PHARMACEUTICAL OUTCOMES RESEARCH (PHD)

Who decides if a drug is worth producing? Which drugs should insurance companies cover? How do we determine who gets access to lifesaving therapies? Earn your PhD in Pharmaceutical Outcomes Research and join us as we lead the way in evaluating health care interventions and their economic, clinical, and humanistic outcomes.

The traditional requirements for admission to the graduate program in pharmaceutical sciences include:

- BA or BS from an accredited institution
- Academic record
  - Satisfying the minimum admission requirements established by the CU Graduate School
  - Normally admission dependent on GPA of 3.0 or better
  - GPA <3.0 may be considered individually on a provisional basis

If you do not have a degree from a U.S. or Canadian institution, the International Affairs Office will evaluate the transcripts to determine G.P.A. equivalency. A transcript evaluation from an agency such as World Education Services is not required. If an applicant would like to include a previously completed evaluation with their application as a courtesy, they are welcome to do so.

The admission deadline for completed applications is December 1.

Application Information
Given that admission to the program is very competitive, it is impossible to evaluate your qualifications for admission (test scores, grades) until the selection committee assesses the entire applicant pool. If you are selected for an interview, we do our best to pay your travel expenses to and from campus. The initial process involves submitting an online application to graduate school and can be initiated by following the link on the main page.

We do not have the resources to cover international travel expenses for applicants who live outside North America (regardless of nationality).

Curriculum Requirements

Code	Title	Hours
Required Courses		
Required Core Course Credits: 36		
BIOS 6611	Biostatistical Methods I	3
BIOS 6612	Biostatistical Methods II	3
EPID 6630	Epidemiology	3
EPID 6626	Research Methods in Epidemiology	3
HSMP 6601	Introduction to HSMP	3
HSMP 6609	Cost Benefit and Effectiveness in Health	2
HSMP 7609	Methods in Health Services Research II	3
or EPID 6631	Analytical Epidemiology	
PHOR 7611	Applied Cost-Effectiveness Modeling	4
PHOR 7613	Pharmaceutical Economics	3
PHOR 7615	Pharmacoepidemiology	2-4
CLSC 7150	Ethics and Responsible Conduct of Research	1
PHOR 7570	Special Topics in Outcomes Research	1

Code	Title	Hours
PHOR 8990	Doctoral Thesis	1-10
Total Hours		32-43

Code	Title	Hours
Approved Elective Courses		
BIOS 6603	Statistical Computing - SAS	1
BIOS 6643	Analysis of Longitudinal Data	3
BIOS 6646	Survival Analysis	3
BIOS 6648	Design and Conduct of Clinical Research	2
BIOS 6649	Clinical Trials: Statistical Design and Monitoring	3
BIOS 6680	Data Management Using SAS	3
BIOS 7712	Statistical Methods for Correlated Data	1
BIOS 7713	Statistical Methods for Missing Data	1-2
CBHS 6620	Survey Research	3
ECON 5813	Econometrics I	3
ECON 5823	Econometrics II	3
HSMP 6604	Health Care Economics	3
EPID 6631	Analytical Epidemiology	3
EPID 6633	Clinical Preventive Services: Evidence-Based Practice	1
EPID 6646	Introduction to Systematic Reviews	1
EPID 6635	Infectious Disease Epidemiology	2
EPID 6636	Chronic Disease Epidemiology	3
EPID 6638	Global Cardiovascular Epidemiology	2
EPID 7605	Research Methods with Secondary Data Sources	3
HSMP 7607	Methods in Health Services Research I	3

Course Descriptions

BIOS 6603 - Statistical Computing - SAS (1 Credit)
This course will emphasize statistical analysis and data interpretation through use of the SAS statistical computing package. Instruction will be provided through laboratory exercises and interactive demonstrations Prereq/Coreq: BIOS 6601 Restriction: Credit may be counted toward a CSPH degree for only one of BIOS 6603, 6604 or 6605
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Fall, Spring, Summer.

BIOS 6611 - Biostatistical Methods I (3 Credits)
This first course in applied statistics covers basic descriptive methods and probability; parametric and nonparametric inference for the one- and two-sample location problem; ANOVA, ANCOVA, and multiple linear regression. Matrix notation, R, and SAS are used. Prerequesite: differential calculus or permission of instructor
Grading Basis: Letter Grade
A-PUBH BIOS
Typically Offered: Fall.

BIOS 6612 - Biostatistical Methods II (3 Credits)
This is a continuation of BIOS 6611 covering univariate linear modeling and emphasizing multiple regression and analysis of variance. Logistic regression and methods for correlated data are also covered. Matrix algebra and the statistical package SAS will be used. Prereq: BIOS 6611.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Spring.

EPID 6630 - Epidemiology (3 Credits)
This course provides an introduction to descriptive and analytic methods in epidemiology and their application to research, preventive medicine and public health practice.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Fall, Spring.

