PharmGrad
Pharmacy Graduate Application Service

Areas of Study in Pharmaceutical Graduate Education

Pharmaceutical graduate education encompasses a diverse set of disciplines and interdisciplinary fields that contribute to the discovery, understanding, development, and safe and effective use of substances and interventions for the diagnosis, treatment and prevention of disease or restoration and optimization of health. Pharmaceutical research is concerned with improving treatment and health at both the individual and population levels and includes basic, applied, biological and behavioral studies. The list below introduces some areas of study in pharmaceutical graduate education.

- **Administrative Science** – Administrative science is an interdisciplinary field focused on theory and practice of the administration and management of pharmacy and healthcare organizations. Administrative science in pharmaceutical graduate education focuses on understanding social, cultural, and organizational aspects of drug development, healthcare and medication use, such as drug pricing, medication use and adherence, and pharmacy management practices.

- **Behavioral Science** – Behavioral science relates to the varied factors and influences, including personal, social, economic and political, that affect human choices and actions. Behavioral science in pharmaceutical graduate education focuses on behaviors related to health and pharmaceutical interventions at the individual and population level.

- **Biochemistry** – Biochemistry is the study of the chemical substances and interactions that occur within organisms and that underlie biological processes. Biochemistry encompasses the chemistry of biological molecules and processes and the biological activity of chemical substances, including drugs.

- **Bioengineering** – Bioengineering is the design and manipulation of materials, devices and structures to modify or improve biological, physical or physiological functions. Bioengineering encompasses both the application of engineering principles and practice to biological materials and processes and the development of technology for biological and biomedical applications.[1]

- **Biological Science** – Biological science is the branch of natural sciences that studies life and living processes, at the cellular and organismal level, including plants, microorganisms and animals.[2] Biological sciences within pharmaceutical graduate education may focus on the understanding and treatment of disease and improving health, or other related areas.

[1] https://bioeng.berkeley.edu/about-us/what-is-bioengineering
[2] https://www.nature.com/subjects/biological-sciences

- **Biomedical Sciences** – Biomedical sciences bring together the study of biological processes and medicine to create knowledge and interventions to improve health and healthcare at the individual and population levels.

- **Biometrics/Biostatistics** – Biometrics/biostatistics is the study and analysis of metrics and data related to biological processes and health, applying the methods and techniques of statistical analysis to experimental design, data collection and interpretation of results.[3] In pharmaceutical graduate education, biostatistics is utilized in the study of topics including basic biology, drug design, healthcare utilization and public health.

- **Biotechnology** – Biotechnology is the use of biological systems and processes, such as fermentation, to create or develop biological products that can be used for research, medical, agricultural or industrial purposes.[4] Applications in pharmaceutical research include development of therapeutic cells and antibodies.

- **Cancer** – Cancer is a collection of disease in which cells begin to divide and spread uncontrollably.[5] Cancer diagnosis and treatment is an important area of pharmaceutical research, including development of cancer chemo-, radio- and immunotherapies, precision cancer medicine and advanced drug delivery technology.

- **Cellular Biology** – Cellular biology is the study of the structure and function of cells. The study of cells may be to advance understanding of disease as seen through their effects at the cellular level or to develop cell therapies, such as CAR T cell cancer therapy.

- **Chemical Science** – Chemical science is the study of the properties, behavior, and interactions of atoms, molecules, and ions, including in relation to the formation, composition, structure and properties of compounds and substances and the synthesis of new compounds.

- **Clinical Research** – Clinical research encompasses the knowledge and methods used in investigations in humans, individuals and populations, particularly for the study of health interventions. Clinical science in pharmaceutical research typically focuses on effectiveness or management of medication therapy.

- **Cognitive Science** – Cognitive science is the study of the mind, thought and decision-making processes and their relationship to behavior. In pharmaceutical research, cognitive science studies may focus on decision-making and behaviors that have an impact on health outcomes.

- **Cosmetic Science** – Cosmetic science is the discipline devoted to the development, design, formulation, manufacture and marketing of cosmetics.

- **Developmental Science** – Developmental science is the interdisciplinary study of human development, including atypical development of children. Pharmaceutical research in developmental science may focus on pharmacotherapy of developmental disorders in children and adolescents.

