information, contact the Office of Student Services (612-624-9717).

**Headwaters Ecology Club**—Through this club the University community is informed about the important contributions field stations make to learning, especially in the sciences. An important focus of Headwaters Ecology Club is to promote the Lake Itasca Forestry and Biological Station. The club sponsors social events and regularly scheduled visits and field trips to field stations. For more information, contact the Itasca office on campus (612-624-6743).

**Ecology Club**—This club was established in 1991 to bring together students interested in the ecological and environmental problems of the world. The meetings are basically educational; however, each activity is planned to bring together students and faculty in an informal, social atmosphere. For more information, contact the Office of Student Services (612-624-9717) or the ecology, evolution, and behavior department (612-625-5700).

**Genetics, Cell Biology, and Development Club**—Students formed this club to bring together students, faculty, and staff interested in these disciplines. Members enjoy speakers, educational experiences, and social activities. For more information, contact the Office of Student Services (612-624-9717) or the genetics, cell biology and development department (612-624-3003).

**International Student Science and Cultural Exchange Club**—This club provides an opportunity for international students to interact with one another and with the campus community. Meetings provide a forum for learning about the home countries of CBS students and exploring important features of their cultures. All members of the science community are invited to participate. For more information, contact Kathie Peterson, ISSCEC adviser (612-624-9717).

**Plant Biology Club**—Through this club, students have the chance to interact with other students and faculty interested in plants. Participants enjoy speakers and other educational experiences, usually in an informal, social atmosphere. For more information, contact the Office of Student Services (612-624-9717) or the plant biology department (612-625-1234).

**Society for Microbiology**—The society provides a forum in which students and faculty can meet informally to share common interests in microbiology. All meetings and activities reflect members’ interests. Members are officially part of the Student Chapter of the American Society for Microbiology (ASM), which provides information on microbiology lectures, meetings, seminars, and local job listings. Activities include discussions of microbiological issues, social events, and visits to local employers. For more information, contact the Office of Student Services (612-624-9717) or the microbiology department (612-624-6190).

**Neuroscience Club**—The Neuroscience Club promotes interest in undergraduate neuroscience study and research at the University of Minnesota. Club activities include lab tours, study groups, participation in Department of Neuroscience outreach projects—such as Brain Awareness Week—and faculty-student get-togethers. Club members meet informally every other week; undergraduates interested in neuroscience are encouraged to participate. For additional information, call Kris Bettin (612-626-1458) or visit the club Web site at [www.neurosci.umn.edu/club.htm](http://www.neurosci.umn.edu/club.htm).
Directory
(area code 612)
Office of the Dean
123 Snyder Hall (St. Paul)
624-2244
Robert P. Elde, dean
belede@cbs.umn.edu
Judson Sheridan, associate dean
sher012@umn.edu
John S. Anderson, interim associate dean
anderson@cbs.umn.edu

Student Services
Advising and Registration
223 Snyder Hall (St. Paul)
624-9717
cbs-advisor@cbs.umn.edu
Kathleen Peterson, director,
kathiep@cbs.umn.edu
Leah Clark, leahc@cbs.umn.edu
Sarah Huhta, shuhta@cbs.umn.edu
Jessica Murra, jmurra@cbs.umn.edu
Patrick Sherman, psherman@cbs.umn.edu

Internship Program
John S. Anderson, anderson@cbs.umn.edu
625-8752
123 Snyder Hall (St. Paul)

Multicultural Affairs
123 Snyder Hall (St. Paul)
624-8752
John S. Anderson, anderson@cbs.umn.edu

Recruitment and Retention in the Life Sciences
123 Snyder Hall (St. Paul)
624-8752
John S. Anderson, anderson@cbs.umn.edu

Departments, Institutes, and Programs
Alumni Relations
123 Snyder Hall (St. Paul)
624-3752
Emily Johnston, ejohnsto@cbs.umn.edu

Biochemistry, Molecular Biology, and Biophysics
140 Gortner Laboratory of Biochemistry (St. Paul)
624-7755 and 6-155 Jackson Hall (Mpls.)
625-6100
David Bernlohr, head, david-b@cbs.umn.edu

Biology/Master of Biological Sciences
123 Snyder Hall (St. Paul)
625-3133
James Fuchs, faculty adviser,
james-f@cbs.umn.edu

Biotechnology Institute
240 Gortner Laboratory of Biochemistry (St. Paul)
624-6774
Kenneth Valentas, director,
valentas@cbs.umn.edu