BIOS 6643 - Analysis of Longitudinal Data (3 Credits)
Theory and application of models appropriate for clustered and longitudinal data are studied. Models for different types of outcome variables (e.g., normal , Poisson, binomial) are covered, with an emphasis on linear mixed models for normal outcomes. Prerequisites: BIOS 6632 and BIOS 6612 or permission of instructor.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Fall.

BIOS 6646 - Survival Analysis (3 Credits)
This course covers the analysis of time-to-event data with applications to biology, medicine, and public health. Nonparametric methods for group comparisons and semi-parametric regression models will be emphasized. Parametric methods and distribution theory for survival analysis will also be included. Prereq: BIOS 6611 & BIOS 6631 or instructor permission Coreq: BIOS 6612 & BIOS 6632 or instructor permission.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Spring.

BIOS 6648 - Design and Conduct of Clinical Research (2 Credits)
Design and conduct of clinical research studies. Intended for non-biostatistics students. Topics include: specifying the research question, study endpoints, study populations, study interventions, sample size evaluation, and choice of comparison groups. Common study designs and methods for study conduct are described. Prerequisite: BIOS 6601 or BIOS 6611 or consent of instructor. Offered in odd years.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Fall.

BIOS 6649 - Clinical Trials: Statistical Design and Monitoring (3 Credits)
Statistical and scientific design of clinical trials. Intended for biostatistics graduate students. Topics include: scientific and statistical aspects of the research question, endpoints, treatments, sample size evaluation. A wide range of trial designs including group sequential and adaptive trial designs are covered.Pre/Corequisite: BIOS 6612 or instructor permission. Offered spring semester odd years.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Spring.

BIOS 6680 - Data Management Using SAS (3 Credits)
Students will learn how to use SAS software for data management to prepare data for analyses. Main topics include importing and exporting data, variable and dataset manipulations. Introductions to producing reports, basic statistics, figures and SAS macros are also covered.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Fall.

BIOS 7712 - Statistical Methods for Correlated Data (1 Credit)
This course will cover statistical models and methods for serially correlated data, including autoregressive models, Markov models, and Markov chain Monte Carlo methods. Prereq: BIOS 6643
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Spring.

BIOS 7713 - Statistical Methods for Missing Data (1-2 Credits)
This course covers methodological research being carried out for longitudinal studies with missing data. Topics may include missing data mechanisms, non-ignorable missing data, multiple imputation, mixture models and sample size determinations. 1 credit or 2 credit course versions offered in variable years. Prereq: BIOS 6643
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Spring.

CBHS 6620 - Survey Research (3 Credits)
Course examines survey research methodology, including face-to-face, telephone, mail and Internet surveys, includes: developing and ordering questions; formatting; reliability and validity; sampling; implementation; maximizing response rate; data issues; survey ethics and reporting. Offered in odd years.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Fall.

CLSC 7150 - Ethics and Responsible Conduct of Research (1 Credit)
Course provides overview of the field of ethics in clinical research. Topics include historical background, current regulations, IRB requirements on human subjects protection issues. Students will learn how to develop approaches to conduct ethical human subjects research in an optimal manner.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Fall, Spring, Summer.

ECON 5813 - Econometrics I (3 Credits)
Theory and application of statistical techniques used to analyze economic problems. Topics include simple and multiple regression models, simultaneous equation models, and the problems encountered in their application. Students formulate models, obtain data, estimate models, interpret results and, forecast. Restriction: Restricted to students with graduate standing and coreq ECON 5803 or undergraduate majors in the Bachelor's to Master's program (ECON BA-BMA). Term offered: fall. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to students with graduate standing and coreq ECON 5803 or undergraduate majors in the Bachelor's to Master's program (ECON BA-BMA).
Typically Offered: Fall.

ECON 5823 - Econometrics II (3 Credits)
Second course in the econometrics sequence, covering intermediate topics in cross-section and time series analysis. Topics include limited dependent variables, autoregressive and distributed lag models, longitudinal data analysis and unit roots, co-integration and other time-series topics. Prereq: ECON 5813 with a B- or higher. Restriction: Restricted to Graduate and Graduate Non-Degree Majors or undergraduate majors in the Bachelor's to Master's program (ECON BA-BMA). Term offered: spring. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: ECON 5813 with a B- or higher Restriction: Restricted to Graduate and Graduate Non-Degree Majors or undergraduate majors in the Bachelor's to Master's program (ECON BA-BMA).
Typically Offered: Spring.

EPID 6626 - Research Methods in Epidemiology (3 Credits)
Principles, concepts and methods for conducting ethical, valid and scientifically correct observational studies in epidemiological research are the focus of this class. Lectures and practical experience reinforce hypothesis formulation, study design, data collection and management, analysis and publication strategies. Prereq: BIOS 6601, BIOS 6680, EPID 6630.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Spring.

