

# College of Pharmacy & Pharmaceutical Sciences

## Graduate Programs

### Degrees Offered

#### Master of Science in Pharmaceutical Sciences

The Master of Science in pharmaceutical sciences degree is designed to prepare an individual for responsibilities in professional practice, the pharmaceutical industry and scientific research beyond those possible with a baccalaureate.

Although a single degree is conferred, specialization is possible in that the curriculum is organized into three distinct disciplines, referred to here as "options". Applicants must select the program of study (option) they wish to pursue. The options available to graduate students are pharmacology/toxicology, administrative pharmacy and industrial pharmacy.

The requirements for the Master of Science in pharmaceutical sciences degree differ according to the option. The minimum course work for the industrial pharmacy major is 30 semester hours, for the pharmacology/toxicology major 36 semester hours and for the pharmacy administration major 32 semester hours. In addition, each major requires a minimum of 6 semester hours of thesis research.

#### Admission Requirements

In general, a baccalaureate in the sciences is required for admission, although applicants possessing other bachelor's degrees will be considered if the latter represent adequate preparation. Certain options and graduate courses require undergraduate preparation as prerequisites, and this preparation should be completed as soon as possible upon admission. The total time required for completion of the graduate program leading to the Master of Science in pharmaceutical sciences degree will depend upon the preparation of the student entering the program. Normally two years of study and research are required.

The admission requirements of the College of Graduate Studies of the University apply. The basic requirement is a 2.7 (on a 4.0 scale) GPA on all undergraduate work leading to the bachelor's degree. Applicants having less than a 2.7 GPA on all undergraduate work will be considered for admission if other criteria for estimation of potential success in graduate studies are positive.

Each student must submit three copies of transcripts, one of which must be official and show all post-secondary academic work and degrees granted, three letters of recommendation from college faculty members acquainted with the applicant's character and ability, and scores from the aptitude portion of the GRE.

International students are required to take the TOEFL, which will be given in their own country by the Educational Testing Service.

Normally, acceptance will be decided by April 1 for admission during the following fall semester. The priority deadline for completed applications is January 15th. Complete applications received by this deadline will be considered for admission. Applications received after the January 15th deadline may also be considered, if positions are available in a program. International students are encouraged to submit applications one month prior to the stated deadline to allow for delays in international correspondence.

## Curriculum and Options – M.S. Program in Pharmaceutical Science

**Pharmacology/Toxicology option: A minimum of 36 semester hours of courses plus a minimum of 6 thesis credit hours are required for the degree.**

### Undergraduate courses required (or their equivalents):

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CHEM3710	Physical Chemistry for the Biosciences I	3
CHEM3720	Physical Chemistry for the Biosciences II	3
MATH1750	Calculus for the Life Sciences I	4
MATH1760	Calculus for the Life Sciences II	3
MBC3310	Medicinal Chemistry I: Drug Action and Design	3
MBC3320	Medicinal Chemistry II: Drug Targeting to Receptors	3
MBC4300	Medicinal Chemistry III: Chemotherapy and Immunotherapy	3
PHCL2600	Functional Anatomy and Pathophysiology I	4
PHCL2620	Functional Anatomy and Pathophysiology II	4

### Graduate courses required:

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
PHCL5140	Interpretation of Pharmaceutical Data	2
PHCL5700	Pharmacology I-Principles of Pharmacology, Autonomic Pharmacology and Non-Steroidal Anti-inflammatory Agents and Related Pharmacology	3
PHCL5720	Pharmacology II: Endocrine and CNS Pharmacology	3
PHCL5730	Toxicology I	3
PHCL5760	Toxicokinetics	3
PHCL6600	Seminar in Pharmacology	1-2
PHCL6700	Pharmacology III: CNS and Cardiovascular/Renal Pharmacology	3
PHCL6720	Pharmacology IV: Chemotherapeutics	3
PHCL6900*	M.S. Thesis Research in Pharmacology	1-6
PHCL6920*	M.S. Thesis Research in Pharmacology	1-6

\*6 credit hours are the required minimum, more than 6 credit hours can be taken.

