

# LIFE SCIENCES AND CLINICAL INVESTIGATION DUAL DEGREE

Degree Types: MS/PhD

The Driskill Graduate Program in the Life Sciences (DGP) and the Master of Science in Clinical Investigation (MSCI) is dual degree program leading to the PhD and MS degrees. The DGP/MSCI degree, leverages CTSA and NUCATS Institute resources to extend integrated clinical/translational research training to DGP PhD students. This dual degree is designed to connect PhD trainees in life sciences early in their research experience with clinician investigators who can help them see the value of understanding the clinical needs of patients. These DGP/MSCI trainees will have a more informed perspective on the intersection between translational and clinical research. They are positioned to become bi-directional collaborators and innovators in this critical space.

Graduates of this program will be uniquely positioned to work in multidisciplinary teams in academic, corporate or government positions to accelerate the translation of research discoveries that improve human health.

#### **Additional resources:**

- Department website (<https://www.feinberg.northwestern.edu/sites/dgp/>)
- Program handbook(s)

## Degree Offered

- Life Sciences and Clinical Investigation Dual Degree MS/PhD (<https://catalogs.northwestern.edu/tgs/life-sciences-clinical-investigation-dual-degree/life-sciences-clinical-investigation-dual-degree-ms-phd/>)

## Life Sciences and Clinical Investigation Dual Degree Courses

### **DGP 402-0 Fundamentals of Biomedical Sciences 1 (1 Unit)**

Fundamentals of Biomedical Sciences 1 and 2 provide an overview of the foundations of modern biomedical sciences. Students will learn about key concepts in biochemistry, molecular biology, genetics, and cell biology. Emphasis will be placed on understanding foundational science, experimental techniques and design. Fundamentals of Biomedical Sciences 1 will cover protein biochemistry, nucleic acids and molecular genetics.

Prerequisite: Open Registration restricted to IGP Students Only.

### **DGP 403-0 Advanced Immunology (1 Unit)**

Topics in immunology. Discussion of current experimental papers. Prerequisite: Open Registration restricted to IGP Students Only.

### **DGP 404-0 Fundamentals of Biomedical Sciences 2 (1 Unit)**

Fundamentals of Biomedical Sciences 1 and 2 provide an overview of the foundations of modern biomedical sciences. Students will learn about key concepts in biochemistry, molecular biology, genetics, and cell biology. Emphasis will be placed on understanding foundational science, experimental techniques and design. Fundamentals of Biomedical Sciences 2 topics will include cellular homeostasis and metabolism, cytoskeleton, adhesion and extracellular matrix, and cell signaling. Prerequisite: Open Registration restricted to IGP Students Only.

### **DGP 415-0 Radiation Biology (1 Unit)**

Understanding how cells, tissues, and the body as a whole respond to ionizing radiation is important for a comprehension of radiotherapy. This course will discuss the effects of ionizing radiation at the molecular, cellular, tissue, and whole organism level. The effects of repair, reoxygenation, repopulation, and cell cycle redistribution will be discussed. Normal tissue toxicities including acute and late effects will be detailed in the course. Discussion will include radiation carcinogenesis, radiation cataractogenesis, low dose effects, the linear non-threshold model for radiation damage. Course is offered only on demand.

Prerequisite: Open Registration restricted to IGP Students Only.

### **DGP 420-0 Introduction to Pharmacology (1 Unit)**

This lecture-based course begins with an introduction to the basic principles of pharmacology, namely pharmacodynamics (what the drug does to the body) and pharmacokinetics (what the body does to the drug). The subsequent topics apply these basic pharmacological principles to a discussion of the normal physiology, the pathophysiological processes that produce disease, and the targeted pharmacological treatment of disease. This integrated physiological, pharmacological and clinical approach will be applied to the following global topics in sequence: Neuropharmacology (Peripheral and Central Nervous Systems), Antimicrobial and Anticancer Chemotherapy, Cardiovascular and Renal Physiology and Pharmacology, Endocrine and Immunopharmacology.

Prerequisite: Open Registration restricted to IGP Students Only.

