PHARMACEUTICAL AND CHEMICAL SCIENCES

Programs Offered
The program offers training in one of these five focus areas: Bioanalytical and Physical Chemistry, Chemical Synthesis, Drug Discovery and Design, Molecular-Cellular Pharmacology and Toxicology, and Pharmacoeconomics and Health Care Outcomes and Clinical Services, leading to the following degrees in Pharmaceutical and Chemical Sciences:

- Master of Science
- Doctor of Philosophy
- Combined Doctor of Pharmacy and Doctor of Philosophy

Mission
The mission of the Pharmaceutical and Chemical Sciences Graduate Program (PCSP) is to prepare Doctor of Philosophy and Master of Science graduates for working in the increasingly complex and integrated research in the pharmaceutical, chemical and biotechnological environment. This integrated, multidisciplinary program provides a student-centered learning environment and will produce new scientists with both brand and in-depth training by preparing them for work as part of interdisciplinary research/development teams.

The PCSP program is offered jointly by the School of Pharmacy and College of the Pacific. The participating departments in the program are Chemistry, Pharmacy Practice, Pharmacology and Physiology and Pharmaceutics and Medicinal Chemistry.

Program Goals
The goals of the PCSP curriculum are to:

- prepare students for the challenges in both basic and applied research
- advance knowledge in pharmaceutical and chemical sciences
- encourage fundamental discovery in the chemical, pharmaceutical and healthcare sciences

For additional information and admission requirements visit:
http://www.pacific.edu/Documents/school-graduate/acrobat/PharmChem.pdf

Master of Science in Pharmaceutical and Chemical Sciences
Students must complete a minimum of 32 units with a Pacific cumulative grade point average of 3.0 in order to earn the Master of Science degree in Pharmaceutical and Chemical Sciences.

I. Category I (minimum 8 units)
- PCSP 201 Statistics and Experimental Design 3
- PCSP 203 Information and Laboratory Management 1
- PCSP 209 Technical Writing and Presentation 1
- Select one of the following: 3-4
  - PCSP 205 Instrumental Analytical Chemistry
  - PCSP 207 Bioanalytical Techniques
  - PCSP 208 Applied Pharmaceutical Analysis
  - PCSP 263 Analytical Techniques in Pharmaceconomics and Health Care Outcomes and Services

II. Category II (minimum 7 units)
- PCSP 283 Multidisciplinary Project 1
- PCSP 295 Graduate Seminar (Required to register once every academic year) 2
- PCSP 297 Graduate Research * 2
- PCSP 299 Thesis ** 2

* PCSP 297 is optional in the non-thesis option.
** PCSP 299 is not required in the non-thesis option.

Thesis Requirement
Students conduct research, write a thesis and complete a final oral defense of their thesis. The thesis is based upon a research project that constitutes a contribution to knowledge, or the student must design and evaluate a unique procedure or program in their field. A minimum of two semesters of full-time residence at the University is required following the baccalaureate degree or the equivalent in part-time residence during summers. The average time to complete the program is approximately 2-3 years.

Thesis Committee
The committee is formed after a student selects an advisor for his/her research. The committee assists the student in designing a plan of study, providing the student with guidance in his/her thesis research and monitoring the student’s research progress.

Internship (optional)
Students complete an internship outside the University in either an industry setting or at another research institution. The internship provides valuable work experience and better prepares the student for future careers working within an interdisciplinary research and development team.

III. Courses in Specialized Areas
Complete required and elective courses in one of the following specialized areas:

A. Bioanalytical Chemistry, Physical Chemistry and Biochemistry
- PCSP 212 Methods in Bioanalytical, Physical and Biochemistry 2
Select two of the following (with approval of advisor): 8

PCSP 240  Molecular Spectroscopy
PCSP 244  High-Resolution NMR Spectroscopy
PCSP 245  Proteins and Nucleic Acids
PCSP 246  Selected Topics in Advanced Biochemistry
PCSP 247  Mass Spectrometry
PCSP 248  Enzymology

Select 6-8 units of the following Preferred Elective Courses: * 6-8

PCSP 206  Models and Concepts in Chemistry
PCP 215  Molecular Modeling and Drug Design
PCSP 217  Drug Biotransformation
PCSP 222  Thermodynamics of Pharmaceutical Systems
PCSP 230  Molecular Pharmacology of Nucleic Acids
PCSP 234  Neurochemical Pharmacology
PCSP 237  Cell Culture Techniques
PCSP 241  Advanced Organic/Bioorganic Chemistry
PCSP 242  Selected Topics: Advanced Organic Chemistry
PCSP 243  Applied Computational Chemistry
PCSP 245  Proteins and Nucleic Acids
PCSP 246  Selected Topics in Advanced Biochemistry
PCSP 248  Enzymology

* This is a preferred list of electives. Additional electives can be chosen in consultation of advisor. Electives must be at the 200 level or above. Courses below 200 level must be approved by PCSP committee.

