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General Information

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, the college integrates a strong basic research program with both traditional and innovative classroom teaching and with intensive mentoring of students at all levels.

Admission

Admission to the College of Biological Sciences is competitive. Decisions are based on an overall assessment of each applicant’s accomplishments and potential as presented in the application materials. New freshmen are admitted once a year in the fall. Transfer students are admitted at any point in their course of study and can enter either fall or spring semesters. Admission of transfer students is also based on overall assessment of their application and usually requires satisfactory completion of prerequisite coursework as detailed below. All prospective students are encouraged to visit campus and meet with admissions. For more information, see the Office of Admissions Web site at http://admissions.tc.umn.edu.

Requirements

Freshman 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 within the University of Minnesota:

1. 2.00 or higher GPA and grades of at least C- in the following courses is usually required:
   a. Biol 1009 or 1001 or equivalent
   b. Chem 1021 or equivalent
   c. Math 1271 or 1281 or equivalent
2. Prerequisite courses must usually be completed at the time of application, with the following exception: students with a 3.00 or higher GPA may be admitted with two of the three prerequisite courses completed and the last prerequisite course in progress (courses in progress during summer session are not included). For more specific transfer information visit the CBS Web site at www.cbs.umn.edu or call 612-624-9717.

Admission requirements for transfer students from higher education institutions other than the University of Minnesota:

The preferred GPA for admission is 2.50 or higher. At the time of application, students should have completed the following prerequisite coursework with C- or better.

- One semester or two quarters of college-level calculus
- One semester or two quarters of inorganic chemistry with lab
- One semester or two quarters of general biology with lab

Exception: students with a cumulative GPA of 3.00 or higher and two of the three prerequisite courses completed with the last course in progress, will be considered for admission (courses in progress during summer session are not included).

For students transferring with quarter-based courses, one quarter of biology, two quarters of chemistry, and two quarters of calculus are considered for prerequisite coursework.

Please visit the CBS Web site at www.cbs.umn.edu to find more specific transfer information and course equivalencies for chemistry, math, and physics, or call 612-624-9717.

For more information on transfer course equivalencies, visit

http://admissions.tc.umn.edu/AdmissionInfo/trans_evaluation.html For course equivalencies in chemistry, math, and physics, go to www.it.umn.edu/prospective/equiv/.

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).

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

Thanks to advances, such as the sequencing of the human genome and the development of new biotechnologies, biology is playing an increasingly important role in health, agriculture, the environment, the economy, and society in general. New career opportunities are emerging in the biotechnology industry, government, and education. As a result, 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 faculty are engaged in federally sponsored research, which gives undergraduates many opportunities to gain research experience working with faculty in laboratories. It also means that many of your classes will be taught by leading researchers in their fields.

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 were inspired to learn more about biology by a special teacher or course in high school. Some see biology as a step toward a career in medicine or preserving the environment; 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, consider the following questions.

CBS graduates go on to careers in biotechnology, health sciences, environmental planning, law, research and education, and government.
Do all students have the opportunity to be involved in research?
Most CBS 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, including an honors program, research, internship and study abroad opportunities, and Career Services.

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?
All undergraduates take general education courses, including biology. It is always possible to change your mind and transfer to another college, but this decision may impact your ability to graduate in four years. If you are undecided and considering several options, courses in the College of Liberal Arts can help you explore a variety of interests.

Orientation
Before classes begin, freshmen and all transfer students are required to attend orientation. Orientation 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.

Freshmen attend a two-day program that is designed to provide the information needed for a successful beginning at the University. During the first day, students meet other incoming students while attending small group sessions on University of Minnesota programs, including information about specific CBS programs, courses, and opportunities. CBS advisers also help students start planning their class schedule. During the second day, students register for fall semester classes.

Transfer Orientation is a one-day program designed to help students make a smooth transition to the University. During orientation new transfer students meet other CBS students, get acquainted with the Twin Cities campus, plan a schedule of classes, and register online.

Undergraduate Programs
Students choose CBS because it has high quality programs offered by professors who are nationally recognized researchers and educators who care about their students. 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 also explore biology career interests through the Biology Colloquium, freshman seminars, and a broad selection of seminars offered by Career Services.

The CBS bachelor of science degree program is composed of four essential elements. Each helps prepare 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. Students develop communication skills; an understanding of the ways scientists and others contribute to knowledge; historical and philosophical perspectives on the world; and 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 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 described using mathematics. Modern biologists in the field and in the laboratory must be able to use principles of mathematics, chemistry, and physics to understand living organisms at all levels from molecules to ecosystems.

III. Biology Core Curriculum—Specialists will always be important in biology, but today there is a growing need for people whose understanding spans the disciplines of biology. CBS 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 introduce students to populations, evolution, and the behavior of animals.

