University of Hawai‘i at Hilo
The Daniel K. Inouye College of Pharmacy

Ph.D. in Pharmaceutical Sciences

Student Handbook
2013 - 2014

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Rev. 10.01.13

Introduction

The *Ph.D. in Pharmaceutical Sciences Student Handbook 2013-2014* for the Daniel K. Inouye College of Pharmacy (DKICP), Ph.D. in Pharmaceutical Sciences supplements the policies and procedures set forth by the University of Hawai‘i at Hilo (UH Hilo) Graduate Council as outlined in the UH Hilo Graduate Student Handbook. Graduate students within the DKICP at the University of Hawai‘i at Hilo are also members of the University's Graduate Program and should be familiar with both student handbooks. **This document outlines additional policies and procedures—**departmental policies and procedures that have been established by the faculty of DKICP. Upon reading these procedures and requirements, you will realize that the faculty of the department has set basic goals for all graduate students. We hope that each of you will set higher goals for your own personal and scientific development. The faculty of the department will do everything possible to assist you in achieving those goals.

Accreditation

The Daniel K. Inouye College of Pharmacy Ph.D. in Pharmaceutical Sciences was provisionally approved by the Western Association of Schools and Colleges (WASC) on April 11, 2011.

Program Mission

The mission of the Ph.D. program in Pharmaceutical Sciences is to train students to be skilled researchers and critical thinkers who will play key leadership roles in furthering the development of the Pharmaceutical Sciences and related fields now and into the future.

Program Description

The Daniel K. Inouye College of Pharmacy at the University of Hawai‘i at Hilo is proud to offer a Ph.D. program in the Pharmaceutical Sciences which aims to utilize the extraordinary intellectual, biological, physical and cultural diversity of its geographic region as a focus of investigation and study.

This program, which is the only program of its type in the Pacific region, provides graduate training in the Pharmaceutical Sciences including; Medicinal Chemistry, Pharmacology, Pharmaceutics, and Pharmacognosy. It is aimed at students with B.S., M.S., or Pharm.D. degrees, and individuals currently working in the field. Studies culminate with the award of a Ph.D. in Pharmaceutical Sciences, with an emphasis on

natural products discovery and development and their importance in pharmacy and healthcare.

Students will be prepared for senior leadership positions in the pharmaceutical sciences in academia, research, education, government, industry and related fields and become leaders who can identify, research, and problem solve issues related to the pharmaceutical sciences. The Ph.D. program is designed to foster student development as critical thinkers, team players, self-directed interdisciplinary scholars and communicators.

Selection of a Major Professor

It is essential that each graduate student select a Major Professor (primary academic advisor, dissertation supervisor, thesis advisor) early in their graduate career. This selection process is initiated by contacting and visiting with various faculty members in the department. These interviews will help students become acquainted with the individual faculty members and to learn of their research interests. As you approach a final decision on the selection of a Major Professor, you may wish to talk more than once with those faculty members of particular interest. Selection of a Major Professor must be completed by the end of the first academic year (exceptions require approval of the Ph.D. Program Director). The individual faculty must agree to serve as the student's Major Professor before the selection can be finalized. It is strongly suggested that the student select his/her Major Professor as early as possible to permit formulation of a Plan of Study. Before the start of the second year in the program, the student, in consultation with the Major Professor and Graduate Committee, will create a Plan of Study consisting of appropriate didactic courses and research credits that will fulfill the requirements for graduation. In addition, students are encouraged to begin their research no later than the summer of the first academic year. The Ph.D. Program Director will serve as the faculty advisor until a Major Professor has been selected.

Selection of Graduate Committee

The Graduate Committee (advisory committee, thesis committee, dissertation committee) will be responsible for providing professional advice to the student throughout the program and assessing the student's performance. The Graduate Committee will consist of a minimum of the Major Professor and two additional faculty. Two of the members of the committee must be tenured/tenure-track faculty at the University of Hawai'i at Hilo. Before the selection becomes finalized, individual faculty must agree to serve as members of the student's committee. The Graduate Committee will be expanded to include the Outside Member and the External Examiner before the Dissertation Defense. Please refer to appropriate section of the UH Hilo Graduate Student Handbook for additional details.

Alphabetical Listing of Ph.D. Program Faculty in the Daniel K. Inouye College of Pharmacy

Name and Title	Topic Area	Institution	Year	Email
Julie Adrian, DVM Assistant Professor	Small Animal Medicine	Oklahoma State	2004	jluiz@hawaii.edu
Andre Bachmann, Ph.D. Associate Professor	Biology	University of Zurich	1998	andre@hawaii.edu
Forrest Batz, Pharm.D. Assistant Professor	Clinical Pharmacy	UC San Francisco	1989	fbatz@hawaii.edu
Robert P. Borris, Ph.D. Associate Dean for Research and Associate Professor	Pharmacognosy	University of Illinois at Chicago	1981	borris@hawaii.edu
Leng Chee Chang, Ph.D. Assistant Professor	Pharmacognosy	University of Illinois at Chicago	1998	lengchee@hawaii.edu
Mahavir Chougule, Ph.D. Assistant Professor	Pharmacy	Maharaja Sayajirao University of Baroda, Vadodara, India	2007	mahavir@hawaii.edu
Linda Connelly, Ph.D. Assistant Professor	Molecular Pharmacology	University of London, England	2002	lindacon@hawaii.edu
Edward Fisher, Ph.D., R.Ph Professor and Associate Dean for Academic Affairs	Pharmacology and Toxicology	Temple University	1987	fishere@hawaii.edu
Daniela Guendisch, Ph.D. Assistant Professor	Pharmaceutical Chemistry	Eberhard-Karls University, Germany	1992	danielag@hawaii.edu
Aaron Jacobs, Ph.D. Assistant Professor	Pharmacology	University of California at Los Angeles	2003	jacobsa@hawaii.edu
Susan I. Jarvi, Ph.D. Associate Professor	Biology	Northern Illinois University	1989	jarvi@hawaii.edu

Tamara Kondratyuk, Ph.D. Assistant Specialist	Biochemistry	Moscow State University	1992	kondraty@hawaii.edu
Dana-Lynn Koomoa-Lange, Ph.D. Assistant Professor	Molecular Pharmacology, Physiology and Biotechnology	Brown University	2005	danalynn@hawaii.edu
Russ J. Molyneux, Ph.D. Affiliate Faculty	Organic Chemistry	University of Nottingham, England	1964	molyneux@hawaii.edu
Kenneth Morris, Ph.D. Professor	Pharmaceutics	University of Arizona	1988	krmorris@hawaii.edu
Anthony Otsuka, Ph.D. Instructor	Chemistry	University of California at San Diego	1979	ajotsuka@hawaii.edu
Karen Pellegrin Ph.D., M.B.A. Director of Strategic Planning	Psychology, Business Administration	University of South Florida and The Citadel	1991 1996	karen3@hawaii.edu
John M. Pezzuto, Ph.D. Professor and Dean	Biochemistry	University of Medicine and Dentistry of New Jersey	1977	pezzuto@hawaii.edu
Dianqing Sun, Ph.D. Assistant Professor	Organic Chemistry	University of Memphis	2004	dianqing@hawaii.edu
Ghee Tan, Ph.D. Assistant Professor	Biochemistry and Molecular Pharmacology	University of Illinois at Chicago	1992	gheetan@hawaii.edu
Gary R. Ten Eyck, Ph.D. Assistant Professor	Biological Sciences	University of South Dakota	1997	gte4@hawaii.edu
Supakit Wongwiwatthananukit, Pharm.D., Ph.D. Associate Professor	Pharmacy Practice	Purdue University	2001	supakit@hawaii.edu
Anthony D. Wright, Ph.D. Associate Professor	Organic Chemistry	James Cook University, Australia	1988	adwright@hawaii.edu