---

[3] https://en.wikipedia.org/wiki/Biostatistics
[4] https://en.wikipedia.org/wiki/Biotechnology
[5] https://www.cancer.gov/about-cancer/understanding/what-is-cancer

- **Drug Delivery** – Drug delivery is the study of technology, materials, and strategies to control the distribution and transport of drugs in the body, to improve their safety and effectiveness, where drugs are broadly understood as substances with therapeutic properties. Drug delivery technologies include nanoparticles, liposomes and peptides and generally improve therapeutic effect by enabled controlled release, targeting and dose.

- **Drug Development** – Drug development is the process by which a substance, typically called a lead compound, that has been identified as having therapeutic value is brought to market in a finished form. Drug development includes preclinical research *in vitro* and in animals, safety studies, regulatory filings, and clinical trials.

- **Drug Discovery** – Drug discovery is the process of identifying new candidates for development as therapeutic substances, traditionally by screening libraries of natural products or chemical compounds for activity in whole cells but now commonly through high throughput screening of compound libraries against isolated biological targets identified through genomic studies. Promising compounds continue through the drug development process.

- **Drug Metabolism** – Drug metabolism is the process by which pharmaceutical substances are transformed and broken down within the body. Drug metabolism determines the lifetime of drug circulation in the body, how much of a drug is absorbed and active within the body, the strength of drug action, and the likelihood of drug resistance or drug-drug interactions.

- **Education** – Educational studies within pharmaceutical graduate education focus on developing effective methods for the transfer of knowledge and development of student competencies in pharmaceutical research and curricular design.

- **Engineering** – Engineering is the application of scientific principles and knowledge to the design and production of materials, processes, devices, technology, and infrastructure to solve problems or enhance the quality of life and lived experience.

- **Environmental Science** – Environmental science is an interdisciplinary field devoted to studying the environment, the effects of human activity on the environment and remediation of those effects, and the impact of environmental factors, particularly pollution, on human health and wellness. Within pharmaceutical research, drug metabolism, toxicology and natural products studies may be pursued in the context of environmental science.

- **Epidemiology** – Epidemiology is the study of the incidence, distribution, patterns, trends and determinants of disease and health conditions in populations. Epidemiology uses approaches from medicine, social science and data sciences to advance public health. Within pharmaceutical research, epidemiology may address infectious disease, substance use and misuse, and access to and use of health interventions and medications.

- **Experimental Therapeutics** – Experimental therapeutics is the pursuit of new therapies that are more effective and have fewer side effects than existing therapies, particularly for cancer. Experimental therapeutics engage novel targets including cell signaling pathways, the tumor microenvironment, and immune response.

- **Forensic Science** – Forensic science is the application of scientific principles to criminal investigations and civil litigation., through the collection and analysis of evidence. Within pharmaceutical research, forensic science can involve studies of drug metabolism, toxicology and pharmacology related to substance use and misuse, poisoning, medical malpractice, among other issues.

- **Health Outcomes** – Health outcomes are the changes in health that result from specific healthcare intervention, at the individual or population level.[6] Health outcomes are studied by analyzing data related to utilization of specific interventions and correlating with data on health outcomes related to those interventions. Health outcomes is an important focus of research in pharmaceutical graduate education, often focused on medication use and health services utilization.

- **Health Policy** – Health policy "refers to the plans, decisions and actions that are undertaken to achieve specific health care goals within a society," according to the World Health Organization.[7] Many fields in pharmaceutical graduate education, including health outcomes, health services, and, pharmacoeconomics, engage in studies intended to inform health policy.

- **Health Services** – Health services is a collective term for the varied interventions provided to individuals and populations to treat disease and improve health, typically through health delivery systems. Pharmaceutical graduate education in social and administrative sciences typically focuses on study of some aspect of health delivery systems or health services utilization.

- **Human Population** – Human population studies focus on the health of groups of individuals who share a characteristic of interest, generally to determine patterns or outcomes to improve healthcare for that population or extrapolation to the general population. Human population studies in pharmaceutical research may encompass pharmacoepidemiology, health outcomes and health services.

- **Immunology** – Immunology is the study of the immune system and its functions, including healthy function and response to challenges including disease, allergens or transplantation. Immune function may also be harnessed as a therapeutic strategy, as in cancer immunotherapy.

