GRADUATE PROGRAM IN:

DRUG DISCOVERY AND DEVELOPMENT
This handbook outlines the philosophy and requirements of the Graduate Degrees offered in the discipline of Pharmaceutical Sciences, Drug Discovery and Development Track, at the University of Arizona. It is intended to be used as a tool to understand the requirements for obtaining a graduate degree. This handbook should be used in conjunction with the current Graduate College Catalog. The requirements of the Graduate Program Track in Drug Discovery and Development outlined herein are under the authority of and consistent with the rules and guidelines set forth by the Graduate Council of the University. In those cases where the requirements are slightly different from those stated in the Graduate College Catalog, the requirements in this Handbook pertain. Certain general University regulations and specific Drug Discovery and Development Track degree requirements are only outlined in this document; consult the current Graduate College Catalog for complete details (http://grad.arizona.edu/catalog/index.php).

Attainment of a graduate degree in Pharmaceutical Sciences requires outstanding scholarship and demonstration of distinguished research leading to a thesis/dissertation that contributes significantly to the general body of knowledge in the discipline. The degrees are never granted solely as certification of faithful performance of a prescribed program of study. All degree requirements must be fulfilled. Therefore, the requirements for these degrees are also outlined in this Handbook.
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1.0  INTRODUCTION

The Drug Discovery and Development Track of the Graduate Program in Pharmaceutical Sciences offers well-funded research opportunities, and the strong multidisciplinary nature of the program provides students with a highly interactive approach to research and education in Drug Discovery and Development.

Master of Science (M.S.) Degree in Pharmaceutical Sciences
The Drug Discovery and Development Track of the Graduate Program in Pharmaceutical Sciences does not admit students with the expressed interest in pursuing the M.S. degree. For a variety of reasons, students admitted to the Ph.D. Program may complete an M.S. degree in lieu of a Ph.D. degree. These reasons may range from unsatisfactory academic performance in the Ph.D. program to a desire to make a course correction in career path. The overall expectations for these students are similar to those for students in the Drug Discovery and Development Ph.D. program.

Doctor of Philosophy (Ph.D.) Degree in Pharmaceutical Sciences
The Drug Discovery and Development Track of the Graduate Program in Pharmaceutical Sciences offers a Ph.D. degree in pharmaceutical sciences. Students in this program must take courses in the major area as well as one of the several possible minor areas of study.

The objective of the Drug Discovery and Development Track is to impart advanced scientific knowledge in the drug discovery and design phases of pharmaceutical development, and to provide training opportunities in conducting state-of-the-art approaches in basic research in pharmaceutical sciences, and closely related sub-disciplines, in order to prepare the students for careers in independent research or related careers in academia, industry or government. The average time to graduation is less than five years.

Drug Discovery and Development Option in Biological Chemistry Program
Students in the College of Pharmacy’s Drug Discovery and Development Track have the option of participating in the Biological Chemistry Program at the University of Arizona.

Many of the most exciting research opportunities today are at the interface of biology and chemistry. The Biological Chemistry Program offers an opportunity for the interdisciplinary study of molecules in living systems that integrates the traditional disciplines of chemistry and biology.

The Biological Chemistry Program consists of faculty and students from three departments that have joined together to provide this graduate education. The cross-discipline structure allows for students to explore interests that may not be confined to one graduate program.

The Biological Chemistry Program is supported by a training grant from the National Institutes of Health. Visit the Biological Chemistry Program website for information about the program’s requirements, faculty, and application process (http://www.biochem.arizona.edu/bcp/Intro.html).
1.1 BACKGROUND

Drug Discovery and Development is an interdisciplinary program involving many aspects of chemistry and molecular biology, ultimately associated with intellectual property and clinical trials. As such, Drug Discovery and Development is a critical component of the drug discovery, design, and development pathway. No longer is the medicinal chemist just the synthetic chemist who synthesizes a range of compounds in the hope that one of them will turn out to be a lead compound for development. He or she has a firm basis in chemistry that may be focused in organic synthesis, computational chemistry, or one of the allied chemistry disciplines, but also has a familiarity with pharmacology, structural biology, pharmacokinetics, toxicology, and intellectual property. At the University of Arizona, our drug discovery and development faculty have a variety of expertise, such as synthetic medicinal chemistry, structure-based design, molecular modeling, NMR spectroscopy, and molecular biology (including transcriptional control, DNA repair, cell signaling, and oxidative damage mechanisms). The Drug Discovery and Development Program and its students have participated in drug discovery programs leading to clinical trials of agents in a number of therapeutic areas, including cancer and cardiovascular diseases.

Research in Drug Discovery and Development operates at the interface of chemistry and biology. It requires a broad perspective in science and typically involves interactions with chemists, botanists, pharmacologists, and clinicians. Drug discovery and quality control may require further contacts with business leaders, lawyers, intellectual property rights specialists, and government and non-government officials. Thus, Drug Discovery and Development offers many challenging opportunities in both basic and applied research.

The role of Drug Discovery and Development in the health-related sciences is evidenced by the increased need for highly trained professional personnel (M.S., Ph.D. degrees). This need is reflected in the number of positions available in research/teaching/service areas of health professional schools (of human medicine, pharmacy), university undergraduate and graduate programs, pharmaceutical and chemical industries, hospitals, and state and federal government research and regulatory agencies.

The Graduate Program Track in Drug Discovery and Development at the University of Arizona is oriented toward modern areas, especially those areas dealing with the discovery and development of drugs from natural resources. Current research of the participating faculty members in the Program include investigations in the fields of cancer chemoprevention, natural products chemistry, antioxidant chemistry, drug design and synthesis, molecular graphics, and the application of NMR and mass spectrometry to biomedical problems.
2.0 THE GRADUATE PROGRAM ORGANIZATION

2.1 PHILOSOPHY AND GOALS

A primary mission of the Drug Discovery & Development Track of the Pharmaceutical Sciences Graduate Program is to graduate outstanding scientists who will make strong contributions to the education of future pharmaceutical scientists and to the discovery and design of increasingly effective pharmaceuticals, while at the same time appreciating the other aspects of pharmaceutical development. Related to that, our mission is to contribute to the body of knowledge through scientific research.