### Elective course work may be selected from the following\*\*\*:

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
PHCL5630	Cancer Chemotherapy (highly recommended)	3
PHCL5750	Toxicology II	3
PHCL5990**	Problems in Pharmacology (highly recommended)	6-18

\*\*May replace PHCL5700, 5720, 5730, 6700, 6720, and 5760 if these were taken at UT at the undergraduate level as PHCL3700, 3730, 4730, 4810, 4820 and 4760, respectively, and a grade of B- or above was received for the course.

MBC6100	Advanced Immunology	2
MBC6550	Biochemistry	4
MBC5620	Biochemical techniques	2
MBC6800	Methods in Biotechnology	3

\*\*\*Other electives may be recommended by the department graduate committee.

**Administrative Pharmacy option: A minimum of 32 semester hours of course work plus a minimum of 6 thesis hours are needed for the degree.**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MKTG5410	Marketing Systems	3
PHPR 5260	Pharmacy & Healthcare Administration I	2
PHPR5520	Pharmaceutical Marketing and Management	3
PHPR5590	Readings in Health Care Access and Cultural Competence	2
PHPR5610	Pharmacoeconomics and Outcomes Research I	2
PHPR6600	Seminar in Administrative Pharmacy	1
PHPR6520	Analysis of the Pharmaceutical Environment	2
PHPR6530	Research Methods in Pharmacy Practice	2
PHPR6960	Thesis Research in Pharmacy	1-6*
RESM5110	Statistics and Quantitative Methods I	3
RESM6120	Statistics and Quantitative Methods II	3
**Track courses	As approved by advisor	minimum of 9 credit hours

\*A minimum of 6 credit hours of Thesis Research In Pharmacy is required.

\*\*Students enrolled in this option must select a Track Focus after the first semester.

Program Tracks, with approved track courses are as follows:

**1. Business Administration**

- BUAD6100 Accounting for Strategic Decisions 3
- BUAD6200 Financial Systems 3
- BUAD6300 Strategic Marketing & Analysis 3
- BUAD6400 Results-Based Management 3
- BUAD6500 International business 3
- BUAD6600 Supply Chain Management 3
- BUAD6800 Information Technology & E-Business 3
- BUAD6900 Strategic management Capstone 3

**2. Outcomes Research-Track Courses**

- PUBH6600 Health Behavior 3
- PUBH6460 Health Promotion Programs 3
- PUBH6010 Public Health Epidemiology 3
- PUBH6030 Advanced Epidemiology 3
- PUBH6110 Categorical Data Analysis 3

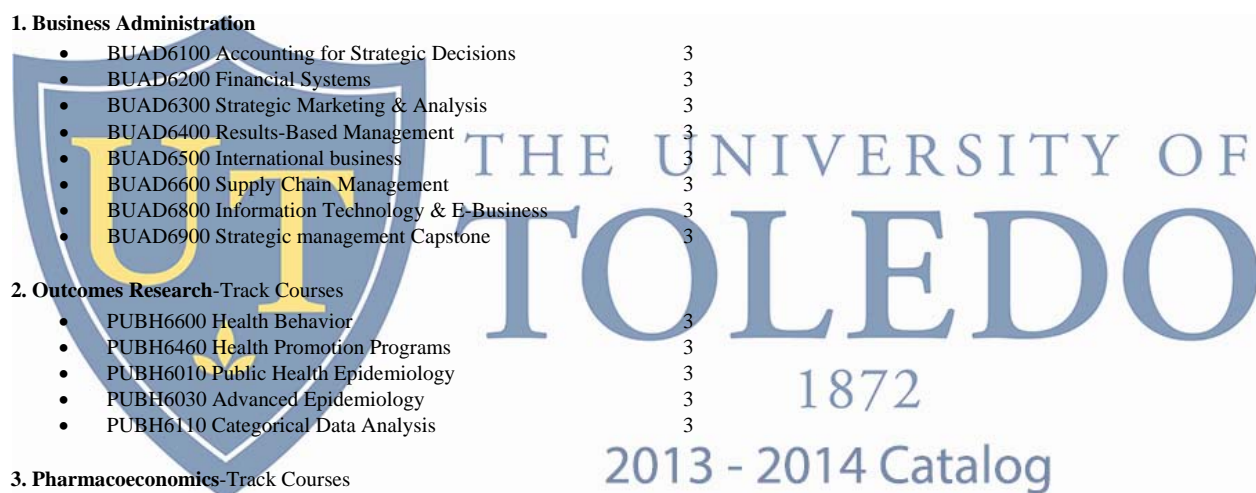
**3. Pharmacoeconomics-Track Courses**

- PHPR5620 Pharmacoeconomics and Outcomes II 3
- ECON5750 Health Economics 3
- ECON5810 Econometrics Models and Methods I 3
- ECON5820 Econometrics Models and Methods II 3
- ECON5830 Econometrics Models and Methods III 3

