School of Applied Science, Engineering, and Technology

Dean: John R. Wright

The School of Applied Science, Engineering, and Technology offers the master of science degree in computer science, the master of science degree in manufacturing systems, and the master of science degree in applied medical sciences. Faculty in the Department of Applied Medical Sciences collaborate with faculty at the University of Maine Graduate School of Biomedical Sciences in offering a Ph.D. degree in biomedical disciplines. Students may elect to take most of their classes at USM and to have a USM faculty member as their primary research advisor.

Master of Science in Applied Medical Sciences

Chair: W. Douglas Thompson
Professors: Ng, Thompson, Wise; *Associate Professors:* Duboise, Pelsue; *Assistant Research Professors:* Meyer, Lichter, Paulu, Xie; *Adjunct Professors:* Ault, Rhodes, Rice; *Adjunct Associate Professors:* Allan, Chandler, Craig, Davidoff, Fletcher, Follansbee, Friesel, Liaw, Lindner, Smith, Vary; *Adjunct Assistant Professor:* Beckett

Program Description

The M.S. program in applied medical sciences is designed to prepare students for careers in basic research, clinical diagnosis, industrial research, and teaching. Graduates of the applied medical science program are competitive for further graduate studies at the doctoral level (Ph.D., M.D., D.O., D.V.M., and D.D.S.) as well as for research positions in biotechnology companies and academic or private research laboratories. The program is an interdisciplinary biomedical graduate program with coursework and research opportunities in diverse disciplines such as: immunology, microbiology, toxicology, virology, cancer biology, epidemiology, and applied biostatistics. The program is a combination of challenging coursework, specialized readings, and research. Students will be given the opportunity to tailor their program of study to specific interests by choosing a concentration in toxicology and cancer biology, immunology and infectious disease, epidemiology, or biotechnology. In addition, students will learn general skills required of all scientists, namely: critical evaluation and presentation of the current scientific literature, reading and writing of technical material, problem solving, experimental design, logic, and ethics.

Admission

Applicants for admission to the M.S. program in applied medical sciences should have a baccalaureate degree from an accredited institution, preferably in biology or chemistry, with a minimum GPA of 3.0. It is highly recommended that the applicant have completed courses in the following subjects: organic chemistry, biochemistry, microbiology, genetics, and cell biology.

The applied medical sciences graduate admissions committee is responsible for evaluating applicants and recommending candidates for admission. Interviews by members of this committee may be required of applicants. Qualified applicants who have deficiencies in background courses that the committee considers essential for success in the program may be conditionally admitted, with full admission dependent on satisfactory completion of recommended courses.

Application Materials

In addition to materials described in the Admissions chapter of this catalog, applicants must submit the following information:

1. *Test scores:* Official scores from the general test of the Graduate Record Examination (GRE) are required. Official scores from the GRE subject test in biology or chemistry are recommended but not required.
2. *Transcripts:* Official undergraduate and graduate transcripts are required from all colleges or universities attended.

3. *Essay:* The essay should discuss your academic and professional goals as well as identify research interests in the applied medical sciences program.

4. *Letters of Recommendation:* Three letters of recommendation are required for all applicants. Each letter must address the applicant's academic and/or professional record and potential for success in a master's graduate program in biomedical science.

Application Deadline

Application and supporting materials must be received by *March 1* for maximum consideration for fall semester admission and consideration for financial support. Applications and supporting materials must be received by *October 15* for spring semester admission. Spring semester applicants are unlikely to obtain financial support in their first semester.

Program Policies

In addition to the general policies described in the Academic Policies chapter, this program also has the following policies:

1. *Transfer Credits:* Students may transfer a maximum of 9 credits earned within the past 5 years with a grade of B- or better. Approval of transfer credits must be requested at the time of application and approval is at the discretion of the applied medical sciences graduate admissions committee.

2. *Time Limit:* All courses for the M.S. degree must be completed within six years from the time of matriculation. Students may apply for an extension through the program coordinator and must be approved by Department faculty.

3. *Grade Policy:* Students must earn a C or better for courses to count towards the M.S. degree. If the cumulative GPA drops below 3.0, the student will be placed on probation; the terms and conditions of the probation will be determined by the student's advisory committee.