Faculty Research Interests

Supervisor	Research Areas
Andre Bachmann	Research emphasis on new treatment options for children with relapsed pediatric neuroblastoma. Identification and characterization of natural product small molecules and chemically modified analogs that block ODC, Akt, ALK, mTOR, STAT3, and the proteasome. Mechanistic intracellular trafficking studies to understand PRAF2, a novel prognostic marker in neuroblastoma.
Robert P. Borris	Terrestrial Phytochemistry: Production of metabolites by plant cell and tissue culture; Microbial chemistry
Leng Chee Chang	Natural products as Inhibitors of Raf Targeting Oncogenic Kinases; Medicinal plants of Hawaiian as sources of Cancer Chemopreventive agents; Potential Smoking Cessation agents from *Vernonia cinerea* Less
Mahavir Chougule	Development of targeted therapies for lung cancer and asthma, Multifunctional nano-carriers for treatment of lung cancer; Inhalable nano-spheres for treatment of asthma; siRNA and drug delivery
Linda Connelly	The role of inflammation in tumor progression
Daniela Guendisch	Development of central nervous system drugs; Development of radiotracers for *in vivo* imaging (PET, SPECT); Development of DMLs (desired multiple ligands); Development of nAChR ligands; in silico ADMET; organic chemistry of drug degradation.
Aaron Jacobs	Molecular and phenotypic characterization of novel heat-shock induced gene products; Mechanisms of signal transduction cross-talk between heat shock and hypoxia-induced cellular responses
Susan I. Jarvi	The role of host genetics in resistance to malaria (*Plasmodium relictum*); Parasite-parasite interactions and influences on virulence; rat lung worm studies
Dana-lynn Koomoa-Lange	(1) Elucidating the mechanisms that alter calcium signaling in diabetes, cancer and other pathophysiological disorders and diseases. (2) Screening extracts and synthesized compounds for potential anti-cancer effects.
Ken Morris	Pharmaceutical Materials Science for dosage form design and processing
John M. Pezzuto	Anti-cancer potential of synthetic indenoisoquinolines in breast cancer cells; Anti-inflammatory and chemopreventive potential of synthetic stilbenoids; Aromatase induction and cancer chemoprevention by analogs of casimiroin; 4-Bromoflavone and the potential benefits of bifunctional inducers of phase II enzymes;

	Marine phenazines as possible chemopreventive compounds; Mechanistic studies of NFκB inhibition by resveratrol derivatives; Molecular mechanism phenazine inhibition of breast cancer cell lines' invasiveness
Dianqing Sun	Design and synthesis of novel small molecule and natural product-inspired antitubercular and antibacterial agents; Synthesis and evaluation of anticancer and cancer chemopreventive agents.
Ghee Tan	Drug discovery for cancer and malaria; Endophytic bacteria and fungi as sources of new drug leads; Assay development and validation; Mechanism of action of bioactive natural products and molecular target identification; Natural products as probes for biological processes; Pharmacological validation of medicinal plants and ethnopharmacology.
Gary R Ten Eyck	Neuroendocrine and neurochemical studies in aggression and stress; Investigations in behavioral neuroscience, particularly parental care and territoriality; Pharmacological and/or environmental studies on *E. coqui* and its effect on the Island of Hawaii.
Supakit Wongwiwatthananukit	Clinical research of drugs, complementary and alternative medicine in the areas of tobacco cessation, hyperlipidemia, obesity, diabetes, cancer therapy; Investigation of the availability and use of medicines, complementary and alternative medicines by consumers in communities, instrument to assess humanistic outcomes and evaluation of the patient-oriented pharmacy services/interventions and/or interdisciplinary teams, and pharmaceutical care.
Anthony D. Wright	Endophytic Fungi and Bacteria: Secondary metabolites their structure and biological activities; Marine Organism ~Macro and Micro~: Secondary metabolites their structure and their biological and ecological activities; Microbes from Marine and Terrestrial Sediments: Secondary metabolites their structure and biological activities; Analysis, quantification and validation of natural materials currently used or that may be used in the health care industry.

UHH University-wide Doctoral Degree Requirements

The UHH Graduate Catalog stipulates the specific requirements for the doctoral degree in each program. The campus-wide requirements, excerpted directly from the UHH Graduate Catalog, include:

1. Maintenance of at least a B average in courses approved by the program's graduate committee and presented for the degree.
2. Fulfillment of all program course requirements (no credit is granted for graduate courses in which a grade lower than B- has been received).
3. Completion of at least 24 credit hours in residence regardless of any previous graduate coursework elsewhere. **Students continuing their studies for a doctoral degree in the same UH Hilo program from which they earned their masters' degree need not fulfill a second residence requirement.**
4. Continuous registration including the semester in which final degree requirements are completed (this does not include summer terms).
5. Demonstration to the graduate committee by means of a comprehensive examination (written and/or oral) of familiarity with basic hypotheses and techniques of the discipline and competence in applying them.
6. Fulfillment of any research skills requirements.
7. Submission of a dissertation on a topic approved by the department or school, embodying the results of original research and giving evidence of high scholarship.
8. Successful defense of the dissertation at a final oral examination.
9. Completion of any other requirements specific to the graduate program.

Ph.D. in Pharmaceutical Sciences Graduation Requirements

1. Successful completion of the first year requirements which serve as the Comprehensive Examination in our program.
2. Regardless of any previous graduate experience, a minimum of 24 graduate didactic credit hours must be taken at UH Hilo before the Ph.D. degree can be granted.
3. Completion of all first year graduate courses each with a grade of no less than "B", and a cumulative grade point average than "B". Specific minimal grades may be required for particular courses.
4. Successful completion of required seminars.
5. No later than the end of the third year of the program, the student shall write a dissertation research proposal and present a public seminar on his/her planned dissertation research. Following the public seminar, the student will take an oral examination (Proposal Defense) covering the dissertation research proposal and any other topics that the Graduate Committee deems necessary. In this examination, the student's Graduate Committee will determine if the student is sufficiently prepared in the selected field of study to continue with their dissertation. Once the student passes the Comprehensive Examination and the Proposal Defense, they are eligible to be admitted to Candidacy for the Ph.D. Degree.
6. Successful completion of a dissertation, with enrollment in a minimum of 56 credits of PHPS 800. Upon completion of the dissertation, a final public seminar and oral dissertation defense (Dissertation Defense) will follow.
7. Completion of at least 96 combined credits of graduate courses and dissertation; PHPS 600, PHPS 700 and PHPS 800.
8. Compliance with UH Hilo rules and regulations for graduation.

