The following document lists the educational outcomes/competencies expected and required of students graduating from the Doctor of Pharmacy program. It uses as an organizing framework the AACP Center for the Advancement of Pharmaceutical Education (CAPE) Educational Outcomes report issued in 2004. Outcomes/competencies are segregated into two broad categories, *foundational learning outcomes* and *applied competencies*. Foundational learning outcomes are fundamental facts, concepts, and abilities taught in many of the courses in our curriculum. These form the foundation upon which applied competencies can be built. Applied competencies require integration and application to pharmacy practice of foundational learning outcomes and are substantially congruent with the “educational outcomes” cited in the CAPE document.

I. **PHARMACEUTICAL CARE.** Provide pharmaceutical care in cooperation with patients, prescribers, and other members of an interprofessional health care team based upon sound physical, chemical, biological, and therapeutic principles and evidence-based data, taking into account relevant legal, ethical, social, economic, and professional issues, emerging technologies, and evolving biomedical, sociobehavioral, and clinical sciences that may impact therapeutic outcomes.

A. **Provide patient-centered care**

   1. **Foundational learning outcomes**

      a. Numeracy, statistics, experimental design, measurement, medical terminology

         1) Demonstrate an understanding of the classical “scientific method”
         2) Demonstrate an understanding of appropriate experimental design
         3) Demonstrate an understanding of the basic principles of probability theory, population distributions and random sampling
         4) Demonstrate an understanding of the basic principles of statistical inference and hypothesis testing
         5) Demonstrate an understanding of statistical methods commonly employed in biomedical sciences (e.g., ANOVA, multiple regression, survival analysis)
         6) As applicable to pharmaceutical preparations, demonstrate knowledge of logarithms, elements of calculus, statistical treatment of errors, measuring, weighing, and significant figures
         7) Demonstrate an understanding of the dimensions and units of measurements for drugs and chemicals, expressions of quantity and concentration for drug products and preparations,
and appropriate methods of expressing doses and dosing
regiment for patients
8) Demonstrate a grasp of basic medical terminology used in
health care professions

b. Biochemistry

1) Describe the structures and properties of the four main
building blocks of biochemistry (carbohydrates, lipids, amino
acids and nucleic acids), the polymers constructed from these
building blocks, and the supermolecular assemblies
constructed from these polymers
2) Describe the kinetic mechanisms of enzyme inhibition and
chemical binding modes of enzyme inhibitors
3) Describe the regulatory mechanisms that control the flux
through metabolic pathways
4) Describe the nature of genetic materials and the universal
遗传 code
5) Identify and describe the molecular processes known as
replication, transcription and translation

c. Microbiology

1) Demonstrate an understanding of the classification and
phylogeny of microscopic pathogens (e.g., bacteria, viruses, fungi)
2) Demonstrate an understanding of the structure and function of
bacterial cells and viruses
3) Demonstrate an understanding of the biology of bacterial and
viral growth and factors which control bacterial and viral
growth
4) Demonstrate an understanding of the energy generating
metabolism of bacteria
5) Demonstrate an understanding of the normal microbiologic
flora of the human organism
6) Demonstrate an understanding of bacterial and viral
pathogenicity and of host antimicrobial defense mechanisms
7) Demonstrate an understanding of bacteria and viruses of
medical importance and their association with disease

d. Anatomy, physiology, pathology

1) Describe the nature, location and function of a selected
component of the human anatomy
2) Describe the basic structure and function of a normal human
cell
3) Describe the basic organization, structure and function of
selected human tissues
4) Describe the basic normal physiology of a selected human
organ
5) Describe the basic normal physiology of a selected human
functional system (e.g., cardiovascular system)

6) Describe the general pathophysiologic processes, which result in disease
7) Describe the specific pathophysiologic basis of common diseases
8) Demonstrate an understanding of the relationship between pathophysiologic principles and the clinical manifestations, diagnosis, prognosis and treatment of common diseases