EPID 6631 - Analytical Epidemiology (3 Credits)
Fundamental analytical skills for assessing and reporting disease status, determinants of disease and their impact on public health including determining rates of disease occurrence, measures of associations between exposures and disease, and techniques for identifying and correcting for misclassifications, effect modifiers and confounder.
Prerequisites: EPID 6630 and BIOS 6601 or BIOS 6611
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Fall.

EPID 6635 - Infectious Disease Epidemiology (2 Credits)
This course considers the epidemiology of selected communicable diseases. Methods for their prevention and control, and assessment of these methods will be treated primarily through case studies. Prereq: EPID 6630.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Spring.

EPID 6636 - Chronic Disease Epidemiology (3 Credits)
The major chronic diseases of Western countries will be reviewed including heart disease, cancer, stroke, diabetes, neurological diseases, and selected other conditions. Factual information about epidemiology of these diseases will be provided with the discussion of methodological issues which arise. Prereq: EPID 6630.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Fall.

EPID 6638 - Global Cardiovascular Epidemiology (2 Credits)
A review of the major issues in global cardiovascular disease epidemiology, including trends, the extent of the disease nationally and internationally, implications of major epidemiologic studies, and strategies for prevention. Emphasis of the course will be on review and interpretation of the cardiovascular epidemiology literature. Prereq: EPID 6630. Restriction: Offered even years.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Fall.

EPID 6646 - Introduction to Systematic Reviews (1 Credit)
Introduces methods of conducting systematic reviews to identify the best available evidence about health and public health interventions. Topics will include the design and implementation of reviews, publication bias, search strategies, meta-analysis, and reporting results through the Cochrane Library. Prereq: EPID 6630 or permission of instructor. Restriction: Offered odd years.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Summer.

EPID 7605 - Research Methods with Secondary Data Sources (3 Credits)
Principles and methods for research design and analysis of secondary data sources including those designed for surveillance and those derived from practice. Students evaluate whether specific research questions can be answered with secondary data. Offered Spring of even years.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Spring.

HSMP 6601 - Introduction to HSMP (3 Credits)
Provides an introduction to health systems, management and policy. Topics include the financing and organization of the U.S. healthcare system; introduction to health policy, including stakeholder analysis; and basic managerial skills, including human resources and budgeting.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Spring, Summer.

HSMP 6604 - Health Care Economics (3 Credits)
Uses economic theory to analyze and understand the U.S. health care system. Topics include: demand and supply of health and health care, health insurance, hospitals, pharmaceuticals, and physicians. Analyzes institutional and legal incentives that affect physician, patient, and insurer decision-making.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Fall.

HSMP 6609 - Cost Benefit and Effectiveness in Health (2 Credits)
Introduces students to the basics of economic evaluations of health care interventions or technology. Economic evaluations provide a method to assimilate different cost and health outcomes associated with medical treatments into a common metric.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Spring.

HSMP 7607 - Methods in Health Services Research I (3 Credits)
The first of a 2-course sequence in empirical methods in health services research. The statistical theory underlying basic empirical methods and the thoughtful implementation/practice of these methods are emphasized. Topics covered include: OLS, Gauss-Markov assumptions, logit/probit. Stata will be used. Prereq: BIOS 6611
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only.
Typically Offered: Spring.

PHOR 7611 - Applied Cost-Effectiveness Modeling (4 Credits)
This is an applied course in cost-effectiveness analysis. This course will apply the theory and methods learned in HSMP 6609 to develop competency in conducting cost-effectiveness analysis in health and medicine. Students will complete their own cost-effectiveness model. Prerequesite: HSMP 6609 Cost Benefit/Cost Effitiveness Analysis. Restrictions: Successful completion of HSMP 6609 or permission of primary instructor.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Fall.

PHOR 7613 - Pharmaceutical Economics (3 Credits)
An introduction to pharmaceutical economics with emphasis on the role of pharmaceuticals and the pharmaceutical industry, regulation, and pricing. This course will also cover modeling microeconometric data including costs and health state preferences for advanced economic evaluation using primary data sources.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Spring.

PHOR 7615 - Pharmacoepidemiology (2-4 Credits)
This course builds upon fundamental concepts and methods of epidemiology, applied to the study of pharmaceuticals. Topics included: the FDA approval process, mechanisms of adverse drug effects, methods and data systems for studying drug-effect relationships, and evaluating published pharmacoepidemiology studies. Crosslisted: EPID 7615. Prereq. EPID 6630,2-course biostatistics series (either BIOS 6601-6602 or BIOS 6611-6612) Restrictions: Consent of instructor to determine level of credit to be taken.
Grading Basis: Letter Grade
Repeatable. Max Credits: 4.
A-GRAD Restricted to graduate students only.
Typically Offered: Fall.

PHOR 8990 - Doctoral Thesis (1-10 Credits)
Doctoral thesis work in pharmaceutical sciences. Prereq: Consent of Instructor.
Grading Basis: Letter Grade with IP
Repeatable. Max Credits: 10.
A-GRAD Restricted to graduate students only.
Additional Information: Report as Full Time.
Typically Offered: Fall, Spring, Summer.