Academic Calendar

Please go to: http://hilo.hawaii.edu/registrar/currentterm.php

Checklist for Ph.D. in Pharmaceutical Sciences

- ***Student:*** Completes the first year core course requirements, passing each course with B grade or better, and presents and defends a public seminar; these requirements constitute the Comprehensive Examination. Students can place out of certain core courses by testing.
- ***Student:*** Completes interviews with faculty, completes lab rotations, and chooses a Major Professor (principal academic advisor) before the end of the second semester of the first year.
- ***Student:*** For each semester that they enroll in PHPS 800 (Dissertation Research and Graduate Seminar), the students fill out the Thesis/Dissertation Form for Graduate Level Degree, obtain the required signatures, and submit the completed form to the DKICP Office of Student Services who will register the student for PHPS 800. For students that do not have a Major Professor, the student should fill out the form through the Ph.D. Program Director.
- ***Student:*** In conjunction with Major Professor, chooses the Graduate Committee before the end of the second semester of the first year. The Graduate Committee consists of the Major Professor and 2 faculty members chosen as specified in the Graduate Catalog. Student and Major Professor should fill out Form 1: Graduate Committee Formation and forward it to the Ph.D. Program Director.
- ***Graduate program:*** Reports the designation of the Major Professor and the constitution of the Graduate Committee to the Graduate Division. Submits Form 1: Graduate Committee Formation.
- ***Student:*** In conjunction with Major Professor and the Graduate Committee, reviews student's progress and reports it annually at the end of the academic second semester to the Ph.D. Program Committee. Submits Annual Progress Report Form.
- ***Student:*** Submits a Plan of Study to the Ph.D. Program Director before the start of the Fall semester of the 2nd year of study. The student must take 6 credits of didactic courses beyond the first year to satisfy the 24 credits of didactic courses requirement.
- ***Student:*** Writes Dissertation Proposal and schedules Proposal Defense to take place before the end of the 6th semester of the student's program. The arrangements for the proposal defense must be made known to the Ph.D. Program Director 4 weeks before the exam is given. In addition to an oral examination, the proposal defense will include a public seminar.
- ***Student:*** Submits Form 2: Thesis/Dissertation Proposal to the Ph.D. Program Director once the proposal defense has been successfully completed and when ready to begin thesis research.

- ***Student and Major Advisor:*** If the thesis project involves regulated procedures and materials, and approval has not already been obtained, then appropriate approval must be obtained from IACUC, IRB, and IBC, as necessary, before initiating the research. Submit Recommendation for Admission to Candidacy for a Doctoral Degree form and appropriate regulatory documents to the Ph.D. Program Director who will forward them to the Graduate Division. The student must have completed the Comprehensive Examination and Proposal Defense before Admission to Candidacy.
- ***Student:*** Satisfies residence and course requirements.
- ***Student:*** Writes a prospectus.
- ***Student:*** Maintains appropriate registration for dissertation credit each semester, including semester in which all degree requirements will be completed.
- ***Student:*** Completes dissertation.
- ***Student:*** Submits to the Ph.D. Program Director a list of completed courses, credit hours, and grades on the Degree Audit for Ph.D. Form to ensure that the course requirements have been met.
- ***Graduate program:*** For the purpose of the final oral examination, the Graduate Committee is expanded to include an outside member and an external examiner.
- ***Graduate program:*** Nominates outside member by memo to the VCAA or designee.
- ***VCAA or designee:*** Appoints outside committee member and so notifies the graduate program.
- ***Graduate program:*** Nominates external examiner by memo to the VCRED or designee.
- ***VCRED or designee:*** Appoints external examiner and so notifies the graduate program.
- ***Student:*** Notifies the Ph.D. Program Director of plans to defend the Ph.D. dissertation at least 4 weeks in advance of the defense. The Ph.D. Program Director will publicize the defense seminar.
- ***Student:*** The student will provide copies of the dissertation to the Graduate Committee at least 3 weeks before the Dissertation Defense. Normally, two months is recommended by the Graduate Division; the student should consult with the Graduate Committee.
- ***Student:*** Undertakes the Dissertation Defense which includes a public seminar and a final oral examination.
- ***Student:*** Passes final oral examination.
- ***Student:*** Obtains signatures of all committee members and Ph.D. Program Director on Form 3: Thesis/Dissertation Completion and submits it to the Ph.D.

Program Director for copying. The Ph.D. Program Director returns Form 3 to the student.

- ***Student*:** Obtains the signature of the VCRED on Form 3: Thesis/Dissertation Completion.
- ***Student*:** Submits dissertation on ETD Administrator.
- ***Student*:** Obtains initials of the Collection Development Librarian (or designee) on Form 3, then submits Form 3 to the Graduate Division for signature, and finally to the Office of the Registrar by the required deadline in the University calendar.
- ***Student:*** Collects signatures on Form 4: Certification of Degree Requirements and submits it to the Ph.D. Program Director who will forward it to the Graduate Division.
- ***Student*:** Completes the Survey of Earned Doctorates (optional). Details may be found in the UH Hilo Graduate Student Handbook.

Ph.D. in the Pharmaceutical Sciences Curriculum

To successfully complete the Ph.D. degree candidates must complete; 1) qualifying year 1 (Minimum GPA = 3.0); 2) a minimum of 24 graduate-level didactic credits; 3) after the first year, courses must be completed with GPA average of no less than 3.0; 4) a minimum 56 credits of Dissertation; and 5) a minimum of 96 credit hours overall (Minimum average GPA = 3.0).

Ph.D. Year 1 (Qualifying Year) Fall Courses *Total of 11 credits*

PHPS 750 Overview of the Pharmaceutical Sciences (3)
PHPS 751 Biochemistry I– Biomolecules (4)
PHPS 755 Advanced Pharmaceutics I, including Dosage Form Design and Processing (3)
PHPS 718 Lab Visits & Supervisor Select (1)

Ph.D. Year 1 (Qualifying Year) Spring Courses *Total of 13 credits*

PHPS 800 Dissertation Research and Graduate Seminar (6)
PHPS 752 Biochemistry II– Metabolism (4)
PHPS 756 Advanced Pharmaceutics II, including Dosage Form Design and Processing (3)

Ph.D. Year 2 Fall Courses *Total minimum of 12 credits*

PHPS 800 Dissertation Research and Graduate Seminar– (Minimum 6)
Electives – (No minimum, however 6 credits of didactic courses are required beyond the first year)

Ph.D. Year 2 Spring Courses *Total minimum of 12 credits*

PHPS 800 Dissertation Research and Graduate Seminar– (Minimum 6)
Electives – (No minimum, however 6 credits of didactic courses are required beyond the first year)

Ph.D. Year 3 Fall Courses *Total minimum of 12 credits*

PHPS 800 Dissertation Research and Graduate Seminar– (Minimum 6)
Electives – (No minimum)

Ph.D. Year 3 Spring Courses *Total minimum of 12 credits*

PHPS 800 Dissertation Research and Graduate Seminar– (Minimum 6)

Electives – (No minimum)

Ph.D. Year 4 Fall Courses *Total minimum of 12 credits*

PHPS 800 Dissertation Research and Graduate Seminar– (Minimum 6)
Electives – (No minimum)