### **DGP 422-0 Introduction to Translational Research (1 Unit)**

This course is intended to introduce basic life sciences and clinical research graduate students to the thought processes involved in human disease research and its translation into therapy by providing an overview of disease processes, how they are treated, how basic biological science is used to develop those treatments, and the role of various stakeholders in the translational research pipeline. At the end of this course the student should understand the medical rationale for studying basic pathomechanisms and how to utilize that rationale to design studies and grant proposals. In addition, the student will obtain background knowledge for further, disease- or organ-specific upper-level courses.

Prerequisite: Open Registration restricted to IGP Students Only.

### **DGP 425-0 Topics in Drug Discovery (1 Unit)**

Key precedents and contemporary topics in drug discovery research in academia and industry. Principles of drug design and action, pharmacogenetics, macromolecular target identification and characterization, bioassays and animal models of disease, study design and information management.

### **DGP 430-0 Genetics (1 Unit)**

Genetics of prokaryotic and eukaryotic organisms; gene regulation and variation; chromosome structure and behavior; linkage and recombination; quantitative and population genetics; biochemical and developmental genetics; and manipulation of genes in organisms, including humans.

Prerequisite: Open Registration restricted to IGP Students Only.

### **DGP 432-1 Chromatin & Epigenetics (1 Unit)**

Students will understand foundational and transformational studies in chromatin and epigenetics. Enrollment is restricted to DGP Students.

### **DGP 433-0 Advanced Microbial Pathogenesis (1 Unit)**

AMP is an advanced paper discussion and grant writing course centered around topics such as immune responses to and pathogenesis of bacterial and viral infections, as well as basic mechanisms of pathogen replication and disease causation. The class begins with an overview of the NIH grant system followed by student-led paper discussions and writing of 1-page Aims pages, which serve to build critical thinking skills.

The course culminates in the writing of a 6-page R21-style grant that is reviewed in a student-led mock NIH-style study section.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 435-0 Signal transduction and human diseases (1 Unit)**

Integrated discussion of different superfamilies of signaling receptors and their effectors. Pathways discussed include G-protein linked, growth factors and cytokines, nuclear receptors and transcription factors.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 436-1 Drugs and the Brain (1 Unit)**

Graduate neuropharmacology course with a mix of didactic instruction (33%) and in-depth classroom discussion of primary research papers (66%). The course is not a survey course, but rather will cover selected topics in neuropharmacology with the goals of 1) informing the student of the latest neuropharmacology knowledge, 2) inculcating a rigorous approach to examination of the scientific literature, and 3) encouraging best practices in experimental design.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 440-0 Immunology (1 Unit)**

An integrated view of contemporary immunology: antigens, antibodies, humoral and cell-mediated immune responses, cellular interactions, and regulation of immune responses.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 442-0 Fundamentals of Microbiology (1 Unit)**

This course emphasizes the basic principles of virology and bacteriology, focusing on selected molecular aspects of viral and bacterial lifecycles, as well as on the interactions between these microbes and the host immune system. The course will consist of a blend of instructor lectures, journal club discussions, and take-home assignments. In addition to acquiring fundamental knowledge in microbiology, students will refine their critical analysis and scientific communication skills through the evaluation and presentation of journal articles.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 450-0 Tumor Cell Biology (1 Unit)**

Basic aspects of the neoplastic phenotype, including morphologic, biochemical, genetic, cytogenetic, and other features; regulation of cell proliferation and differentiation; basic concepts in molecular mechanisms of chemical, viral, and radiation carcinogenesis; solid tumor growth, progression, and metastasis; tumor immunology.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 456-0 Topics in Developmental Biology (1 Unit)**

Survey of current models in mammalian and nonmammalian development. Emphasis on stem cell biology. Discussion of experimental papers.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 460-0 Pharmacovigilance in Early Drug Development (1 Unit)**

Pharmacovigilance is the science dealing with the collection, assessment, monitoring, and prevention of adverse effects of drugs and pharmaceutical products and is a fast-growing area in industry, health sciences, and in regulatory agencies. The course will address the fundamentals of pharmacovigilance especially in the context of early drug development. Topics covered will include causality assessment and management of drug safety during drug discovery, benefit-risk analysis, signal management, and product safety monitoring in clinical trials. Students will learn about how to monitor, recognize, and manage adverse drug reactions, medication errors, issues related to misuse and abuse of drugs, as well as drug safety during pregnancy and pediatric populations. The lectures will be given by experts in the field affiliated with Northwestern University and Abbvie, Inc. A key aspect of the course will include Case studies, which will discuss real published

data on assessment of a specific drug or pharmaceutical products.