IV. Specialization in the Major—All seven major programs in CBS lead to the bachelor of science degree. Students may major in
- biology
- biochemistry
- ecology, evolution, and behavior
- genetics, cell biology, and development
- microbiology
- neuroscience
- plant biology

All CBS freshmen start as lower division students and choose one of the majors listed above at the end of the first year. During the first year, students take the foundation courses in mathematics, chemistry, and general biology that will ensure success in any of the biological sciences majors. Transfer students can declare a specific major when they begin their studies in CBS. During their junior and/or senior years, most students complete a research project in their area of interest, often by taking Directed Study (4993 and 4793W) and Directed Research (4994 and 4794W).
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 Bridgette Barry, 624-6732

Conservation Biology—Francesca Cuthbert, 624-1756

Ecology, Evolution, and Behavior—Claudia Neuhauser, 624-6790

Genetic Counseling—Bonnie LeRoy, 624-7193

Joint Program in Law, Health, and Life Sciences—Susan Wolf, 625-3356

Microbial Engineering—Michael Sadowsky, 625-1722

Microbiology, Immunology, and Cancer Biology—Christopher Pennell, 625-7138

Molecular, Cellular, Developmental Biology, and Genetics—Margaret Titus, 625-8498

Neuroscience—John Soechting, 625-7961

Plant Biological Sciences—David Somers, 625-5769

Water Resources Science—Ray Newman, 624-9282

Honors Program

The CBS honors program is designed for highly motivated students who want more challenging courses, closer contact with faculty, an extensive research experience, and a supportive academic community. Students in honors choose from dozens of honors courses and benefit from special co-curricular events and extended library privileges.

Freshman-Sophomore Program—During the first two years, students are strongly encouraged to explore research opportunities and to complete at least two honors courses per year. First-year students participate in early orientation sessions and a Nature of Life honors focus session during the summer. Honors students may choose to live in the CBS Honors Living and Learning Community in Middlebrook Hall.

Students apply to the honors program when they apply to the University by completing the Application for Scholarships and Honors Programs. Admission is based on high school grades, coursework, standardized test scores, an essay, extracurricular involvement, evidence of leadership, and a letter of recommendation. Application forms are available in the Office of Admissions and online at http://admissions.tc.umn.edu/forms/scholapp.html.

Students who complete the honors program course requirements and achieve a minimum cumulative GPA of 3.50 receive a certificate and a notation on their transcript after the second year. The requirements to complete the freshman-sophomore program include:

1. a freshman seminar during the first year,
2. two honors courses in any subject, and
3. Biol 2960H, the CBS honors colloquium, during fall semester of the second year.

Junior-Senior Program—The junior-senior honors program focuses on a directed research project, which is presented in a written thesis and at the Life Sciences Undergraduate Research Symposium. Seniors participate in a yearlong capstone seminar, in which they explore the breadth of biological inquiry and have opportunities to refine their communication skills. Admission to the upper division honors program is based on grades earned during the first two years of college and does not require participation in the freshman-sophomore program. Students with a 3.50 GPA are eligible to apply to upper division honors upon completion of 60 college credits. Participants are encouraged to select a research adviser from University faculty and start on a research project early in their junior year.

Graduation With Honors—To qualify for a degree “with honors” (e.g., cum laude), a student must have completed 60 or more semester credits at the University of Minnesota and be enrolled in the upper division honors program for at least two semesters. In addition to the requirements for graduation, candidates for graduation with honors must complete the following:

1. two semesters (6 credits) of directed research, the results of which are reported in an honors thesis, written in the style of a publishable manuscript. The thesis must be approved by the faculty research adviser and by two other faculty (at least one of whom must be from CBS).
2. two semesters of CBS honors seminars (Biol 3960H), one of which must be completed during the fall semester and the other during the last spring semester in residence.
3. one additional honors research opportunity, which may be selected from
   a. an additional semester (or 2 credits) of participation in directed research
   b. an upper division honors course or seminar (3xxx-4xxx)
   c. a graduate-level course (seniors only; requires permission)
4. achieve a GPA for the last 60 credits of A-F registration of 3.750 for summa cum laude, 3.666 for magna cum laude, and 3.500 for cum laude.
   a. The last 60 credits include all courses taken in the earliest term included in this calculation.
   b. If a portion of the last 60 credits 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.

Graduation With Distinction—A student may obtain a degree with both honors and distinction. To qualify for a degree “with distinction,” a student must have completed 60 or more semester credits at the University and have a cumulative GPA of 3.75 or higher. To graduate “with high distinction,” a student must have a cumulative GPA of 3.90 or higher.

For More Information—For information and application materials, please refer to the honors program Web site at http://cbs.umn.edu/main/Honors. Students should feel free to discuss questions with an Office of Student Services adviser (612-624-9717) or honors program staff (612-624-3481).
Advising

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

To help students navigate the University and take advantage of these opportunities, current and prospective students are served by the advising services, resources, and programs provided by CBS Office of Student Services.

First-year students are assigned to a professional adviser in CBS Student Services. Students meet with their adviser at least twice during their first year to review academic progress, plan course schedules, and learn about additional college and University resources. At the end of their first year of study, CBS students are assigned to a faculty mentor in their particular area of interest. Professional advisers continue to assist all CBS students with setting goals, selecting courses, developing skills, and interpreting and navigating University rules and policies.

In addition to academic advising, the Office of Student Services coordinates undergraduate admission, provides student orientation and registration programs, offers academic progress review, evaluates student records for degree certification, and provides career resources and counseling.