B. Chemical Synthesis, Drug Discovery and Design

Select 4-8 units from the following Preferred Elective Courses: * 4-8

PCSP 206  Models and Concepts in Chemistry
PCSP 211  Drug Design
PCSP 213  Biotransformation of Pharmaceutical Agents
PCSP 215  Molecular Modeling and Drug Design
PCSP 217  Drug Biotransformation
PCSP 222  Thermodynamics of Pharmaceutical Systems
PCSP 224  Selected Topics: Advanced Toxicology
PCSP 227  Cell Culture Techniques
PCSP 228  Mathematical Modeling in Pharmaceutical Research
PCSP 234  Neurochemical Pharmacology
PCSP 237  Cell Culture Techniques
PCSP 239  Advances in Drug Delivery Systems
PCSP 241  Advanced Organic/Bioorganic Chemistry
PCSP 242  Selected Topics: Advanced Organic Chemistry
PCSP 244  High-Resolution NMR Spectroscopy
PCSP 245  Proteins and Nucleic Acids
PCSP 246  Selected Topics in Advanced Biochemistry
PCSP 247  Mass Spectrometry
PCSP 248  Enzymology

* This is a preferred list of electives. Additional electives can be chosen in consultation of advisor. Electives must be at the 200 level or above. Courses below 200 level must be approved by PCSP committee.

C. Health Care Outcomes and Clinical Services

Select 3 units from the following Preferred Elective Courses: * 3

PCSP 258  Teaching and Evaluation of Learning and Competency
PCSP 265  Health Care Economics
PCSP 255  Long Term Care Practice
PCSP 256  Health Services Management and Finance
PCSP 257  Ambulatory Care Practice
PCSP 259  Topics in Acute Care Practice
PCSP 260  Advances in Neuropsychiatric Pharmaceutical Care

* This is a preferred list of electives. Additional electives can be chosen in consultation of advisor. Electives must be at the 200 level or above. Courses below 200 level must be approved by PCSP committee.

D. Biopharmaceutical Sciences

Select two of the following: 6-7

PCSP 213  Biotransformation of Pharmaceutical Agents
PCSP 214  Advanced Molecular Biochemistry
PCSP 222  Thermodynamics of Pharmaceutical Systems
PCSP 223  Pharmacokinetics and Pharmacodynamics
PCSP 224  Diffusion in Pharmaceutical Sciences
PCSP 225  Pharmaceutical Technologies
PCSP 226  Industrial Pharmacy I
PCSP 227  Industrial Pharmacy II
PCSP 228  Mathematical Modeling in Pharmaceutical Research
PCSP 229  Advances in Drug Delivery Systems
PCSP 235  Current Topics in Pharmacology and Toxicology
PCSP 236  Selected Topics: Advanced Toxicology
PCSP 237  Cell Culture Techniques
PCSP 246  Selected Topics in Advanced Biochemistry
PCSP 248  Enzymology

Non-thesis Required Courses: 7

PCSP 226  Industrial Pharmacy I
PCSP 227  Industrial Pharmacy II

* This is a preferred list of electives. Additional electives can be chosen in consultation of advisor. Electives must be at the 200 level or above. Courses below 200 level must be approved by PCSP committee.

E. Molecular-Cellular Pharmacology and Toxicology

Select 6-8 units from the Preferred Elective Courses: * 6-8

PCSP 231  Molecular Pharmacology I
PCSP 232  Molecular Pharmacology II
PCSP 233  Molecular Pharmacology III
PCSP 235  Current Topics in Pharmacology and Toxicology
PCSP 236  Selected Topics: Advanced Toxicology
PCSP 237  Cell Culture Techniques
PCSP 238  Immunology
PCSP 240  High-Resolution NMR Spectroscopy
PCSP 241  Advanced Organic/Bioorganic Chemistry
PCSP 242  Selected Topics: Advanced Organic Chemistry
PCSP 243  Applied Computational Chemistry
PCSP 245  Proteins and Nucleic Acids
PCSP 246  Selected Topics in Advanced Biochemistry
PCSP 247  Mass Spectrometry
PCSP 248  Enzymology

* This is a preferred list of electives. Additional electives can be chosen in consultation of advisor. Electives must be at the 200 level or above. Courses below 200 level must be approved by PCSP committee.
The committee also conducts the dissertation defense. The defense is presented by the student to the committee. The dissertation must be monitored by the student's research progress. The student ultimately of study, providing the student with guidance in his/her research, and her research. The committee assists the student in designing a plan

Dissertation Committee

The committee is formed after a student selects an advisor for his/her research. The committee assists the student in designing a plan of study, providing the student with guidance in his/her research, and monitoring the student's research progress. The student ultimately presents his/her dissertation to the committee. The dissertation must provide a genuine contribution to knowledge in the student's focus area. The committee also conducts the dissertation defense. The defense is

Doctor of Philosophy in Pharmaceutical and Chemical Sciences

Students must complete a minimum of 45 units with a Pacific cumulative grade point average of 3.0 in order to earn the Doctor of Philosophy degree in Pharmaceutical and Chemical Sciences.