Upon completion of this course, graduate students will demonstrate an understanding of pharmacovigilance and patient safety in the context of early drug development.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 466-0 Structural Basis of Signal Transduction (1 Unit)**

The structural and thermodynamic basis by which protein-protein or protein-nucleic acid interactions mediate signal transduction. Signaling pathways used to explore how the structural biological mechanisms underlying these pathways can be experimentally determined and understood.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 475-0 Virology (1 Unit)**

Mechanisms of genome replication, control of gene expression, and protein functions are analyzed in RNA and DNA viruses.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 480-0 Molecular Mechanisms of Carcinogenesis (1 Unit)**

Current literature relating experimental approaches and recent discoveries in the fields of cell biology, virology, and molecular genetics to mechanisms of carcinogenesis. Advanced level.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 484-0 Quantitative Biology: Statistics and Data Analysis for Life Scientists (1 Unit)**

Parametric statistics (such as the familiar t test); nonparametric and simulation approaches (such as permutation tests) better suited to "real" data; and a conceptual survey of more sophisticated data-mining/machine-learning techniques.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 485-0 Data Science For Biomedical Researchers (1 Unit)**

Introduction to the data and analysis tools from several areas of study within the Biomedical Informatics research spectrum. Didactic instruction as an introduction to the topics followed by hands-on demonstrations and exercises to reveal practical use of relevant software tools.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 486-0 Advance Bioinformatics and Genome Informatics (1 Unit)**

The course will be oriented towards graduate students in HSIP, DGP and related programs. It will consist of lectures/seminars, each two hours in duration. The course will introduce various high-throughput technologies, such as microarray and Next Generation Sequence data, for measuring and analyzing gene expression, chromosomal deletions and amplifications, methylation patterns and genome architecture. Further, various algorithms and bioinformatics tools for analyzing the produced high-dimensional data will be discussed. The course begins with couple of introductory lectures in the biology part (Experimental/Technology part - 2 hours duration - no laboratory) followed by presentations on algorithms and data analysis (Bioinformatics part - 2 hours duration). Finally some recently published articles using these technologies will be discussed. At the end of the course, the students will be expected to gain an overview of the current highthroughput technologies and use of associated bioinformatics algorithms and analytical methods. Students will gain experience in genomic data visualization tools to analyze multi -omics data for gene expression, genome rearrangement, somatic mutations and copy number variation. The course will conclude with analyzing and conducting pathway analysis on the resultant cancer gene lists and integration of clinical data.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 494-0 Colloquium on Integrity in Biomedical Research (0 Unit)**

Required by National Institutes of Health (NIH) but does not count as one of the required IGP courses.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 496-1 Introduction to Life Science Research (0 Unit)**

Provides first-year IGP students with tools to develop the knowledge base and skill set necessary for competent research.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 496-2 Introduction to Life Science Research (0 Unit)**

Provides first-year IGP students with tools to develop the knowledge base and skill set necessary for competent research.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 496-3 Introduction to Life Science Research (1 Unit)**

Provides first-year IGP students with tools to develop the knowledge base and skill set necessary for competent research.

Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 499-0 Independent Study (1-3 Units)**

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Prerequisite: Open Registration restricted to IGP Students Only.

**DGP 590-0 Research (1-3 Units)**

Independent investigation of selected problems pertaining to thesis or dissertation.

Prerequisite: Open Registration restricted to IGP Students Only.

**MSCI 311-0 Clinical Research Design, Methods, and Grant Writing (1 Unit)**

This course presents students with a comprehensive survey of concepts vital to a career in clinical & translational science. The course will fill a void in the curriculum by functioning as foundation from which other MSCI courses will spring and afford students an opportunity to interface with basic clinical and translational concepts before delving into these subjects more granularly as they pursue the degree. Items that will be reviewed in more depth later such as reviewing study designs and recognizing the types of research problems that lend themselves to interventional study designs are approached here as a way of better preparing students for the challenges ahead.