Program Planning—Students should meet with their faculty mentor each year to evaluate and plan their academic program. Students can consult their faculty mentors regarding progress in specific courses, graduate study, planning internships, or arranging directed research in laboratory and field settings.

Special Learning Opportunities and Resources

Students are encouraged to explore the full scope of learning experiences available at the University, including those beyond the required curriculum. Many students plan projects they carry out under faculty supervision in research laboratories and at environmental field stations. Some students participate in off-campus internships in private industry, government agencies, and nonprofit organizations. Other students seek employment as undergraduate teaching and research assistants or museum tour guides.

Nature of Life—Incoming freshmen are required to take a 1-credit class at the Itasca Biological Station and Laboratories. At Itasca, students explore some of the major issues in biology, learn about ways of discovery in various fields of biology, and begin to see the interdisciplinary nature of the field. In addition, they get to know each other and many CBS faculty, leaving Itasca with new friends and a better understanding of how to make the most of their CBS experience. Follow-up activities during fall semester continue to build a sense of community and connection among students and faculty.

BioBuds—BioBuds is a peer mentor program in CBS that matches incoming freshmen with current CBS students based on their interests. BioBuds provides an opportunity for freshmen to meet new people, learn about CBS, and prepare for a successful academic career during their first weeks on campus. Students participate in a variety of large and small group activities on or near campus. BioBuds also provides leadership opportunities for sophomores, juniors, and seniors in CBS.

Biology House—Biology House, located in Frontier Hall, combines residence hall life with social and academic opportunities for students interested in the biological sciences. Activities include social events, lab tours and field trips, study groups, on-site advising, faculty and student research presentations, and career exploration. Space in Biology House is limited to incoming freshmen and PSEO students, and applicants are encouraged to apply early for admission to this community. For more information, visit the Housing and Residential Life Web site at www.housing.umn.edu.

New Student Reception—This annual welcome event helps new students connect with CBS departments, majors, clubs, and research opportunities.

Biology Colloquium (Biol 1020)—This unique course, organized and run by students, provides an opportunity to explore a variety of fields and careers in the biological sciences. The course 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.

Freshman Seminars—These discussion-focused small classes are taught by the University’s finest faculty. Students explore exciting topics and also learn more about the wide range of services and opportunities available at the University.

The College of Biological Sciences Alumni/Student Mentor Program—This program provides an opportunity for CBS students to connect one-to-one with an alumnus or friend of the college for career exploration, planning, and networking. Mentors advise about career-related issues such as career options, the value of networking and gaining work experience, resume writing, and interviewing skills. Mentors also provide feedback and support to help students succeed in their chosen fields.
**Multicultural Affairs** —CBS seeks to increase the diversity of its students and faculty because it recognizes that studying and working with individuals from a variety of backgrounds improves the educational experience of all students.

**Internship Program**—The CBS Internship Program, coordinated by CBS Career Services, promotes career exploration, skills development, academic and professional competence, personal growth, and social responsibility by supporting student involvement in structured work situations. Recent internships involved conducting molecular biology research at a new company developing plastics from renewable resources, assisting with maintaining exhibits at a large aquarium, researching new forensic science techniques in a criminal identification lab, organizing volunteers for tissue donor programs, assisting high school biology teachers, helping develop a groundwater monitoring program, and researching the needs of people with neurological injuries.

Students can earn internship credit by registering for Biol 3610—Internship: Professional Experience in Biological Science.

**Undergraduate Research**—As part of a large public research university, CBS offers a wealth of opportunities for hands-on research experience. Most students complete an independent research project under the supervision of a faculty member. All students are invited to present their research at the Life Sciences Undergraduate Research Symposium, which is held annually in the spring. Opportunities to get involved in research include volunteer experiences, directed research for academic credit, part-time jobs, and special grants through the Undergraduate Research Opportunities Program. Information about research opportunities and resources for finding a faculty mentor are available at [http://cbs.umn.edu/main/studentservices/research.html](http://cbs.umn.edu/main/studentservices/research.html).

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**Scholarships**

CBS offers a variety of scholarships to new and continuing students based on academic achievement, leadership, research experience, and humanitarian service. Scholarship information, deadlines, and application materials are available at [www.cbs.umn.edu/main/Honors/scholarships/scholarships.htm](http://www.cbs.umn.edu/main/Honors/scholarships/scholarships.htm).

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**Career Information**

Biology encompasses many fields of study and appeals to students with diverse interests. Career opportunities are equally broad. Although students might be drawn to 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. 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 CBS major provides a good foundation in pre-medicine, pre-pharmacy, pre-dentistry, and other health fields. 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 seeking full-time employment immediately following graduation frequently obtain 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 employment 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 has increased over time. Details about follow-up studies of graduates are available on request in 229 Snyder Hall.

**Career Services**—The CBS Career Center provides resources and services for students at all levels to explore career options and prepare for professional success in the multitude of bioscience-related careers available to CBS graduates.

Undergraduates are encouraged to take advantage of CBS Career Services throughout their undergraduate experience. Resources in the Career Center and programs such as Explore Careers in the Life Sciences help students investigate careers, learn about career preparation activities, and begin planning their career paths.