Eligibility for Financial Aid During Thesis Completion Stage

To be eligible for federal financial aid (including deferment of student loans), a student must be enrolled in a minimum of 6 graduate credits in the master's degree program. However, a student who has completed coursework and is engaged in finishing his/her thesis will be considered eligible if he/she meets *one* of the following conditions:

- Is enrolled in at least 6 graduate credits

or

- Is enrolled in less than 6 graduate credits, has obtained certification of satisfactory progress from the chair of his/her thesis committee, indicating that the student is actively progressing in the work leading to completion of the master's degree, *and* is registered for GRS 602.

GRS 602 is a 1-credit course that permits students to retain eligibility for financial aid including University-funded fellowships, scholarships, and graduate assistantship, and access to University services, including USM Libraries and Internet.

Program Requirements

Forty credits are required for the M.S. degree in applied medical sciences: 30 credits of coursework (lectures, labs, and readings), 4 credits of Journal Club and Seminar, and 6 credits of thesis or externship research. Students will have to enroll in a specific concentration by the completion of their first year. The four concentrations are: toxicology and cancer biology, immunology and infectious disease, epidemiology, and biotechnology. Each student will be assigned an academic committee that will be responsible for ensuring that the student fulfills all requirements for the program.

All students will be required to take the following core courses (16 credits):

AMS	530	Molecular Biology
AMS	531	Molecular Biology Lab
AMS	535	Introduction to Epidemiologic Research
AMS	545	Applied Biostatistical Analysis
AMS	595	Seminar: Journal Club
AMS	691	Seminar: Advanced Seminar in Biomedical Sciences

In addition students must complete the requirements for their chosen concentration:

A. Toxicology and Cancer Biology Concentration

AMS	590	Introduction to Toxicology I
AMS	591	Introduction to Toxicology II
AMS	698	Thesis

Electives (6 credits to be approved by the advisory committee)
Two of the following:
AMS 674 Neurotoxicology
AMS 675 Developmental Toxicology
AMS 694 Genetic Toxicology
AMS 695 Chemical Carcinogenesis
AMS 696 Metal Toxicology

B. Immunology and Infectious Disease Concentration
AMS 551 Immunology Lab
AMS 552 Immunology
AMS 560 Virology or AMS 565 Molecular Microbiology
AMS 698 Thesis
Electives (6 credits to be approved by the advisory committee)
One of the following:
AMS 692 Advanced Readings in Biomedical Sciences
AMS 693 Advanced Research Techniques in Biomedical Sciences

C. Epidemiology
AMS 578 Epidemiology of Infectious Disease
AMS 579 Epidemiology of Chronic Disease
AMS 677 Regression Models in the Health Sciences
AMS 698 Thesis
Electives (6 credits to be approved by the advisory committee)
One of the following:
AMS 635 Applications of Epidemiology in Public Health Agencies
AMS 636 Environmental Epidemiology
AMS 638 Practicum in Epidemiologic Research
AMS 673 Epidemiology and Prevention of Cancer

D. Biotechnology
AMS 551 Immunology Lab
AMS 552 Immunology
AMS 540 Interdisciplinary Biomedical Science and Biotechnology
AMS 698 Thesis or AMS 697 Externship
Electives (6 credits to be approved by the advisory committee)
One of the following:
AMS 560 Virology
AMS 565 Molecular Microbiology
AMS 680 Molecular Basis of Disease
One of the following:
AMS 541 Independent Study in Biotechnology Strategies
MMS 520 Quality System
MMS 525 Manufacturing Strategies

Laboratory Fees

Laboratory fees are assessed in all AMS laboratory courses to cover the cost of supplies.

AMS 530 Molecular Biology
This course covers basic principles of molecular biology. Lecture topics include biomolecules and cellular organization, structure and function of DNA, DNA replication, gene expression, RNA transcription and processing, protein synthesis and ribosome structure, cell cycle and signaling, gene rearrangement, retrovirology, developmental and cancer genetics, and recombinant DNA technology. Prerequisites: undergraduate biology, biochemistry, or permission of the instructor. Cr 3.