CBS Computing Services
625-9284

Cedar Creek Natural History Area
509 Ecology Building (St. Paul)
625-5743
Cedar Creek area
763-434-5131
G. David Tilman, director,
tilman@iter.umn.edu

Developmental Biology Center
4-122 Malcolm Moos Health Sciences Tower (Mpls.)
625-6042
Michael B. O’Connor, director,
moconnor@umn.edu

Ecology, Evolution, and Behavior
110 Ecology Building (St. Paul)
625-5700
Robert W. Sterner, head
stern007@umn.edu

Electronic Instrument Services
25 Biological Sciences Center (St. Paul)
625-8267

General Biology Program
3-140 Molecular Cellular Biology (Mpls.)
625-6636
John S. Anderson, director,
anderson@cbs.umn.edu

Genetics, Cell Biology, and Development
250 Biological Sciences Center (St. Paul)
624-3003 and 6-160 Jackson Hall (Mpls.)
624-3110
gcd@biosci.cbs.umn.edu
Brian Van Ness, head, vanne001@umn.edu

Imaging Center
35 Snyder Hall, (St. Paul)
624-3454
Mark Sanders, director,
msanders@cbs.umn.edu

Institute of Human Genetics
7-218 Malcolm Moos Health Sciences Tower (Mpls.)
625-1609
Harry Orr, director,
harry@mail.med.umn.edu

Instructional Computing Center
406 Biological Sciences Center and 170 Ecology (St. Paul)
624-2789

Itasca Biology Program
720 Biological Sciences Center (St. Paul)
624-6743
David Biesboer, director, biesboer@umn.edu

Microbiology (Medical School)
1460 Mayo Memorial Building (Mpls.)
624-6190
Ashley T. Haase, head,
ashley@lenti.med.umn.edu

Neuroscience
6-145 Jackson Hall (Mpls.)
626-6800
Timothy J. Ebner, head
ebner001@umn.edu

Plant Biology
220 Biological Sciences Center (St. Paul)
625-1234
Kate VandenBosch, head,
vande102@umn.edu

Plant Molecular Genetics Institute
220 Biological Sciences Center (St. Paul)
625-1234
Susan M. Wick, director,
swick@cbs.umn.edu

Teaching Laboratory Support Staff
123 Biological Sciences Center (St. Paul)
624-2789
Jane Phillips, coordinator,
janep@cbs.umn.edu

Directors of Undergraduate Studies
Biochemistry
158 Gortner Laboratory of Biochemistry (St. Paul)
624-6774
Janet Schottel, schott001@umn.edu

Biology
123 Snyder Hall (St. Paul)
624-2244
John S. Anderson, anderson@cbs.umn.edu

Ecology, Evolution, and Behavior
412 Ecology Building (St. Paul)
625-5296
Anne E. Pusey, pusey001@umn.edu

Genetics, Cell Biology, and Development
250 Biological Sciences Center (St. Paul)
624-5399
Stuart Goldstein, golds004@umn.edu

Microbiology (Medical School)
1435 Mayo Memorial Building (Mpls.)
624-9933
Leslie Schiiff, schiiff@lenti.med.umn.edu

Neuroscience
6-145 Jackson Hall (Mpls.)
625-7623
Richard Poppele, dick@cbs.umn.edu

Plant Biology
768 Biological Sciences Center (St. Paul)
625-2761
D. Peter Snustad, pete-s@biosci.cbs.umn.edu

The CBS annual Career and Internship Fair brings in prospective employers representing the full range of career choices for CBS graduates.
Biochemistry

Department of Biochemistry, Molecular Biology, and Biophysics

B.S.

Biochemists study molecules found in living organisms, particularly proteins, nucleic acids, lipids, and carbohydrates. Biochemistry majors learn about the basic molecules of life to gain an understanding of how diseases like cancer and diabetes develop, and to learn how genetic engineering and biotechnology can be used to clean up the environment and improve crops.

The B.S. program in biochemistry prepares students for graduate study in biochemistry or a related biological science, professional training programs in the health sciences, or entry-level scientist positions in industry.

Biochemistry is an experimental science, and majors, especially those planning to pursue graduate studies in the field, should become acquainted with laboratory research approaches beyond those in the formal lab courses. Research options are available through BioC 4994 or BioC 4794W—Directed Research and the Honors Program. Students should consult early with their faculty adviser to begin planning the research component of their major.

Degree Requirements

Students must complete 120 credits, including at least 70 credits in the major.