I. Category I

PCSP 201  Statistics and Experimental Design  3
PCSP 203  Information and Laboratory Management  1
PCSP 209  Technical Writing and Presentation  1
Select one of the following:  3-4
PCSP 205  Instrumental Analytical Chemistry
PCSP 207  Bioanalytical Techniques
PCSP 208  Applied Pharmaceutical Analysis
PCSP 263  Analytical Techniques in Pharmaceutics and Health Care Outcomes and Services

II. Category II

PCSP 283  Multidisciplinary Project  1
PCSP 395  Graduate Seminar (Required to register once every academic year)  3
PCSP 397  Graduate Research (6 units is minimum total degree requirement)  6
PCSP 399  Dissertation (2 units is minimum total degree requirement)  2

Note: Students are encouraged to complete coursework during the early part of their graduate studies so that the latter part of the program can be spent on full-time research.

Internship

Students complete an internship outside the University in either an industry setting or at another research institution. The internship provides valuable work experience and better prepares the student for future careers working within an interdisciplinary research and development team.

Dissertation

Student conduct original research, write a dissertation, and complete a final oral defense of their dissertation. The dissertation is based upon a research project that constitutes a fundamentally new contribution to knowledge in their field. A minimum of two semesters of full-time residence at the University, is required following the baccalaureate degree or the equivalent in part-time residence during summers. The average time to complete the program is approximately 5-6 years.

Dissertation Committee

The committee is formed after a student selects an advisor for his/her research. The committee assists the student in designing a plan of study, providing the student with guidance in his/her research, and monitoring the student's research progress. The student ultimately presents his/her dissertation to the committee. The dissertation must provide a genuine contribution to knowledge in the student's focus area. The committee also conducts the dissertation defense. The defense is

Qualifying Examinations

To be eligible for qualifying exams, the student must complete all core courses and required courses for dissertation research that the student has elected to pursue. Exams should be taken within an appropriate amount of time, preferably at the end of the second year. The content and requirements of the qualifying exams are defined by the research focus area and consist of comprehensive written and oral examinations.

III. Courses in Specialized Areas

Complete required and elective courses in one of the following specialized areas:

A. Bioanalytical Chemistry, Physical Chemistry and Biochemistry

PCSP 212  Methods in Bioanalytical, Physical and Biochemistry  2
Select two of the following (with approval of advisor):  8
PCSP 240  Molecular Spectroscopy
PCSP 244  High-Resolution NMR Spectroscopy
PCSP 245  Proteins and Nucleic Acids
PCSP 246  Advanced Organic Chemistry
PCSP 247  Mass Spectrometry
PCSP 248  Enzymology
Select 12-14 units of the following Preferred Elective Courses:  6-8
PCSP 206  Models and Concepts in Chemistry
PCSP 215  Molecular Modeling and Drug Design
PCSP 217  Drug Biotransformation
PCSP 222  Thermodynamics of Pharmaceutical Systems
PCSP 230  Molecular Pharmacology of Nucleic Acids
PCSP 234  Neurochemical Pharmacology
PCSP 237  Cell Culture Techniques
PCSP 241  Advanced Organic/Bioorganic Chemistry
PCSP 242  Selected Topics: Advanced Organic Chemistry
PCSP 243  Applied Computational Chemistry
PCSP 245  Proteins and Nucleic Acids
PCSP 246  Selected Topics in Advanced Biochemistry
PCSP 248  Enzymology

* This is a preferred list of electives. Additional electives can be chosen in consultation of advisor. Electives must be at the 200 level or above. Courses below 200 level must be approved by PCSP committee.

B. Chemical Synthesis, Drug Discovery and Design

PCSP 241  Advanced Organic/Bioorganic Chemistry  4
PCSP 242  Selected Topics: Advanced Organic Chemistry  4
PCSP 244  High-Resolution NMR Spectroscopy  4
Select 10-12 units from the following Preferred Elective Courses:  4-8
PCSP 206  Models and Concepts in Chemistry
PCSP 211  Drug Design
PCSP 213  Drug Transformation of Pharmaceutical Agents
PCSP 215  Molecular Modeling and Drug Design
PCSP 217  Drug Biotransformation
PCSP 222  Thermodynamics of Pharmaceutical Systems
PCSP 230  Molecular Pharmacology of Nucleic Acids
PCSP 234  Neurochemical Pharmacology

Pharmaceutical and Chemical Sciences 3
C. Health Care Outcomes and Clinical Services

PCSP 258 Teaching and Evaluation of Learning and Competency 2
PCSP 265 Health Care Economics 2

Select 3 units from the following Preferred Elective Courses: *

- BUSI 250 Health Finance: Health Insurance
- PCSP 255 Long Term Care Practice
- PCSP 256 Health Services Management and Finance
- PCSP 257 Ambulatory Care Practice
- PCSP 259 Topics in Acute Care Practice
- PCSP 260 Advances in Neuropsychiatric Pharmaceutical Care

* This is a preferred list of electives. Additional electives can be chosen in consultation of advisor. Electives must be at the 200 level or above. Courses below 200 level must be approved by PCSP committee.

