



# *Medical Technology*

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# Medical Technology

## General Information

The medical technology program (also called clinical laboratory science) was established at the University of Minnesota in 1922 to prepare men and women for professional work in laboratory science and advanced study. This program provides a strong foundation in the sciences together with rich experiences in the clinical laboratory. Approximately 20 percent of medical technology graduates go on to complete an advanced degree.

Clinical laboratory scientists (medical technologists) perform many and varied laboratory analyses and use critical thinking in determining the correctness of test results. They recognize the interdependency of testing information and have knowledge of physiologic and pathologic conditions affecting results in order to validate them. In many health care settings, they provide data used by physicians in determining the presence, extent, and, as far as possible, causes of disease.

Clinical laboratory scientists/medical technologists

- develop and establish procedures for collecting, processing, and analyzing biological specimens and other substances;
- perform analytical tests of body fluids, blood, serum, plasma, cells, and other substances.
- integrate and relate data generated by various clinical laboratories while making decisions regarding possible discrepancies.
- confirm abnormal results, verify and execute quality control procedures, and solve problems concerning the generation of laboratory data to maintain accuracy and precision.
- establish and perform preventive and corrective maintenance of equipment and instruments as well as identify appropriate sources for repairs.
- develop, evaluate, and select new techniques, instruments, and methods in terms of their usefulness and practicality within the context of a given laboratory's personnel, equipment, space, and budgetary resources.
- demonstrate professional conduct through interpersonal skills with patients, laboratory personnel, other health care professionals, and the public.
- participate in continuing education for growth and maintenance of professional competence.
- provide leadership in educating other health personnel and the community.
- exercise principles of management, safety, and supervision.
- apply principles of educational methodologies.

*Source: National Accrediting Agency for Clinical Laboratory Sciences, Chicago, Illinois, 1995.*

Tests and procedures are performed or supervised by laboratory technologists in hematology, coagulation, microbiology, immunohematology, immunology, clinical chemistry, and urinalysis. Subspecialty areas in which laboratory personnel work include such fields as molecular diagnostics, cytogenetics, fertility testing, flow cytometry, tissue typing, bone and skin banks, forensics, and infection control.

As complexities of clinical laboratories increase, many medical technologists specialize in immunohematology, hematology, microbiology, chemistry, immunology, virology, coagulation, administration, computer science, education, quality assurance,

and other areas. There are opportunities for graduates to work in hospital laboratories, clinics, physician offices, public health agencies, research, and industry.

As a general rule, a student who has excelled in scientific subjects in high school will succeed in medical technology.

The program is fully accredited by the National Accrediting Agency for Clinical Laboratory Sciences, 8410 West Bryn Mawr, Suite 670, Chicago, IL 60631 (773-714-8880; e-mail [INFO@naacls.org](mailto:INFO@naacls.org)).

### Mission Statement

The mission of the Division of Medical Technology is to be a leader in educating clinical laboratory science professionals. In accordance with the University of Minnesota's mission, the division strives to do this in an environment that embodies the values of academic freedom, responsibility, integrity, and cooperation; that provides an atmosphere of mutual respect, free from racism, sexism, and other forms of prejudice and intolerance; that assists individuals, institutions, and communities in responding to a continuously changing world; that is conscious of and responsive to the needs of the many communities it is committed to serving; that creates and supports partnerships within the University, with other educational programs, and with communities to achieve common goals; and that inspires, sets high expectations for, and empowers the individuals within the community.

The division pursues this mission through teaching, research, and actively working with the health care community to assist in meeting the clinical laboratory needs of the state of Minnesota. Specifically, the division

- educates students to be clinical laboratory professionals who have the knowledge, skills, and values to provide competent and ethical practice in clinical laboratory science;
- develops new knowledge about the practice of clinical laboratory sciences;
- helps communities and other professionals develop an awareness and understanding of the role of the clinical laboratory professional and the work they perform;
- collaborates with other professionals within the health care community to assess the changing needs of the clinical laboratory, design solutions to meet the challenges, and monitor the quality of laboratory practice; and
- provides continuing education opportunities to practicing clinical laboratory professionals.