Opportunities for mid-level students to gain invaluable work experience, clarify their career goals, make connections with professionals, and make well-informed career decisions are plentiful. These students are encouraged to participate in the Internship Program, attend the annual Career and Internship Fair, use the Career Network, and participate in the Mentor Program. Information to guide students in the application process for graduate and professional school is also available.
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 Cady Paulaha (612-625-4289).

AED—Alpha Epsilon Delta (AED), the pre-med honor society, is for anyone who is considering becoming a physician in the future. Members meet other pre-med students and learn about how to prepare for a career in medicine.

American Medical Student Association (AMSA) Pre-med Chapter—AMSA is a national pre-med student group that helps students connect with others who share their interests in the health sciences and helps prepare them for medical school and the MCAT.

Ambassador Program—Selected students have the opportunity to promote the opportunities available within the college and the University to other students and the community by participating in college-sponsored outreach activities and working with prospective students. This program provides leadership and skills development training.

Biochemistry Club—This club strengthens ties between biochemistry students and faculty, provides personalized career guidance, helps undergraduates identify biochemistry labs for directed research, and 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).

Biology Club—This organization promotes interest in undergraduate study in biology at the University. This club helps biology majors explore their options, the major, and learn about other CBS majors early in their academic careers. Fields of research, career possibilities, and unique educational experiences are also showcased at club meetings. For more information, contact the Office of Student Services at 612-624-9717.

Biological Sciences Alumni Society (BSAS)—BSAS is a professional association for CBS graduates that fosters relationships among alumni, students, faculty, and the community. Enhancing student opportunities is a top priority of BSAS. Toward that end, BSAS sponsors scholarships, research and internship grants, and a mentor program. Additionally, alumni work 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 at 612-624-4770 or ejohnsto@cbs.umn.edu, or stop by 123 Snyder Hall.

Biological Sciences Student Association (BSSA)—Through BSSA, biology undergraduates can assume 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. 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—The Headwaters Ecology Club promotes interest in undergraduate study in ecology, evolution, and animal behavior through social, educational, and volunteer events. An important focus of the Headwaters Ecology Club is to promote the unique educational opportunities available through the Itasca Biological Station and Laboratories, and other national and international field biology programs. For more information, contact the Office of Student Services at 612-624-9717.

Forensic Science Club—This club organizes events, field trips, information, and guest speakers for members of the University community interested in forensic science.

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).

Microbiology Club—This club provides a forum in which students and faculty can meet informally to share common interests in microbiology. 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 plant biology department (612-625-1234).

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 meetings. Club members meet informally every other week; undergraduates interested in neuroscience are encouraged to participate. For additional information, call Kris Betsin (612-626-1458) or visit the club Web site at www.neurosci.umn.edu/club.html.

Pre-Dental Club—Students learn about preparing to become a dentist, the practice of dentistry, opportunities at the University and the American Student Dental Association, and meet other students with common interests.
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. CBS 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 and learning about other cultures. 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, contact the Learning Abroad Center at 612-626-9000 or visit the Web site at www.UMabroad.umn.edu.

Graduation Requirements

To earn a B.S. degree from CBS, students must meet the following requirements:

• Be admitted to a CBS degree program or major and complete all campus, college and program requirements with a minimum GPA of 2.00 in the major and a cumulative GPA of 2.00 or higher in all University coursework.

• Complete at least 120 credits; grades of C- or better are required in the math, chemistry, physics, or biological sciences courses used to meet requirements for the major.

• S grades are not allowed in major courses unless the course is only offered S-N.

• Have at least 30 semester credits from the University, including 24 credits after admission to CBS.

• Earn at least 15 of their last 30 credits from courses offered by the University.

Students must apply for graduation by submitting a completed Application for Degree to the Office of the Registrar. CBS students may apply to clear for graduation after fall, spring, May, or summer session. There is no fee to apply for the degree, and students need to apply for graduation only once. Students are strongly encouraged to apply a few semesters in advance of the desired semester of graduation. Procedures and forms for submitting applications for degree can be found at http://onestop.umn.edu/registrar/Graduating/info.html.

Research and Teaching Facilities

CBS has faculty and facilities on both the Minneapolis and St. Paul campuses, each with new buildings that provide state-of-the-art teaching and research facilities.

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.

Biological Sciences Greenhouse—Located 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 Biological Station and Laboratories—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 www.cbs.umn.edu/itasca.

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 (612-625-5740), or visit the Web site at www.iter.umn.edu.

General Biology Program—Located in 3-104 Molecular Cellular Biology on the Minneapolis campus, this program administers introductory 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.cbs.umn.edu or call 612-625-2532 for more information.

CBS houses the Jane Goodall Institute for Primate Behavior—a National Science Foundation, long-term ecological research site at Cedar Creek National History Area—and the BioTechnology Institute.

Instructional Computing Centers—Biological sciences have access to a well-equipped Macintosh computer facility in 58 Biological Sciences Center, Windows facilities in 170 Écologie Building, 406 Biological Sciences Center, and 2-585 Moos Tower. Priority in the computer centers is given to undergraduate classes and undergraduate students working on course-related materials.