AMS 531 Molecular Biology Laboratory
This laboratory course introduces the student to basic molecular biology research methods using a project-based approach that emphasizes development of knowledge, laboratory skills, and accurate record keeping. The course includes fundamentals of molecular cloning, nucleic acid isolation and analysis, polymerase chain reaction, DNA sequencing, hybridization-based methods, site-directed mutagenesis, eukaryotic and bacterial expression of selected gene products, and basic bioinformatics. Prerequisites: undergraduate biology, biochemistry, and permission of the instructor. Cr 3.

AMS 535 Introduction to Epidemiologic Research
This course is intended to give students a basic foundation in principles for the conduct and interpretation of population-based studies of the distribution, etiology, and control of disease. Topics will include randomized experiments, non-randomized cohort studies, case-control studies, cross-sectional and ecological studies, causal inference, source of bias, and measures of effect. Recent publications from the epidemiologic and general medical literature will be used to illustrate the application of the concepts to specific epidemiologic issues. Cr 3.

AMS 540 Interdisciplinary Biomedical Science and Biotechnology
This course surveys new development in biomedical science and introduces students to the principles of biotechnology. It emphasizes the recent trend of integration of multiple disciplines of science and technology to advance the fields of biomedical science and biotechnology. This concept of scientific cross-pollination will be demonstrated by lecture series to be delivered individually or through teamwork by experts in a range of scientific fields that cover immunology, infectious disease, cancer research, environmental health and epidemiology, genomics and proteomics, development and production of diagnostics and therapeutics, animal models of human diseases, and bioethics. Lecturers include USM faculty, adjunct faculty, and other invited speakers from local research institutions and biotech industries. Prerequisites: undergraduate biology, biochemistry, or permission of the instructor. Cr 3.

AMS 541 Independent Study in Biotechnology Strategies
This course is designed to help students develop an understanding of the manufacturing, quality control, and management aspects of the biotechnology industry. This will be accomplished by developing and completing a project in association with a local biotechnology company. The project will be developed in conjunction with and approved by the student's advisor and/or advisory committee. Prerequisite: permission of the instructor. Cr 3.

AMS 545 Applied Biostatistical Analysis
This course is intended to give students a working understanding of the major types of biostatistical analysis used in laboratory sciences, clinical research, and public health. Topics will include estimation, descriptive statistics, hypothesis testing, crosstabulations and stratified analysis, life tables, multiple regression, and logistic regression. The course is designed primarily for students with little formal training in biostatistics, but may also prove valuable to other students who desire a course providing an integrated approach to diverse biostatistical techniques within an applied framework. Students will learn to manipulate datasets, analyze them, and interpret the results using the SAS software package. Cr 3.

AMS 551 Immunology Laboratory
This course consists of a series of comprehensive laboratories in which students learn basic immunoassays (e.g. enzyme-linked immunoadsorbent assay, immunofluorescence assay, immunoelectrophoreseis, immunoprecipitation, and immunoblot assay) as well as techniques for the isolation, identification, and functional analysis of immune cells and their products such as antibodies and cytokines. The roles of T cells, B cells, NK cells, macrophages, and neutrophils in the immune response are examined through assays such as cell proliferation assay, cytotoxicity assay, and flow cytometry. The techniques of monoclonal antibody production will also be introduced. Course emphasis will be on experimental design, and the clinical and research applications of the procedures used. Prerequisite: permission of the instructor. Cr 3.

AMS 552 Immunology
This graduate immunology course stresses both the cellular and the molecular components of the immune system. It covers basic topics including cells and tissues of the immune system, inflammation, generation of diverse immune responses, molecules with immune functions, immune tolerances, autoimmunity, immune-mediated diseases, infection and immunity, transplantation immunology, tumor immunology, immune deficiencies, and other immune disorders. This course will also discuss practical aspects of antibody production, immunoassays, and other immunological techniques. Prerequisite: undergraduate biology, biochemistry, or permission of the instructor. Cr 3.