### Facilities

Health sciences facilities are in a complex of buildings on the East Bank of the Minneapolis campus, including the Mayo Memorial Building, Malcolm Moos Health Sciences Tower, Weaver-Densford Hall, and the Phillips-Wangensteen Building. Close to or connected with the complex are Fairview-University Medical Center, Dwan Variety Club Cardiovascular Research Center, Veterans of Foreign Wars Cancer Research Center, and Children's Rehabilitation Center. Extensive resources and services of the Bio-Medical Library, including the Learning Resources Center, are housed in Diehl Hall.

These facilities provide learning, research, and internship sites for many students. They are excellent research centers, not only for studying diseases, healthy physiological processes, and environmental health, but also for developing new procedures and delivering expert health care. The proximity of the Academic Health Center units to each other and to the rest of the campus facilitates interdepartmental communication and underscores the interdisciplinary nature of health care. The Academic Health Center units also maintain affiliations with many hospitals and health care facilities around the Twin Cities and greater Minnesota, which afford students access to a wide spectrum of health care situations.

Clinical experiences for University of Minnesota medical technology students are available at the Veterans Affairs Medical Center, Allina Laboratories, and Fairview Health Services; Mayo Clinic (Rochester); the North Central Blood Services of St. Paul, Regions Hospital (St. Paul), and HealthEast Hospitals (St. Paul and Maplewood), Park Nicollet Health Services (St. Louis Park), St. Cloud Hospital (St. Cloud), and Immanuel–St. Joseph’s Hospital (Mankato).

## Admission

The Division of Medical Technology sets its own standards and requirements for admission. These include a strong background in the natural sciences (specifically biology, chemistry, and physiology), as well as in the social and behavioral sciences. The Division recommends that applicants be genuinely interested in human services and sincerely committed to promoting the public’s health and general welfare. Students generally enter the program at the beginning of their junior year.

### Application Process

The medical technology curriculum consists of the preprofessional program at the University of Minnesota or its equivalent at another regionally accredited institution and the professional program in the Division of Medical Technology, which is part of the Academic Health Center.

**Admission to the Preprofessional Program**—Students who apply to enroll in a preprofessional program must meet the admission criteria and follow academic regulations of that college. The preprofessional program is pursued during the first two years of college.

The medical technology sequence is based on entrance to the professional program in the fall semester of year three or four, depending on completion of prerequisites. Admission to year three of the curriculum sequence is preferred.

Admission to the preprofessional program at the University of Minnesota does not assure admission to the professional program.

**Admission to the Professional Program**—For admission to the Division of Medical Technology, a student must have completed 60 semester credits, including required courses. The major criterion for admission is satisfactory academic performance as judged by the student’s grade point average (GPA) in prerequisite science courses and cumulative GPA. Students are admitted once each year for the fall semester. Admission to the professional program is competitive because of the limited number of students who can be accommodated in the teaching and clinical facilities.

Students in residence at the University of Minnesota who expect to complete the requirements for admission to the professional program must file an *Application for Undergraduate Change of College* form with the One Stop Student Services Center, 200 Fraser Hall, by March 1. (Priority deadline is March 1. Applications are accepted until the class is full.) Students with sufficient credits but have course deficiencies should consult the Division of Medical Technology adviser regarding their status.

Students from other regionally accredited colleges and universities may transfer to the University of Minnesota to complete the medical technology program. Courses completed that are equivalent to those offered at the University of Minnesota are accepted to satisfy the requirements for admission to the Division of Medical Technology. Students who have a baccalaureate degree in a science curriculum and have completed required courses may finish the program in 15 months, as space is available in affiliated laboratories. Students transferring from other colleges may obtain an *Application for Admission* by requesting a form from the following e-mail address: [admissions@tc.umn.edu](mailto:admissions@tc.umn.edu) or from the Office of Admissions, 240 Williamson Hall, 231 Pillsbury Drive S.E., Minneapolis, MN 55455-0213 (612-625-2008 or 800-752-1000). Refer to the admissions Web site <http://admissions.tc.umn.edu> for other information or an online application. Applications must be filed with the Office of Admissions by March 1. It is strongly advised that transfer students ascertain their status by writing to the Adviser, Division of Medical Technology, University of Minnesota, MMC 609, 420 Delaware Street S.E., Minneapolis, MN 55455, so that, if necessary, they may complete required courses during the summer.