Ph.D. Year 4 Spring Courses *Total minimum of 12 credits*

PHPS 800 Dissertation Research and Graduate Seminar– (Minimum 6)
Electives – (No minimum)

Ph.D. Year 5 and beyond are taken on an as required basis. *Total minimum of 12 credits*

PHPS 800 Dissertation Research and Graduate Seminar– (Minimum 6)
Electives – (No minimum)

Ph.D. Course Listings

Ph.D. First Year, Fall (11 Core credit hours)

PHPS-750* Overview of the Pharmaceutical Sciences (3 Core credit hours)

This 3 credit, 45 lecture and written research assignment course will draw on the basic principles of chemistry, biology and physics to provide an introduction to the basics of the Pharmaceutical Sciences. Some of, but not all, the areas covered include: an overview of the subject as a whole, basic organic functional group chemistry, an introduction to Pharmacognosy, and introduction to Medicinal Chemistry, Combinatorial Chemistry and high throughput technologies in modern drug discovery, architecture of drugs, metabolic changes that occur to drugs, introduction to general Pharmacology, transport of drugs across the biological membranes, introduction to Pharmacodynamics and Pharmacogenomics, general mechanisms of drug action, and variations in drug action. Pre: Enrollment in the College of Pharmacy Ph.D. program.

PHPS-751* Ph.D. Biochemistry I– Biomolecules (4 Core credit hours)

This course is designed to provide a basic foundation for the understanding of medicinal biochemistry, pharmacology, and the structure and function of various biomolecules. Topics will include physical and chemical properties of amino acids, structural and physical properties of proteins, nucleic acids (DNA and RNA), lipids, and their

relationship to their biological function, fundamentals of signal transduction, DNA replication, mutation, and repair, nucleotide biosynthesis, protein synthesis, and transcription. These principles will provide the basic concepts for understanding the biochemical basis for disease states and drug action. Pre: Enrollment in the College of Pharmacy Pharmaceutical Sciences Ph.D. program.

PHPS-755* Advanced Pharmaceutics I, including Dosage Form Design and Processing (3 Core credit hours)

This course will draw on the basic principles of chemistry, biology and physics to provide an understanding of how drug physico-chemical properties at the molecular and macroscopic assembly level are manifest in dosage form properties and performance. Students will integrate these principles to understand issues in the rational selection of dosage forms and drug delivery systems as well as their role in drug product development. Discussions of Good Manufacturing Practices and Good Compounding Practices will carry over into the lab portion of the class. Students will become comfortable with equipment; procedures and records used in the compounding of various dosage forms, and will practice clinical dispensing skills vital to shaping a truly professional pharmacist. Pre: Approval of Major Professor.

PHPS-718 Lab Visits & Supervisor Selection (1 Core credit hour)

This one credit course is designed to enable all Ph.D. candidates time to become familiar with the research being undertaken by possible dissertation supervisors. Each candidate will visit with and interview at least six possible dissertation supervisors and discuss with them dissertation research projects they will be offering. As required, individual candidates may want to spend a longer period in the laboratory of potential dissertation supervisors to actual gain some hands on experience as to what is going on in given laboratory to assist them in making their decision about whose group they would like to join. At the end of the interview process each candidate will submit a three page paper detailing the overall process they went through to eventually select a dissertation supervisor and dissertation topic. Pre: admission into the Ph.D. program in Pharmaceutical Science.

Ph.D. First Year, Spring (13 Core credit hours)

PHPS-800 Research Dissertation Research and Graduate Seminar (6 Core credit hours)

This course outlines the conduct of the dissertation project and preparation of the actual dissertation document for the Doctoral level student. The dissertation is a major undertaking that is a demonstration of mastery of a field of research in the

Pharmaceutical Sciences and should represent an original and significant contribution to the field. The dissertation document will usually be no less that 150 pages in length and be based on a research project defined by the candidate's Major Professor. The project may take a variety of forms, for example, be quantitative, qualitative, or theoretical, the main criteria being that at the completion of the research the candidate can demonstrate mastery of, and excellence in, their chosen area of research. Prerequisites after first year in Ph.D. program: Successful completion of the first, qualifying year of the Ph.D. program which is the equivalent of the Comprehensive Examination, and selection of a Major Professor, a Dissertation research topic and a Graduate Committee.

PHPS-752* Biochemistry II– Metabolism (4 Core credit hours)

Biochemistry II - Metabolism will delve into metabolism and the interrelationships/integration of metabolic processes. The biochemistry of metabolism focuses on glycolysis, the tricarboxylic acid cycle, gluconeogensis, and the synthesis and breakdown of biomolecules (carbohydrates, lipids, and amino acids). Metabolic control and regulation of pathways will be emphasized. This includes a discussion of mechanisms and control of signal transduction pathways, and recurring motifs in metabolism. Clinical correlates and metabolic diseases will be examined, with a substantial emphasis on metabolic syndrome. A sampling of biochemical techniques will also be described. Pre: Enrollment in the College of Pharmacy Pharmaceutical Sciences Ph.D. Program

PHPS-756* Advanced Pharmaceutics II, including Dosage Form Design and Processing (3 Core credit hours)

This course will draw on the basic principles and developmental aspects of drug formulation to deliver the active pharmaceutical ingredient through biological membranes to exert the therapeutic effect at site of action. Understanding of physicochemical properties of active pharmaceutical ingredient and additives or excipients, pharmacological properties and processability of drug delivery systems can be utilized for optimal performance of the drug delivery systems. Understanding of active pharmaceutical ingredient and additive or excipients physico-chemical properties at the molecular and macroscopic assembly level are manifest in dosage form properties and performance. Students will integrate these principles to understand issues in the rational choice of dosage forms and drug delivery systems as well as their role in drug product development. Discussions of Good Manufacturing Practices and Good Compounding Practices will carry over into the lab portion of the class. Students will become familiar with procedures and records used in the compounding of various dosage forms, and will practice clinical dispensing skills vital to shaping a truly professional pharmacy professional scientist. Pre: Enrollment in the College of Pharmacy Pharmaceutical Sciences Ph.D. program.

Ph.D. Second Year Fall to end of Program

A minimum of 12 credit hours have to be taken each semester. Six credit hours of didactic courses need to be taken after the first year in order to satisfy the requirement for 24 credits of didactic courses.

PHPS-800 Dissertation Research and Graduate Seminar – (6 Core credit hours)

A minimum of 6 credit hours of PHPS-800 have to be taken each semester.

Electives – (No minimum)

Please see Appendix 1 for elective course descriptions.