D. Biopharmaceutical Sciences

Select two of the following: 6-7

- PCSP 237 Cell Culture Techniques
- PCSP 245 Proteins and Nucleic Acids
- PCSP 246 Selected Topics in Advanced Biochemistry
- PCSP 247 Mass Spectrometry
- PCSP 248 Enzymology

* This is a preferred list of electives. Additional electives can be chosen in consultation of advisor. Electives must be at the 200 level or above. Courses below 200 level must be approved by PCSP committee.

Select 4-8 units from the following Preferred Elective Courses: *

- BIOL 222 Immunology
- PCSP 205 Instrumental Analytical Chemistry
- PCSP 207 Bioanalytical Techniques
- PCSP 211 Drug Design
- PCSP 216 Special Topics in Drug Discovery
- PCSP 218 Animal Techniques for Pharmaceutical Sciences
- PCSP 222 Thermodynamics of Pharmaceutical Systems
- PCSP 223 Pharmacokinetics and Pharmacodynamics
- PCSP 224 Diffusion in Pharmaceutical Sciences
- PCSP 225 Pharmaceutical Technologies
- PCSP 226 Industrial Pharmacy I
- PCSP 227 Industrial Pharmacy II
- PCSP 228 Mathematical Modeling in Pharmaceutical Research
- PCSP 229 Advances in Drug Delivery Systems
- PCSP 235 Current Topics in Pharmacology and Toxicology
- PCSP 236 Selected Topics: Advanced Toxicology
- PCSP 237 Cell Culture Techniques
- PCSP 246 Selected Topics in Advanced Biochemistry
- PCSP 248 Enzymology

* This is a preferred list of electives. Additional electives can be chosen in consultation of advisor. Electives must be at the 200 level or above. Courses below 200 level must be approved by PCSP committee.

E. Molecular-Cellular Pharmacology and Toxicology

Select 12-14 units from the Preferred Elective Courses: *

- PCSP 231 Molecular Pharmacology I 4
- PCSP 232 Molecular Pharmacology II 4
- PCSP 235 Current Topics in Pharmacology and Toxicology 2

Select 6-8 units from the following:

- PCSP 205 Instrumental Analytical Chemistry
- PCSP 213 Biotransformation of Pharmaceutical Agents
- PCSP 233 Molecular Pharmacology III
- PCSP 236 Selected Topics: Advanced Toxicology
- PCSP 237 Cell Culture Techniques

* This is a preferred list of electives. Additional electives can be chosen in consultation of advisor. Electives must be at the 200 level or above. Courses below 200 level must be approved by PCSP committee.

Pharm Chem Sciences Courses

PCSP 201. Statistics and Experimental Design. 3 Units.
This course involves the study of the application and limitations of statistical methods of inference as they apply to the fields of chemistry and the pharmaceutical sciences. Topics include the use of parametric statistics for statistical inference, comparisons of means, analysis of variance and linear regression. Parametric statistics and nonparametric measures of association and elements of good experimental design are also included. Graduate standing.

PCSP 203. Information and Laboratory Management. 1 Unit.
This course covers basic knowledge of Information Management, Intellectual Property and Patenting, Research Laboratory Operations and Safety, Good Maintenance Practice (GMP) and Good Clinical Practice (GCP). Graduate standing.

PCSP 204. Introduction to Nanotechnology. 4 Units.
The course provides an overview of Molecular Nanotechnology. It shows that the nano regime is so different from other regimes because both classical and quantum effects can be active, thus leading to unique properties of nano devices. MNT is a highly interdisciplinary science, which will be reflected in the course by making reference to physics, chemistry, biology, pharmacy and engineering. Applications of MNT, as they are already in use today or as they are planned for the future, will be discussed. Graduate standing or permission of instructor.

PCSP 205. Instrumental Analytical Chemistry. 4 Units.
Lectures focus on the theory and physical principles of instruments for the analysis of matter. Laboratory lecturer describes the actual operation of instruments. Students gain hands-on experience with the operation of instruments. Graduate standing.

PCSP 206. Models and Concepts in Chemistry. 4 Units.
The course focuses on a general understanding of chemistry in terms of models and concepts that describe structure, stability, reactivity and other properties of molecules in a simple, yet very effective way. Many chemical problems from organic, inorganic, and transition metal chemistry and biochemistry are presented and the applicability of the various models and concepts as well as their limitations are demonstrated. Graduate standing or permission of instructor.
PCSP 207. Bioanalytical Techniques. 3 Units.
Students are introduced to techniques of bioanalysis for the pharmaceutical and chemical sciences. The course provides a conceptual understanding and practical familiarity with techniques used for analysis of proteins and nucleic acids. Recommended: Basic biochemistry.

PCSP 208. Applied Pharmaceutical Analysis. 4 Units.
Students study analytical methods applied for the assessment of pharmaceutical quality, and the identification and quantification of active pharmaceutical molecules and metabolites in biological samples. Prerequisite: any analytical Chemistry or Biology background and permission of instructor.