**English Proficiency**—If students are not native speakers of English, they must take the Test of English as a Foreign Language (TOEFL) or the Michigan English Language Assessment Battery (MELAB). To register for the TOEFL, students should contact the agency that handles TOEFL registration in their country or write to the Educational Testing Service (Box 6151, Princeton, NJ 08541, USA) at least 10 weeks before any scheduled test date. If students are already in the Twin Cities area, they may register for the MELAB with the Minnesota English Center, University of Minnesota, 315 Nolte Center for Continuing Education, Minneapolis, MN 55455, or call 612-624-4548. To register for the MELAB outside the Twin Cities area, contact the English Language Institute, Testing and Certification Division, University of Michigan, Ann Arbor, MI 48109, USA, or call 734-764-2416. The minimum scores required are 572 for the TOEFL (230 on the computer-based exam) or 84 for the MELAB.

Those who have completed two years of instruction at a college or university where English is the language of instruction may have the English requirement waived.

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*The medical technology program holds the only two endowed professorships in medical technology in the United States.*

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## Degrees

**Bachelor of Science**—The Division of Medical Technology offers the bachelor of science (B.S.) degree.

**Bachelor of Applied Science**—The College of Continuing Education offers the bachelor of applied science (B.A.S.) degree in clinical laboratory science through the Division of Medical Technology for students with MLT/CLT certification from a MNSCU program.

**Master of Science**—Graduate work in clinical laboratory science is available for qualified candidates who wish to prepare for a career of research, teaching, or work in industry. The master of science (M.S.) program in clinical laboratory science is offered by the Graduate School. The program is offered only under Plan A (master’s degree with thesis). Each student must complete a thesis involving independent research in one of the subareas of this field under the direction of an adviser.

Extended Career Paths in Medical Technology			
Hospital/Medical Center: Laboratory Areas		Health Care Administration	Health Care Agency/Government
Acute care Andrology/Fertility testing Blood bank Bone marrow Cell markers Chemistry Coagulation Computer science Components - Transfusion service Cytogenetics Cytodiagnostic urinalysis Cytology/Histology Development laboratory Drug analysis (toxicology) Endocrinology Flow cytometry Forensic science Genetics Hematology Immunology Immunopathology Immunophenotyping Infection control Laboratory supervisor or administrator	Microbiology Molecular diagnostics Mycology Nuclear medicine Out patient or clinic laboratory Parasitology Pathology - Surgical, autopsies Phlebotomy/Specimen processing Platelet studies Photography/Illustration (e.g., in forensic medicine) Quality assurance Serology Skin or bone bank Special stains STAT (emergency) laboratory Tissue typing Transfusion technical specialty Transplant services Urinalysis Virology	Clinic manager/administrator Coder-Abstractor (business or medical records office) Consultant service specialist Personnel director Emergency medical services coordinator Financial manager/planner Group practice administrator Hazardous waste coordinator Health care administrator Health insurance administrator Health policy analyst Health promotion coordinator Hospital quality assurance coordinator Infection control officer Epidemiologist Laboratory supervisor Laboratory director Laboratory utilization review coordinator Long-term care administrator Mental health administrator Purchaser (laboratory/hospital/medical center) Staffing coordinator (laboratory or home care)	Administrator for Veterans Affairs hospital Biometrist Crime laboratory scientist Department of Health - Educator Department of Health - Proficiency test consultant Employee recruiter/Placement officer Environmental health specialist (inspector) Environmental pathology technologist Fraud investigator Health Management Organization - Health educator JCAHO Survey team member/CAP inspector Medical examiner investigator (e.g., for coroner) Military service - Armed Forces, ROTC, National Guard NASA mission specialist Patient educator Private investigator FBI/Special agent (forensic lab)
<b>Management Information System</b>	<b>Research - Basic and Applied</b>	<b>Industry (U.S. or International)</b>	
Biometrician Director - Division of Biometry Hospital Information Systems - Team leader Installer/Educator Programmer Systems analyst	Associate scientist/Scientist Clinical trial coordinator Director of research Research analyst Research assistant	Adviser to or inventor of "home" or other lab tests Biomedical specialist - Occupational health Cell culture consultant Clinical trial coordinator Compliance coordinator Computer consultant Director of marketing Documentation supervisor Editor/manager - Medical publications Food technologist - Quality assurance manager Health care reimbursement coordinator Health promotion and education specialist Industrial hygiene specialist Installation specialist	Insurance underwriter Manager-Health claims administration Medical claims reviewer/Auditor/Insurance processor Medical consultant (TV/Movie industry) Medical fee analyst - Insurance Owner/Director of employee placement service Product specialist Quality control/Quality assurance monitor/Director Research and development technologist or director Research scientist Risk management representative - Insurance Salesperson Technical representative
<b>Other Professional Routes</b>		<b>Education</b>	<b>Humanitarian Work</b>
Accounting Consultant to physician office laboratories Dentistry Health radiation science Laboratory scientist Law (e.g., patent attorney) Legislature - Politician, lobbyist, regulations writer	Medical Physics/Engineering Medicine Optometry Public health Reference/Independent/Commercial laboratory scientist Veterinary medicine	Academician Allied health dean/Health sciences administrator Education coordinator or program director Educator of students in clinical settings Faculty member in CLS/CLT/Cyto/SBB program Higher education administrator Instructor in veterinary medicine or other allied health program Medical community services program coordinator	Medical missionary work Peace Corps Project HOPE, others