- **Industrial Pharmacy** – Industrial pharmacy is a discipline devoted to the development, manufacture, marketing and distribution of pharmaceuticals, including quality control and assurance. Pharmaceutical graduate education in industrial pharmacy prepares students to work in the pharmaceutical industry.

- **Infectious Disease** – Infectious diseases are caused by microorganisms, such as viruses, bacteria, fungi, and parasites, that transmit between individuals or, in the case of zoonotic disease, between animals and humans. Pharmaceutical research seeks to lessen the burden of infectious disease by developing and delivering treatments and preventive measures, such as vaccines.

[6] https://www.cihi.ca/en/outcomes
[7] https://www.who.int/topics/health_policy/en/

- **Informatics** – Informatics is the application of the principles of information science, including computer science, statistics, and systems engineering, to problems involving large amounts of data. In pharmaceutical research, informatics may be applied to drug discovery and development, as well as to studies of health systems and health care utilization.

- **Material Science** – Material science is an interdisciplinary field dedicated to the synthesis and characterization of new materials. Originally a fusion of physics, chemistry, and metallurgy, biological materials are increasingly used, such as in the creation of DNA or RNA nanoparticles.

- **Medicinal Chemistry** – Medicinal chemistry applies the principles and methods of chemistry to discover new medicines and improve processes by which medicines are made, by isolating active ingredients from natural substances and creation of new synthetics. Many pharmacy schools have departments of medicinal chemistry.

- **Molecular Biology** – Molecular biology is the study of biological molecules and biological processes and interactions at the molecular level, including molecular activity at the cellular level that underlies many biological processes. Important topics of study includes RNA, DNA, and protein synthesis, modification, mechanisms and interaction.[8] In pharmaceutical research, molecular biology is an important approach to discovery and development of disease diagnostics and treatments.

- **Molecular Medicine** – Molecular medicine seeks to understand, diagnose and treat disease through the study and modification of cellular molecules, including genes and proteins. Pharmaceutical research in molecular medicine brings together biological and informatics approaches to identify and treat novel targets for disease treatment.

- **Molecular Science** – Molecular science is the study of materials at the molecular level, using principles and techniques from physics, chemistry, and biology to understand, design and manipulate materials at the molecular level. In pharmaceutical graduate education, molecular science can encompass biochemistry, molecular biology, nanoscience and related disciplines with the goal of treating disease and improving health.

- **Nanoscience** – Nanoscience is the interdisciplinary study of structures and materials at the nanometer (10^{-9} m) scale, focused on understanding size-dependent properties that emerge at the nanoscale. Many important biological materials, including RNA/DNA and viruses, inhabit the nanoscale and their structure and behavior can be studied using nanoscience approaches.

- **Nanotechnology** – Nanotechnology is the interdisciplinary study of structures and materials at the nanometer (10^{-9} m) scale, focusing on the synthesis and characterization of materials with size-dependent properties that emerge at the nanoscale. Since many biological materials and processes occur at the nanoscale, nanomaterials and nanotechnology are attractive technologies for use in drug delivery, regenerative medicine, and other biomedical applications.

- **Natural Product** – Natural products are substances or compounds produced by living organisms.[9] Natural products have traditionally been an important resource for drug discovery

[8] https://en.wikipedia.org/wiki/Molecular_biology
[9] https://www.nature.com/subjects/natural-products

and development. Pharmaceutical research may involve the isolation or synthesis of natural products, their characterization, and testing as therapeutic agents.

- **Neuroscience** – Neuroscience is the study of the structure and function of the brain and nervous systems, including molecular and cellular process, anatomical structure, and physiology. Within pharmaceutical research, important topics of study include neuropharmacology and the treatment of disorders of the brain and nervous system, including behavioral disorders.

- **Occupational Health** – Occupational health concerns the safety, health, and well-being of workers, including physical, environmental and psychological factors that may affect workers, such as hazards that may lead to accidents or injury or conditions that promote high stress levels. Within pharmaceutical graduate education, occupational health studies may concern worker conditions in pharmaceutical manufacturing or pharmacies.

- **Patient Safety** – Patient safety is an approach that promotes reduction of medical errors and replacement of practices that may harm patients. Patient safety calls for team-based patient care, accountability and reporting of errors, and instillation of a safety culture. Within pharmaceutical graduate education, patient safety may focus on safe medication use and medication management therapy.