The biochemistry major is based on a broad foundation in the physical sciences (mathematics, chemistry, and physics) and an extensive knowledge of the cellular, molecular, and genetic aspects of biology, in addition to formal course and laboratory work in biochemistry.

Required Courses

Complete requirements in the categories of general and organismal biology, biology core, biochemistry courses, and electives in the major. The following courses must be taken A-F unless the course is only offered S-N. Grades in all chemistry, math, physics, biochemistry and biological sciences courses taken to complete requirements in the major must be at least C-.

General and Organismal Biology—Choose sequence A or B:

Sequence A. (preferred)

Biol 1001—Introductory Biology I: Evolutionary and Ecological Perspectives
Biol 1002—Introductory Biology II: Molecular, Cellular, and Developmental Perspectives

Sequence B.

Biol 1009—General Biology
Choose one organismal course or course pair from the following list: Biol 2012 or Biol 3211 and Biol 2005; Biol 2022 or Biol 3002 and Biol 3003W, or Biol 3007; Biol/MicB/VPP 2032 or Biol/MicB 3301

Biology Core—Complete each of the following:

Biol 4003—Genetics
Biol 4004—Cell Biology

Choose one course or course pair from the following (courses used to meet this requirement cannot be used to meet other requirements for the major)

Biol 3211—Animal Physiology and Biol 2005—Animal Diversity Laboratory
Biol 3002—Plant Biology and Biol 3005W—Plant Function Laboratory
Biol 3007—Plant Biology: Diversity and Adaptation
Biol/MicB 3301—Biology of Microorganisms
Biol 3407 Ecology
Biol 3409 Evolution
Biol 3411 Introduction to Animal Behavior

Biochemistry Courses—Complete each of the following:

BioC 3960—Research Topics in Biochemistry
BioC 4025—Laboratory in Biochemistry
BioC 4331—Biochemistry I: Structure, Catalysis and Metabolism in Biological Systems
BioC 4332—Biochemistry II: Molecular Mechanisms of Signal Transduction and Gene Expression
BioC 4521—Introduction to Physical Biochemistry or Chem 3501 and 3502—Physical Chemistry I-II

Electives in the Major

Six credits of electives in biochemistry or related biological disciplines (one course must include an upper division CBS laboratory experience). Course list available in 223 Snyder Hall.

Required Courses From Other Programs

The following courses must be taken A-F, unless the course is only offered S-N.

Math 1271-1272 or 1281-1282—Calculus I-II
Chem 1021-1022—Chemical Principles I-II
Chem 2301-2302—Organic Chemistry I-II
United States

Biology

B.S.

Biology touches every aspect of our lives—from the food we eat and our health, to the plants and animals who share the planet and the air we breathe. Biology majors gain a broad understanding of the fundamental nature and characteristics of living things and the way they interact. The study of biology covers the full range of life sciences, from cancer genes to acid rain, from lichens to marine mammals.

The biology B.S. program prepares students for further study in graduate or professional schools, and also trains students for careers in industry, education, or government.

Degree Requirements

Students must complete at least 120 credits, including at least 69 credits in the major. The biology curriculum also includes courses in biology, chemistry, physics, and mathematics.

Required Courses

Complete requirements in the categories of general and organismal biology, biology core, and electives in the major. The following courses must be taken A-F, unless the course is only offered S-N. Grades in all chemistry, math, physics, and biological sciences courses used to complete requirements in the major must be at least C-. A or B:

General and Organismal Biology—Choose sequence A or B:

**Sequence A (preferred sequence)**

1. Biol 1001—Introductory Biology I: Evolutionary and Ecological Perspectives
2. Biol 1002—Introductory Biology II: Molecular, Cellular, and Developmental Perspectives
3. Choose one organismal biology course or course pair from the following list:
   - Biol 2012 or Biol 3211 and Biol 2005
   - Biol 2022 or Biol 3002 and Biol 3005W or Biol 3007
   - Biol/MicB/VBP 2032 or Biol/MicB 3301

**Sequence B**

1. Biol 1009—General Biology
2. Choose two organismal biology courses or course pairs from the following list:
   - Biol 2012 or Biol 3211 and Biol 2005
   - Biol 2022 or Biol 3002 and Biol 3005W or Biol 3007
   - Biol/MicB/VBP 2032 or Biol/MicB 3301

**Biology Core—Complete each of the following:**

- Biol/BioC 3021—Biochemistry
- or BioC 4331—Biochemistry I: Structure, Catalysis, and Metabolism in Biological Systems
- Biol 4003—Genetics
- Biol 4004—Cell Biology

- Choose one course from Biol 3407, Biol 3409, and Biol 3411

**Electives in the Major—Complete each of the following:**

Eleven additional upper division credits in mathematics, physical, biological science and/or computer science. (Biol 3051 may not be used to fulfill this requirement).