Admission requirements include a bachelor's degree from an accredited institution of higher learning with sufficient scholarly attainment in medical technology or chemistry and the biological sciences to justify graduate work in these areas.

For more information, see the *Graduate School Catalog* or contact the Clinical Laboratory Science Graduate Program Coordinator, MMC 609, 420 Delaware Street S.E., Minneapolis, MN 55455 (612-625-8952).

## Policies

**Immunizations**—Upon enrollment into the medical technology program, students are required to submit proof of the following immunizations and vaccinations:

- Measles/mumps/rubella documentation or positive titre
- Two- step tuberculosis skin test (Mantoux)
- Hepatitis B series or documented immunity
- Past DTP or diphtheria/tetanus within the last 10 years
- Varicella Zoster (chicken pox) positive history or two doses of vaccine

See the medical technology Web site <http://medtech.umn.edu> for the specific policy and form.

**Health Insurance Coverage**—Medical technology students are expected to carry health insurance to cover emergency medical situations. The student insurance policy is recommended because of its scope of coverage. Other personal, spousal, or parental policies that are equivalent to the student policy are acceptable. Students should carry their insurance information at all times on clinical and community educational rotations.

**Background Check**—Medical technology students are placed in a variety of clinical settings during their clinical coursework. In accord with Minnesota law, a criminal background check is required of each student before clinical courses. The Division of Medical Technology arranges this check.

**Satisfactory Academic Progress**—Students in the professional program are subject to the regulations established by the Division of Medical Technology and must maintain satisfactory academic progress.

Satisfactory performance is considered to be not only a passing level in scientific and technical skills together with theoretical knowledge, but also complete personal integrity and honesty.

Students not achieving satisfactory progress may be placed on scholastic probation upon recommendation of the Student Scholastic Standing Committee (SSSC). This committee is composed of Division of Medical Technology faculty and student representatives, as appropriate.

Students' work is considered unsatisfactory when they earn less than a C- grade average (1.67 grade points for each credit) for any course in a given year or semester. In addition, students must earn a minimum grade of C- in selected courses to enroll in related clinical rotations, and maintain an overall GPA of 2.00 in the professional program.

If students receive an unsatisfactory grade in a course, remedial work in the course may be provided, if possible; if not, students must repeat the course the next time it is offered. If students receive an unsatisfactory grade in more than one course, either concurrently or in different semesters, the matter is referred to the SSSC for investigation and action. If the committee decides students should not continue in the curriculum, students are notified. Unsatisfactory grades in two courses are sufficient basis for dismissal.

## Medical Technology Essential Functions

To successfully complete a clinical laboratory science program, medical technology students must be able to perform the following functions.

**Communication skills**—Must be able to communicate effectively in written and spoken English; comprehend and respond to both formal and colloquial English—person-to-person, by telephone, and in writing; appropriately assess nonverbal as well as verbal communication.

**Locomotion**—Must be able to move freely from one location to another in physical settings, such as the clinical laboratory, patient areas, corridors, and elevators.

**Small motor skills**—Must have sufficient eye-motor coordination to allow delicate manipulations of specimens, instruments, and tools. Must be able to grasp and release small objects (e.g., test tubes, microscope slides); twist and turn dials/knobs (e.g., for a microscope, balance, or spectrophotometer); and manipulate other laboratory materials (e.g., reagents and pipettes) in order to complete tasks.