e. Medicinal chemistry and pharmacology

1) Describe fundamental concepts of drug-receptor interactions
2) Describe the intermolecular energies that allow drug molecules to bind to proteins and how these interactions dictate binding specificity
3) Understand structure-activity relationships defining the interaction of a drug with its receptor, and be able to identify the pharmacophoric functional groups that are important for receptor binding and biological activity
4) Utilize receptor binding models to predict the ability of a structural analog of a characterized drug to bind to the target receptor
5) Given the chemical structure of a selected drug, be able to identify the pharmacological class of the drug
6) Describe the principles of dose-response relationships and their use in quantifying drug actions
7) Describe the structure and function of cellular protein drug targets and how amino acid functionality leads to binding specificity with receptor ligands
8) Describe the relation between cell membrane or intracellular drug targets and intracellular signaling systems which mediate cellular response
9) Demonstrate an understanding of acid-base equilibria (pH, pKa, buffers) and the partition coefficient concept as they apply to pharmacology and physiology
10) Describe the impact of drug accessibility to biological compartments on drug action
11) Describe the mechanism of therapeutic action of a selected drug at the molecular, cellular, organ system and whole body levels
12) Describe the common adverse effects of a selected drug and their mechanism of production
13) Describe the purpose as well as the detailed mechanisms of the biochemical reactions that render drug and xenobiotic compounds more suitable for elimination from the body
14) Predict possible metabolic outcomes of a given drug based on its chemical structure
15) Describe the fundamental mechanisms responsible for various types of drug interactions
16) Given the chemical structure of a given drug or xenobiotic, predict possible toxicity or mutagenicity due to the substance’s
metabolic conversion to a problematic product

17) Identify and describe the genetic elements responsible for the clinical resistance to antimicrobials

18) Describe the mechanisms of transfer and of manipulation of the genetic elements involved in antimicrobial resistance

f. Pharmaceutics, biopharmaceutics, pharmacokinetics and pharmacodynamics

1) Demonstrate an understanding of thermodynamic principles and concepts as applied to the stability and properties of pharmaceutical compounds

2) Demonstrate a basic understanding of binding equilibria with respect to pharmaceutics

3) Demonstrate an understanding of acid-base equilibria (pH, pKa, buffers) and the partition coefficient concept as they apply to pharmaceutics

4) Demonstrate an understanding of the application of interfacial properties in the formulation of pharmaceutical dosage forms

5) Demonstrate an understanding of colligative properties and their application to make pharmaceutical preparations isotonic with biological fluids

6) Demonstrate an understanding of physical pharmacy principles and formulation in pharmaceutical compounding

7) Demonstrate an understanding of basic calculations and their use in the practice of pharmacy

8) Demonstrate an understanding of reaction rate constants and orders of reactions (e.g., zero order, first order, pseudo-orders)

9) Demonstrate an understanding of the major determinants of the extent and kinetics of drug and drug product instability (e.g., temperature, humidity, light, pH, oxygen, free radicals) and the common types of reactions (and their mechanisms) which influence drug and drug product stability (e.g., hydrolysis, oxidation, cyclization, racemization)

10) Demonstrate an understanding of the use of the Arrhenius relationship in accelerated stability testing

11) Demonstrate an understanding of stabilization and extending the expiration date of drug products (e.g., pH control, antioxidants, packaging)

12) For a given compound, describe the relationship between the compound’s chemical structure and its acid/base properties, water solubility, lipophilicity, chemical stability, stereochemical properties, and ability to traverse biological membranes

13) Describe the anatomical and physiological factors which influence the route of administration of a drug in common dosage forms

14) Describe the anatomical and physiological factors which influence the absorption, distribution, metabolism and elimination of a drug

15) Describe the major physical and chemical properties of drugs and excipients which influence the performance of drugs and
dosage forms
16) Describe the formulation and properties of liquid, semi-solid, and solid dosage forms
17) Describe the composition, mechanisms of drug release, incompatibilities and quality assurance tests used for common dosage forms
18) Perform basic calculations related to the physical and chemical properties of drugs and common dosage forms, emphasizing solubility, stability, release, dissolution, diffusion, partitioning, dose, absorption, disposition and elimination
19) Demonstrate an understanding of the fundamental properties of radiopharmaceuticals and their delivery systems
20) Demonstrate an understanding of the principles of aseptic technique and aseptic processing of sterile dosage forms
21) Demonstrate an understanding of the principles and use of infusion devices and catheters
22) Describe the physiologic determinants of systemic clearance and volume of distribution, including the specific physiologic determinants that govern the absorption, distribution, metabolism and excretion of drugs
23) Demonstrate an understanding of the mathematical relationships used to quantify the pharmacokinetic and pharmacodynamic properties of drugs
24) Determine primary and secondary pharmacokinetic parameters from concentration-time data
25) Recognize and critically evaluate how drug interactions, pathophysiological conditions, patient variabilities and other factors (e.g., environmental) can affect the absorption, distribution, metabolism and excretion of drugs
26) Design a pharmacokinetically-based dosage regimen for individual patients
27) Modify dosage regimens for patients based on the physiological changes brought about by disease, patient variability, drug interactions or other factors
28) Understand the primary factors that contribute to the variability in the pharmacokinetic parameters for frequently monitored drugs and apply this information to solve relevant problems in pharmaceutical care
29) Effectively integrate basic pharmacokinetic and biopharmaceutic information in patient case situations and effectively communicate rational treatment to patients and health care providers