Laboratory or fieldwork in two additional upper division biological science courses or course pairs. Credits earned may be applied toward fulfilling the 11 upper division credits above. A list of acceptable courses follows:


All 38xx or 48xx CBS courses offered at the Lake Itasca Forestry and Biological Station are acceptable (if not used to complete other requirements in the major)

**Required Courses From Other Programs**

- Math 1271-1272 or 1281-1282—Calculus I-II
- Chem 1021-1022—Chemical Principles I-II
- Chem 2301-2302—Organic Chemistry I-II
- Chem 2311—Organic Lab
- Phys 1201W-1202W—General Physics I-II
- or Phys 1301W-1302W—Introductory Physics I-II

**Upper division electives (3xxx, 4xxx, or 5xxx courses having Biol 1002 or 1009 as a prerequisite) may be selected from any CBS department, as well as appropriate mathematics, physical science, and computer science courses.**

**An independent research project is strongly recommended for every student. To apply a Directed Research course to satisfy one of the upper division lab or fieldwork requirements, students must complete at least 3 credits under the 4794W/4994 course number. Biology majors may satisfy both of the lab/field course requirements through Directed Research only if 3 credits of 4794W/4994 are completed in each of two different labs. A maximum of 6 credits of 4794W/4994 counts toward the 11 upper division elective credits.**

Biology Minor

To declare a biology minor, students must make an appointment (and bring a transcript). Call 612-624-9717. All courses must be completed with a grade of at least C-.

**Required Courses**

1. Biol 1001 and 1002 and one organismal course
2. Biol 1009 and two organismal courses in different areas.
3. 15 additional upper division credits in biological sciences including:
   - One of EEB 3001, Biol/BioC 3021, GCD 3022, Biol 3407, Biol 4003, or BioC 4331.
   - An additional lab or field course. If directed research (BioC, EEB, GCD, MicB, NSci or PBio 4794W or 4994) is used, it must be at least 2 credits.
   - At least 10 credits at the U of MN, Twin Cities campus.
   - At least 10 credits on the A/F grading system.

**Organismal course options:**

- Biol 2012—General Zoology with lab
- Biol 2022—General Botany with lab
- Biol/MicB 2032—General Microbiology with lab
- Biol 3002—Plant Biology Function and Biol 3005W—Plant Function Laboratory
- Biol 3007—Plant Biology: Diversity and Adaptation with lab
- Biol 3211—Animal Physiology and Biol 2005—Animal Diversity Laboratory
- Biol/MicB 3301—Biology of Microorganisms with lab

The annual Biology Week celebration features student organizations at the activities fair kick-off event.
Laboratory field course options (if not used for organismal requirement):

* Must complete at least 3 credits of research (4994 or 4794W) in one lab to use for a lab requirement. 4794W is directed research with a writing intensive component.

All 38xx or 48xx Lake Itasca Field Station courses satisfy field requirement (if not used to satisfy other requirements in the major).

**Biology, Society, and Environment**

**B.S.**
This interdisciplinary major, available beginning fall 2002, combines training in biology with an examination of its relationship to society and the relevance of biology to social and environmental problems. Students may choose a theme to integrate their studies. Examples include the global environment; the ethics, economics, and politics of health care; biology and U.S. government; and communicating biology to the public. Students and advisers design a program drawing from courses offered throughout the University.

This new program option is offered jointly by CBS and the College of Liberal Arts (CLA) and replaces the CLA program in biology. For more information, contact Kathie Peterson at kathiep@cbs.umn.edu.

**Ecology, Evolution, and Behavior**

**Department of Ecology, Evolution, and Behavior**

**B.S.**
This program brings together the related fields of ecology, evolution, and behavior.

Ecology examines the growth and maintenance of populations and their interactions in communities, and relationships among organisms and physical events in terrestrial and aquatic ecosystems. Evolution investigates the origin and change of biological diversity by studying evolutionary patterns and processes at various temporal and spatial scales. Behavioral biology explores behavioral adaptations to the environment, mechanisms of behavior, and the evolution of social systems.