- **Pharmaceutical Marketing** – Pharmaceutical (drug) marketing is the identification of potential patients and users for therapeutic products and the development of strategies to promote drug use and purchasing by these patients. This may encompass product development and launch, reimbursement strategies and payer relations, communications, advertising, and sales. The audience for pharmaceutical marketing includes patients, their physicians, health care systems and payers.

- **Pharmaceutical Science** – Pharmaceutical science is an interdisciplinary field devoted to the discovery, development and dissemination of new therapies and treatments. Pharmaceutical graduate education may involve study at any stage of the drug development and distribution pipeline, from molecular synthesis of new drug candidates to economic studies of their cost-effectiveness.

- **Pharmaceutics** – Pharmaceutics is the study of how to develop biologically active molecules and chemicals into safe and effective medications, through formulation design, dose optimization, and pharmaceutical manufacturing.

- **Pharmacodynamics** – Pharmacodynamics is the branch of pharmacology concerned with biological, biochemical and physiological effects of substances on organisms and the mechanisms of action of drugs. Pharmacodynamics is the study of how drugs effect organisms.

- **Pharmacoeconomics** – Pharmacoeconomics is the study of the cost and value of health interventions, especially drugs and drug therapies, including cost-effectiveness analyses and comparisons of therapies. In pharmaceutical graduate education, pharmacoeconomics may be studied on its own or integrated into a health or pharmacy policy framework.

- **Pharmacogenomics** – Pharmacogenomics is the study of how a patient's genes affect their response to drugs, combining pharmacology and genomics to determine safe treatments and optimal doses of drugs for patients based on their genetic profile.

- **Pharmacognosy** – Pharmacognosy is the study of drugs derived from plants and other natural sources, including characterization of properties of drugs derived from natural sources and the discovery and development of new drugs.

- **Pharmacokinetics** – Pharmacokinetics is the branch of pharmacology concerned with metabolism, deposition and elimination of substances within organisms. Pharmacokinetics is the study of how organisms process substances.

- **Pharmacology** – Pharmacology is the study of the action of drugs within the body and the interactions between drugs and the body, from the cellular to organismic level. In pharmaceutical research, drugs are understood to broadly refer to external chemical and biological substances intended to have physiological effect.

- **Pharmacometrics** – Pharmacometrics is the use of computational methods and models to predict and understand the interactions between substances and exposed patients, such as drug-drug interactions and adverse side effects. Pharmacometric models incorporate biology, pharmacology, and physiology to aid in drug discovery and development, including efficient and safe clinical testing and treatment.

- **Pharmacotherapy** – Pharmacotherapy is the use of medication to treat a disease or disorder. In pharmaceutical graduate education, the study of pharmacotherapy covers the safe and effective use of mediation therapy, including adherence and cost effectiveness.

- **Pharmacy Care** – Pharmacy care is medication-focused counseling and advice to help patients use prescription and over-the counter medications and supplements safely and effectively, identifying potential interactions or adverse events and helping patients make informed decisions about medication therapy, immunizations and other healthy lifestyle choices. Pharmaceutical graduate education in social and administrative sciences may include studies of pharmacy care models.

- **Pharmacy Communication** – Pharmacy communication is education, counseling and marketing related to medications and therapeutics, typically delivered to patients and prescribers, but also to payors and other health system stakeholders. Pharmaceutical graduate education in social and administrative sciences may include the study of effective and pharmacy communications strategies and models.

- **Pharmacy Management** – Pharmacy management encompasses the administrative, financial and leadership skills and practices necessary to ensure pharmacies provide effective, patient-centered health care and services. Pharmaceutical graduate education in pharmacy management may include the study of practice and reimbursement models in community and health systems pharmacy.

- **Pharmacy Marketing** – Pharmacy marketing brings together principles and skills from clinical practice, communications, public relations, market research, economics, health systems and

pharmacy management, and industrial pharmacy to deliver pharmaceuticals and pharmacy services to patients and health systems.

- **Pharmacy Policy** – Pharmacy policy is concerned with the plans and actions related to pharmacies, health systems, pharmaceutical manufacturing and distribution, and public health that are intended to bring about desired public health, health care or economic goals. In pharmaceutical graduate education, topics of study in pharmacy policy may include pharmacoeconomics, pharmacy administration, health outcomes, or pharmacy practice.