Cargill Building for Microbial and Plant Genomics—This facility houses more than 22 principal investigators and 175 supporting researchers. Research focuses on using microorganisms to clean up the environment; making agricultural plants more resistant to disease, pests, and climate; and developing new drugs for cancer and other life-threatening diseases.

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 (612-624-4981).
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 612-624-8411 or visit the Web site at www.ihg.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 612-624-6714 or visit the Web site at www.discoverchimpanzees.org.

Molecular and Cellular Biology Building—This new building opened its doors in September 2002 and offers state-of-the-art research and instructional labs and a collaborative environment for researchers and students. General biology labs are housed on the second floor of this building. Comfortable lounge spaces with wireless Internet access are available on the third and fourth floors.

Plant Molecular Genetics Institute—The Institute fosters research and education in molecular biology and genetics of economically important plants and relevant model plant systems. 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 technologically advanced 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, visit the Web site at http://biosci.cbs.umn.edu/bti or call 612-624-6774.

BIODALE—Biodale is a consortium of University of Minnesota service centers offering state-of-the-art instrumentation and user-friendly, walk-in service and training. Biodale is located in the lower levels of Snyder Hall and Gortner Laboratory on the St. Paul campus. Biodale’s research services cover the following:

The Advanced Genetic Analysis Center—The center provides automated DNA sequence analysis, sequence data management, Genescan fragment analysis, oligonucleotide synthesis RNA analysis, and MicroArray spotting and scanning. For more information, call 612-625-7736 or see the Web site at www.umn.edu/agac.

Bioinformatics and Research Computing Facility—Bioinformatics is the science of analysis and comparison of genetic sequence and genome information. The high-speed networks available at this facility help users analyze what they have sequenced. For more information, call 612-624-3993 or visit the Web site at http://ccgb.umn.edu/support/facility.

Mass Spectrometry Consortium for the Life Sciences—In addition to the traditional areas of organic mass spectrometry, the facility has added state-of-the-art instruments with MALDI and electrospray ionization on ion-trap, time-of-flight and hybrid mass spectrometers. The emphasis is on the study of molecules of biological origin, particularly in the emerging field of proteomics. The facility is available to all University biologists as well as outside researchers. For more information, visit the Web site at www.cbs.umn.edu/mass_spec or call 612-624-7715.

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 612-625-5782.

Imaging Center—A state-of-the-art facility for imaging of biological specimens using light and electron optical methods with expertise centered on live cell imaging as well as a large format capacity printer. 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.
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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 focus their studies on the biosynthesis, metabolism, function, and regulation of these molecules of life. This information is essential to gain an understanding of many biological processes, including how diseases like cancer and diabetes develop, and how genetic engineering and biotechnology can be used in ways that benefit society.

Earning a B.S. in biochemistry prepares students for graduate study in biochemistry or other biological sciences, professional training programs in the health sciences, careers in teaching, and entry-level scientist positions in industry, agencies, and universities.

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 mentor to begin planning the research component of their major.

Degree Requirements

Students must complete 120 credits, including at least 70 credits in the major. Requirements include coursework in biology, chemistry, physics, and mathematics.

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 1002W—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 3005W; Biol 3007; Biol/VPB 2032 or 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: Function and Biol 3005W—Plant Function Laboratory
  - Biol 3007—Plant Biology: Diversity and Adaptation
  - 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**
- 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
Biology

B.S.

Biology majors gain a broad understanding of the fundamental nature and characteristics of living things and the ways in which they interact. Their studies cover 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 graduate study in a broad spectrum of biological sciences, for professional training programs in the health sciences, careers in teaching, and entry-level scientist positions in industry, government agencies, and universities.

Degree Requirements

Students must complete at least 120 credits, including at least 69 credits in the major. Requirements include 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-.

- 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
      - Choose one organismal biology course or course pair from the following list:
        - Biol 2012 or Biol 3211 and Biol 2005
        - Biol 2022 or Biol 3007 or Biol 3002 and Biol 3005W
        - Biol/VPB 2032 or MicB 3301
  - **Sequence B**
    - Biol 1009—General Biology
      - Choose two organismal biology courses or course pairs from the following list:
        - Biol 2012 or Biol 3211 and Biol 2005
        - Biol 2022 or Biol 3007 or Biol 3002 and Biol 3005W
        - Biol/VPB 2032 or MicB 3301
  - **Biology Core—Complete each of the following:**
    - BioC 3021—Biochemistry
    - 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.
    - 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 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

*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 taken A-F with a grade of C- or better.

Required Courses

- Biol 1001 or Biol 1009
- Chem 1021

12 credits of biological sciences, with at least 3 credits at 3xxx or above.

All courses for the minor must have a CBS designator (Biol, BioC, GCD, EEB, MicB, NSci, PBio) or be cross listed with CBS designators.

The minor must be declared and approved prior to application for degree.

Ecology, Evolution, and Behavior

Department of Ecology, Evolution, and Behavior

B.S.

Students majoring in ecology, evolution, and behavior (EEB) focus on three related areas of biology. 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.