AMS 560 Virology
This is a graduate-level survey of virology with a biomedical emphasis that is also suitable for advanced undergraduate biology and biochemistry students. Virus structure, molecular biology, evolution, epidemiology, pathogenesis, and medical importance of major virus groups are discussed. Molecular genetic manipulation of viral genomes for gene therapy and vaccine development is also a major focus of the course. Experimental approaches that have provided significant insights into the biology of viruses and their host interactions are emphasized. Prerequisites: undergraduate biology, biochemistry, and permission of the instructor. Cr 3.

AMS 565 Molecular Microbiology
This graduate-level molecular microbiology course emphasizes the fundamental importance of the microbial world in human health and disease and current understanding of selected topics in the biology and molecular genetics of bacterial and eukaryotic microbes and their viruses. The molecular foundations of microbial pathogenesis and host-pathogen interactions and co-evolution are explored in the context of important human and animal diseases. Prerequisites: undergraduate biology, biochemistry, and permission of the instructor. Cr 3.

AMS 578 Epidemiology of Infectious Disease
This course will provide an introduction to the epidemiologic basis for the prevention and control of communicable diseases through the study of specific infections including HIV/AIDS, tuberculosis, viral hepatitis, rabies, influenza, and Lyme disease. The course will also include exercises on the investigation of acute disease outbreaks and discussions of immunization, institutional infection control, foodborne illnesses, and emerging infectious diseases. Cr 3.

AMS 579 Epidemiology of Chronic Disease
This course examines empirical human evidence concerning the genetic, environmental, and behavioral determinants of some of the most common and debilitating chronic diseases, including several of the following: coronary heart disease, stroke, diabetes, selected forms of cancer, chronic obstructive pulmonary disease, asthma, neurological diseases, musculoskeletal conditions, and psychiatric disorders. Relevance of the following tools are considered: descriptive epidemiology, experimentation on humans, observational cohort studies, case-control studies, and formal meta-analysis. Strategies for the prevention of each of the diseases considered are critically evaluated in the context of epidemiologic evidence for causation. Prerequisite: AMS 545. Cr 3.

AMS 580 AIDS: Scientific, Social, and Political Foundations
This course will approach HIV/AIDS from a multidisciplinary perspective. It is intended to provide a solid introduction to HIV/AIDS for persons who are likely to be confronting AIDS issues in their professional work. Scientific topics to be addressed include HIV virology, immunology, natural history, and transmission. Guest lecturers will also address psychological and sociological aspects of the epidemic as well as issues in law, ethics, education, and prevention strategies. Cr 3.

AMS 590 Introduction to Toxicology I
This course introduces students to the principles and practice of toxicology. The major focus of the course is on basic principles, mechanisms, and common methods underpinning the science of toxicology. Selected target organ systems (e.g. respiratory, nervous, and immune systems) are studied with respect to understanding how representative chemicals damage and impair their ability to function. Students will develop a fundamental understanding of how chemicals may exert toxic effects and gain insight into the importance of organ specific effects. Prerequisite: molecular biology, biochemistry, or permission of the instructor. Cr 3.

AMS 591 Introduction to Toxicology II
This course continues to introduce students to the principles and practice of toxicology. The course continues to focus on basic principles, mechanisms, and common methods underpinning the science of toxicology. Selected toxicants are studied with respect to their source of exposure and mechanisms of effect. Selected disease processes (e.g. mutagenesis, carcinogenesis, and teratogenesis) are studied with respect to understanding their basic pathways and common mechanisms. Selected fields are presented to give students insight into the applications of toxicology and its relationship with other fields. Prerequisites: AMS 590, molecular biology, biochemistry, or permisson of the instructor. Cr 3.

AMS 595 Seminar: Journal Club
The Journal Club is intended to keep the participants current in biomedical science, to instruct them in the techniques of evaluating scientific literature critically, and to clearly present scientific information. The seminar, directed by faculty members responsible for the corresponding core course material and including outside lectures from among the affiliates as well as other academic institutions, will provide the student with an opportunity to discuss practical applications of the core lecture material. Cr 1.