**Degree Requirements**
Students must complete at least 120 credits, including at least 72 credits in the major. The program also includes coursework in math, physics, and chemistry.

**Required Courses**
Complete requirements in the categories of general and organismal biology, biology core, and electives in the major. The following courses must be completed with A-F grades unless they are offered S-N only.

**General and Organismal Biology—Choose sequence A or B:**

**Sequence A (preferred)**
Biol 1001—Introductory Biology I: Evolutionary and Ecological Perspectives
Biol 1002—Introductory Biology II: Molecular, Cellular and Developmental Perspectives
Choose at least two organismal courses or course pairs representing two kingdoms (plant, animal, or microorganismal) from Biol 2012, Biol 2022, Biol 3007, Biol 3002 and 3005W, Biol/MicB/VBP 2032, Biol 3211 and 2005, Biol/MicB 3301, Ent 3005, EEB 4129, EEB 4134, EEB 4136

**Sequence B**
Biol 1009—General Biology
Choose three organismal courses or course pairs representing three kingdoms (plant, animal, or microorganismal) from Biol 2012, Biol 2022, Biol 3007, Biol 3002 and 3005, Biol/MicB/VBP 2032, Biol 3211 and 2005, Biol/MicB 3301.

**Biology Core—Complete each of the following:**
Biol/BioC 3021—Biochemistry
At least two courses from Biol 3407, Biol 3409, and Biol 3411

**Electives in the Major**
13 additional 3xx or 4xx ecology, evolution or behavior (and related) courses, including a biology field experience (which can be satisfied with a 4-credit course involving extensive field experience taken at the Lake Itasca Forestry and Biological Station or equivalent). Biol 3407, 3409 and 3411 credits may be used in this area if not used to meet Biology Core requirements (above). Organismal biology credits (see above list) may be used in this area if not used to meet requirements for general and organismal biology above.

**Required Courses From Other Programs**
Math1281-1282 (preferred) or Math 1271-1272—Calculus I-II
Stat 3021—Introduction to Probability and Statistics
Chem 1021-1022—Chemical Principles I-II
Chem 2301-Organic Chemistry I and one of the following: Chem 2302, EEB 4631, Geo 4701, Geo 4703, Math 2243, Soil 5515, Soil 5555, Soil 5402.
Phys 1201-1202—General Physics I-II
or Phys 1301-1302—Introductory Physics I-II

Note: Grades in all chemistry, math, physics, and biological sciences courses taken to complete requirements in the major must be at least C-. All courses in the major must be taken A-F unless the course is only offered S-N.
Genetics, Cell Biology, and Development

Department of Genetics, Cell Biology, and Development

B.S.

Understanding how a fertilized egg develops into a complete organism is at the heart of the fields of genetics, cell biology, and developmental biology. The answers lie in genes—the blueprint of life carried by cells, the fundamental units of all living things. Genes direct cells to create networks that give rise to tissues, organs, and ultimately organisms, including humans. Genetics, cell biology, and development (GCD) majors learn about advances in the field by studying model organisms like plants, fruit flies, zebrafish, and mice.

Degree Requirements

Students must complete at least 120 credits, including at least 75 credits in the major. Requirements include coursework in biology, chemistry, physics, and mathematics.

Required Courses

Complete requirements in the categories of general and organismal biology, cell biology, and electives in the major. Grades in all chemistry, math, physics, and biological sciences courses taken to meet requirements in the major must be at least C-. All courses in the major must be taken A-F unless the course is only offered S-N.

General and Organismal Biology—Choose sequence A or B:

Sequence A (preferred)

- Biol 1001—Introductory Biology I: Evolutionary and Ecological Perspectives
- Biol 1002—Introductory Biology II: Molecular, Cellular, and Developmental Perspectives

One organismal course or course pair from the following list:
- Biol 2012 or Biol 3211 and 2005;
- Biol 2022 or Biol 3002 and 3005W or Biol 3007;
- Biol/MicB/VPB 2032 or Biol/MicB 3301

Sequence B

- Biol 1009—General Biology
- Two organismal courses or course pairs from the following list:
  - Biol 2012 or Biol 3211 and 2005;
  - Biol 2022 or Biol 3002 and 3005W or Biol 3007;
  - Biol/MicB/VPB 2032 or Biol/MicB 3301

Biology Core—Complete each of the following:

- Biol/BioC 3021—Biochemistry
- or Biol/C 4311—Biochemistry I: Structure, Catalysis, and Metabolism in Biological Systems
- Biol 4003—Genetics
- Biol 4004—Cell Biology
- Choose one course from Biol 3407, Biol 3409, Biol 3411

Electives in the Major—Complete each of the following:

Eighteen additional credits in life sciences, physical science, mathematics, statistics and/or computer science, chosen in consultation with the major adviser. The 18 credits must include:

- At least one genetics course from EEB 5033, GCD 4034, GCD 4143, GCD 4151*
- At least one course in cell biology from GCD 5036, GCD 4111, GCD 4134, MicB 4131, PBio 5414, Biol/NSci 3101
- At least one course in developmental biology from GCD 4151*, GCD 4161 or PBio 5416
- Two laboratory courses from the following: Biol 4025, BioC 4125, GCD 4015, GCD 4025, MicB 4235, GCD 4794W or 4994—Directed Research. Must complete at least 3 credits of research (4994 or 4994W) in one lab to use for a lab requirement. A maximum of 7 credits of GCD 4794W/4994 may be applied toward the 18-credit total.

Advanced laboratory courses—Choose option a or b:

a. MicB 4215—Advanced Laboratory: Microbial Physiology and Diversity
b. MicB 4235—Advanced Laboratory: Virology, Immunology, and Microbial Genetics

Microbiology

Department of Microbiology

B.S.

Microbes make up 60 percent of the earth’s biomass. Regarded by many as the foundation of the biosphere, microbes were likely the first form of life on earth, predating plants and animals by more than three billion years. Microbiologists study the role of microbes, such as bacteria, fungi, and viruses, in our world. A key goal of microbiologists today is to find new ways to use microbes to our advantage, such as engineering bacteria to synthesize cancer drugs or clean up toxic waste sites. The microbiology major prepares students for advanced work in graduate programs and serves as preparation for a career in the health sciences. Microbiologists find employment in agriculture and industrial and pharmaceutical fields.

Degree Requirements

Students must complete at least 120 credits, including at least 75 credits in the major.

Required Courses

Complete requirements in the areas of general and organismal biology, biology core, and electives in the major. Grades in all chemistry, math, physics, and biological sciences courses taken to complete requirements in the major must be at least C-. All courses in the major must be taken A-F unless the course is only offered S-N.

General and Organismal Biology—Choose sequence A or B:

Sequence A (preferred)

- Biol 1001—Introductory Biology I: Evolutionary and Ecological Perspectives
- Biol 1002—Introductory Biology II: Molecular, Cellular, and Developmental Perspectives

Sequence B

- Biol 1009—General Biology
- Two organismal courses or course pairs from the following list:
  - Biol 2012 or Biol 3211 and 2005;
  - Biol 2022 or Biol 3002 and 3005W or Biol 3007;
  - Biol/MicB/VPB 2032 or Biol/MicB 3301

Biology Core—Complete each of the following:

- Biol/BioC 3021—Biochemistry
- or Biol/C 4311—Biochemistry I: Structure, Catalysis, and Metabolism in Biological Systems
- Biol 4003—Genetics
- Biol 4004—Cell Biology
- Choose one course from Biol 3407, Biol 3409, Biol 3411

Electives in the Major—Complete each of the following:

Eighteen additional credits in life sciences, physical science, mathematics, statistics and/or computer science, chosen in consultation with the major adviser. The 18 credits must include:

- At least one genetics course from EEB 5033, GCD 4034, GCD 4143, GCD 4151*
- At least one course in cell biology from GCD 5036, GCD 4111, GCD 4134, MicB 4131, PBio 5414, Biol/NSci 3101
- At least one course in developmental biology from GCD 4151*, GCD 4161 or PBio 5416
- Two laboratory courses from the following: Biol 4025, BioC 4125, GCD 4015, GCD 4025, MicB 4235, GCD 4794W or 4994—Directed Research. Must complete at least 3 credits of research (4994 or 4994W) in one lab to use for a lab requirement. A maximum of 7 credits of GCD 4794W/4994 may be applied toward the 18-credit total.