PCSP 209. Technical Writing and Presentation. 1 Unit.
This course covers common written and oral forms of communication and scientific material. Graduate standing.

PCSP 211. Drug Design. 4 Units.
Students study modern methods used in the design of new drugs. Target selection, lead compound discovery and molecular modifications to optimize activity are studied. Graduate standing or bachelor's degree and permission of instructor.

PCSP 212. Methods in Bioanalytical, Physical and Biochemistry. 2 Units.
As a general survey, this course is an introduction to the current methodologies commonly used in bioanalytical, physical and biochemistry labs. These methods will be investigated by understanding their use in the lab and through studies published in the primary scientific literature. Lecture will focus on the technique and instruments and a lab component will consist of a demonstration of the method. A mini project that using a single selected methodology will be performed by each student with a final report detailing the underlying technology and theory.

PCSP 213. Biotransformation of Pharmaceutical Agents. 3 Units.
This course teaches the graduate students the chemical and biological principles of the transformations of pharmaceutical agents in the body and the impact of such transformations on pharmacokinetics, pharmacodynamics, toxicity, drug design and drug delivery. Graduate standing in TJ Long School of Pharmacy & Health Sciences or in Chemistry Department, or permission of instructor.

PCSP 214. Advanced Molecular Biochemistry. 4 Units.
This course presents a conceptual study of cellular function and control mechanisms at the molecular level. Prerequisite: Graduate standing.

PCSP 215. Molecular Modeling and Drug Design. 4 Units.
The course presents a thorough and in-depth overview of methods and techniques in computer assisted drug design (CADD) where especially the needs of the pharmaceutical industry are considered. Graduate standing or permission of instructor.

PCSP 216. Special Topics in Drug Discovery. 3 Units.
This course is designed mainly for graduate students, with emphasis on new concepts in the discovery of small molecules and biologic drugs. Prerequisite: Advanced biochemistry course.

PCSP 217. Drug Biotransformation. 3 Units.
This course generally meets two times a week (two 75-minute lectures per week). In this course, a mechanistic approach is employed to study human drug metabolizing enzymes. Other aspects related to the differential expression of these enzymes are discussed. Students need to submit a research proposal at the end of the course. Graduate standing or permission of instructor.

PCSP 218. Animal Techniques for Pharmaceutical Sciences. 2 Units.
This course is designed to present an opportunity for graduate students to understand animal techniques to pharmaceutical science research. Prerequisite: Graduate standing or permission of the instructor.

PCSP 221. Fundamentals of Dosage Forms. 3 Units.
In this course the fundamental physicochemical properties and composition of various dosage forms is taught. Graduate standing.

PCSP 222. Thermodynamics of Pharmaceutical Systems. 3 Units.
This is a classical course on the applications of thermodynamics to the study of pharmaceutical systems. The course includes a review of the basic principles of thermodynamics. These principles are used to describe and study physical and chemical transformations of pure substances and mixtures in pharmaceutical systems. Graduate standing or permission of instructor.

PCSP 223. Pharmacokinetics and Pharmacodynamics. 3 Units.
This course teaches critical concepts and basic principles of pharmacokinetics and pharmacodynamics. Such concepts and principles are required for the students to understand the drug behavior in the body. Graduate standing or permission of instructor.

PCSP 224. Diffusion in Pharmaceutical Sciences. 3 Units.
Students discuss diffusion theories, experimental methods, and application to pharmaceutical/biological systems. Prerequisites: CHEM 161 and MATH 033 or equivalent or permission of instructor.

PCSP 225. Pharmaceutical Technologies. 2 Units.
Students study theory and practice in industrial pharmacy that include pre-formulation, formulation and pharmaceutical manufacture. Prerequisites: PHAR 114, 123, 133. Graduate standing.

PCSP 226. Industrial Pharmacy I. 4 Units.
This course is the first part of Industrial Pharmacy series designed mainly for graduate students, with emphasis unit operations, technology and formulation of pharmaceuticals. This is also very useful to professional students who are interested to pursue careers in pharmaceutical and biopharmaceutical industry. The basic understanding of Preformulation, pharmaceutical operations as they are applied to solid dosage forms from laboratory scale to manufacturing scale will be discussed in lectures and all students will do hands on experiments. In addition, quality and regulatory processes will be outlined for solid dosage forms. Prerequisites: PHRM 114 and PHRM 124.

PCSP 227. Industrial Pharmacy II. 3 Units.
This course is the second part of Industrial Pharmacy course series designed mainly for graduate students, with emphasis unit operations, technology and formulation of pharmaceuticals. This is also very useful to professional students who are interested to pursue careers in pharmaceutical and biopharmaceutical industry. The basic understanding of pharmaceutical operations as they are applied to semi-solid and modified release dosage forms from laboratory scale to manufacturing scale will be discussed in lectures and all students will conduct hands on experiments. In addition, quality and regulatory processes will be outlined for semi-solid and modified release dosage forms. Prerequisites: PHRM 114; PHRM 124; PCSP 226.