AMS 633 Interdisciplinary Collaboration in Research and Education
This course is primarily for bioscience graduate students and teachers participating in USM science education outreach through programs such as the Maine ScienceCorps. The course provides collaborative interdisciplinary professional development opportunities for participating graduate students, secondary school teachers, and science faculty. Active participation is required in scientific seminar presentations, in discussions of readings, and in collaborative development of research based laboratory activities for scientific education at all levels. Prerequisite: permission of the instructor. Cr 1-3.

AMS 635 Applications of Epidemiology in Public Health Agencies
This course focuses on the role of epidemiologic principles and methods in the practice of public health. Topics include surveillance of the health status of populations, vital records, disease registries, special-purpose population-based surveys, responses to public concern about perceived clusters of disease, evaluation of the efficacy of public health interventions, the roles of state and federal government in collecting and interpreting epidemiologic data, and the uses of epidemiology in the formulation of policy in public health. Students will work on individual or group projects that involve hands-on participation in the application of epidemiologic methods within a public health organization. Prerequisite: AMS 545 or permission of the instructor. Cr 3.

AMS 636 Environmental Epidemiology
This course focuses on the effects of the physical environment on human health. Among the risk factors examined are a variety of pollutants found in outdoor air, indoor air, surface water, ground water, and food. Special attention is given to heavy metals, ionizing radiation, pesticides, flame retardants, carbon dioxide, and others of current public concern. Effects on human development, on the nervous system, and on respiratory disease and cancer receive particular attention. Topics include: environmental monitoring, quantification of exposure at the individual level, hazards in occupational settings, time-space clustering of disease, use of ecologic studies to estimate risks at the individual level, interactive effects of exposure to multiple environmental risk factors, perceptions of risk, integration of laboratory science with population-based studies, and the role of epidemiologic evidence in setting environmental standards. Prerequisites: AMS 545 or permission of the instructor. Cr 3.

AMS 638 Practicum in Epidemiologic Research
This course is designed to provide students with direct experience in the formulation of epidemiologic hypotheses and the analysis and interpretation of data. Each student will frame a research question that can be addressed using a dataset available on campus or elsewhere in Maine. With guidance from faculty, each student will conduct data analyses and will write a report in the format of a journal article. Prerequisites: AMS 535 and AMS 545 or permission of the instructor. Cr 3.

AMS 641 Flow Cytometry
This course will cover the theory and principles of flow cytometry and cell sorting, applications of flow cytometry, introduction to the use of the flow cytometer, and analysis of flow cytometric data. Prerequisites: undergraduate biology and biochemistry, or permission of the instructor. Cr 2.

AMS 651 Electron Microscopy
This course will provide training and appropriate technical support for student research projects requiring transmission electron microscopy. Prerequisite: permission of the instructor. Cr 3.

AMS 654 Hybridoma Methodology
This laboratory course covers basic concepts and techniques in tissue culture and hybridoma production. Intensive laboratory work will include immunogen preparation, immunization, cell hybridization, hybridoma screening by immunoassay, cell cloning, scale-up hybridoma production, and antibody purification. Prerequisite: permission of the instructor. Cr 1.

AMS 673 Epidemiology and Prevention of Cancer
This course provides a comprehensive review and synthesis of epidemiologic studies of the causes of several of the most common forms of cancer in humans. The role of genetics, diet, smoking, hormones, occupation, and other factors will be considered. The public health implications of interventions to alter behavior and to remove environmental risk factors will also be discussed, as will epidemiologic issues in the reduction of mortality through screening for cancer. Prerequisite: AMS 535 or permission of instructor. Cr 3.

AMS 674 Neurotoxicology
Prerequisites: AMS 572, molecular biology, biochemistry, or permission of the instructor. Cr 3.

AMS 675 Developmental Toxicology
Prerequisites: AMS 572, molecular biology, biochemistry, or permission of the instructor. Cr 3.

AMS 677 Regression Models in the Health Sciences
This course will familiarize students with the use of regression models for the analysis of epidemiologic and other biomedical data. Topics will include multiple linear regression, logistic regression, log-linear models, proportional hazard models, Poisson regression, generalized linear models, goodness of fit, and analysis of residuals and other diagnostics. Students will work on individual projects and will learn to use SAS software for conducting analyses. Cr 3.