Advanced laboratory courses—Choose option a or b:

a. MicB 4215—Advanced Laboratory: Microbial Physiology and Diversity
b. MicB 4235—Advanced Laboratory: Virology, Immunology, and Microbial Genetics

The college currently has 12 Morse-Alumni Outstanding Undergraduate Teachers and six John Tate Undergraduate Advising Award winners.
Required Courses From Other Programs
Math 1271-1272 or 1281-1282—Calculus I-II
Chem 1021-1022—Chemical Principles I-II
Phys 1301W-1302W—Introductory Physics I-II
or Phys 1201W-1202W—General Physics I-II

Neuroscience
Department of Neuroscience
B.S.
Neuroscientists study the molecular and cellular building blocks that make up the brain and control its function. Neuroscience majors learn how people see and hear, move, think and feel. They also study abnormalities that cause diseases and mechanisms that underlie pain and addiction.

The major prepares undergraduates to pursue advanced studies in neuroscience; a professional degree in medicine or psychology; or careers in the rapidly growing areas of the pharmaceutical, medical, or biotechnology industries.

Degree Requirements
Students must complete at least 120 credits, including at least 89 credits in the major. Requirements also include courses in biology, chemistry, physics, and mathematics.

Required Courses
Complete requirements in categories of general and organismal biology, biology core, neuroscience courses, and electives in the major. Grades in all chemistry, math, physics, and biological sciences courses taken to meet requirements in the major must be at least C-. All courses in the major must be taken A-F unless the course is only offered S-N.

General and Organismal Biology—Choose sequence A or B:

Sequence A (preferred)
Biol 1001—Introductory Biology I: Evolutionary and Ecological Perspectives
Biol 1002—Introductory Biology II: Molecular, Cellular, and Developmental Perspectives
Biol 3211—Animal Physiology
or Phsl 3051—Human Physiology
and Biol 2005—Animal Diversity Laboratory
or Biol 2012—Zoology

Sequence B
Biol 1009—General Biology
Biol 3211—Animal Physiology
and Biol 2005—Animal Diversity Laboratory
or Phsl 3051—Human Physiology
and Biol 2005—Animal Diversity Laboratory
or Biol 2012—Zoology

Choose one organismal course or course pair from the following list: Biol 2222, Biol/MicB/VPB 2232, Biol 3002 and 3005W, Biol 3007, Biol/MicB 3301

Biological Core—Complete each of the following:
Biol/BioC 3021—Biochemistry
or BioC 4331—Biochemistry I: Structure, Catalysis, and Metabolism in Biological Systems
Biol 4003—Genetics
Biol 4004—Cell Biology
Biol 3407—Ecology
or Biol 3409—Evolution
or Biol 3411—Introduction to Animal Behavior

Neuroscience Courses—Complete each of the following:
Biol/NSci 3101—Introduction to Neuroscience I: From Molecules to Madness
Biol/NSci 3102W—Introduction to Neuroscience II: Biological Basis of Behavior
Biol/NSci 4105-4115—Neurobiology Laboratory I-II
At least 2 credits of NSci 4794W/4994—Directed Research

Electives in the Major
Choose a minimum of 9 credits from groups A-C with at least one course in each group:

Group A—Cell and molecular biology
NSc 5461—Cellular and Molecular Neuroscience
GCD 4034—Molecular Genetics
GCD 5036—Molecular Cell Biology
EEB 5221—Molecular and Genomic Evolution
Other courses must be approved by the Director of Undergraduate Studies (requires petition)

Group B—Neural systems and behavior
EEB 5321—Evolution of Social Behavior
EEB 5323—Neural and Endocrine Mechanisms Underlying Vertebrate Behavior
EEB 5327—Behavioral Ecology
NSci 4151—Advanced Topics in Neuroscience (Spring)
NSc 5202—Theoretical Neuroscience: Systems and Information Processing
NSc 5462—Neuroscience of Drug Abuse
NSc 5481—Invertebrate Neurobiology
NSc 5661—Behavioral Neuroscience
Psy 5036W—Computational Vision
Psy 5038W—Introduction to Neural Networks
Psy 5061—Neurobiology of Behavior
Other courses must be approved by the Director of Undergraduate Studies (requires petition)

Group C—History and philosophy of science
HSci 3211—Biology and Culture in the 19th and 20th Centuries
HSci 3242—Darwinian Revolution
Phil 3601W—Scientific Thought
Phil 4607W—Philosophy of Biological Science

Required Courses From Other Programs
Math 1271-1272 or 1281-1282—Calculus I-II
Chem 1021-1022—Chemical Principles I-II
Chem 2301-2302—Organic Chemistry I-II
Chem 2311—Organic Lab
Phys 1201W-1202W—General Physics I-II
or Phys 1301W-1302W—Introductory Physics I-II
Plant Biology

Department of Plant Biology

B.S.