2.2 Graduate Council Pharmaceutical Sciences for Graduate Programs

The Graduate Council in the Department of Pharmaceutical Sciences for Graduate Programs in the College of Pharmacy is comprised of one voting faculty member from each of the program tracks, one non-voting program coordinator, and a non-voting graduate student representative from each program track. The Council formulates policies and coordinates activities of the graduate program for all disciplines within the College of Pharmacy, including the Drug Discovery & Development track. This council is charged with the overall evaluation of graduate student performance and also makes final decisions concerning applicants for admission to the program. The council is also charged with overseeing all curriculum matters. A chart of the organizational structure of the graduate tracks that are housed within the College of Pharmacy is shown below.

2.3 EXECUTIVE COUNCIL ON DRUG DISCOVERY AND DEVELOPMENT

The Executive Council on Drug Discovery and Development consists of seven voting faculty members and one non-voting program coordinator. The Council formulates policies and coordinates activities of the Drug Discovery and Development Program, evaluates and selects applicants for admission to the Program, and considers curriculum matters.
2.4 Participating Faculty

The following is a list of full and associate faculty with whom students may pursue their research.

**Eli Chapman, Ph.D.,** Assistant Professor, Drug Discovery and Development
Our lab uses chemistry, biochemistry, biophysics, structural biology, and cell and molecular biology to discover targeted modulators of a diverse array of pathologically relevant targets.

**Chris Hulme, Ph.D.,** Professor, Drug Discovery and Development
Discovery and development of novel anticancer therapeutics; high-throughput Medicinal Chemistry and the development of novel chemistries with iterative efficiency to expedite the drug discovery process; Microwave Assisted Organic Synthesis (MAOS), Flow chemistry, Multicomponent reactions (MCRs) and C-H bond activation methodologies utilizing hypervalent iodine reagents for the design of peptidomimetics.

**Laurence H. Hurley, Ph.D.,** Professor, Drug Discovery and Development
Discovery and development of novel anticancer drugs; telomeres; telomerase; transcriptional control; topoisomerasases as drug targets; targeting transcriptional control; c-MYC, VEGF, Bcl-2; secondary DNA structures; biophysical methods; molecular biology.

**Hongyu Li, Ph.D.,** Associate Professor, Drug Discovery and Development
Discovery and development of novel anticancer therapeutics; Development of a novel fragment-based drug discovery approach and synthetic methodologies to expedite the drug discovery process.

**Daekyu Sun, Ph.D.,** Assistant Professor, Drug Discovery and Development
Discovery and development of novel anti-angiogenic agents targeting transcriptional activation of VEGF and HIF-1alpha genes; Study of the mechanism of action of novel anticancer agents derived from natural products: Investigation of DNA-repair interference as a potential approach for cancer treatment.

**Jun Wang, Ph.D.,** Assistant Professor, Drug Discovery and Development
Structure-based design of ion channel blockers; development of anti-influenza drugs; discovery of miniprotein-based therapeutics.

**Georg Wondrak, Ph.D.,** Associate Professor, Drug Discovery and Development
Reactivity-based drug discovery targeting the redox Achilles heel of skin cancer.

**Danzhou Yang, Ph.D.,** Professor, Drug Discovery and Development
DNA and DNA interacting proteins as potential anticancer drug targets. Structure-based rational drug design.
2.5 **Graduate Student Representatives**

Graduate student representatives are elected by the graduate student body of the Program Track in Drug Discovery and Development for two-year terms. The representatives serve as an official liaison between the students and faculty of the Program. The representatives are responsible for organizing graduate student participation in Program endeavors, as well as serving on Program committees in an advisory capacity. Each student should seriously consider his/her choice for the graduate student representative(s) in order to maintain an effective student voice in Program issues.
3.0 PHYSICAL RESOURCES AND FACILITIES

3.1 LABORATORY SPACE

The faculty and graduate students in the Drug Discovery and Development Program occupy space in the College of Pharmacy, the Arizona Cancer Center, and the BIO5 building. This distribution of labs in three different locations is a reflection of the interdisciplinary nature of the program. Drug Discovery and Development’s weekly seminars are held in the College of Pharmacy, and there are organized social events to bring faculty and students together periodically.

3.2 EQUIPMENT RESOURCES

Availability of modern scientific instruments is crucially important to research and graduate education programs. We are fortunate to possess ample instrumentation to conduct research at all levels of biological organization. Each investigator’s laboratory is equipped with specialized instrumentation required for research in their particular field.

Drug Discovery and Development laboratories are especially well endowed with instruments necessary for modern Drug Discovery and Development, including high-field NMR, molecular graphics, mass spectrometers, and high-performance liquid chromatographs. All laboratories have access to modern computers and data processing systems.

3.3 LIBRARY RESOURCES

The University of Arizona takes pride in the outstanding quality of its libraries. The Main Library and the Science Library, both the main campus, hold extensive collections of general and scientific periodicals and books. The Health Sciences Library is located in the Arizona Health Sciences Center. In addition to its holdings of pertinent periodicals and books, the library provides an excellent array of valuable services, including computerized bibliographic searches, state-of-the-art electronic information retrieval services with related on-line and off-line nationwide linkups, and access to a vast number of online journals. A large selection of supplemental audio-visual teaching aids is available in the media section.

3.4 EXPERIMENTAL ANIMALS

The availability of high quality experimental animals is of great importance to modern research in pharmacology and toxicology. Graduate students MUST become familiar with safe and humane animal care and handling techniques. The University Animal Care Facility procures and cares for all animals used in teaching and research by the Program. The staff of University Animal Care is available to students for consultation on problems related to the use of animals in scientific research.

All students are required to complete a training course by the University Animal Care staff before the end of their first semester of residence in order to comply with federal, state, and local regulations governing animal care.

3.5 LABORATORY SAFETY AND ENVIRONMENTAL HEALTH

Students are required to attend courses on these topics by the end of their first semester of residence, preferably as soon after their arrival as possible. It is the responsibility of all personnel involved in scientific study to be aware of the safety precautions and the proper disposal of hazardous wastes specific to the research effort. The student has a moral obligation to not only familiarize him/herself with, but also
follow, the specifics of laboratory safety associated with his/her desired area of research. The offices of Risk Management and Radiation Control offer seminars covering such subjects as fire prevention, hazardous waste disposal, compressed gas safety, basic radiation protection, industrial hygiene, etc. Laboratory directors and technicians are the best source for day-to-day laboratory safety techniques and advice on safety seminars required for laboratory personnel.

