

TOXICOLOGY CONCENTRATION

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Program Focus

The Master of Science (M.S.) Toxicology curriculum in the Graduate School of Public Health (GSPH) at San Diego State University (SDSU) offers a solid base of toxicology knowledge and laboratory skills within a public health context. The curriculum is designed to accommodate both students with the masters degree as a final objective and students who may be considering a more advanced degree but needing more exposure to the field or research experience before making the commitment to a doctoral program.

All students in the Toxicology program are expected to master fundamental principles and general applications and methods. In addition, each student is expected to develop expertise in at least one specialized areas of toxicology. Typical areas of specialization at SDSU currently include reproductive or endocrine toxicology, use of aquatic models in public health, mechanisms research as applied to public health risk assessment or pharmaceutical product safety testing, and genetic toxicology and human genetic biomarkers of chemical exposure. Enrollment in the program is limited so that the individual interests and expertise of each student may be identified and developed through elective courses, thesis work, and field experiences. Course elective and thesis requirements are sufficiently flexible to satisfy students who wish to emphasize applied or regulatory toxicology as well as those preparing for research careers. Class assignments include proposal writing and a laboratory write-up in the form of a scientific journal submission. All students are strongly encouraged to present thesis work at scientific meetings, and most student thesis data results in peer reviewed publications. A list of recent student research presentations, publications, awards, and other acknowledgments is available on request from the program director.

Graduate students in the Toxicology program are likely to share classes with other graduate students in the Division of Occupational and Environmental Health whose primary interests are in chemicals found in the workplace, home or ambient environment. Exposure to the practice of toxicology in pharmaceutical and contract laboratories, the San Diego Regional Poison Information Center, the County Health Department and environmental consulting firms is encouraged for students with special interests in these areas.

The GSPH offers the Doctor of Philosophy (Ph.D.) in Public Health, with an emphasis in Epidemiology. Whereas a Ph.D. in Toxicology is not offered within the GSPH at this time, prospective epidemiology doctoral students interested in the study of human toxicology, pharmacoepidemiology, or human biomarkers of chemically-related diseases, and medical residents with an interest in becoming a Toxicology Fellow, should contact the Toxicology program coordinator for possible opportunities for more advanced study at the GSPH in these specific areas.

Toxicology Master of Science Degree Requirements

The Graduate Bulletin of San Diego State University is the official source of detailed information explaining requirements for degrees awarded by SDSU, including descriptions of courses offered. Prospective students should consult the SDSU Graduate Bulletin website for details or obtain a current Bulletin from the Aztec Bookstore, San Diego State University.

Briefly, Master of Science degree students with a concentration in Toxicology complete a total of 42 semester units. This includes required and elective lecture, laboratory, and seminar courses related to toxicology, including the Biostatistics and Epidemiology core public health courses. Each student must also conduct independent research for, write, and defend a laboratory-based thesis. A field practice experience may be arranged as an elective. Completion of other public health core breadth classes is also encouraged.

All Toxicology students currently take the following required toxicology courses (12 units):

PH638A Principles of Toxicology: An overview of toxicology principles and effects on major organ systems.

PH638B Methods in Toxicity Testing: A hands-on laboratory course providing exposure to both traditional and state-of-the art test methods, and also to toxicity testing policies and regulations, including Good Laboratory Practices.

PH637 Mechanisms of Action of Toxicants: Survey lecture and lab course covering some of the more common biochemical and other mechanisms and approaches to studying mechanisms of action of chemicals, ranging from the molecular to the whole organism levels of organization.

PH738 Topics in Toxicology: Seminar/discussion course that covers 3-4 topics of current interest each semester. Typical examples of topics discussed in more depth include specialty areas (e.g., developmental toxicology, aquatic toxicology), or issues in toxicology (e.g., hormone-dependent cancers, aquatic toxicology, toxicology in risk assessment).

Related course Requirements (9) units):

PH630 Risk Assessment

PH601 Epidemiology

PH602 Biostatistics

In addition to the 21 units of required courses listed above, students also complete a minimum of 15 units of elective courses, Research (3 units) and Thesis (3 units). Depending on the student's future goals (e.g., doctoral studies or entry immediately into a public health or industrial toxicology career) typical electives chosen often include Advanced Statistical Methods, Clinical Trials, Multivariate Analysis, seminars in Biomarkers of Exposure or Genomic Epidemiology, Water Quality Investigation, Principles of Industrial Hygiene, Occupational and Environmental Health Policy, Occupational Medicine, and Environmental Epidemiology. Other courses strongly recommended are 1-unit computer statistics courses (e.g., SPSS, SAS) and OEH Thesis Preparation Seminar (currently a 798 section),

Classroom and Laboratory Options

Curriculum requirements are sufficiently flexible to satisfy either students preparing for careers in research or students wishing to emphasize applied toxicology and considering the masters degree as their terminal degree. Hypothetical programs illustrate two typical student tracks:

Student A enjoys working in a laboratory and is considering a career in research. A doctoral degree is among future goals. This student designs a thesis involving the investigation of molecular mechanisms of genotoxic action. Each year students with this academic orientation are accepted to doctoral programs. Responsible positions in pharmaceutical companies or contract testing laboratories may also be immediate career objectives of these students, although an increasing number of graduates are applying to doctoral programs after a few years of post-masters experience.