Electives – Listed by Course Number

Course code	Course Title	Credits
PHPS 701	Apoptosis and Angiogenesis in Disease Processes and Drug Development	1
PHPS 702	Biological Evaluation of Natural Products	3
PHPS 703	Cancer Biology	2
PHPS 704	Combinatorial Chemistry and High Throughput Technologies in Drug Discovery	2
PHPS 705	Designing Clinical Research	3
PHPS 706	Environmental Toxicology	2
PHPS 707	Genetics in Medicine	2
PHPS 708	Isolation methods for natural product discovery	2
PHPS 709	Instrumental methods and structure elucidation of mainly natural products	2
PHPS 710	Laboratory Animal Care, Management and Medicine I	2
PHPS 711	Laboratory Animal Care, Management and Medicine II	2
PHPS 712	Medical Cell Biology	2
PHPS 713	Organic Medicinal Chemistry I	2
PHPS 714	Organic Medicinal Chemistry II	2
PHPS 715	Organic Medicinal Chemistry III	2
PHPS 716	Organic Medicinal Chemistry IV	2
PHPS 717	Medicinal Chemistry of CNS Drugs and	2

	Development of *in vivo* CNS Tracers	
PHPS 719	Molecular Biology Techniques and Applications for Healthcare Professionals	2
PHPS 720	Natural Products and Cancer Chemoprevention	2
PHPS 721	Neuropsychopharmacology	2
PHPS 722	Pharmaceutical Marketing	2
PHPS 723	Pharmacognosy	2
PHPS 724	Pharmacology I	3
PHPS 725	Pharmacology II	3
PHPS 726	Pharmacology III	3
PHPS 727	Pharmacology IV	3
PHPS 728	Phytochemistry of Terrestrial Plants	2
PHPS 729	Receptor Theory and Signal Transduction	2
PHPS 730	Sample collection, documentation and preservation	1
PHPS 731	Toxicants and Toxicity	3
PHPS 732	Toxic plant natural products and their therapeutic potential	2
PHPS 7XX	Biotechnology Laboratory	2

Academic Performance during the First Year of Study

You must take a full course load during each semester of your first year and achieve a grade of B or better in each course. If you do not achieve a B grade or better in courses taken during the two semesters of your first year, the Ph.D. Program Committee will review your case, and you may be asked to leave the program. Each student must present a public seminar and successfully defend it to his/her Graduate Committee. These first year requirements constitute the Comprehensive Examination in our program.

Plan of Study

You will be required to file a Plan of Study tailored to your research interests and the goals of your Graduate Committee at least one month prior to the start of your second year. This Plan of Study will contain the proposed courses you will be taking during your studies in the department as agreed by your Graduate Committee.

Academic Performance during the Second and Subsequent Years of Study

A cumulative GPA of 3.0 or above is required for continuation in the department graduate program during the second and subsequent years. The department will review

grades after each semester. After one semester with a semester GPA below 3.0, the student is placed on departmental probation. A semester GPA below 3.0 for two consecutive semesters constitutes grounds for dismissal from the departmental graduate program. In such cases, the student's Graduate Committee shall meet with the student and submit a written report to the Ph.D. Program Director, with a copy going to the student, justifying continuation or recommending termination of the student.

Each student is required to receive a grade of A or B in all departmental courses. A student receiving a C grade in a departmental course may have to re-evaluate his/her commitment to graduate study in the department. In addition, the Graduate Committee may require a minimum B grade for other selected courses, which will be so noted on the plan of study.

Proposal Defense

Each student must prepare a written proposal for their dissertation research and defend it in a Proposal Defense (Preliminary Examination, Qualifying Examination). You must submit a written copy of your research proposal to each member of your Graduate Committee at least three weeks prior to the day of the Proposal Defense. The proposal should follow the NIH or NSF format, or an equivalent format as defined by your Major Professor. The student will present the research proposal in a public seminar. The public seminar will be followed by an oral examination that is based on the written research proposal and general knowledge in pharmaceutical sciences. The examination, that emphasizes literature review, formulation of a hypothesis/model, and experimental plan, must be taken within three years of starting the program. The research proposal will serve as a basis for questions during the oral proposal defense; however, the examination is not limited to the specifics of the proposal. The Ph.D. Program Director shall be informed of the Proposal Defense date at least 4 weeks in advance.

The Proposal Defense may be repeated once, but if it is not passed on the second attempt, the student may not continue in the graduate program. Thus, you may earn only one failing grade on the Proposal Defense.

Research Performance

The early selection of your Major Professor is important not only from the standpoint of course registration but also from the standpoint of initiating a research project early in your graduate career. Once your research is in progress your Major Professor and your Graduate Committee will monitor your research progress. Throughout the research phase of your program, it is required that you provide research reports to your Graduate Committee annually. It is further required that you meet with your Graduate Committee on an annual basis, typically at the end of each academic year, to discuss your research.

Satisfactory or unsatisfactory performance in research will result in a satisfactory (S) or unsatisfactory (US) grade in PHPS 800. The student's actual grade will not be recorded until the student graduates or leaves the program. Students receiving a US grade are required to meet with their Graduate Committee. If a student receives a second US grade in research, she or he may be asked to leave the department.

Departmental Seminar Program

Each student will be required to present a seminar during the second semester of each academic year while enrolled in the graduate program or at a date acceptable to their Major Professor and Director of the program. The seminar should cover some aspect of the scientific literature, or their graduate research, and should be carefully thought out and prepared by the student. These seminars are evaluated by the faculty and are the basis for a grade in seminar during that semester as well as serving as an evaluation of new graduate students. Each student is also required to present a seminar on their graduate research as part of their dissertation defense.

Attendance at all seminars is mandatory for all students unless excused by the Major Professor.

Overall Student Performance Review

The Ph.D. Program Committee will review the progress of all the graduate students at least once a year. This review will include academic performance, including grade index, course hours completed, and attainment of departmental and University minimal requirements. The purpose of this review is to provide graduate students with an early indication of faculty concern with their progress. If it is found that any aspect of the student's performance is lacking, the student, the student's Major Professor, and the student's Graduate Committee will be informed in writing. The Ph.D. Program Committee may, as a result of such a review, recommend that a particular student terminate graduate study. The student involved may request an appeal of that recommendation via the Ph.D. program student complaint guidelines.

Outside Employment

Graduate school is a full-time endeavor and students are expected to devote their entire efforts toward completing their research and dissertation. Outside employment of any kind is discouraged. The program will not take outside employment or activities into consideration when scheduling classes, examinations, etc. If financial exigencies require you to pursue outside employment, please confer with your advisor.

Graduate Student Code of Conduct

Please refer to the Graduate Student Handbook which can be found at:
http://hilo.hawaii.edu/academics/graduate/documents/GraduateStudentHandbook2013-2014-2.pdf

The Daniel K. Inouye College of Pharmacy Directory

http://hilo.hawaii.edu/directory/depts.php?dept=79

UH Hilo Campus Directory

http://hilo.hawaii.edu/directory/

UH Hilo Security Report (Clery Act)

http://hilo.hawaii.edu/auxsvc/security/documents/2012UniversityofHawaiiAnnualSecurityReportwattachment9.26.12.pdf

Appendix 1: Elective Course Descriptions (by Course Number)

PHPS-701 Apoptosis and Angiogenesis in Disease Processes and Drug Development (1 credit hour)

The course will cover mechanisms of apoptosis, or programmed cell death, and angiogenesis, or new vessel growth, and mechanisms of their regulation in different cell types. Students will learn how unbalanced angiogenic and apoptotic responses contribute to a wide variety of disease conditions, including cancer, neurodegenerative, cardiac, inflammatory and autoimmune diseases. The course will discuss experimental techniques that are used in the studies of these processes. Part of the course is devoted to approaches to development of drugs that will modulate apoptotic and angiogenic processes, and discussions of critical signaling molecules in these pathways as potential targets for drug development efforts. Pre: Approval of Major Professor.