PCSP 228. Mathematical Modeling in Pharmaceutical Research. 3 Units.
Students study the mathematical modeling theory and application to problems in pharmaceutical research. Modeling is applied to three major areas: drug delivery, metabolic/biological cascades and pharmacological response kinetics. Prerequisites: PHAR 113 or permission of instructor. Recommended: MATH 057; PHAR 114 and PHAR 134.
PCSP 229. Advances in Drug Delivery Systems. 3 Units.
In this course the design and formulation/fabrication of controlled release and other novel drug delivery systems for oral, transdermal, ocular and other routes of delivery are covered. The biopharmaceutical rational and evaluation of such systems is also discussed. Graduate standing.

PCSP 230. Molecular Pharmacology of Nucleic Acids. 3 Units.
Students study the mechanisms by which drugs and other chemicals can affect gene expression and cell division through actions on DNA structure and nucleic acid and protein metabolism. Graduate standing.

PCSP 231. Molecular Pharmacology I. 4 Units.
This is the first course in the Molecular Pharmacology series. Effects of autonomic and central nervous system therapeutic agents and the mechanisms whereby these effects are induced. Drug classes are presented to illustrate the effects of drug classes in the treatment of disease. The molecular principles of drug action and receptor theory are covered. Enrollment in the PCSP program is required.

PCSP 232. Molecular Pharmacology II. 4 Units.
This is the second course in the Molecular Pharmacology series, effects of cardiovascular, endocrine, cancer chemotherapy, immunologic therapeutic agents and the mechanisms whereby these effects are induced. Drug classes will be presented to illustrate the effects of drug classes in the treatment of diseases. Enrollment in the PCSP program is required.

PCSP 233. Molecular Pharmacology III. 4 Units.
This is the third course in the Molecular Pharmacology series, effects of antimicrobial, hematologic and gastrointestinal therapeutic agents and the mechanism whereby these are induced. Drug classes are presented to illustrate the effects of drug classes in the treatment of diseases. The mechanisms of drug toxicity are also covered. Enrollment in the PCSP program is required.

PCSP 234. Neurochemical Pharmacology. 3 Units.
Students study neurobiology of nerve cells and the neurochemical pharmacology associated with function of central and peripheral nervous systems. Graduate standing.

PCSP 235. Current Topics in Pharmacology and Toxicology. 2 Units.
Each week this course focuses on a different area of research interest in pharmacology and toxicology. It involves discussions of assigned research papers that provide students with a current perspective and understanding of issues and techniques associated with the selected research topics. Graduate standing in the PCSP program.

PCSP 236. Selected Topics: Advanced Toxicology. 2 Units.
This course teaches students the organ systems and mechanistic approach to toxicological assessment. Quantitative, environmental and regulatory aspects of toxicology are included as essential elements of toxicological evaluation. Graduate standing in the PCSP program or permission of instructor.

PCSP 237. Cell Culture Techniques. 3 Units.
This course teaches students basic techniques in mammalian cell culture. In addition, advanced topics of cellular techniques are demonstrated and discussed representative of current research methods. Permission of PCSP Program Director.

PCSP 240. Molecular Spectroscopy. 4 Units.
The basic theory behind infrared, visible, ultraviolet, and magnetic resonance spectroscopy are studied. The course includes the quantum mechanics of light absorption, atomic absorption and emission spectroscopy, vibrational spectroscopy of diatomic and polyatomic molecules, absorption and emission electronic spectroscopy and magnetic resonance spectroscopy. Graduate standing or permission of instructor.

PCSP 241. Advanced Organic/Bioorganic Chemistry. 4 Units.
Synthetically useful organic reactions not normally covered in the introductory courses are emphasized. The reactions are grouped according to their mechanistic type and discussed in terms of their reaction mechanisms and synthetic utility. Prerequisites: CHEM 121 and CHEM 123 with a "C" or better.

PCSP 242. Selected Topics: Advanced Organic Chemistry. 4 Units.
Topics presented at various times under this course description include: Physical organic, natural products and structure elucidation, stereochemistry, heterocycles and carbohydrate chemistry. Prerequisites: CHEM 121 and CHEM 123 with a "C" or better.

PCSP 243. Applied Computational Chemistry. 4 Units.
Besides the normal laboratory experiments traditionally expected, modern chemists/biochemists, whether in the chemical/pharmaceutical industry or academia, perform "experiments" on the computer by calculating the outcome of chemical and biochemical reactions. This in silico chemistry has become an integral part of the education in chemistry and the present course will provide an introduction into this field by addressing a general audience of chemists/biochemists and students from neighboring fields.

PCSP 244. High-Resolution NMR Spectroscopy. 4 Units.
A study of one and two dimensional FT-NMR techniques used for structure elucidation of organic molecules. Emphasis is placed on understanding the capabilities and limitations of these techniques, the information they provide and the practical aspects of their implementation. Permission of instructor.

PCSP 245. Proteins and Nucleic Acids. 3 Units.
Students study the chemical, physical and biological properties of the proteins and nucleic acids and their constituents. Topics include isolation, determination of composition, sequence and structure; correlation of structure and biological properties. Prerequisite: CHEM 151 with a "C" or better.