3.6 Poison Control Center

The College of Pharmacy is responsible for the operation of a State-wide Poison Control and Drug Information Center; these facilities are located in the Health Sciences Center Library. Faculty and fellows in Clinical Pharmacology provide expert advice and consultative services for these centers.
4.0 GENERAL INFORMATION

4.1 STUDENT RESPONSIBILITIES

The Graduate Program Track in Drug Discovery and Development stresses to the student the following issues of the utmost importance. First, any student who is found to be using drugs for non-experimental purposes will be expelled from the Program. Second, students are to conduct their experiments in an ethical manner; scientific fraud related to the creation of false data or the theft of others’ work will not be tolerated by this Program. Students should keep their data in a format acceptable to the research advisor and be prepared to turn over their records to the Drug Discovery and Development Track Director at any time. Third, the student is expected to complete the required and elective coursework in a timely manner under the ethical constraints of the College in which the course is being offered.

4.2 ORIENTATION

All entering students are required to attend the Program’s Orientation held prior to the first day of classes.

4.3 INDIVIDUAL HEALTH INSURANCE THROUGH CAMPUS HEALTH SERVICES

Students who are hired as a Graduate Assistant/Associate (GA) are eligible to receive individual health insurance through Campus Health Services. The student's admission paperwork must already have been submitted to the Graduate College before they are able to enroll. Even though the charges for health insurance show up on your student account, the university will off-set the charge later. You will not be responsible for health insurance costs.

Health insurance coverage for the fall semester begins the Monday prior to the beginning of classes, and continues till the beginning of the spring semester. Coverage for the spring semester starts at the beginning of the spring semester and continues through the summer. New students must register for health insurance when registering for courses on-line through the UA Student Link system. Continuing students who were enrolled in student health insurance in the previous semester will be automatically re-enrolled. Once you have enrolled in the plan, your coverage cannot be canceled, even if you resign or are terminated as a GA. If you resign or are terminated from your GA during the period of coverage, you will be personally responsible for the payment of the remaining coverage.

4.4 Creating a UA NetID and UA Email Account, and College of Pharmacy Email/Computer Account

All UA students are required to set up a UA email account (free to UA students), but first a UA Net ID must be established. The instructions on the UITS website (https://netid.arizona.edu/) will walk you through establishing your UA NetID, and then your email account. Students in the College of Pharmacy will also have a College of Pharmacy computer and email account created for them. The College of Pharmacy email will be the primary email account. Students should forward their UA email to their College of Pharmacy account so they only have to check one email account and not both.
4.5 **Financial Support**

Financial assistance in the form of teaching/research assistantships or traineeships is available to all first-year Ph.D. students admitted into the Program. Later support will include either traineeships or research assistantships. Students are also encouraged to apply for individual predoctoral fellowships from sources outside the University. Appointments as teaching or research assistants provide a waiver of tuition, health insurance and a partial remission of in-state registration fees.

4.6 **Graduate Assistant/Associate Stipend Levels and Benefits 2013–2014**

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<tr>
<th>FISCAL</th>
<th>50% FY</th>
<th>TUITION WAIVER FALL/SPRING</th>
<th>100% FALL/SPRING REGISTRATION REMISSION</th>
<th>STUDENT INSURANCE FULL YEAR</th>
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<tr>
<td>Graduate Assistant I (All 1st-Year Students) Late start in August</td>
<td>$21,300 <strong>Prorated</strong></td>
<td>$16,982</td>
<td>$10,718</td>
<td>$2,400</td>
</tr>
<tr>
<td>Graduate Assistant II (2nd-Year Students, except Ph.D. with M.S.)</td>
<td>$23,194</td>
<td>$16,982</td>
<td>$10,718</td>
<td>$2,400</td>
</tr>
<tr>
<td>Graduate Associate I (2nd-Year Student, with M.S. or Pharm.D.)</td>
<td>$23,767</td>
<td>$16,982</td>
<td>$10,718</td>
<td>$2,400</td>
</tr>
<tr>
<td>Graduate Associate II (Ph.D. students completed Prelim Exam)</td>
<td>$24,238</td>
<td>$16,982</td>
<td>$10,718</td>
<td>$2,400</td>
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4.7 **Graduate Assistantships/Associateships**

Please refer to the Graduate College GA Hiring Manual for complete details regarding your GA. [http://grad.arizona.edu/financial-resources/ua-resources/employment/ga-manual](http://grad.arizona.edu/financial-resources/ua-resources/employment/ga-manual)

4.8 **Tax Information**

Students should be aware of current tax laws which impact salaries or stipends from graduate teaching/research assistantships, fellowships, and stipends. Contact the IRS at (800) 829-1040 and ask for the scholarship/fellowship publication or visit the IRS forms/publications website at [http://www.irs.gov/forms_pubs/](http://www.irs.gov/forms_pubs/)

Graduate students, who are in Graduate Assistant/Associate positions, must be enrolled in half-time status in order to qualify for exemption from FICA taxes. (Rev. Proc. 98-16.) Graduate students in graduate positions, who are enrolled in less than 6 units during the current semester, will have FICA taxes deducted from their pay. To be exempted from FICA taxes, graduate students will need to be enrolled in at least 6 units during the fall and spring semesters, and in at least 3 units during Summer I and II.
5.0 GRADUATE STATUS AND ADMISSION

5.1 Regular Graduate Status

Students who meet all admission requirements may be admitted to Regular Graduate Status to undertake work leading to an advanced degree.

5.2 Graduate Non-Degree Status

Individuals holding a bachelor’s degree, or its equivalent, from a college or university which grants degrees recognized by The University of Arizona, may attend graduate-level courses without being admitted to a graduate degree program. Such students may enroll in graduate level coursework as their qualifications and performance permit. It is advisable to contact the department(s) offering courses of interests, to insure that the courses are available to non-degree students. Up to twelve (12) units of graduate credit, earned in non-degree status and/or transferred from other institutions, may be petitioned for application toward an advanced degree once the student obtains regular admission to a degree program. International applicants requiring a student visa are not eligible for graduate non-degree admission.