**4. Social Behavior Sciences- Track Courses**

- PUBH6600 Health Behavior 3
- PUBH6460 Health Promotion Programs 3
- RESM6220 Measurement I 3
- RESM6230 Measurement II 3

Other Track Courses or electives may be approved by the department graduate committee



**Industrial Pharmacy option: A minimum of 30 semester hours of course work and a minimum of 6 credit hours of thesis work is required for the degree.**

**Undergraduate courses required:**

**Courses will be evaluated for students with a B.S. in pharmacy, Pharm.D. or B.S.P.S. degree.**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MBC3550	Physiological Chemistry I: Structure and Function of Biological Macromolecules	3
MBC3560	Physiological Chemistry II: Chemical Regulation of Cells and Organisms	3
PHPR3070 PHPR3080	Pharmaceutics and Pharmaceutical Technology I and Pharmaceutics and Pharmaceutical Technology II or	8-9
CHEM3710 CHEM3720 CHEM3730	Physical Chemistry for the Biosciences I and Physical Chemistry for the Biosciences II and Physical Chemistry I	
PHPR4520 PHPR4550	Pharmaceutical Management and Marketing Analysis of the Pharmaceutical Environment	3 3

**Graduate required courses:**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CHEM6300	Advanced Analytical Chemistry	2-4
CHEM6310	Separation Methods	2-4
EEES5710	Advanced Biostatistics	4
PHCL6150	Advanced Pharmacokinetics	2
PHPR5690	Dosage Form Design	3
PHPR5700	Equilibrium Phenomenon	2
PHPR5720	Pharmaceutical Rate Processes	3
PHPR6600	Seminar in Administrative Pharmacy	1
PHPR6850	Product Development	3
PHPR6960	M.S. Thesis Research in Pharmacy	6

**Additional course work may be selected from the following:**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CHEM6320	Characterization of Condensed Phases and Surfaces	2-4
CHEM6330	Spectroscopic Methods and Analysis of Spectra	2-4
CHEM6720	Physical Chemistry of Material Transformations	2-4
CHEM6810	Materials Science I	4
CHEM6820	Materials Science II	4
CHEM6980	Special Topics in Chemistry	2-4
PHCL5760	Toxicokinetics	3
PHPR5680	Parenteral Manufacturing	2
PHPR5710	Selected Topics in Pharmaceutical Technology	2-4
PHPR5990	Problems in Pharmacy Practice	1-6
PHPR6530	Research Methods in Pharmacy Practice	3
PHPR6610	Seminar I	1

Applicants for the administrative pharmacy and industrial pharmacy options who possess a B.S. in pharmacy, Pharm.D. or bachelor of science in pharmaceutical sciences degree from an ACPE-accredited institution will be given preference for admission into those options. International applicants must have earned pharmacy degrees from their home institutions.

# Master of Science in Medicinal Chemistry

## Admission Requirements

Satisfactory completion of a bachelor's degree in chemistry, biology, pharmacy or a related discipline is required. It is assumed the undergraduate training will include differential and integral calculus, college physics, a one-year course in general and inorganic chemistry including a laboratory, a one-year course in organic chemistry including a laboratory, and training in analytical chemistry. An undergraduate course in physical chemistry is recommended.

The admission requirements of the College of Graduate Studies of the University apply.

## Degree Requirements

Master's students need to complete the following courses as partial fulfillment of their requirement for an M.S. degree:

Course	Course Name	Credit Hours
MBC5100	Research Practices in Medicinal Chemistry	1
MBC5620	Biochemical Techniques	2
MBC5900	Medicinal Chemistry Seminar (4 hours required)	1
MBC6190	Advanced Medicinal Chemistry	4
MBC6200	Biomedical Chemistry	4
MBC6550	Biochemistry	4
MBC6960	M.S. Thesis Research in Medicinal Chemistry (6 hours required)	1-15
Other 5000- to 6000-level courses as advised		

In addition, the following items also must be completed:

- Minimum of 30 semester hours of graduate credit, of which no more than six hours are counted from the category of M.S. thesis or Ph. D. dissertation research (MBC6960/8960)
- Preparation of a written M.S. thesis based upon the results of an original research investigation performed by the student during the M.S. program at The University of Toledo.
- Successful oral defense of the thesis before the thesis advisory committee (consisting of the thesis adviser and two other members) and presentation of the results of the thesis research in a seminar before the department of medicinal and biological chemistry.
- Acceptance of this thesis by the M.S. thesis adviser and the thesis advisory committee.
- Maintenance of a cumulative graduate GPA of 3.0 or higher.
- Two semesters of experience as a teaching assistant. The program believes experience in teaching is critical to solidifying the student's understanding of the basics of the field and improving communication skills.

## Doctor of Philosophy in Medicinal Chemistry

### Admission Requirements

Satisfactory completion of a bachelor's degree in chemistry, biology, pharmacy or a related discipline is required. It is assumed that the undergraduate training will include differential and integral calculus, college physics, a one-year course in general and inorganic chemistry including a laboratory, a one-year course in organic chemistry including a laboratory, and training in analytical chemistry. An undergraduate course in physical chemistry is recommended.

The ability to excel in graduate studies and research must be evident based on grades from undergraduate studies, recommendations from college faculty, results from standardized aptitude and achievement examinations (Graduate Record Examination), and performance in research and independent study.

Students with M.S. degrees in medicinal chemistry or related fields may be admitted directly to the Ph.D. program. Students without M.S. degrees may be admitted directly to the Ph.D. program, but must take 30 credits at the master's level prior to accruing doctoral level credits.



Ph.D. students need to complete the following courses as partial fulfillment of their requirement for a Ph.D. degree. Additional graduate courses (5000 to 8000 level) may be required, as advised during the development of each student's plan of study.

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MBC5100/7100	Research Practices in Medicinal Chemistry	1
MBC5620/7620	Biochemical Techniques	2
MBC 5900/7900	Medicinal Chemistry Seminar (6 hours required)	1
MBC6190/8190	Advanced Medicinal Chemistry	4
MBC6200/8200	Biomedical Chemistry	4
MBC6300/8300	Biomedical Chemistry Laboratory I	4
MBC6310/8310	Biomedical Chemistry Laboratory II	4
MBC6550/8550	Biochemistry	4
MBC8960	Ph.D. Dissertation Research in Medicinal Chemistry (30 hours required)	1-15

**Select 8 hours in chemistry, biology, or medicinal and biological chemistry:**

**Chemistry Courses**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CHEM6330	Spectroscopic Methods	2-4
CHEM6400/8400	Advanced Organic Chemistry	2-4
CHEM6410/8410	Organic Synthesis	2-4
CHEM6420	Physical Organic Chemistry	2-4
CHEM6510/8510	Protein Chemistry	2-4
CHEM6520/8520	Enzymology	2-4
CHEM6530/8530	Nucleic Acid Chemistry	2-4

**Biology Courses**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIOL6010/8010	Advanced Molecular Biology	4
BIOL6020/8020	Advanced Molecular Biology Laboratory	3
BIOL6090/8090	Advanced Cell Biology	4
BIOL6100/8100	Research Methodology: Cell and Molecular Biology	3

**Medicinal and Biological Chemistry Courses**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MBC5380/7380	Medicinal and Poisonous Plants	3
MBC6100/8100	Advanced Immunology	2
MBC6800/8800	Methods in Biotechnology	3
Other MBC courses as advised		

In addition, all students must satisfy the following:

1. Minimum of 60 semester hours of graduate credit beyond the master's level (see master of science in medicinal chemistry), including a minimum of 15 hours of courses, laboratories and seminars (exclusive of dissertation research) and a minimum of 30 hours of Ph.D. dissertation research.
2. Satisfactory overall performance on a written qualifying examination covering graduate-level medicinal chemistry, biochemistry and either organic chemistry or advanced cell/molecular biology.
3. Selection of a doctoral research adviser, preparation of an acceptable written Ph.D. dissertation proposal in consultation with the adviser, and the satisfactory oral defense of the proposal before the dissertation advisory committee. The written qualifying examination and the defense of the dissertation proposal will constitute the examination requirements necessary for advancement to candidacy for the Ph.D. in medicinal chemistry. The chair of the doctoral dissertation advisory committee will be the student's doctoral research adviser. The dissertation advisory committee will consist of two additional faculty plus one member from outside the student's department or college.
4. Subsequent to admission to candidacy for the Ph.D. degree, the student is expected to spend a minimum of two semesters in full-time study at The University of Toledo.
5. Preparation of a Ph.D. dissertation based on the results of an original research investigation performed by the student during his/her Ph.D. program at The University of Toledo.