PCSP 246. Selected Topics in Advanced Biochemistry. 4 Units.
The field of biochemistry is always developing in new and different directions; the purpose of this course is to expose graduates students to the newest and most cutting edge research topics in the field of biochemistry. The materials will primarily primary literature articles. Graduate students will learn to quickly process scientific papers and then, synthesize simple explanations of notable research areas in biochemistry. Graduate students will refine these skills in a series of lectures by the student and instructor as well as student led discussions.

PCSP 247. Mass Spectrometry. 4 Units.
Students study the fundamentals of mass spectrometry, theory, instrumentation and applications to organic and biological molecules. Prerequisite: PCSP 205.

PCSP 248. Enzymology. 4 Units.
This class gives an introduction into the biochemistry of the various classes of enzymes with emphasis on laboratory techniques. Prerequisite: CHEM 151 with a "C" or better.

This course prepares graduate students in Pharmacoconomics and Health Care Outcomes and Services as a successful researcher by gaining experience in the development of a research plan, obtaining approval of the Institutional Review Board, submission of an extramural grant, dissemination of the student findings at a national or international meeting, and submission of a manuscript to a peer-reviewed journal. Prerequisite may be taken concurrently: PCSP 201, or other comparable statistics course at the discretion of the course coordinator. Permission of the instructor is required.
PCSP 255. Long Term Care Practice. 3 Units.
This class covers the clinical pharmacy component of a long term facility with special emphasis on opportunities and research needs. Students study the systematic approach to monitor the drug therapy of the long term care patient. Graduate standing.

PCSP 256. Health Services Management and Finance. 2 Units.
Health Care Finance offers an introduction to accounting, financial theory and practice in health care settings. It is designed to familiarize students with financial concepts and issues confronting managers in the health and pharmaceutical sectors. Prerequisites: Admission to the PCSP graduate program and permission of the instructor.

PCSP 257. Ambulatory Care Practice. 3 Units.
Students examine the application of clinical pharmacy to ambulatory care settings in an affiliated clinic or community pharmacy. Special emphasis is placed on opportunities and research needs. Graduate standing.

PCSP 258. Teaching and Evaluation of Learning and Competency. 2 Units.
Student abilities in development as a teacher are developed in an interactive, evidence-based manner covering the major components of teaching, learning, evaluation and assessment. Prerequisites: Admission to the PCSP graduate program and permission of the instructor.

PCSP 259. Topics in Acute Care Practice. 3 Units.
Students examine the application and investigation of clinical pharmacy in acute care setting with emphasis on medical management of common diseases and rational drug selection and dosing. Graduate standing.

PCSP 260. Advances in Neuropsychiatric Pharmaceutical Care. 2 Units.
Students examine pharmaceutical care for the patient with neurologic and psychiatric disorders. Emphasis is placed on appropriate use of drug therapy in the management of these disorders. Graduate standing. Permission of instructor.

PCSP 261. Advances in Cardiovascular Pharmaceutical Care. 3 Units.
Students explore the application of Drug Therapy to patient care with assignments that expand the students' knowledge of background material that support therapeutic guidelines. Permission of instructor.

PCSP 262. Vascular, Renal and Pulmonary Care. 4 Units.
Students study the pharmaceutical care for the patient with cardiovascular, respiratory and renal diseases. Emphasis is placed on appropriate use of drug therapy in the management of the disease. Prerequisites: Successful completion of all courses in semesters 1-3 of the Doctor of Pharmacy Program.

PCSP 263. Analytical Techniques in Pharmacoeconomics and Health Care Outcomes and Services. 4 Units.
This course prepares graduate students in Pharmacoeconomics and Health Care Outcomes and Services to meet the challenges of a broad assortment of health services related research by providing fundamental principles and tools for the discipline. The class uses real world examples of research design, statistical evaluations and database selection and use to assess therapeutic, economic and humanistic outcomes. Prerequisites: PCSP 201 and PCSP 203.

PCSP 264. Applied Statistics in Health Services Research and Analysis. 3 Units.
This course prepares graduate students in Pharmacoeconomics and Health Care Outcomes and Services to meet the challenges posed by the need to rapidly and accurately review, critique and assimilate information from health care and economic literature and to complete a full, advanced statistical analysis such as that required for the introduction and discussion sections of a research article or dissertation in pharmacoeconomics and health care outcomes. Prerequisites: PCSP 201, 203, 263.

PCSP 265. Health Care Economics. 2 Units.
This course is a current medical literature based course and is designed to prepare graduate students in Pharmacoeconomics and Health Care Outcomes and Services to meet challenges associated with understanding microeconomics terms and tools used in health care, medical literature and health care decision making processes. Readings, lectures and discussions emphasize processes used in economic decisions made by health care consumers, providers and third party payers. Primary topics include the demand for health care, how it may vary based on payment/payer options and the scope and supply of care available. Prerequisites: PCSP 263, 264, and permission of the instructor.