- **Pharmacy Practice** – Pharmacy practice encompasses the different settings in which pharmacists work and provide or guide patient care, traditionally focused on medication use but also covering diet and nutrition, substance use, and minor wound or injury care, among other services. In pharmaceutical graduate education, pharmacy practice studies may include social and administrative pharmacy, community pharmacy, clinical or health systems pharmacy or pharmaceutical sciences.

- **Physical Science** – Physical science is the study of inanimate objects and the laws that govern their structure, composition and behavior. Physical sciences include physics, the study of matter, energy, and force; chemistry, the study of the composition, structure, properties, and interactions between materials; and earth science, the study of the natural environment. In pharmaceutical research, principles and methods from physical sciences are often applied to understanding and developing substances and their interactions with biological systems, organisms, and the environment.

- **Physiological Science** – Physiological science is the study of mechanisms and functions in living systems across levels of organization from cellular function to structure and behavior of the whole body. Physiological science includes healthy function and practices to maintain healthy function, as well as disease.

- **Psychiatric/Psychological Sciences** – Psychiatric and psychological sciences are the study of the mental health and disease and the relationship between mind and behavior, including the conditions that support good mental health and functioning and the causes, diagnosis, prevention, and treatment of mental disorders. In pharmaceutical graduate education, psychiatric and psychological sciences may focus on neuropharmacology, pharmacotherapy of mental health disorders and substance use and misuse.

- **Public Health** – Public health is "is the science of protecting and improving the health of people and their communities," according to the CDC Foundation.[10] This includes research to identify behaviors and societal practices that promote health, causes of disease and injury, and interventions at the individual and population level that promote best practices to preserve health and prevent disease. In pharmaceutical graduate education, public health studies may be concerned with practices related to medication, diet, and substance use.

- **Radiopharmacy** – Radiopharmacy is the preparation of radioactive materials for use in diagnostic imaging and radiotherapy of disease. Also known as nuclear pharmacy, radiopharmacy typically involves compounding a radioactive tracer or treatment agent with a

[10] https://www.cdcfoundation.org/what-public-health

biological or molecular targeting agent to localize the compound to a desired site in the body. Within pharmaceutical graduate education, radiopharmacy may involve the development of new materials, improved production of existing compounds, or regulatory science related to radiocompounds.

- **Regulatory Science** – Regulatory science is "the science of developing new tools, standards, and approaches to assess the safety, efficacy, quality, and performance of all FDA-regulated products," according to the FDA.[11] In pharmaceutical graduate education, regulatory science studies may focus on the development, clinical testing, quality assurance, manufacture, or marketing of medications, dietary supplements, or diagnostic tests.

- **Social Science** – Social science is the study of society and social relationships and the roles and relationships between individuals in a society, and the affect societal roles and influences have on individual behavior and outcomes. In pharmaceutical research, social science studies typically focus on social aspects of health and healthcare.

- **Structural Biology** – Structural biology is the study of structural properties and dynamics of biological molecules, using the principles of biology, biochemistry, and physics to relate the structure and structural changes of biomolecules to their function.

- **Toxicology** – Toxicology is the study of the adverse effects on living organisms and biological and environmental systems resulting from exposure to chemical substances and toxins.

- **Transdermal Drug Delivery** – Transdermal drug delivery is the systemic delivery of drugs through unbroken skin, typically by absorption of drugs released from a depot or microneedles, enabling sustained, consistent release of drug. Transdermal drug delivery is primarily used for delivery of low-dose, small molecule drugs.

- **Translational Science** – Translational science is the discipline concerned with turning discoveries and observations from laboratory and social sciences into interventions that improve the health of individuals and population.[12]

- **Vaccine Technology** – Vaccine technology seeks to enhance the effectiveness, improve the shelf-life or stability, ease manufacture or create new delivery routes for vaccines. Pharmaceutical research on vaccine technology may involve nanoparticles, RNA and DNA technology, and viral vectors.

[11] https://www.fda.gov/science-research/science-and-research-special-topics/advancing-regulatory-science
[12] https://ncats.nih.gov/translation/spectrum