g. Pharmaceutical biotechnology

1) Describe the tools required for recombinant DNA (rDNA) technology, genomic and complementary DNA (cDNA) library construction, gene isolation and characterization
2) Identify and describe the genetic elements responsible for much of the clinical resistance to antimicrobials and the mechanisms of transfer and of manipulation of these elements
3) Outline DNA sequencing, the polymerase chain reaction, site-directed mutagenesis and molecular hybridization and the utility of these procedures in biotechnology

4) Describe the terms genomics, proteomics, human haplotype map and epigenetics and rDNA biopharmaceuticals such as cytokines, hormones, monoclonal antibodies and RNA/DNA drugs

5) Demonstrate an understanding of stem cell and gene therapy approaches, prospects and limitations

6) Demonstrate an understanding of the basic terminology of genetics and describe pharmacogenomics fundamentals including single nucleotide polymorphisms (SNPs), the human haplotype map and gene-disease association studies

7) Describe the influence of a given genetic polymorphism on drug metabolism and site of drug action or transport in an individual’s response to medication

h. Health behavior

1) Describe how patient characteristics (e.g., age, gender, income, race, ethnicity, family status) can influence the patient’s health-related beliefs, attitudes, expectations, and behaviors

2) Describe how behaviors of patients and health care providers are influenced by health-related beliefs, attitudes, and expectations

3) Describe the concepts and underlying assumptions of key theories/models of health behavior, including the Health Belief Model, the Health Communication Model, the Behavioral Intention Model, and the Transtheoretical Model

4) Identify and describe the effects of factors that influence patient learning and comprehension

i. Law and Ethics

1) Recognize the pharmacists professional obligation to patients

2) Describe the reasonable person concept

3) Identify the requirements for issuance of a prescription/drug order

4) Identify the requirements for appropriately counseling a patient, including requirements for documentation

5) Describe the role of the pharmacist as patient advocate

6) Compare and contrast ends-oriented and means-oriented ethical principles

7) Differentiate between judgment, ethics, and values as it applies to the profession of pharmacy

8) Differentiate between legal and ethical duties related to patient rights, including patient confidentiality

j. Information retrieval and handling
1) Demonstrate proficiency in searching the biomedical literature using a variety of resources (including librarians and information professionals) and interfaces, in analyzing the data obtained for potential biases and conflicts of interest, in determining the applicability of the information to the query at hand, and in communicating the information to various potential audiences.

2) Demonstrate an understanding of issues of privacy, copyright, plagiarism and other issues germane to the legal and ethical uses of information.

2. Applied competencies

a. Retrieve, analyze, and interpret the professional, lay, and scientific literature to provide drug information to patients, their families, and other involved health care providers.

1) Maintain awareness of evidence-based information resources, and use principles of evidence based medicine to assess information needs, formulate focused queries, acquire the best available evidence, evaluate the evidence and communicate it to the appropriate individuals.

2) Identify and regularly utilize information resources that enhance the pharmacist’s understanding of stakeholder viewpoints, beliefs and attitudes.

3) Provide information regarding disease prevention and detection.

4) Provide information regarding prescription medications and products.

5) Provide information regarding non-prescription and herbal products.

6) Provide information regarding non-drug therapies.

7) Provide information regarding diet and nutrition.

b. Design, implement, monitor, evaluate, and adjust pharmaceutical care plans that are patient-specific and evidence based which ensure effective, safe, and economical care.

1) Maintain awareness of evidence-based information resources and use principles of evidence based medicine to assess information needs, formulate focused queries, acquire the best available evidence, evaluate the evidence, and apply clinical expertise in using the evidence in providing patient-centered care.

2) Compile and evaluate patient-specific information.

3) Recommend medications and/or laboratory tests in accordance with established standards of practice and available clinical data.

4) Select the appropriate dosage form, formulation, administration, and/or delivery system for specific drug...
entities, and assess existing dosage schedules and recommend modifications based on sound pharmacokinetic and therapeutic principles.

5) Carry out proper handling, compounding, and storage of common dosage forms, including those for newer drugs that are being approved at a rapid pace, such as proteins, peptides, and poorly water-soluble drugs requiring drug solubilization.

6) Ensure that patients or their agents understand the importance, nature and scope of the therapeutic plans being implemented, are informed about the benefits and risks of such plans, agree to participate in the implementation of the plans, and understand the appropriate use of medication included in the plans.