Student B is more interested in immediate applications of toxicology and decides to develop further expertise in environmental risk assessment. Employment in a regulatory agency or consulting firm is a career goal. Environmental Epidemiology, Occupational and Environmental Health Policy, Water Quality Investigation, and an internship with the local air pollution control district involving conducting risk assessments are selected as electives. To complete thesis requirements this student designs a study that involves developing expertise with a toxicity bioassay and the GC/MS with implications for risk assessment and policy development.

Housed within the Graduate School of Public Health are multipurpose laboratories equipped for student research in toxicology, environmental health science and industrial hygiene. In addition to basic lab equipment and vivarium facilities, chemical hoods and analytical instrumentation required for most studies involving chemical analysis (GC/MS, AA, HPLC, radiation counters, etc.) are also available for student use. There are also opportunities each year for students to work in biotechnology and other pharmaceutical company laboratories in San Diego that support their thesis work.

Time Required to Complete the Program

Motivated, disciplined full-time students can complete the Toxicology program requirements within two years, including summers. Students are strongly encouraged to make a serious effort to choose a thesis topic within the first two semesters and spend the following summer in the laboratory perfecting methods and conducting pilot studies. These students may then complete and defend the thesis by the end of the second year (spring or summer). Classes are not offered by the GSPH during summers when students typically focus on completing thesis requirements or internships.

Part-time study is also allowed. Many GSPH students complete degrees as part-time students; however, working students who wish to complete the entire program are advised that required courses may be taught during working hours. Toxicology thesis research also requires a significant time commitment. Therefore, cooperation of a working student's employer is a key element in the successful completion of this degree.

Student and Faculty Research

Examples of general areas of research undertaken by students and faculty currently include:

Studies of mechanisms of reproductive and developmental toxicity.

Aquatic tests (e.g., fathead minnow, Medaka, Ceriodaphnia) to study waterborne toxicants.

Comet assay testing of toxicants for genotoxic activity.

Biological monitoring of workers (e.g., using genetic or hair analysis).

The expertise of the current full- and part-time program faculty and adjuncts spans the areas of in vivo and in vitro reproductive and developmental toxicology, genetic toxicology, mechanisms research involving biochemical and molecular methods, and aquatic toxicology. If other specialized expertise is required for thesis work, faculty in other University departments, particularly Biology and Chemistry, or off campus community partners with expertise in toxicology, are available for assistance. Major pharmaceutical and other companies support combined thesis and field training opportunities for selected SDSU toxicology students. Interested applicants may request additional information on toxicologists and others participating in the program, a typical sequence of courses, and recent masters student thesis titles, publications, conference presentations, and research awards to appreciate the broad range of interests of graduates of this program.

Financial Support

See current opportunities described elsewhere on the GSPH and SDSU websites. As noted above, major local pharmaceutical and other companies support combined thesis and field training opportunities for selected SDSU toxicology students.

Background of Applicants

An undergraduate degree in a basic or applied science discipline is not an absolute requirement for acceptance into the Toxicology concentration; however, virtually all entering students have strong undergraduate backgrounds in biology, chemistry, environmental science, nursing, or medicine (e.g., pre-med, pre-dental, pre-vet). All prospective students are expected to have successfully completed a minimum of at least one year of general college chemistry, one year of general biology, human physiology, cell and/or molecular biology, biochemistry, and no less than one quarter or one semester of organic chemistry. Faculty on the admissions committee also look for strong performance in any additional courses and laboratory experience in chemistry (e.g., analytical chemistry) and biology (e.g., histopathology, genetics).

Further Education and Employment of Graduates

Students who show promise of success in independent research and clearly enjoy it are encouraged to pursue doctoral degrees. Recent graduates have been accepted to toxicology or pharmacology doctoral programs at the University of Washington, Dartmouth, Cornell, University of Arizona, Michigan State University, University of Kansas, University of Chicago, University of North Carolina, and programs within the University of California system (U.C. Davis, UCLA, U.C. Irvine, and U.C. Riverside), to name a few. Other graduates prefer to find employment after the masters degree in local, state, and federal health and environmental regulatory agencies, pharmaceutical companies and other industries, contract testing

laboratories, and consulting firms. Many of the recent toxicology graduates have accepted positions in biopharmaceutical firms, contract laboratories,

environmental consulting, the San Diego County Hazardous Materials Management Division, and research organizations. Employment opportunities for laboratory-oriented M.S.-degree toxicologists to work "at the bench" in contract testing or in -house laboratories in industry have traditionally been greater on the east coast of the U.S. This is changing dramatically on the west coast as the biotechnology industry has grown and prospered, and demand is increasing for entry-level toxicologists with masters level research experience.

Brief History of the Program

Coursework in toxicology was first offered within the Division of Occupational and Environmental Health of the GSPH in 1982, three years after the founding of the GSPH. By 1984, toxicology course offerings had expanded sufficiently to provide Master of Public Health (M.P.H.) degree students the opportunity to focus their major studies in toxicology. The Graduate School of Public Health programs first received national accreditation from the Council on Education for Public Health (CEPH) in 1985. New laboratory facilities were completed the following year for the use of toxicology and other laboratory science masters degree students in the GSPH. In 1990, the "focus area" in toxicology became a full Concentration in Toxicology and the degree objective was changed from M.P.H. to Master of Science (M.S.). Also in 1990, the growing interest in toxicology in the greater San Diego community resulted in the formation of the San Diego Toxicology Association, a professional association organized by students and faculty in the Graduate School of Public Health with other toxicologists in the community. Many students are also active in the Society of Toxicology (SOT) and the Society for Environmental Toxicology and Chemistry (SETAC), both at the local and national levels. These networking opportunities are invaluable and are strongly encouraged.

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