5.3 Conditional Admission

Although The College of Pharmacy does not generally admit students conditionally, the program’s admissions faculty may recommend conditional admission on a case-by-case basis. Prospective students applying for conditional admission must meet all Graduate College requirements except for the minimum 550 TOEFL requirement (or 213 in the computerized version or 79 in the IBT version).

Conditional Admission requires that the student apply to and enroll at the UA Center for English as a Second Language (CESL) at their own expense (or their sponsor’s) with the expectation of achieving TOEFL-equivalent English proficiency within one year. The initial 1-20 will be generated by CESL to allow the student to attend CESL classes. Once CESL certifies that the student has achieved English proficiency at the TOEFL minimum, he or she will be admitted as a regular standing student.
6.0 PH.D. PROGRAM IN DRUG DISCOVERY AND DEVELOPMENT

6.1 ADMINISTRATION

The Drug Discovery and Development Track Director helps the first-year student plan his/her program with an emphasis on the first year’s courses. In succeeding years, the student’s Major Research Advisor and Dissertation Committee tailor the coursework to fit specific needs and objectives. The faculty encourages the student to take advanced courses in organic and analytical chemistry and pharmacology and to diversify his/her program with courses in genetics, microbiology, biological sciences, molecular biology, botany, plant taxonomy, biochemistry, and related areas.

The Major Research Advisor and Dissertation Committee will help the student plan an educational program in which coursework is completed as quickly as possible. Because of individual interests or conflicts in scheduling, some formal coursework may extend into the third year of graduate study.

6.2 RESEARCH ADVISOR AND DISSERTATION COMMITTEE

Prior to the selection of a Major Research Advisor, the student must become familiar with the research interests of the faculty. Students should meet individually with the faculty whose research is of particular interest or potential interest. Additional familiarity is gained through the laboratory rotations.

After these preliminary interviews and research laboratory experiences, the student decides with whom he/she would like to do his/her dissertation research. After consultation with, and agreement of the faculty member, the student must communicate this decision to the Chairperson of the Program before the end of the Spring Semester. No firm commitments between students and faculty should be made until this date. The Major Research Advisor must be a tenure track full faculty member in the Program. In the event that the research project is carried out in the laboratory of an individual who is not a member of the Program faculty, a co-director from the Program Faculty must be appointed.

At the time of Major Research Advisor selection, or shortly thereafter, a Dissertation Committee is formed. The Dissertation Committee consists of three members from the Program faculty and one or two from the minor field and is chaired by the Major Research Advisor. The Major Research Advisor discusses membership of the Dissertation Committee with the student and recommends the composition of the Dissertation Committee to the Drug Discovery and Development Track Director, who may modify Committee membership. Faculty members of the Dissertation Committee are selected on the basis of their ability to provide useful advice about the research problem, to assist in selection of appropriate coursework, and to help guide the student to successful completion of degree requirements.

The Dissertation Committee will meet with the student at least once each calendar year (June 1–May 31) to review progress in coursework and research. The student will be responsible for giving a private dissertation proposal, which will consist of a private seminar to the Dissertation Committee, which will outline the background, preliminary data, and goals of the proposed dissertation topic. The Advisory Committee will be helpful in focusing the objectives of the proposed dissertation as well as limiting the scope. It is strongly recommended that the student meet with the advisory committee shortly before scheduling the final defense. You must indicate in your Annual Report the date of your annual committee meeting.
6.3 COURSES FOR DRUG DISCOVERY AND DEVELOPMENT MAJOR

A minimum of 39 units of course work in the area of the major subject including 8 seminar credits, 8 laboratory rotation units, and a maximum of 8 research conference credits must be completed. In addition, 9 units of course work in the minor subject, and 18 units of dissertation must be completed. Courses in the Drug Discovery and Development program are listed under two different prefixes to the course numbers: PHSC and PCOL. All research and dissertation units are registered under PHSC.

Required Core Courses:

PHSC 537 a/b: Medicinal Chemistry II (3 units, fall) and III (2 units, spring)
PHSC 670: Principles in Drug Discovery, Design, and Development (3 units, spring)
CHEM 550: Synthetic & Mechanistic Organic Chem (3 units, fall)
BIOC 565: Proteins and Enzymes (3 units, fall)
PHSC 596a Seminar (fall & spring semesters until final defense, 8 units)
PCOL586a Laboratory rotations (fall & spring first year only, 8 units)
PHSC 795a/b BCP Laboratory rotations (fall & spring first year only, 8 units)
PCOL695a Research Conference (fall & spring semesters, second year and beyond, 8 units)
MCB 695e Science, Society & Ethics (fall, spring, and summer, 1 unit)

Electives:

There are many elective possibilities from many different graduate programs. Some possibilities offered by Chemistry/Biochemistry, Pharmacology and Toxicology, and Cancer Biology are shown here.

Fall Electives:
PCOL 601a: Epigenetics in Development and Disease (1 unit)
PCOL 601b: Proteomics (1 unit)
PCOL 630B: Cell communication & Signaling (3 units)
CBIO 597a: Experimental Design (1 unit)
CBIO 552: Cancer Biology (4 units)
CHEM 584: Nuclear Magnetic Resonance Spectroscopy (3 units)
CHEM 543: Structural Organic Chemistry (3 units)

Spring Electives:
PCOL 550: Drug Metabolism and Disposition (2 units)
BIOC 585: Biological Structure I (4 units)
BIOC 568: Nucleic Acids (4 units)
CBIO553: Advanced Topics in Cancer Biology (4 units)
CBIO 597a: Grant Writing for Graduate Student (1 unit)
PCOL 630A: Cell communication & Signaling (3 units)
CHEM 541: Mechanisms of Organic Reactions (3 units)
CHEM 548 Advanced Synthetic Chemistry (3 units)
CHEM 587: Intro to Molecular Spectroscopy (3 units)
CHEM 534A/B: Practical NMR Spectroscopy (3 units)

6.4 SEMINAR PHSC 596A, 1 CREDIT HOUR (TUESDAYS, 4:00–5:30 pm)

Students are required to attend a weekly seminar, consisting primarily of scientists from other institutions, on various subjects related to Drug Discovery and Development. The students are also encouraged to invite one speaker each semester. Students who have chosen to participate in the BCP program are also required to attend a weekly journal club/research-in-progress seminar, in which they will present their work at least once each year.