A B.S. degree in EEB prepares students for graduate study in integrative biology and related biological sciences, careers in teaching, and entry-level scientist positions in industry, government agencies, non-profit organizations, and universities.

Degree Requirements

Students must complete at least 120 credits, including at least 73 credits in the major. Requirements include coursework in biology, math, physics, and chemistry.

Required Courses

Complete requirements in the categories of general and organismal biology, biology core, 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-. 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 1002W—Introductory Biology II: Molecular, Cellular and Developmental Perspectives

Choose at least two organismal courses or course pairs representing two kingdoms (animal, plant or microorganismal)
Animal: Biol 2012 or Biol 3211 and 2005
Plant: Biol 2022 or Biol 3007 or Biol 3002 and 3005W
Microorganismal: Biol/VPB 2032 or MicB 3301

**Sequence B**
Biol 1009—General Biology

Choose three organismal courses or course pairs representing three kingdoms (animal, plant or microorganismal)
Animal: Biol 2012 or Biol 3211 and 2005
Plant: Biol 2022 or Biol 3007 or Biol 3002 and 3005W
Microorganismal: Biol/VPB 2032 or MicB 3301

**Biology Core—Complete each of the following:**
- At least two courses from Biol 3407, Biol 3409, Biol 3411
- Biol 3021—Biochemistry
- Biol 4003—Genetics

**Electives in the Major**
13 additional 3xxx-5xxx upper division credits in the biological and physical sciences, including:
- A biology field or lab experience. This can be satisfied with 4 credits of coursework involving extensive field experience taken at the Itasca Biological Station and Laboratories or 4 credits of directed research (EEB 4994/4998W) or an approved substitution, such as an internship or study abroad experience involving data analysis. Substitutions must be arranged in advance.
- At least 7 credits of EEB coursework, which may not be used to satisfy other major requirements, chosen from EEB 3963/5963, 4014W, 4016W, 4129, 4134, 4239, 4601, 4605, 4609W, 4611, 4814, 4839, 4842, 4844, 4793W, 4993, 4794W, 4994, 5008, 5009, 5011, 5013, 5033, 5053, 5122W, 5146, 5221, 5321, 5326, 5327, 5371, 5609, 5961, ENB 3005
- Biol 3407, 3409 and 3411 credits may be used in this area if not used to meet Biology Core requirements (above).

**Required Courses From Other Programs**
- Math 1271-1272—Calculus I-II
- or Math 1281-1282—Calculus With Biological Emphasis I-II
- Stat 3021—Introduction to Probability and Statistics
- or Stat 3011—Introduction to Statistical Analysis
- Chem 1021-1022—Chemical Principles I-II
- Chem 2301—Organic Chemistry I and one of the following:
  - Chem 2302—Organic Chemistry II
  - or EEB 4611—Biogeochemical Processes
- Phys 1201-1202—Introductory Physics for Biology and Pre-medicine I-II
- or Phys 1301-1302—Introductory Physics for Science and Engineering I-II

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**Genetics, Cell Biology, and Development**

**Department of Genetics, Cell Biology, and Development**

**B.S.**

Genetics, cell biology, and development (GCD) majors focus their studies on the mechanisms by which genetic information is used to specify cell structure and function, and how that information drives cellular interactions that convert a single cell to develop into a complete organism. GCD majors learn about advances in the field by studying model organisms like plants, fruit flies, zebrafish, and mice.

A B.S. degree in GCD prepares students for graduate study in molecular biology or related biological sciences, for professional training programs in health sciences, careers in teaching, and entry-level positions in industry, government agencies, and universities.

**Degree Requirements**

Students must complete at least 120 credits, including at least 77 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, biology core, 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 1002W—Introductory Biology II: Molecular, Cellular, and Developmental Perspectives

**Sequence B**
Biol 1009—General Biology

**Electives in the Major**

Complete each of the following:
- 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, Biol 3411

**Electives in the Major**

Complete each of the following:

- At least one course in developmental biology—GCD 4151*, GCD 4161, or PBio 5514*
- At least one course in molecular biology or related biological sciences, for professional training programs in health sciences, careers in teaching, and entry-level positions in industry, government agencies, and universities.
Two laboratory courses from the following: BioC 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 4794W) in one lab or on one project to use for a lab requirement. A maximum of 7 credits of GCD 4794W/4994 may be applied toward the 18-credit total.

*GCD 4151 and PBio 5314 can be used in only one elective area.

**Required Courses From Other Programs**

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<tr>
<th>Course Code</th>
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<td>Math 1271-1272 or 1281-1282</td>
<td>Calculus I-II</td>
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<td>Organic Laboratory</td>
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<tr>
<td>Phys 1201W-1202W</td>
<td>Introductory Physics for Biology and Pre-Medicine I-II</td>
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<tr>
<td>or Phys 1301W-1302W</td>
<td>Introductory Physics for Science and Engineering I-II</td>
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**Microbiology**

**Department of Microbiology**

**B.S.**

Microbiologists study the structure, function, and interaction of microbes, which 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 microbiology and related fields, and serves as preparation for a variety of careers in the health sciences. Microbiologists find employment government, industrial, and pharmaceutical fields.