6. Successful oral defense of the dissertation before the dissertation advisory committee and presentation of the results of the dissertation research in a seminar before the department of medicinal and biological chemistry.
7. Acceptance of the dissertation by the Ph.D. dissertation adviser and the dissertation advisory committee.
8. Maintenance of a cumulative graduate GPA of 3.0 or higher.
9. Three semesters of experience as a teaching assistant. The program believes experience in teaching is critical to solidifying the student's understanding of the basics of the field and improving communication skills.

## Doctor of Philosophy in Experimental Therapeutics

### Program Overview

Experimental therapeutics is the integration of basic and applied sciences focused on the study and development of new treatments for human disease. Research in experimental therapeutics seeks to understand human diseases from the molecular level to the whole organism in order to develop rational approaches for new pharmacological treatments. In addition, experimental therapeutics includes the development of new therapies through systematic investigation at increasing levels of complexity ranging from individual molecules and proteins, to cellular and tissue based assays and to the whole organism. The purpose of the program is to train students at the doctoral level who can translate discoveries in the laboratory to therapies in a clinical setting.

### Admission Requirements

Satisfactory completion of a bachelor's degree in chemistry, biology, pharmaceutical sciences, pharmacy or a related discipline is required.

The ability to excel in graduate studies and research must be evident based on grades from undergraduate studies, recommendations from college faculty, results from standardized aptitude and achievement examinations (Graduate Record Examination), and performance in research and independent study.

Students with M.S. degrees in pharmacology or related fields (e.g., pharmaceutical sciences) may be also admitted to the program. However, they are expected to have a minimum of 30 credits at the Master's level prior to accruing doctoral level credits.

### Required Courses

Ph.D. students need to complete the following required courses at the 5000 to 8000 level as partial fulfillment of the requirements for a Ph.D. degree. The course level is determined by the number of graduate credits completed at the time of registering for that particular course.

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
PHCL5700	Pharmacology I	3 <sup>a</sup>
PHCL5100/7100	Principles of Experimental Therapeutics I	3
PHCL5200/7200	Principles of Experimental Therapeutics II	3
PHCL5770/7770	Current Topics in Toxicology I	1
PHCL6650/8650	Seminar in Experimental Therapeutics (Minimum 6 hours required)	2
PHCL5460/7460	Current Topics in Pharmacokinetics/Toxicokinetics	1
PHCL5440/7440	Current Topics in Interpretation of Pharmaceutical Data	1
PHCL6300/8300	Research Experience in Experimental Therapeutics	2-6 <sup>b</sup>
PHCL8960	Ph.D. Dissertation Research in Experimental Therapeutics	1-15 <sup>c</sup>
MBC6190/8190	Advanced Medicinal Chemistry	4
MBC6550/8550	Biochemistry	4 <sup>d</sup>
INDI6020/8020	On Being a Scientist	1

<sup>a</sup> Not required if this same course, or PHCL3700 or equivalent was taken previously. If taken by Masters' students admitted to the program, the credit will not count toward those required for the Ph.D. degree.

<sup>b</sup> To fulfill the required laboratory rotations, a minimum of 4 hours must be taken in two different sections of the course (2 hours in each).

<sup>c</sup> A minimum of 30 hours is required

<sup>d</sup> Not required if this same course or, (MBC3550+MBC3560), or (CHEM3510+ CHEM3520), or equivalents were taken previously.