PHPS-702 Biological Evaluation of Natural Products (3 credit hours)

The biological activity of secondary metabolites is central to the process of drug discovery and development from nature. Natural products may be explored as potential sources of food supplements, pharmaceuticals and agrochemicals. The majority of academic-based research efforts are essentially "biologically driven", hinging upon the bioassay-guided separation of crude natural product extracts that have been identified as active through a strategic screening and prioritization process that emphasize potency, specificity and selectivity. The chemically-driven approach that seeks biological activities for purified compounds plays a lesser, but nevertheless, significant role. This course will introduce students to the technologies and procedures useful for the discovery and characterization of potential natural product drugs, and principles of more advanced drug development at the preclinical stage. Lectures will discuss the use of specific assays with target receptors and enzymes involved in the pathogenesis of select diseases, in addition to procedures involving tissues, whole cells and organisms ("functional assays"). Lectures will also include the applications of genetically engineered microorganisms in drug discovery, as well as animal models where applicable. The genomics era will present opportunities for the exploration of novel assays as new molecular targets for chemotherapy are identified. Pre: Approval of Major Professor.

PHPS-703 Cancer Biology (2 credit hours)

An introduction to cancer biology covering the processes involved in tumorigenesis (oncogenes, mutagenesis, proliferation, apoptosis, angiogenesis, invasion and metastasis). There will be discussion of active areas of interest such as cancer stem cells and the role of inflammation in cancer. Lectures will include descriptions of current therapeutics, describe efforts to design new drugs and recent clinical trials. Pre: Approval of Major

Professor.

PHPS-704 Combinatorial Chemistry and High Throughput Technologies in Drug Discovery (2 credit hours)

This course is designed to teach students the essential elements of combinatorial chemistry and evolving high throughput technologies in drug discovery. Combinatorial chemistry and high throughput chemistries are dynamic, rapidly evolving fields that have an important role in drug discovery. Most pharmaceutical companies have now incorporated combinatorial and high throughput platforms into their drug discovery research program. Combinatorial chemistry is a relatively new approach to the synthesis of compound libraries in a highly efficient and automated fashion. The topics of this course will include, but not limited to, combinatorial chemistry and parallel synthesis; solid-phase organic synthesis; solution-phase synthesis with solid supported reagents and scavenger resin technology; diversity-oriented synthesis; dynamic combinatorial chemistry; high throughput screening of combinatorial libraries; microwave-assisted organic synthesis; fluorous technology, fragment-based drug discovery; and automation and instrumentation. Pre: Approval of Major Professor.

PHPS-705 Designing Clinical Research (3 credit hours)

The course introduces the science and methodological principles of undertaking clinical research. Emphasis is placed upon clinical trials of complementary and alternative medicine therapies. Topics include research question/problem/objective, research hypothesis, research processes, types of clinical research design, strengths and weaknesses of each design, measurements, concepts of reliability and validity, sampling designs, recruitment, sample size determinations, chance and bias, threats to the internal and external validity, monitoring safety and efficacy data, statistical tests and data management, ethical and regulatory considerations, translational research and funding agency. Students will be given the opportunity to identify a researchable idea/ question and design his/her own clinical or translational research project by preparing a written mini-proposal and then its presentation. Pre: Approval of Major Professor.

PHPS-706 Environmental Toxicology (2 credit hours)

This course is designed to introduce students to the field of environmental toxicology. The emphasis will focus more on ecotoxicology, rather than classical toxicology. Topics that will be covered include toxic and radioactive metal, toxicity of solvents and pesticides, halogenated aromatic compounds, environmental endocrine disruptors, and pharmaceuticals and personal care products in the environment. The environmental impact of global warming will also be addressed. Course format will include student lead discussions and presentations, lectures, and general discussion. Pre: Approval of Major

Professor.

PHPS-707 Genetics in Medicine (2 credit hours)

This course will provide an exposition of the fundamental principles of human and medical genetics with emphasis on the genes and molecular mechanisms operating in human diseases. The contributions made by genetic variation to disease susceptibility and treatment outcomes will be discussed. Clinical cases will be used to demonstrate and reinforce the general principles of disease inheritance, pathogenesis, diagnosis, management, and genetic counseling. Students will learn how understanding genetics can lead to new strategies in drug development and treatment. A seminar experience will keep students abreast of recent developments in the field by presenting current literature. Pre: Approval of Major Professor.

PHPS-708 Isolation methods for natural product discovery (2 credit hours)

This course will examine the theory and practice of the various types of chromatographic and non-chromatographic methods that are commonly used for the isolation of biologically active natural products from plants, microorganisms and marine organisms on scales ranging from microgram to kilograms of pure compound. Starting with simple extraction methods, the course will progress through liquid-liquid interactions to liquid-solid interactions and then to gas-solid interactions. Completion of this course will provide the student an understanding of the application of each of the techniques discussed, as well as their relative advantages and disadvantages. Pre: Approval of Major Professor.

PHPS-709 Instrumental methods and structure elucidation of mainly natural products (2 credit hours)

This course will introduce many of the pieces of spectroscopic equipment relevant to solving the three dimensional structure of organic molecules. Hands on use of the equipment to obtain spectroscopic data will be an emphasis of this course. The other emphasis of this course will be how to interpret the recorded information to enable a viable chemical structure to be proposed. During each session it is anticipated that prepared examples and examples arising from current research will be used to enhance participants' knowledge. Pre: Approval of Major Professor.

PHPS-710 Laboratory Animal Care, Management and Medicine I (2 credit hours)

This course is part one of a two part lecture series and is designed to introduce students to the care and use of laboratory animals in accordance with the National Research Council and the Institutional Animal Care and Use Committee (IACUC). Included in this course are alternatives to traditional use of live animal species and the laws, regulations and

guidelines important to laboratory animal research. Emphasis will be placed on the use of rats and mice, rodent anesthesia and analgesia and rodent surgery. Pre: Approval of Major Professor.

PHPS-711 Laboratory Animal Care, Management and Medicine II (2 credit hours)

This course is part two of a two part lecture series and is designed to introduce students to the care and use of laboratory animals in accordance with the National Research Council and the Institutional Animal Care and Use Committee (IACUC). Included in this course is a review of Laboratory Animal Care, Management and Medicine I. Emphasis will be placed on rabbits, Mongolian gerbils, guinea pigs, Syrian hamsters, dogs and cats, and primates. Pre: Approval of Major Professor.

PHPS-712 Medical Cell Biology (2 credit hours)

This course focuses on the scientific aspects of cell biology important to graduate students with primary focus on eukaryotic cell biology. The course will provide a basis to general cell biology principles in the context of organ systems and human and animal disease. Clinical cases will be used to build a framework for the basic concepts of medical cell biology and help reinforce conceptual understanding. Pre: Approval of Major Professor.

PHPS-713 Organic Medicinal Chemistry I (2 credit hours)

Organic Medicinal Chemistry I provides the chemical and structural basis for the interdisciplinary field of therapeutics related to diuretics, autonomic nervous system and cardiovascular systems. The topics will include the drug discovery and development process of these important medicines, the chemical and structural basis for the pharmacological and therapeutic action drugs, structural classifications, molecular mechanism of actions, structure activity relationship and how the physicochemical properties of drug molecules affect their route of administration stability, and absorption, distribution, metabolism and excretion. Synthesis of important molecules from each drug class will also be presented. Pre: Approval of Major Professor.