Plant biologists study the genetics, development, and evolution of plants. They make important contributions to analyzing and preserving biodiversity worldwide. They work to enhance the nutritional value of crops as well as their resistance to disease, pests, and drought while working to reduce the need for pesticides, fertilizer, and irrigation.

Current faculty research interests include gene expression, chromosome structure, plant growth substances, signal transduction, plant responses to stress, the plant cytoskeleton and cell morphogenesis, metabolic activities during development, cellular structure and ultrastructure of vascular and nonvascular plants, aquatic biology, lichenology, molecular evolution and systematics, fungal/plant interactions, biological rhythms, and fungal diversity.

Plant biology majors follow one of two tracks. One track fits the needs of students who are primarily interested in organismal or environmental biology, while the other track is appropriate for students interested in molecular, cellular, and development biology.

Degree Requirements

Students must complete at least 120 credits, including 66 credits in the major. The program also includes coursework in mathematics, physics, and chemistry. Grades in all chemistry, math, physics, and biological sciences courses taken to meet requirements in the major must be at least C-.

Required Courses

Complete requirements in categories of general and organismal biology, biology core, laboratory or fieldwork, and electives in the major.

General and Organismal Biology—Choose sequence A or B:

**Sequence A (preferred)**

- Biol 1001—Introductory Biology I: Evolutionary and Ecological Perspectives
- Biol 1002W—Introductory Biology II: Molecular, Cellular, and Developmental Perspectives
- Plus either Biol 3002 and 3005, or Biol 3007

**Sequence B**

- Biol 1009—General Biology
- Plus Biol 3002 and 3005, and Biol 3007

Students who decide to major in plant biology after taking a course in general botany may substitute that course for either Biol 3002 and 3005, or Biol 3007.

**Biology Core**

- Biol/BioC 3021—Biochemistry
- Biol 3407—Ecology
- or Biol 3409—Evolution
- or Biol 3411—Introduction to Animal Behavior
- Biol 4003—Genetics
- or Biol 4004—Cell Biology

**Laboratory or Fieldwork**

Choose two courses or course pairs from the following list:

- Biol 3211 and 2005; Biol/MicB 3301; Biol/NSci 3105 and 3115; BioC 4125; BioC 4025; BioC 4794W/4994; EEB 4014W; EEB 4016; EEB 4129; EEB 4134; EEB 4136; EEB 4605; EEB 4607; EEB 4631; EEB 4794W/4994; GCD 4015; GCD 4025; GCD 4111; GCD 4794W/4994; MicB 4215; MicB 4235; MicB 4794W/4994; NSci 4794W/4994; PBio 4321; PBio 4404; PBio 4511; PBio 5416; PBio 4794W/4994; or any 38xx or 48xx CBS course offered at the Lake Itasca Forestry and Biological Station. Biol 3002 and 3005W or Biol 3007 may be used to meet a laboratory/field requirement if not used to meet plant biology requirements in Sequence A (above).

**Electives in the Major**

Choose three courses from the following list, with at least one course each from Group A and Group B. Other appropriate courses may be substituted by petition.

**Group A—Integrative and organismal biology**

- EEB 4014W—Ecology of Vegetation
- PBio 4321—Taxonomy of Minnesota Flora
- or PBio 4511—Flowering Plant Systematics
- PBio 4404—Developmental Plant Anatomy
- PBio 5416—Plant Morphology, Development and Evolution
- or EEB 5122W—Plant Interactions with Animals and Microbes

**Group B—Cellular and subcellular biology**

- BioC 5401W—Advanced Metabolism and its Regulation
- PBio 5103—Plant Genomics
- PBio 5412—Plant Physiology
- PBio 5414—Plant Cell and Molecular Biology
- or PBio 5640—Discussions in Plant Molecular Biology

**Required Courses From Other Programs**

- Math 1271-1272 or 1281-1282—Calculus I-II
- Chem 1021-1022—Chemical Principles I-II
- Chem 2301-2302—Organic Chemistry I-II
- Chem 2311—Organic Lab
- Phys 1201-1202—General Physics I-II
- or Phys 1301-1302—Introductory Physics I-II

**Note:** All courses in the major must be taken A-F unless the course is only offered S-N.

**Plant Biology Minor**

Students must complete four courses in this list:

- Biol 3002—Plant Biology: Function
- Biol 3005—Plant Function Laboratory
- Biol 3007—Plant Biology: Diversity and Adaptation
- Choose one course from PBio 4321, 4404, 4511