7) Monitor the patient in order to identify, assess, and solve medication-related problems, assess and promote adherence to the therapeutic plan, and evaluate the effectiveness of the plan in producing the intended therapeutic outcomes.

8) Administer medications and immunizations to patients, when appropriate.

c. Evaluate drug orders or prescriptions, accurately and safely compound drugs in appropriate dosage forms, package and dispense dosage forms to meet specific patient care needs, and provide proper advice regarding dosage form factors which influence drug stability, drug release, drug absorption and bioavailability.

d. Communicate and collaborate with the patient, caregiver(s), prescriber(s), and other involved providers to engender a team approach to patient care.

1) Identify and regularly use information resources that enhance the pharmacist’s understanding of stakeholder viewpoints, beliefs and attitudes.

2) Establish a trust-based relationship with the patient and other stakeholders.

3) Interact with the patient and other stakeholders in a manner that is culturally appropriate.

4) Encourage and respect stakeholder input while remaining the patient’s advocate from an optimum pharmaceutical care perspective.

e. Demonstrate the ability to practice within a selected patient care setting within state and federal pharmacy regulations.

1) Label and package a selected dosage form according to state and federal laws.

2) Provide and document appropriate patient consultation.

f. Practice ethically in a patient care setting.
1) Evidence personal commitment to the welfare of the patient
2) Demonstrate respect for the dignity of the patient
3) Use awareness of personal values and a code of professional ethics to guide behavior

g. Effectively solve situational dilemmas
   1) Identify the ethical principles associated with a given patient care scenario
   2) Reason through conflicts between personal values and professional ethics to assure optimal patient care
   3) Justify a decision made in a patient care setting

h. Maintain professional competence by identifying and analyzing emerging issues, products, and services that may impact patient-specific therapeutic outcomes
   1) Maintain a zeal for and practice of life long professional learning.
   2) Access Continuing Education vehicles such as seminars, online training, etc.
   3) Utilize current awareness tools, such as journal and database alerting services
   4) Subscribe to professional journals
   5) Maintain an up-to-date personal professional library

B. Provide population-based care

   1. Foundational learning outcomes
      a. Describe the U.S. health care system with respect to: public and private sectors, persons and organizations that provide health services, payment mechanisms, insurance mechanisms, and 3rd party payers
      b. Describe how characteristics of the U.S. health care system influence prescribing, dispensing, and use of prescription medications, non-prescription medications, and complementary/alternative medicines
      c. Describe economic, clinical, and humanistic outcomes and their importance in evidence-based research and practice
      d. Define the concept of public trust

   2. Applied competencies
      a. Retrieve, evaluate, and manage professional information and literature
      b. Prepare and deliver educational programs to health professionals, patients, and other stakeholders in health care systems regarding drug therapy, accessing drug therapies via health insurance including prescription insurance, and navigating the health care
c. Prepare and deliver patient case presentations incorporating a critical analysis of the drug therapy and subsequent therapeutic outcome
d. Develop and implement population-specific, evidence-based disease management programs and protocols based upon analysis of epidemiologic and pharmaco-economic data, medication use criteria, medication use review, and risk reduction strategies
e. Apply principles of pharmaco-economics to recommend or select drug products for inclusion in treatment protocols or guidelines
f. Communicate and collaborate with pharmacy colleagues, prescribers, population members, caregivers, and other involved health care providers to engender a team approach to patient care.
g. Retrieve, analyze, and interpret the professional, lay, and scientific literature to provide drug information to other health care providers and the public
h. Carry out duties in accordance with legal, ethical, social, economic, and professional guidelines
i. Maintain professional competence by identifying and analyzing emerging issues, products, and services that may impact population-based therapeutic outcomes
j. Accept responsibility for involvement in the advancement of the profession and leadership in community health care issues

II. SYSTEMS MANAGEMENT. Manage and use resources of the health care system, in cooperation with patients, prescribers, other health care providers, and administrative and supportive personnel, to promote health, provide, assess, and coordinate safe, accurate, and time-sensitive medication distribution, and to improve therapeutic outcomes of medication use

A. Manage human, physical, medical, informational, and technological resources

1. Foundational learning outcomes

   a. Identify legal responsibilities of the pharmacist and other pharmacy personnel
   b. Identify legal requirements for acquisition, distribution, and prescribing of pharmaceutical products
   c. Identify procedures necessary for proper dispensing or distribution of prescription and nonprescription pharmaceutical products, including controlled substances
   d. Identify record-keeping requirements related to pharmaceutical products, including requirements for protecting patient confidentiality
   e. Identify requirements and process for licensure, registration, or certification of a pharmacist, a pharmacy, a pharmaceutical manufacturer, a pharmaceutical distributor