**Degree Requirements**

Students must complete at least 120 credits, including at least 71 credits in the major. Requirements include coursework in biology, chemistry, physics, and mathematics.

**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.

**Sequence A** (preferred)

- Biol 1001—Introductory Biology I: Evolutionary and Ecological Perspectives
- Biol 1002W—Introductory Biology II: Molecular, Cellular, and Developmental Perspectives
- Biology Core—Complete each of the following:
  - Biochemistry course: BioC 3021 or BioC 4331
  - Genetics course: Biol 4003
  - Microbiology course: MicB 3301—Biological Microorganisms
- Electives in the Major
  - Choose four courses from MicB 4111, MicB 4121, MicB 4131, MicB 4141W/ MicB 4171, MicB 4151, MicB 5352
- Advanced laboratory courses—Choose option a or b:
  - a. MicB 4215—Advanced Laboratory: Microbial Physiology and Diversity and MicB 4235—Advanced Laboratory: Virology, Immunology, and Microbial Genetics
  - b. MicB 4215 or MicB 4235 plus 6 credits of MicB 4794W/4994—Directed Research, completed in one lab

**Sequence B**

- Biol 1009—General Biology
- Choose one of the following course pairs: Biol 2012 or Biol 3211 and Biol 2005; Biol 2002 or Biol 3007 or Biol 3002 and Biol 3005W.

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

- Biochemistry course: BioC 3021 or Biol 4331
- Genetics course: Biol 4003
- Microbiology course: MicB 3301—Biological Microorganisms

**Electives in the Major**

- Choose four courses from MicB 4111, MicB 4121, MicB 4131, MicB 4141W/ MicB 4171, MicB 4151, MicB 5352
- Advanced laboratory courses—Choose option a or b:
  - a. MicB 4215—Advanced Laboratory: Microbial Physiology and Diversity and MicB 4235—Advanced Laboratory: Virology, Immunology, and Microbial Genetics
  - b. MicB 4215 or MicB 4235 plus 6 credits of MicB 4794W/4994—Directed Research, completed in one lab

**Required Courses From Other Programs**

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<td>Phys 1201W-1202W</td>
<td>Introductory Physics for Biology and Pre-Medicine I-II</td>
</tr>
<tr>
<td>or Phys 1301W-1302W</td>
<td>Introductory Physics for Science and Engineering I-II</td>
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**Neuroscience**

**Department of Neuroscience**

**B.S.**

Neuroscience majors study the molecular and cellular building blocks that make up the brain and control its function. The study of neuroscience aims to understand how complex animals—including humans—see, hear, move, think, and feel. Neuroscientists also study abnormalities that cause diseases and mechanisms that underlie pain and addiction.

A B.S. in neuroscience prepares undergraduates to pursue advanced studies in neuroscience or related health careers; a professional degree in medicine or psychology; or careers in the pharmaceutical, medical, and biotechnology industries.

**Degree Requirements**

Students must complete at least 120 credits, including at least 81 credits in the major. Requirements 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.

**Award-winning teachers and advisers are a tradition in CBS.**

The college currently has 12 Morse-Alumni award winners, recognized for their outstanding contributions to undergraduate education; and six John Tate Undergraduate Advising Award winners.

**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
- Biology Core—Complete each of the following:
  - Biochemistry course: BioC 3021 or BioC 4331
  - Genetics course: Biol 4003
  - Microbiology course: MicB 3301—Biological Microorganisms
- Electives in the Major
  - Choose four courses from MicB 4111, MicB 4121, MicB 4131, MicB 4141W/ MicB 4171, MicB 4151, MicB 5352
- Advanced laboratory courses—Choose option a or b:
  - a. MicB 4215—Advanced Laboratory: Microbial Physiology and Diversity and MicB 4235—Advanced Laboratory: Virology, Immunology, and Microbial Genetics
  - b. MicB 4215 or MicB 4235 plus 6 credits of MicB 4794W/4994—Directed Research, completed in one lab

**Sequence B**

- Biol 1009—General Biology
- Biol 3211—Animal Physiology
  - and Biol 3051—Human Physiology
  - and Biol 2005—Animal Diversity Laboratory
  - or Biol 2012—Zoology
- Biology Core—Complete each of the following:
  - Biochemistry course: BioC 3021 or BioC 4331
  - Genetics course: Biol 4003
  - Microbiology course: MicB 3301—Biological Microorganisms
- Electives in the Major
  - Choose four courses from MicB 4111, MicB 4121, MicB 4131, MicB 4141W/ MicB 4171, MicB 4151, MicB 5352
- Advanced laboratory courses—Choose option a or b:
  - a. MicB 4215—Advanced Laboratory: Microbial Physiology and Diversity and MicB 4235—Advanced Laboratory: Virology, Immunology, and Microbial Genetics
  - b. MicB 4215 or MicB 4235 plus 6 credits of MicB 4794W/4994—Directed Research, completed in one lab