**Other physical requirements**—Must be able to lift and move objects of at least 20 pounds. Must have a sense of touch and temperature discrimination.

**Visual acuity**—Must be able to identify and distinguish objects macroscopically and microscopically; read charts, graphs, and instrument scales.

**Safety**—Must be able to work safely with potential chemical, radiologic, and biologic hazards and follow prescribed guidelines for working with all potential hazards, including mechanical and electrical.

**Professional skills**—Must be able to follow written and verbal directions; work independently and with others and under time constraints; prioritize requests and work concurrently on at least two different tasks; maintain alertness and concentration during a normal work period.

**Stability**—Must possess the psychological health required for full use of abilities and be able to respond to others in a collegial manner; must be able to recognize emergency situations and take appropriate actions.

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*Initiated in 1922, the medical technology program was the first in the nation to offer a baccalaureate degree.*

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**Affective (valuing) skills**—Must show respect for self and others and project an image of professionalism, including appearance, dress, and confidence; and have complete personal integrity and honesty. Must adhere to appropriate professional manner and conduct.

**Application skills**—Must be able to apply knowledge, skills, and values learned from previous coursework and life experiences to new situations.

## Certification and Placement

Division of Medical Technology graduates are eligible to take national examinations for certification as medical technologists or clinical laboratory scientists. These examinations are conducted by national certifying agencies. Many organizations and institutions require certification for employment.

Program graduates are assisted in finding employment by the Division of Medical Technology adviser. Notices of employment opportunities in the field are received from all parts of the United States and are posted in the medical technology office, 15-170 Phillips-Wangensteen Building.

### Licensure

The licensed medical technologist practices in accordance with the requirements of individual state laws. In some states, a medical technologist must participate in continuing education courses for license renewal. Minnesota does not require a license to practice.

## Advising

The Division of Medical Technology offers centralized advising services to undergraduates currently enrolled or interested in medical technology. In addition, the medical technology adviser works closely with the College of Liberal Arts natural science advisers. For more information, contact the medical technology office, 15-170 Phillips-Wangensteen Building (612-625-9490).

## Special Learning Opportunities and Resources

**Minority Program**—The Academic Health Center is committed to the recruitment and retention of minority persons who come from groups underrepresented in the health professions. Advising and special courses are offered through the Martin Luther King Program and the following learning resource centers: African

American Learning Resource Center, American Indian Learning Resource Center, Asian/Pacific American Learning Resource Center, and Chicano-Latino Learning Resource Center.

## Scholarships

The Division of Medical Technology offers seven scholarship programs for students in the professional program. Scholarships are provided on the basis of scholastic achievement, need, and professional promise. For more information, contact the medical technology office, 15-170 Phillips-Wangensteen Building (612-625-9490) or visit the Web site <http://medtech.umn.edu>. The scholarship application deadline is April 1.

## Career Paths

The Extended Career Paths in Medical Technology chart on page 218 represents positions taken by University of Minnesota medical technology graduates. It shows the opportunity and versatility of a medical technology (laboratory science) degree for positions not only in hospital laboratories, but also in industry, research, public health, government, information systems, consulting, reference (private) laboratories, education, and other areas.

## Student Organizations

**Council for Health Interdisciplinary Participation**—The Council for Health Interdisciplinary Participation (CHIP) is an interdisciplinary student service organization dedicated to enhancing the quality of life and education of all Academic Health Center students. Activities include noontime lectures, evening workshops, and weekend symposia in areas such as bioethics, international health, alternative health care, and women's issues. CHIP publishes a newsletter featuring announcements of upcoming health sciences events, volunteer opportunities, and articles about topics of current interest to students. CHIP headquarters are located in an informal, comfortable lounge in 1-425 Malcolm Moos Health Sciences Tower. For more information, call 612-625-7100.

**Medical Technology Student Council**—Students in the professional program are represented on the Medical Technology Council by elected members from each class. The council promotes student-faculty relationships, sponsors social and educational activities, and considers matters affecting students in the program.

**Student Membership in Professional Organizations**—Medical technology undergraduates are eligible for student membership in the American Society for Clinical Laboratory Science. Medical technology students are also urged to participate in the activities of the Academic Health Center's Council for Health Interdisciplinary Participation (CHIP) and other University student organizations.