6.5 LABORATORY ROTATIONS

Each first-year student must participate in three-four research laboratory rotations (PCOL586a, or PHSC 795a,b for BCP students). The objective of the required laboratory research rotations is the introduction
of the graduate student to research and familiarization with the scope and nature of the faculty’s research endeavors. The research laboratory rotation constitutes a major part of the first-year graduate curriculum, and performance in the rotation will bear heavily upon overall evaluation of the student. Performance criteria to be used by the laboratory director will include assessment of the student’s initial familiarity with the research, the development of library and literature skills, ability to apply the scientific method and use pharmacological and toxicological principles, development of laboratory skills, attitude toward the research project, and a final written report prepared by the student.

The dates for laboratory rotations for 2014-15 are as follows:
Lab Rotation #1 August 25 - October 17, 2014
Lab Rotation #2 October 20 - December 12, 2014
Lab Rotation #3 January 14 – March 6, 2015
Lab Rotation #4 March 9 – May 8, 2015

6.6 MINOR REQUIREMENTS

One minor is required. Students may choose from among the following approved minor list. Other options will be considered but must be approved individually by the Executive Council and Chairperson of the Program (minimum of 9 units).

6.7 SUGGESTED MINORS FOR DRUG DISCOVERY & DEVELOPMENT MAJORS

1. Chemistry/Biochemistry
2. Molecular and Cellular Biology
3. Pharmacology & Toxicology
4. Cell Biology and Anatomy
5. Microbiology and Immunology
6. Cancer Biology
7. Neuroscience
8. Medical Pharmacology
9. Physiology
10. Pharmaceutical Sciences (Internal Minor)

6.8 MINOR IN DRUG DISCOVERY & DEVELOPMENT FOR STUDENTS IN OTHER PROGRAMS

The faculty welcomes graduate students in other departments and programs of the University to minor in Drug Discovery and Development. Students are required to contact the Program Office and the Graduate Program Chairperson before proceeding with a minor. A student may minor in Drug Discovery and Development by completing nine units of coursework listed below:

PHSC 670 Principles in Drug Discovery, Design, and Development 3 units
CHEM 550 Synthetic & Mechanistic Organic Chem 3 units
BIOC 565 Proteins and Enzymes 3 units

No more than one of the following courses:

PCOL 601a: Epigenetics in Development and Disease 1 unit
PCOL 601b: Proteomics 1 unit
PCOL550 Drug Metabolism and Disposition 2 units
6.9 Credit Requirements and Transfer Credit

The equivalent of at least six semesters of full-time graduate study is required for the Ph.D. A minimum of 36 units of course work in the area of the major subject, 9 units in the minor subject, and 18 units of dissertation must be completed. Graduate credit earned at other approved institutions, if accepted by the major department and the Graduate College and grade was A or B, may be counted toward the requirements of this degree, but will not be calculated in The University of Arizona G.P.A. All required units of credit must be at the 500-level or above at The University of Arizona (or, in the case of transfer units, their equivalent at other institutions). Six units of 400-level credit taken at The University of Arizona may be used in the minor but will not receive graduate credit or be calculated in the graduate grade-point average. At least one half the units used on the Doctoral Plan of Study must be in courses in which regular grades (A, B, C) have been earned. A minimum of 12 units of regular grades taken at The University of Arizona are required to establish a University of Arizona G.P.A. Credit for correspondence courses or extension work obtained at other institutions will not be accepted for graduate credit.

Students who wish to use transfer credit must first submit a request form to the Graduate College (http://grad.arizona.edu/forms) before the end of their first year of study. This allows the Graduate College to evaluate the transfer credit while the transcripts are still in the Graduate College, and ensures that students will know early in their studies whether or not the credits are acceptable. The Graduate College evaluation simply determines whether or not the courses are eligible for transfer; the Drug Discovery and Development Executive Committee will still decide which courses should be part of the Program of Study.

6.10 Registration

Registration is accomplished through the University of Arizona UAccess Student Center System. UAccess Student Center can be accessed from the UA homepage: (http://www.arizona.edu). Contact the Program office for registration of courses that are not open to web registration.

6.11 Graduate Assistants Minimum Registration

All graduate students in the College of Pharmacy who are supported by or through the University are considered to be full-time students. All full-time students are expected to enroll for some combination of coursework, research, or independent study that results in twelve (12) units of credit for the academic semester and one (1) unit each summer session. Students completing their degree in an academic semester may register for less than (12) units as determined by the Major Advisor and Program Office.

6.12 Minimum Registration Requirements for Students NOT Receiving Funding

Each student who is associated with the University in any capacity that utilizes University facilities or faculty time during any academic semester must be registered for at least three (3) units of graduate credit. Each student completing requirements for an advanced degree must be registered during the semester or summer term during which requirements are completed, or the previous semester or term if requirements are completed during an intercession. This includes any semester during which a preliminary or final examination is scheduled.

Ph.D. students who have completed all the degree course requirements but have not completed the comprehensive examination should enroll for Research (PHSC 900). After completion of the comprehensive examination Ph.D. students should enroll for dissertation (PHSC 920).
6.13 Grades in Core Courses

Students must receive a grade of B or better in all core courses. A student who receives a grade of C or less in a core course must repeat that course. A student may petition to have this repeat requirement waived; a waiver can be granted only with the written approval of the course instructor and the Drug Discovery and Development Graduate Executive Committee. A grade of C or less in a core course constitutes grounds for dismissal from the Graduate Program.

6.14 Minimum Academic Requirements

A student cannot receive a graduate degree unless he or she has achieved a grade-point average of 3.00 or higher on all course work taken for graduate credit, whether or not the courses are offered in satisfaction of the specific requirements for a specific graduate degree. A student whose cumulative GPA is below 3.0 for two consecutive semesters will be converted to non-degree status. Programs may allow students to take additional course work while in non-degree status. In order to graduate, the student must apply for readmission to the Graduate College through their graduate department. Readmission is not guaranteed.