**MSCI 321-1 Biostatistics for Clinical Investigators 1 (1 Unit)**

This is an introductory yet rigorous course that covers classic statistical inference and methods. Applications and interpretation of data are emphasized. Mathematical proofs and derivations are not covered; however, theory is addressed conceptually. Readings are intended to be theoretical. Lectures, homework and exams will focus on applying statistical procedures using SPSS and interpreting data. Due to time restrictions, only selected topics are covered. The use of SPSS is a course requirement.

**MSCI 322-0 Introduction to Epidemiology for Clinical Investigators (1 Unit)**

This course is an introduction to the field of epidemiology and its application. Epidemiology is the study of the distribution of disease and determinants of disease in human populations. The most commonly used study designs in epidemiology are observational rather than experimental. The course will introduce these study designs and basic analytic methods. Emphasis will be on the appropriate interpretation of epidemiologic evidence, including the attribution of causality when describing an exposure-disease relationship.

**MSCI 330-0 Electronic Health Record Data as a Foundation for Clinical Research (1 Unit)**

This course will introduce electronic health records as a data source, considerations for working with protected health information and integration of health record data with other data sources and will explore

clinical and research applications of medical records and discuss methods and tools for data validation and analysis.

**MSCI 335-0 Clinical Trials (1 Unit)**

The goal of this course is to provide students with the skills to design, conduct, analyze, interpret, and report the rest of a clinical trial. Trials by definition are experimental and are used to determine whether a clinical intervention works.

**MSCI 350-0 Community Engagement in Action: Applications for Research and Practice (1 Unit)**

Clinical and translational investigation aspires to be patient-focused. That is to say including the patient perspective at all stages of research will improve the likelihood of clinical translation – the concept that discoveries will result in tangible improvements in health. Engaging community partners in projects that may affect them has become a key competency for clinical investigators, but it is not an organic process; it requires skills, knowledge, and education. This course will educate learners in our MSCI program on the principles of community engagement with the goal that it results in their ability to do more impactful research over the course of their careers.

**MSCI 421-0 Biostatistics for Clinical Investigators 2 (1 Unit)**

This course covers advanced modeling techniques for statistical inference. Applications and interpretation of data are emphasized. Mathematical proofs and derivations are not covered; however, theory is addressed conceptually. Lectures, homework and exams will focus on applying statistical procedures using SPSS and interpreting data. Due to time restrictions, only selected topics are covered. The use of SPSS is a course requirement.

**MSCI 440-0 Clinical and Translational Strategies to Advance Health Equity (1 Unit)**

This course provides an overview of how racism, especially anti-Black racism, affects health and health care, focusing on avoiding scientific errors and perpetuation of inequities in the design and conduct of clinical and translational research.

**MSCI 445-0 Writing & Peer Reviewing for Publication for Clinical Investigators (1 Unit)**

This course represents a HANDS-ON experience that will review and discuss the steps involved in preparing, peer reviewing, and revising manuscripts for publication. Students are expected to prepare and hand in written work for each class and to attend and participate actively in class discussion. Advance reading and writing are essential for this course.

**MSCI 480-0 Introduction to Omics in Translational Research (1 Unit)**

The goal of this course is to be foundational for what clinical investigators need to know regarding omics approaches to studying disease and application to novel diagnostics or therapeutics.

**MSCI 490-0 Independent Study (1 Unit)**

Permission of instructor and department required.

**MSCI 499-0 Research Project (2 Units)**

The MSCI Research Project serves as a capstone for the degree; students enroll at or near the end of their coursework and signifies the culmination of a project that they have been working on throughout their time in the program. This is not a traditional classroom course but follows an independent study approach. Research must be data-driven and of publishable quality: clinical case studies or IRB submissions are not acceptable.

**MSCI 514-0 MSCI Concurrent Clinical and Research Responsibilities (0 Unit)**

Elective course for students pursuing Clinical and Research Responsibilities outside direct classroom participation.