AMS 680 Molecular Basis of Disease
This course focuses on the biochemical and genetic nature of human disease. It will cover the strategies of gene mapping and identification, molecular pathology, functional genomics, and gene therapy of heritable diseases. Prerequisite: AMS 530 or permission of the instructor. Cr 3.

AMS 691 Advanced Seminar in Biomedical Sciences
The student participates in a weekly seminar on biomedical sciences. The seminar focuses on current topics in biomedical research. Prerequisite: AMS 590 or permission of instructor. Seminar is offered in both fall and spring semesters. Cr 1.

AMS 692 Advanced Readings in Biomedical Sciences
The student participates in directed readings on a topic in biomedical sciences under the guidance of a faculty member. Readings on specific topics in carcinogenesis, epidemiology, immunology, molecular genetics, neuroscience, parasitology, toxicology, and virology are offered. Prerequisite: permission of instructor. Cr 2.

AMS 693 Advanced Research Techniques in Biomedical Sciences
The student learns laboratory techniques used as tools in biomedical research. The term is spent under the direction of a faculty member. Methods in epidemiology, immunology, molecular genetics, parasitology, toxicology, and virology are offered. This is a hands-on course with close supervision by technically trained personnel. For those sections in laboratories working with biohazards, laboratory safety and use of biosafety hoods are emphasized. Prerequisite: permission of instructor. Cr 2.

AMS 694 Genetic Toxicology
This course is an intensive review of the principles and practice of genetic toxicology. The major focus of the course is on basic principles, mechanisms, and common methods used to study chemical and radiation-induced damage to DNA and its repair. Selected types of damage and repair systems are studied with respect to understanding mechanisms of how representative chemicals or radiation damage and how the cell responds to impair their ability to function. Students will develop a fundamental understanding of how chemicals damage DNA and how human cells repair DNA and gain insight into the state-of-the-art of this field. Prerequisites: AMS 591, molecular biology, biochemistry, or permission of the instructor. Cr 3.

AMS 695 Chemical Carcinogenesis
This course is an intensive review of the principles of chemical carcinogenesis. The major focus of the course is on basic principles, mechanisms, and common methods involved in the neoplastic transformation of cells. Selected models of carcinogenesis are studied with respect to understanding mechanisms of how representative chemicals transform cells. Students will develop a fundamental understanding of the major theories in chemical carcinogenesis and gain insight into the state-of-the-art of this field. Prerequisites: AMS 591, molecular biology, biochemistry, or permission of the instructor. Cr 3.

AMS 696 Metal Toxicology
This course is an intensive review of the principles of metal toxicology. The major focus of the course is on basic principles, mechanisms, and common methods involved in how metals induce toxicity in major organ systems. Selected systems are studied with respect to understanding mechanisms of how metals induce cellular and systemic toxicity. Students will develop a fundamental understanding of the major theories in metal toxicology and gain insight into the state-of-the-art aspects of this field. At each session, a doctoral student will present a lecture on the topic including a review of required readings and directed activities. Offered in the fall of even-numbered years. Prerequisites: AMS 590, AMS 591, either AMS 694 or AMS 695, and permission of the instructor. Cr 3.

AMS 697 Externship
Under the stewardship of the student's graduate advisory committee, an externship will be arranged for a student to gain research training at a laboratory outside the University (e.g. industry, research institute, and government affiliates). Similar arrangement can be designed with some modifications for students who are already employed at the laboratory where an externship will be conducted. A written project on the work experience, similar to a dissertation, to be presented and approved by the advisory committee, is required. Prerequisite: permission of the instructor. Cr var.

AMS 698 Thesis
Under the stewardship of the student's thesis advisor and committee, a hypothesis-driven research project will be developed for a student to gain research training in biomedical science. A written project proposal will be presented to and approved by the thesis advisory committee and upon completion of the research a dissertation will be written and presented to the advisory committee for final approval. Prerequisites: permission of the instructor. Cr var.

GRS 602 Thesis Completion
See the complete course description in the "Continuous Enrollment and Residency" section of the Academic Policies chapter. Cr 1.