## General Elective Courses:

In addition to the required courses, general elective courses may be selected from the following. The course level to be taken is dependent on the number of graduate credits earned at the time of registration for that particular course:

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
PHCL5750	Toxicology II	3
PHCL5630	Cancer Chemotherapy	3
PHCL5990	Problems in Pharmacology	1-6
PHCL6390/8390	Problems in Experimental Therapeutics	1-6
MBC5620/7620	Biochemical Techniques	2
MBC5380/7380	Medicinal and Poisonous Plants	3
MBC6100/8100	Advanced Immunology	2
MBC6800/8800	Methods in Biotechnology	3
CHEM6510/8510	Protein Chemistry	2-4
CHEM6520/8520	Enzymology	2-4
CHEM6530/8530	Nucleic Acid Chemistry	2-4
BIOL6010/8010	Advanced Molecular Biology	4
BIOL6090/8090	Advanced Cell Biology	4
BIOL6100/8100	Research Methodology: Cell Mol. Biol.	3

## Specialized Elective Courses

Specialized elective courses are recommended for students with concentrations in different areas of the program, and may be selected from the following list:

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6340/8340	CPRA in Cell Signaling and Biology	3
BMSP6330/8330	CPRA Protein Structure & Catalysis	2.5
BMSP6340/8340	CPRA Genes & Genomes	2.5
BMSP6360/8360	CPRA Cell Membrane	3
IITP6020/8020	Advanced Immunology	1
NND5810/7810	Neuroscience	6
BIOE5620	Cellular Electrophysiology	3
MFGM8690	Innovation in Technology Commercialization	3

Other elective courses may be taken with the approval of the department graduate committee.

## Additional Requirements

In addition, all students must satisfy the following:

1. Minimum of 90 semester hours of graduate credit, including a minimum of 30 semesters hours at the Masters level, and a Minimum of 60 semester hours of graduate credit beyond the master's level. The required minimum 60 credits beyond the Masters level should include a minimum of 30 hours of Ph.D. dissertation research.
2. A grade of B- or higher is expected to be maintained for the required courses. A grade of B- or higher is also required for all of the pre-requisite courses.
3. A cumulative graduate GPA of 3.0 or higher must be maintained.
4. Satisfactory overall performance is expected on a written qualifying examination, which is administered after completion of the required graduate courses. The qualifying examination covers the following graduate courses, including their pre- and/or co-requisites:

PHCL5100/7100	Principles of Experimental Therapeutics I	3
PHCL5200/7200	Principles of Experimental Therapeutics II	3
PHCL5770/7770	Current Topics in Toxicology I	1
PHCL5460/7460	Current Topics in Pharmacokinetics/Toxicokinetics	1
PHCL5440/7440	Current Topics in Interpretation of Pharmaceutical Data	1



5. Selection of a doctoral research adviser, preparation of an acceptable written Ph.D. dissertation proposal in consultation with the adviser, and the satisfactory oral defense of the proposal before the dissertation advisory committee. The written qualifying examination and the defense of the dissertation proposal will constitute the examination requirements necessary for advancement to candidacy for the Ph.D. in Experimental Therapeutics. The chair of the doctoral dissertation advisory committee will be the student's doctoral research adviser. The dissertation advisory committee will consist of at least two additional faculty members plus one member from outside the student's department or college.
6. Subsequent to admission to candidacy for the Ph.D. degree, the student is expected to spend a minimum of two semesters in full-time study at The University of Toledo.
7. Preparation of a Ph.D. dissertation based on the results of an original research investigation performed by the student during his/her Ph.D. program at The University of Toledo.
8. Successful oral defense of the dissertation before the dissertation advisory committee and presentation of the results of the dissertation research in a seminar before the department of pharmacology.
9. Acceptance of the dissertation by the Ph.D. dissertation adviser and the dissertation advisory committee.

## Doctor of Pharmacy Degree Programs

The Doctor of Pharmacy degree for applicants having, among other qualifications, a B.S. in Pharmacy, is unavailable at this time.

### Combined Pharm.D. – Ph.D. in Medicinal Chemistry Program

#### Admission Requirements

Students who are admitted to both programs separately may pursue both degrees concomitantly.

#### Program Requirements

Although the requirements for both programs will be met, there is some overlap and flexibility, allowing a student to complete graduate-level requirements for both degrees in four to four and a half years. In general terms, students will follow the sequence for the Pharm.D. curriculum during the first four semesters, taking one graduate-level medicinal chemistry course each semester. In the fifth semester, students will take the required Pharm.D. clerkships, plus the two-hour seminar, with at least one clerkship rotation involving a research experience. The Ph.D. requirement for MBC6550 (Biochemistry) will be waived. Beginning with sixth semester (summer following the second year), students will complete the requirements for the Ph.D. in medicinal chemistry.