6.15 Satisfactory Academic Progress

In addition to maintaining a minimum 3.0 grade-point average, students are required to demonstrate satisfactory academic progress toward degree completion. The Program’s policies on what constitutes satisfactory academic progress are listed below.

- **Minimum Grades in a Required Course** - Students must receive a grade of "B" or better in all core courses. A student who receives a grade of "C" or less in a required course must repeat that course. Students failing to obtain a "B" or higher in a required course that is repeated must petition the graduate program faculty to remain in the program. The decision to allow the student to continue in the program requires a majority approval of the program faculty, with two negative votes sufficient for termination.

- **Student Evaluation** - The Program Executive Committee evaluates each student on the basis of accomplishments in formal courses and performance in other areas of the Program including attendance and participation in seminars as well as performance in laboratory rotations. Satisfactory performance in courses and research are also required. Failure to meet performance criteria in any of these areas is grounds for dismissal from the Program.

- **Annual Reports** - All students will submit an annual report to the Graduate Program Coordinator, on or before June 1. The Annual Report must be approved and signed by the graduate track director (first year students) or the Research Advisor (all other students) prior to submission to the Program office. Annual Reports for every year matriculating in the program are mandatory.

- **Sponsorship** - By June 15 the Executive Committee makes a determination if each first year student should be sponsored for the following year. This determination will be assessed yearly thereafter. Poor performance in assigned duties may result in the loss of sponsorship. Sponsorship decisions after the first year are made by the student’s major advisor.

- **Advancement to Candidacy** - Students are evaluated for Advancement to Candidacy at the time of their comprehensive examination. If performance is substandard, the Executive Committee may recommend a probationary period, withdraw program sponsorship, seek dismissal, or may request the student to fulfill the requirements for a Master's degree. The Program Executive Committee will evaluate overall student performance in the Program to date. If performance has been satisfactory, approval will be granted.

- **Dissertation/Thesis Committee Meetings** - All students are required, after the formation of a dissertation/thesis committee, to have at least one committee meeting per year while in the
Program (refer to committee meeting guidelines under section 6.10 Research Advisor and Dissertation Committee.

- **Completion Guidelines** – Students will complete the following according to the time frame listed below.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>TIME-FRAME GUIDELINES</th>
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| YEAR 1 and Summer  | Complete Three Laboratory Rotations  
Complete Deficiency Coursework (if applicable)  
Complete Core Coursework  
End of First Year—Selection of Mentor/Research Advisor  
End of First Year—Begin Doctoral Research |
| YEAR 2 and Summer  | Continue Doctoral Research  
Complete Core Coursework  
Submit Doctoral Plan of Study to Program Office—Fall Semester  
Select Dissertation Committee  
Pass Written Portion of Comprehensive Examination |
| YEAR 3 and Summer  | Continue Doctoral Research  
Pass Oral Portion of Comprehensive Examination  
Submit Committee Appointment Form  
Dissertation Committee Meeting |
| YEARS 4 and 5      | Continue Doctoral Research  
Dissertation Committee Meeting  
Pass Final Examination (Dissertation Defense)  
Identify Employment Opportunities |
| YEARLY             | Students must receive at least a B grade in all core courses  
Attend weekly seminar program  
Complete annual report (on or before June 1)  
Students supported by or through the University are expected to enroll for 12 units of credit each academic semester and 1 unit each summer session |

### 6.16 Appeals Process

If a student wishes to appeal any of the aforementioned requirements the appeal should be made in writing to the Director of the Program Track (Drug Discovery & Development). The appeal will be reviewed by the program faculty and may include a collective meeting with the student. A decision to accept the appeal of the program faculty will be based on a majority vote. The program faculty may place additional requirements/deadlines on the student as a prerequisite for continuing in the program. Students who wish to appeal the decision of the program faculty must submit an appeal in writing to the Associate Dean of the Graduate Program in the College of Pharmacy.
6.17 Student Evaluation

On behalf of the Program Faculty, the Drug Discovery & Development Executive Committee evaluates each student on the basis of accomplishments in formal courses and performance in other areas of the Program including attendance and participation in seminars as well as performance in laboratory rotations. Satisfactory performance in courses and research are also required. **Failure to meet performance criteria in any of these areas is grounds for dismissal from the Program.** All students will submit an annual report to the Graduate Program Coordinator, on or before June 1.

6.18 Annual Reports

**Each student is required to submit an Annual Report** to the Program office, College of Pharmacy, room 336, on or before June 1. An email notice will be sent out from the Program Office at least one month prior to the Annual Report due date, which will include an attachment of the Annual Report form for the student to fill out.

The Annual Report must be approved and signed by the Program track director (first year students) or the Major Research Advisor (all other students) prior to submission to the Program office. Annual Reports for every year matriculating in the program are mandatory.

By June 15 the Drug Discovery and Development Executive Committee decides if each first year student should be sponsored for the following year. Second year students are evaluated for Advancement to Candidacy at the time of their comprehensive examination. If performance is substandard, the Executive Committee may recommend a probationary period, withdraw program sponsorship, seek dismissal, or may request the student to fulfill the requirements for a Master's degree. The Executive Committee will evaluate overall student performance in the Program to date. If performance has been satisfactory, approval will be granted.

The Annual Report will list courses taken and grades received, committee meeting(s) held, abstracts and papers published, seminars and report presentations, honors, outside funding, and a succinct and lucid summary of research progress. The Annual Report must be approved by the Drug Discovery and Development Track Director and signed by the Drug Discovery and Development Track Director before the year’s work is considered complete. Students who do not meet this deadline will receive a one-time letter requesting the information be provided immediately or the student will be dropped from the Program for failure to meet Program degree requirements.

6.19 Qualifying Examination

Satisfactory completion of the first two year’s work constitutes passing of the Qualifying Examination. This entails that the student attain grades of no less than B in core courses and maintain a GPA of at least 3.0. Part of the evaluation includes the submission and approval of an Annual Report outlining his/her activities during that year.

6.20 Plan of Study

In conjunction with his/her major professor or advisor, each student is responsible for developing a Plan of Study during their first year in residence, to be filed with the Graduate College no later than the student's third semester in residence. The Plan of Study identifies (1) courses the student intends to transfer from other institutions; (2) courses already completed at The University of Arizona which the student intends to apply toward the graduate degree; and (3) additional course work to be completed in
order to fulfill degree requirements. The Plan of Study must have the approval of the student's major professor and department head (or Director of Graduate Studies) before it is submitted to the Graduate College.