PHPS-714 Organic Medicinal Chemistry II (2 credit hours)

Organic Medicinal Chemistry II provides the chemical and structural basis for the interdisciplinary field of therapeutics related to diabetes, thyroid/pituitary disorders, hormones/osteoporosis/adrenal, asthma/COPD, and infectious diseases. The topics will include the drug discovery and development process of these important medicines, the chemical and structural basis for the pharmacological and therapeutic action of drugs, structural classifications, molecular mechanism of actions, structure activity relationship, and how the physicochemical properties of drug molecules affect their route of

administration, stability, and absorption, distribution, metabolism and excretion. Synthesis of important drug molecules from each drug class will also be presented. Pre: PHPS 713 and Approval of Major Professor

PHPS-715 Organic Medicinal Chemistry III (2 credit hours)

Organic Medicinal Chemistry III provides the chemical and structural basis for the interdisciplinary field of therapeutics related to antiviral agents, OA/RA/Gout, migraine, CNS agents including Parkinson/Alzheimer/Seizure. The topics will include the drug discovery and development process of these important medicines, the chemical and structural basis for the pharmacological and therapeutic action of drugs, structural classifications, molecular mechanism of actions, structure activity relationship, and how the physicochemical properties of drug molecules affect their route of administration, stability, and absorption, distribution, metabolism and excretion. Synthesis of important drug molecules from each drug class will also be presented. Pre: PHPS 714 and Approval of Major Professor

PHPS-716 Organic Medicinal Chemistry IV (2 credit hours)

Organic Medicinal Chemistry IV provides the chemical and structural basis for the interdisciplinary field of therapeutics related to gastro-intestinal/genito-urinary, chemotherapy, pain management, radiopharmaceuticals. The topics will include the drug discovery and development process of these important medicines, the chemical and structural basis for the pharmacological and therapeutic action of drugs, structural classifications, molecular mechanism of actions, structure activity relationship, and how the physicochemical properties of drug molecules affect their route of administration, stability, and absorption, distribution, metabolism and excretion. Synthesis of important drug molecules from each drug class will also be presented. Pre: PHPS 715 and Approval of Major Professor

PHPS-717 Medicinal Chemistry of CNS Drugs and Development of *in vivo* CNS Tracers (2 credit hours)

The course will focus on modern aspects of the design and development of compounds for the treatment of central nervous system disorders, and in addition on the development of PET (positron emission tomography) and SPECT (single photon emission computed tomography) tracers to monitor functional processes in vivo in the human body. Important properties and steps for profiling a drug to enhance the access to the brain will be discussed. The course will start with an overview about CNS targets and pharmacophore models for diverse compound families and will provide synthetic aspects of important drug templates. The production of relevant radio-nuclides, precursor and radiochemical synthesis, quality control and radio-pharmacological aspects (in vitro, ex

vivo, in vivo experiments) will be discussed. Pre: Approval of Major Professor.

PHPS-719 Molecular Biology Techniques and Applications for Healthcare Professionals (2 credit hours)

This course will provide students with basic and advanced information regarding DNA, RNA, and proteins, and describe current available techniques used in detecting genetic variation. Potential applications of these techniques to disease screening, drug resistance, and drug discovery and development will be reviewed. Isolation and purification of DNA samples from different cell types and tissues, DNA concentration techniques, restriction digestion and analysis, ligation of DNA to create recombinant molecules and designer genes will be discussed. Students will be provided with access to reference texts and selected online peer-reviewed articles in .pdf format by the Instructor. The Instructor will conduct lectures for sessions 1 and 15 and provide background material. Each student will select a topic from the remaining sessions (2-14) and will lead the discussion for that selected topic on the assigned day. Students may work in pairs (or more if necessary), depending on student enrollment. Students will learn to retrieve information from a variety of sources, comprehend and critically evaluate it, and subsequently lead a discussion on the selected topic. There will be no laboratory component. Pre: Approval of Major Professor.

PHPS-720 Natural Products and Cancer Chemoprevention (2 credit hours)

The course will concentrate on the molecular aspects of chemoprevention as a viable strategy in the fight against cancer. The treatment of many diseases is dependent on natural products. Over half of the currently approved anti-cancer and anti-infective drugs are of natural origin. Active leads from different structural classes such as alkaloids, flavonoids, coumarins, and phenazines will be described. Since carcinogenesis is a multistage process, different approaches to monitor inhibition of cancer initiation, promotion and progression will be characterized. The course will provide the student with an understanding of detailed aspects of research processes leading to the discovery of promising natural as well as synthetic and semi-synthetic chemopreventive compounds. Special attention will be given to ensure students are aware that the science of chemoprevention research is well established and offers great research opportunities. Pre: Approval of Major Professor.

PHPS-721 Neuropsychopharmacology (2 credit hours)

This course is designed as an intense, doctoral level class that amalgamates the disciplines of neuroscience, animal behavior, neurochemistry, and pharmacology. The course will cover the major topics of neuropharmacology such as cellular and molecular foundations of neuropsychopharmacology, behavioral pharmacology, receptor biology,

major neurotransmitter systems and antidepressants, anxiolytics, antipsychotics, drugs of abuse, and cognitive and movement disorders. Further, this course will integrate some of the principle topics in behavioral neuroscience, including aggression, fear, stress, memory, internal state, and evolution of sex and mating systems, communication, feeding behavior, anti-predator behavior, and the evolution of behavior. Course format will consist of lectures and exams, student presentations, and require a capstone research review paper. Pre: Approval of Major Professor.

PHPS-722 Pharmaceutical Marketing (2 credit hours)

This course has two major areas of emphasis in pharmaceutical marketing. The first part of the course will introduce the basic theory of pharmaceutical marketing and creative thinking behind product development. Students will learn the basic principles of consumer behavior and evaluation, environmental framework, social, and various other marketing theories to provide an understanding of how these concepts can influence product development in laboratories or drug industries. This section will also integrate these principles and concepts to understand issues related to the distribution and design of an innovative drug product development. The second part of the course is intended to use the principles and concepts learned in the first part to effectively develop a market plan for an innovative product. Pre: Approval of Major Professor.

PHPS-723 Pharmacognosy (2 credit hours)

Pharmacognosy is a highly interdisciplinary field which is one of five major areas of pharmaceutical education. Its scope includes the study of the physical, chemical, biochemical and biological properties of drugs, drug substances, or potential drugs or drug substances of natural origin as well as the search for new drugs from natural sources. This course will focus on chemical aspects of Pharmacognosy. Natural products are normally classified according to their biosynthetic origins and chemical properties. Thus, the objective of the course is to familiarize students with an introduction to and classification of natural products (terpenoids, alkaloids, phenylpropanoids and allied phenolic compounds). The basic metabolic pathways and the origin of secondary metabolites such as the shikimic acid pathways, the acetate-malonate pathway, the mevalonate pathways will be discussed. It is a core course of Pharmacognosy and enable students to use this knowledge in the future to explore Advanced Pharmacognosy. A special emphasis will be placed on how chemical structure affects physiological function of various natural products. Pre: Approval of Major Professor.