PCSP 266. Pharmacoeconomics and Microeconomics/Managerial Economics. 2 Units.
This course is designed to prepare graduate students in Pharmacoeconomics and Health Care Outcomes and Services to evaluate the applicability, importance and relevancy of pharmacoeconomics, microeconomics and managerial economics in answering questions and solving problems within the US health care system. Additionally, after completion of this course, students can assess, apply, interpret and determine the appropriate utilization of pharmacoeconomics, microeconomic, and managerial economic principles to address relevant healthcare issues and questions. Prerequisites: PCSP 201 and permission of the instructor.

PCSP 270. Theory and Methodology of Simulation of Natural Rock Formation. 4 Units.
This course is created particularly for PhD students of the Pharmaceutical and Chemical Sciences Program. It offers a comprehensive integration of multi-disciplinary sciences such as biology, life science, geoscience, ocean science, environment science, material science, etc. The course introduces some new breakthroughs and frontier discovery which reveal the mystery relationship between life science and geoscience. Upon completion of this course, PhD students are able to carry out professional lab and on-site tests and measurements. Graduate standing in chemistry, biology, geology, material science, environmental science or engineering or permission of instructor.

PCSP 283. Multidisciplinary Project. 1 Unit.
Students in the Pharmaceutical and Chemical Science Graduate Program design an interdisciplinary project based upon the relevant contributions of their backgrounds. Enrollment in PCSP Graduate Program.

PCSP 287. Internship. 1-4 Units.
The internship offers an experiential learning program at a pharmaceutical/chemical/biotechnological industry, academic institution, government laboratory, or a clinical site that entitles the students to learn advanced techniques and practical application of the theoretical principles learned in a number of courses. Graduate students that have completed Category I course work, or obtained permission of coordinator shall enroll in this course. For students in thesis/dissertation tracks, concurrence of thesis/dissertation adviser(s) is required.

PCSP 291. Independent Study. 1-4 Units.
Independent Study is restricted to masters or doctoral (PhD) candidates. It may be repeated with permission as progress warrants. No more than eight credits may be used toward doctoral degree requirements. The student must be in good academic standing. Approval of the required contract for Independent Graduate Study is required. Graduate standing and permission of the instructor.
PCSP 295. Graduate Seminar. 1 Unit.
This seminar presents research-related topics given by both PCSP faculty and graduate students. Enrolled students are required to attend all seminars given throughout the pharmacy academic year and to give one seminar in that year. This course is required for all graduate students for the first three years of their tenure in the PCSP. Students who have already enrolled in this course for three years are encouraged to attend seminars without official enrollment. PCSP faculty members present a short talk on their research areas at the beginning of the fall semester each year. Graduate standing.

PCSP 297. Graduate Research. 1-4 Units.
Graduate Research is limited to masters or doctoral (PhD) candidates. It may be repeated with permission as progress warrants. No more than eight credits may be used toward doctoral degree requirements. Admission to the graduate program and permission of research director.

PCSP 299. Thesis. 1-6 Units.
This course provides one-to-one work by student with faculty research mentor to plan, organize, conduct, evaluate and write an original research project as a thesis for partial fulfillment of the MS degree. Admission to MS thesis program (PCSP) and permission of research advisor.

PCSP 387. Internship. 1-4 Units.
This internship offers an experiential learning program at a pharmaceutical/chemical/biotechnological industry, academic institution, government laboratory, or a clinical site that entitles the students to learn advanced techniques and practical application of the theoretical principles learned in a number of courses. Graduate Standing with completed Category I course work or permission of coordinator. For students in thesis/dissertation tracks, concurrence of thesis/dissertation adviser(s) is required.

PCSP 391. Independent Study. 1-4 Units.
Independent Study is restricted to masters or doctoral (PhD) candidates. It may be repeated with permission as progress warrants. No more than eight credits may be used toward doctoral degree requirements. The student must be in good academic standing. Approval of the required contract for Independent Graduate Study is required. Graduate standing and permission of the instructor.

PCSP 391D. Independent Study. 1-4 Units.

PCSP 395. Graduate Seminar. 1 Unit.
This seminar presents research-related topics given by both PCSP faculty and graduate students. Enrolled students are required to attend all seminars given throughout the pharmacy academic year and to give one seminar in that year. This course is required for all graduate students for the first three years of their tenure in the PCSP. Students who have already enrolled in this course for three years are encouraged to attend seminars without official enrollment. PCSP faculty members present a short talk on their research areas at the beginning of the fall semester each year. Graduate standing.

PCSP 397. Graduate Research. 1-4 Units.
Graduate Research is limited to masters or doctoral (PhD) candidates. It may be repeated with permission as progress warrants. No more than eight credits may be used toward doctoral degree requirements. Admission to the graduate program and permission of research director.

PCSP 397D. Graduate Research. 1-4 Units.

PCSP 397E. Graduate Research. 1-4 Units.

PCSP 399. Dissertation. 1-6 Units.
This course is only open to doctoral (PhD) candidates. No more than eight credits may be used toward doctoral degree requirements. Admission to PhD program (PCSP) and permission of research advisor.