6.21 COMPREHENSIVE EXAMINATION

Before advancing to formal candidacy for the Ph.D. degree, all Drug Discovery and Development graduate students must pass a comprehensive examination. The examination consists of a written and oral portion. The written comprehensive exams must be completed prior to taking the oral examination. It is strongly suggested that the written and oral examinations be completed within the third year of graduate study. This deadline can be extended under special circumstances, and an extension requires the approval of the Drug Discovery and Development Executive Committee.

Each student’s dissertation committee serves as the comprehensive examination committee. The Pharmaceutical Sciences Graduate Program stipulates that you must have passed the required core courses in the program with a grade of B (3.0) or better in each course.

Written Examination
The written comprehensive examination is comprised of two parts. The first part of the written examination consists of questions prepared by five members of the faculty who serve as an exam committee. This group will generate a series of five questions. All Drug Discovery and Development students eligible for comprehensive examinations will then select three of the five questions to answer. The goal of this part of the written exam is to teach the student (1) to rapidly assimilate a body of information from the primary literature, (2) to critically evaluate the data within the body of information, summarize the key concepts, and define unsolved problems, (3) to formulate models or hypotheses, (4) to devise experimental approaches to test the predictions of the models or hypotheses, and (5) to communicate the approaches and results in a concise and informative manner. Thus, the format of each question should require the student to learn a concept or principle from a field within the primary literature and then to use the concept or principle to solve a problem or test a hypothesis. The scope of each question should be limited so that it can be concisely answered within no more than ten double-spaced typed pages. The student is allowed three weeks to answer the chosen questions. At the end of the three-week period, the answers to the three questions are turned in to Drug Discovery and Development Graduate Program Coordinator. Students may use library resources, but each student taking the exam must work completely independently of other students taking the exam.

The faculty members who wrote the questions that the student chooses to answer will serve as the primary reviewers of the questions. Prior to starting the exam, the student may discuss with each primary reviewer what is expected in terms of answering the question and any portions of the question that may not be clear to the student. The other members of the exam committee will serve as secondary reviewers. After consultation, each question will be graded as a pass or fail within one week of receiving the student’s written answers. All three questions must be answered satisfactorily in order to pass this portion of the written examination. If the student fails one or more of the questions, the student will be asked to answer one or more of the remaining questions generated by the committee. If the student cannot satisfactorily complete 3 of 5 questions, the student’s continued participation in the program must be discussed with the student’s Dissertation Committee.

The second portion of the written examination consists of a research proposal related to the student’s dissertation topic. The proposal must originate with the student and should be an independent synthesis of ideas and experimental design from within the student’s field of interest. However, the proposal is not expected to serve as a “contract” for research to be accomplished, and may substantially differ from the
final dissertation project. The topic and scope of the research proposal must be approved by the dissertation committee prior to writing the proposal.

The student is advised to develop a well-focused proposal that is not overly ambitious and that can be completed in a timely manner. The responsibility for the quality of the proposal, which includes originality, practicality, significance, and methodology, rests entirely with the student. The student may seek general advice from members of the dissertation committee including the Dissertation Director, but should not expect them to be active participants in the generation and completion of the proposal. The topic for the original research proposition must be approved by the dissertation committee prior to the student's devoting a substantial commitment of time and effort to writing the proposal. The proposal description that the dissertation committee reads for approval should be a concise 2 to 3 page draft of the proposal emphasizing the problem being addressed and the experimental approaches proposed. In general this document should contain an abstract, a brief description of the background material, and specific aims. Try to focus the proposal on no more than 3 specific aims. In addition, the specific aims need to be independent of one another. For example, if A precedes B, which precedes C, and the experiments in A don't work, then B and C cannot be done. These types of proposal are a trap and should be avoided.

Once the topic of the research proposal has been approved by the dissertation committee, the student then proceeds to write the complete document. Be prepared to spend at least 2 to 4 weeks writing this draft. Like any other good grant proposal, quality will come from spending a lot of time thinking about the potential flaws in the proposal and then finding solutions. It is advisable to ask fellow students and colleagues to critique the document before it is distributed to the dissertation committee.

When the proposal has been written as well as possible, a copy should then be given to each member of the committee. The committee will need two weeks to critique the proposal and to give feedback. The dissertation committee has the option of requesting revision of the proposal. The dissertation committee will not sign off on this part of the preliminary exam until the document is acceptable. The proposal should have a Title that accurately describes the major hypothesis. This should be followed by an abstract (<200 words) that concisely summarizes the problem being addressed and the proposed experimental approaches (specific aims). The body of the proposal should include background information, enumerated specific aims, methods of approach, and an appraisal of the significance of the proposition. An excessive bibliography should be avoided; however it needs to include all pertinent references in which the methods are described and any relevant papers that support the goals of the proposal. Use primary references where possible, avoiding excessive reliance on reviews. The total written proposal, including figures and tables, but excluding references, should be limited to 20 double-spaced typewritten pages. Detailed descriptions of established methods can be left to the oral defense. The submitted document should be proofed carefully for grammar and spelling. A general format which can be used is given below:

Drug Discovery and Development Preliminary Exam Guideline, 2003, page 3

I. Title Page
II. Abstract
III. Research Plan (10 pages total)
   A. Hypothesis/Specific Aims (1/2 page)
   B. Background and Significance (2 - 3 pages)
   C. Experimental Design (6 - 8 pages)
IV. References (include full article titles)
V. Appendix (Figures, Tables, flow diagrams)
You may also find that the proposal is easier to read if the figures and tables are included in the text of the research plan rather than as a separate appendix. The above format should be taken as a suggestion with
the exception of the total length of the text. A well written, defensible proposal is the major requirement for passing the written preliminary exam.