PHPS-724* Pharmacology I (3 credit hours)

In this 3 credit, 45 hour lecture, course students will learn pharmacology of specific drug groups. The course uses organ system approach. This course will begin with a discussion

of diuretics followed by autonomic nervous system pharmacology and conclude with a discussion of drug groups used for the treatment of cardiovascular disorders. In the autonomic pharmacology unit, students will learn about adrenergic and cholinergic drugs that possess agonist and /or antagonist activities at different types and subtypes of receptors that are present in autonomic nervous system and other tissues in the body. Cardiovascular pharmacology will include drug groups that are used in the management of hypertension, hyperlipidemia, heart failure, disorders of coagulation, cardiac arrhythmias, and ischemic heart disease. Pre: Approval of Major Professor.

PHPS-725* Pharmacology II (3 credit hours)

In this 3 credit, 45 hour lecture, course students will learn pharmacology of specific drug groups. The course uses organ system approach. This course will begin with a discussion of endocrine disorders pharmacology followed by pharmacology of asthma and chronic obstructive pulmonary disease (COPD), and conclude with a discussion of drug groups used for the treatment of infectious diseases. In the endocrine pharmacology unit, students will learn about drug groups that are used in the treatment of diabetes, thyroid and pituitary disorders, osteoporosis, as well as corticosteroid drugs. Respiratory pharmacology unit will include pathophysiology and pharmacology of drug groups that are used in the treatment of asthma and COPD. Infectious disease pharmacology unit will include discussions of antibacterial, antifungal, antiviral, antiprotozoal and antihelmintic drugs. Pre: Approval of Major Professor.

PHPS-726* Pharmacology III (3 credit hours)

This graduate-level course introduces the student to the basis of disease and pharmacology of drugs used to treat viral infections, osteoarthritis, rheumatoid arthritis, gout, and CNS disorders. Course material covers principles of drug action including drug-receptor interactions and mechanism of action, adverse effects, absorption, distribution, metabolism, elimination and pharmocogenomics. The focus of CNS lectures include therapeutics used to treat migraine, schizophrenia, depression, bipolar disorder, attention deficit hyperactivity disorder, sleep disorders, anesthesia, and neurodegenerative diseases. Students will be assigned a scientific article to read in advance of “Special Topics” lectures. For five of these assignments, the student will also be required to write a one-page summary of the article and its main findings. Pre: PHPS 725.

PHPS-727* Pharmacology IV (3 credit hours)

This graduate-level course introduces the student to the basis of disease and pharmacology of drugs used to treat gastrointestinal and genitourinary disorders, fertility and contraception, as well as cancer and pain management. Course material covers

principles of drug action including drug-receptor interactions and mechanism of action, adverse effects, absorption, distribution, metabolism, elimination and pharmacogenomics. Students will be assigned a scientific article to read in advance of "Special Topics" lectures. For five of these assignments, the student will also be required to write a one-page summary of the article and its main findings. Pre: PHPS 726.

PHPS-728 Phytochemistry of Terrestrial Plants (2 credit hours)

This course will survey the chemical structures, spectroscopic properties, biosynthesis/biogenesis and biological activities of a wide range of major and minor chemical classes occurring in terrestrial plants. These compound classes will include alkaloids, terpenoids, steroids, coumarins, Flavonoids, tannins and other polyphenols, pyrones, quinones, phenylpropanoids, lignans, depsides, depsidones, fats, waxes and lipids among others. Completion of this course will provide the student with a basic familiarity with the kinds of chemical structures found in plants enabling her/him to embark on a career in phytochemical research. Pre: Approval of Major Professor.

PHPS-729 Receptor Theory and Signal Transduction (2 credit hours)

This course is designed to provide the student with knowledge of the historical and practical aspects of receptor theory as it applies to drug action, and to introduce how drug actions are mediated through signal transduction cascades, based on specific examples. Lecture topics include: models for receptor-drug interactions; methods for receptor identification; structure-function analysis of GTP-binding proteins and ligand-operated ion channels; receptor tyrosine kinases; nuclear receptors; and receptor-induced signal transduction cascades. Laboratory component of the course is designed to complement lecture topics. Pre: Approval of Major Professor.

PHPS-730 Sample collection, documentation and preservation (1 credit hour)

Participants in this course will learn strategies for sample collection from both the terrestrial and marine environments and for both macro- and micro-organisms. The course will cover permit application, sample collection, and the various ways in which different sample types are persevered for long term storage and how taxonomic voucher specimens are prepared. Pre: Approval of Major Professor.

PHPS-731 Toxicants and Toxicity (3 credit hours)

This course will provide a general foundation in the understanding of basic toxicological principles. The mechanisms of toxicity and contemporary treatment plans for the most common chemical, environmental and pharmaceutical agents will be presented. Additionally, this course will provide an in-depth review of the neuropharmacology of

substances of abuse including stimulants, depressants, hallucinogens and anabolic steroids. Other types of addiction will be discussed. Special emphasis will be given to basic pharmacokinetic and pharmacodynamic mechanisms as they relate to the effects of the individual substances of abuse. Current theories of addiction and tolerance development will be discussed. Pre: Approval of Major Professor.

PHPS-732 Toxic plant natural products and their therapeutic potential (2 credit hours)

This course will draw on the basic principles of organic chemistry and biology to provide an understanding of the biosynthesis of toxic natural products in plants, their bioassay-directed fractionation and isolation, structural identification, and mode of action in mammalian systems. Toxins discussed will be those responsible for heptotoxicity, teratogenicity, cardiotoxicity, lyosomal storage diseases, and reproductive defects. Students will integrate these principles to understand the importance of dose in discriminating between toxicity and therapeutic action, as well as the role of natural products as lead compounds in drug development. The major classes of toxic compounds occurring in plants will be discussed, with particular reference to those occurring in Hawaii. Discussions of proper experimental design, plant sampling and identification, and structural classification will carry over into the laboratory portion of the class. Students will become familiar with procedures for plant collection, extraction and isolation of pure compounds, and structural identification. Pre: Approval of Major Professor.

PHPS-7XX Biotechnology Laboratory (2 credit hours)

Biotechnology continues to play a greater and greater role in pharmacy. Health conditions can be treated with DNA vaccines, RNAi, monoclonal antibodies, recombinant proteins including peptide hormones, etc. This course will provide hands-on experience with biotechnology techniques. Techniques will be covered from DNA manipulations to expression of recombinant proteins. Students will become familiar with the propagation and purification of bacteria, miniprep isolation of DNA, restriction enzyme digestion of DNA, agarose gel electrophoretic separation of DNA fragments, isolation and cloning of DNA fragments, DNA amplification by polymerase chain reaction (PCR), and detection of DNA sequences by Southern blot hybridization. Proteins will be expressed from inducible promoters and purified by elution of His-Tag proteins from nickel-chelating columns. Proteins will be separated by SDS-polyacrylamide gel electrophoresis (SDS-PAGE) and characterized by antibody techniques employing ELISA, Western blotting, and immunofluorescence microscopy. The utility of GFP-labeled proteins in drug discovery will be demonstrated by screening for compounds that result in nuclear localization of a GFP-tagged FOXO transcription factor in the nematode, *C. elegans*. Pre: Approval of Major Professor.