**Required Courses From Other Programs**

Math 1271-1272 or 1281-1282—Calculus I-II
Chem 1021-1022—Chemical Principles I-II
Phys 1201W-1202W—Introductory Physics for Biology and Pre-Medicine I-II
or Phys 1301W-1302W—Introductory Physics for Science and Engineering I-II
Biology Core

Complete each of the following:
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:
NSci 3101—Introduction to Neuroscience I: From Molecules to Madness
NSci 3102W—Introduction to Neuroscience II: Biological Basis of Behavior
NSci 4105-4115—Neurobiology Laboratory I-II
At least 2 credits of NSci 4794W/4994—Directed Research and/or NSci 4167—Neuroscience in the Community

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 5521—Evolution of Social Behavior
EEB 5327—Behavioral Ecology
NSc 5202—Theoretical Neuroscience: Systems and Information Processing
NSc 5462—Neuroscience of Drug Abuse
NSc 5661—Behavioral Neuroscience
NSci 5201—Computational Neuroscience: Membranes and Channels
NSci 5561—Systems 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—Introductory Physics for Biology and Pre-Medicine I-II
or Phys 1301W-1302W—Introductory Physics for Science and Engineering I-II

Plant Biology

Department of Plant Biology

B.S.

Plant biologists study all aspects of biology as they pertain to plants or fungi. 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 genomics, 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 environmental biology, evolution, or other aspects of whole organisms, while the other track is appropriate for students interested in molecular, cellular, and development biology. All plant biology majors are guaranteed experience (for pay or credit) in a research laboratory as long as they show satisfactory progress toward their degree and make arrangements by the middle of their junior year.

Degree Requirements

Students must complete at least 120 credits, including at least 66 credits in the major. Requirements include 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-. All courses in the major must be taken A-F unless the course is only offered S-N.

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 3007 or Biol 3002 and 3005W

Sequence B
Biol 1009—General Biology
Choose two organismal courses or course pairs from the following: Biol 3007 or Biol 3002 and 3005W (both recommended); Biol 2012; Biol 3211 and Biol 2005; Biol/VPB 2032; or MicB 3301

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

Biology Core

BioC 3021—Biochemistry
Biol 3407—Ecology
or Biol 3409—Evolution
Biol 4003—Genetics
or Biol 4004—Cell Biology
Laboratory or Fieldwork

Choose two courses or course pairs from the following:

- MicB 3301; BioC 4025; BioC 4125; BioC 4794W/4994; EEB 4014W; EEB 4016W; EEB 4605; EEB 4607; EEB 4794W/4994; EEB 4842; EEB 5013; GCD 4015; GCD 4025; GCD 4794W/4994; Misc 4215; Misc 4235; Misc 4794W/4994; NSci 4794W/4994; PBio 4321; PBio 4404; PBio 4511; PBio 5416; PBio 4794W/4994; or any 38xx or 48xx CBS plant or algal biology 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 a minimum of 11 credits from Groups A-C with at least one course from Group A and one course from Group B. Other appropriate courses may be substituted by petition.

Group A—Integrative and Organismal Biology

- EEB 4014W—Ecology of Vegetation
- EEB 4814—Plant Community Ecology
- EEB 4842—Arctic Field Biology
- EEB 5009—Quaternary Vegetation History and Climate
- EEB 5122W—Plant Interactions with Animals and Microbes
- PBio 4321—Taxonomy of Minnesota Flora
- PBio 4404—Developmental Plant Anatomy
- PBio 4511—Flowering Plant Diversity
- PBio 5416—Plant Morphology, Development and Evolution

Group B—Cellular and Subcellular Biology

- BioC 5401W—Advanced Metabolism and its Regulation
- PBio 4516W—Plant Cell Biology: Writing Intensive
- PBio 5301—Plant Genomics
- PBio 5412—Plant Physiology
- PBio 5514—Plant Molecular Biology
- PBio 5516—Plant Cell Biology

Group C—Statistics, Mathematics, Computer Science, and Physical Science

- Stat 3011—Introduction to Statistics
- Stat 3021—Introduction to Probability and Statistics

or other statistics, math, computer science, or physical science courses chosen in consultation with the faculty mentor

Required Courses From Other Programs

BioC 4025—Laboratory in Biochemistry

or

Chem 2311—Organic Lab

Chem 1021-1022—Chemical Principles I-II

Chem 2301-2302—Organic Chemistry I-II

Math 1271-1272 or 1281-1282—Calculus I-II

Phys 1201W-1202W—Introductory Physics for Biology and Pre-Medicine I-II

or

Phys 1301W-1302W—Introductory Physics for Science and Engineering I-II

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

Plant Biology Minor

The plant biology minor is available to CBS students pursuing one of the other department majors. It is also available to non-CBS students. Students must complete a minimum of 10 credits from the courses listed below.

- Biol 3002, 3005W, 3007
- PBio 4321, 4404, 4511, 4516W, 4801, 4811, 5301, 5412, 5416, 5514, 5516

Students must take the courses A-F and earn at least a C- in all credits counted toward the minor. Courses may count toward the electives required to complete a major in another program, but must be taken in addition to the core requirements for the student’s major.

To declare a minor in plant biology, call the director of undergraduate studies for plant biology at 612-624-3499.