Oral Examination

The student’s Dissertation Committee is responsible for administering the oral examination. The student is responsible for scheduling the Oral examination through GradPath. No student will be allowed to officially schedule the oral exam unless the written exam has been passed, although a tentative date can be arranged at any time with the Dissertation Committee. The student is responsible for scheduling the room for the oral exam. The oral portion of the comprehensive exam generally will consist of two components: (1) a defense of an original research proposal and (2) questions concerning general knowledge within the field of Drug Discovery & Development. The defense of the research proposition will test the student’s ability to generate original ideas and to defend the adequacy of the proposal for solving the problems addressed. It is expected that the student will demonstrate a reasonable knowledge of the literature and special techniques of the field. The general questioning portion may account for up to 50% of the oral examination. The general questions will primarily be derived from both the core and elective courses that the student has taken. Additional questions pertaining to the questions from the written portion of the exam may also be asked. The oral exam must last a minimum of 2 hours, but cannot exceed 3 hours. It is common for the student to give a 5- to 10-minute overview of the research proposal followed by questions from the committee centered about a defense of the research proposal (1 to 1.5 hours). The best way to study for the exam is (1) to know the proposal thoroughly, including all related topics, (2) to review all class notes and lecture material from all classes taken as a graduate student up to that point, especially the core course material, and (3) to be familiar with the recent literature (particularly in the fields represented by the committee members). It is important to plan your studying so that you do not get “burned out” before the exam. Know what material you want to cover and then systematically go through it. It is an excellent idea to have at least one “practice oral exam” with other graduate students and postdoctoral associates about two weeks before the scheduled exam. This can be very helpful in identifying weaknesses and will give students practice thinking on their feet.

6.22 Failure of the Second Attempt of the Oral Comprehensive Examination

Students who fail a second attempt of the oral comprehensive examination are automatically dismissed from the Ph.D. Program. It is possible, with a recommendation from the comprehensive examination committee, to convert the student to the M.S. Program. The student will be required to complete an M.S. thesis. See Section 7.0, of this handbook for M.S. degree requirements.

6.23 Advancement to Candidacy

When the student has an approved doctoral Plan of Study on file, has satisfied all course work, language, and residence requirements, and passed the written and oral portions of the Comprehensive Examination, he or she will automatically advance to candidacy. The Candidacy fee, the dissertation processing fee, and the archiving fee (total of $135) will be assessed when the student passes the Oral Comprehensive Exam.

After passing the Oral Comprehensive Exam, the student is required to submit the Committee Appointment Form to the Graduate Degree Certification Office. The Final Oral Defense Examination cannot be scheduled until at least six months after the form is received. Deadlines for the submission of paperwork pertaining to doctoral programs, as well as all forms, are available via GradPath at the Graduate College Website: http://grad.arizona.edu/
6.24 Final Examination

Upon the completion of the dissertation, the candidate is to submit to a Final Oral Defense Examination. A student must be in good academic standing to schedule the defense. The examination focuses on the dissertation itself but can include general questioning related to the field(s) of study within the scope of the dissertation.

The exact time and place of this examination must be scheduled with the Graduate Degree Certification Office at least 7 working days in advance. Announcement of Final Oral Examination form must be filed with Graduate Degree Certification. A format correct copy of the dissertation must be delivered by the candidate to each committee member at least ten (10) working days before the examination. The student should print out two (2) dissertation approval pages, and bring them to the defense. It is expedient to get all signatures at the defense.

The dissertation director presides over the examination. The examination is closed to the public, except for an initial seminar portion during which the student presents the dissertation and entertains questions.

There is no minimum time limit for the Final Oral Examination, but the entire proceedings may not exceed three hours. Members of the committee must be present for the entire examination.

6.25 Dissertation

This begins when the student picks a laboratory and advisor. Planning the research program begins in meetings with the Major Advisor and the Dissertation Committee. The Committee reviews the goals and experimental approaches summarized by the candidate, particularly in relation to the objectives set out in the dissertation proposal, and helps formulate and approve any changes or new plans deemed appropriate. At this time it may become necessary to increase the frequency of Dissertation Committee meetings. The candidate is expected to fulfill specific goals recommended by the Committee.

6.26 Limitation on Time Spans

The Ph.D. degree with a major in Drug Discovery and Development usually requires approximately 4.5-5 years of education beyond the baccalaureate degree. As the success of laboratory experiments or the time required for their completion cannot be predicted accurately, more time may be required for completion of degree requirements. Students who enter the Program with advanced degrees (M.S., MD, Pharm.D., D.V.M.) should complete requirements for the Ph.D. degree in less than four (4) years.

Note: Graduate coursework credit, to be applicable toward a degree, must have been earned not more than ten (10) years prior to the completion of the requirements for the degree. This includes graduate credit earned for a master’s degree, if applicable.

The Graduate Council has instructed that petitions for time-limitation waivers should only be entertained under circumstances that are judged to be extraordinary and extenuating.
6.27 Timetable, Formal Documentation, and Deadline Dates

The following forms and deadlines are required by the Program Office and Graduate Degree Certification. All forms can be downloaded off the Graduate College website: (http://grad.arizona.edu/)

**Doctoral Plan of Study** - The Doctoral Plan of Study is submitted to Graduate Degree Certification no later than the third semester of residence at The University of Arizona.

**Results of the Oral Comprehensive Examination** – This form is filled out on-line through the Graduate College forms website. Print out the form and take it to your oral exam.

**Committee Appointment form** - After satisfactory completion of the Comprehensive Examination, the Committee Appointment form is completed, and must be submitted no later than six (6) months before the Oral Defense Examination (Dissertation Defense) is scheduled. The Program recommends submitting the Committee Appointment form immediately following completion of the Oral Comprehensive Examination.

**Announcement of Oral Defense Examination** - The Announcement of Oral Defense Examination must be submitted to Graduate Degree Certification no later than seven (7) working days before the date of the Final Oral Examination. A format correct copy of the dissertation must be given to each committee member and the Program Office, ten (10) working days before the examination.

6.28 Scientific Meetings

As part of the educational process, students in training will be encouraged to attend national scientific meetings, as travel support permits. Priority for travel support will be given to students presenting communications at national meetings such as the American Chemical Society, American Association for Cancer Research, American Association of Pharmaceutical Scientists, Gordon and Keystone Conferences, Society for Investigative Dermatology, AACR/NCI/EORTC, and related meetings. Students should discuss participation in meetings and travel support with their Research Advisors. Students may also apply for travel funds available from the Graduate College by contacting the Program Office. The Program Office requires a copy of any communications presented (e.g., abstracts).