## Campus Contacts

Patricia Solberg, Division of Medical Technology, University of Minnesota, MMC 609, 420 Delaware Street S.E., Minneapolis, MN 55455. Offices at 15-170 Phillips-Wangensteen Building (612-625-9490; e-mail [medtech@umn.edu](mailto:medtech@umn.edu); Web site: <http://medtech.umn.edu>.)



# Medical Technology

## Degree Program

### Medical Technology

#### B.S.

**Admission Requirements**—Prerequisites include in composition, general biology, two mathematics courses (college algebra or calculus or statistics), general inorganic chemistry, physiology, and organic chemistry.

A minimum GPA of 2.50 is preferred for entrance to the program. Fall 2003 entering class average GPA was 3.12 for year three admission. GPAs into for year four are higher.

#### Degree Requirements

The program requires a minimum of 120 credits of which at least 60 credits are prerequisites and liberal education courses (see liberal education Web site at [www.onestop.umn.edu/registrar/libed](http://www.onestop.umn.edu/registrar/libed)). Junior courses include biochemistry, microbiology, and genetics. Senior courses involve two semesters of professional coursework in hematology, coagulation, clinical chemistry and urinalysis, microbiology/mycology/virology/parasitology and immunohematology/immunology/molecular diagnostics. All required and highly recommended courses, e.g., anatomy, pathophysiology, and immunology, must be taken A-F.

**Writing Intensive Courses**—Students must take four writing intensive courses. These courses are in addition to freshman writing as currently required. At least two of the four required writing intensive courses must be taken at 3xxx or above. MedT 4127W—Introduction to Management and Education I is required for the program and serves as one of the upper division writing intensive courses. Course choices can be found at [www.onestop.umn.edu/registrar/libed/writing.html](http://www.onestop.umn.edu/registrar/libed/writing.html).

#### Required Courses

##### *Preprofessional Program*

Biol 1009—General Biology  
Chem 1021-1022—Chemical Principles I-II  
Chem 2301-2302—Organic Chemistry I-II  
EngC 1011—University Writing and Critical Reading  
Phsl 3051—Human Physiology  
Two from Math 1031, 1142, 1155, 1271, 1272, Stat 3011

##### *Professional Program*

#### Year 3

BioC 3021—Biochemistry  
Biol 4003—Genetics  
or GCD 3022—Genetics  
Biol/MicB/VPB 2032—General Microbiology With Laboratory

#### Year 4

MedT 4064—Introduction to Clinical Immunohematology  
MedT 4065—Introduction to Clinical Immunohematology: Laboratory  
MedT 4100—Virology, Mycology, and Parasitology for Medical Technologists  
MedT 4104—Principles of Diagnostic Microbiology: Lecture  
MedT 4105—Principles of Diagnostic Microbiology: Laboratory  
MedT 4127W—Introduction to Management and Education I  
MedT 4251—Hematology I: Basic Techniques  
MedT 4252—Hematology II: Morphology and Correlation  
MedT 4253—Hemostasis

MedT 4310—Clinical Chemistry I: Lecture  
MedT 4311—Clinical Chemistry I: Laboratory Applications  
MedT 4320—Clinical Chemistry II: Lecture  
MedT 4321—Clinical Chemistry II: Laboratory Applications  
MedT 4400—Immunological and Molecular Basis of Laboratory Testing

#### Clinical Courses

MedT 4082—Applied Clinical Chemistry  
MedT 4085—Applied Clinical Hematology  
MedT 4086—Applied Clinical Immunohematology  
MedT 4088—Applied Diagnostic Microbiology  
MedT 4089—Specialty Rotation

#### Electives—Recommended courses

InMd 3001—Human Anatomy  
LaMP 4177—Pathology for Allied Health Students  
MedT 1010—Orientation in Medical Technology (S-N) (for those interested in the field)  
MicB 4131—Immunology  
Phar 1002—Health Sciences Terminology

#### Clinical Rotations

After completing two semesters of professional coursework, students spend 22 weeks in the clinical laboratories of various health care institutions in the Twin Cities and Rochester, Minnesota, including six weeks in clinical chemistry, five weeks in hematology and coagulation, five weeks in immunohematology, five weeks in microbiology, and one week in a specialty laboratory area such as flow cytometry.