2. Applied competencies

   a. Establish a mission statement, strategic plan, and management plan
with component goals and actions to enhance the delivery of care to patients
b. Develop a business plan (budgets, pricing, contract development, and yearly reports) that assures financial success of the practice
c. Maintain a staff of persons capable of fulfilling the practice mission
d. Specify, acquire, maintain, and update facilities, equipment, and information technology required to fulfill the practice mission
e. Continually review the operational functioning of the pharmacy and recommend strategic changes in relation to the established mission, fiscal resources, and customer needs
f. Resolve ethical dilemmas that develop in management of the pharmacy practice setting
g. Identify actual and potential personnel, technological, financial, or regulatory changes that may impact the practice of pharmacy
h. Formulate and evaluate strategies to adapt to change

B. Manage medication use systems

1. Foundational learning outcomes

a. Identify the authority, responsibilities, and operation of the governmental and nongovernmental agencies and entities that establish and enforce standards that regulate or affect the manufacture, storage, distribution, and dispensing of pharmaceutical products
b. Understand principles of civil law as they relate to professional standards and practice
c. Recognize valid in vitro dissolution and in vivo bioavailability studies
d. Describe key concepts related to of quality assurance, quality improvement, and quality management including: assessment, criterion, indicator, sentinel event, root-cause analysis, quality culture, and improvement cycle

2. Applied competencies

a. Manage the drug distribution system

1) Design, select, implement, and/or manage drug distribution systems for various practice settings
2) Develop and supervise management systems to ensure that adequate supplies of drug products are available to meet patient care needs
3) Manage systems for storage, preparation, and dispensing of medicines
4) Supervise technical personnel involved in the storage, preparation, and dispensing of medicines

b. Assure the quality of drug products

1) Judge the quality of pharmaceutical products and devices and select manufacturers based on appropriate data, such as
biopharmaceutic, economic and quality control information

2) Select drug products on the basis of bioequivalence and therapeutic equivalence. Use pharmacoeconomic data in the selection of drug delivery form, amount, and brand vs. generic of a drug product.

3) Ensure that drug products are stored under appropriate conditions.

4) Apply guidelines and standards of practice for preparation, storage, in-process quality control, and administration of sterile dosage forms and enteral nutrition products.

5) Ensure that products are delivered to patients in a timely, safe, efficient, and ethical manner.

6) Ensure the security of the drug product inventory.

c. Manage the formulary

1) Develop standards for drug product inclusion in the formulary.

2) Apply principles of pharmacoeconomics and evidence-based medicine in making decisions regarding formularies and individual patient care.

3) Implement and manage the formulary system.

4) Participate in deliberations of Pharmacy and Therapeutics Committees or similar groups.

d. Employ practice guidelines and standards

1) Participate in developing critical pathways, clinical practice guidelines, and disease management protocols in the delivery of pharmaceutical care.

2) Use appropriate critical pathways, clinical practice guidelines, and disease management protocols in the delivery of pharmaceutical care.

e. Assess and improve medication use quality

1) Identify medication errors and adverse drug reactions and report them to appropriate individuals and organizations.

2) Manage the incidence of medication errors and adverse drug reactions.

3) Document quality assurance and improvement activities according to the specifications of relevant accrediting and regulatory bodies.

4) Develop appropriate criteria and structure, process, and outcome indicators to evaluate the medication use and the medication use system.

5) Participate in and perform drug use evaluations.
III. PUBLIC HEALTH. Promote health improvement, wellness, and disease prevention in cooperation with patients, communities, at-risk populations, and other members of an interprofessional health care team

A. Assure the availability of effective, quality health and disease prevention services

1. Foundational learning outcomes

a. Understand principles of epidemiology, economics, sociology, and policy studies as they relate to assessing and improving the health of populations and communities
b. Apply a societal/global perspective to analyze contemporary problems in health, illness, and disease
c. Describe public health goals, such as those set in Healthy People 2010, which are well-suited for pharmacist intervention
d. Identify barriers that certain members of the population face in accessing health and pharmaceutical services
e. Describe the roles, goals and organization of the public health system

2. Applied competencies

a. Identify strategies to improve care for underserved populations
b. Provide disease prevention and health promotion programs to the public
c. Recommend and/or administer vaccines to the public
d. Provide health screening/early detection and intervention services to the public
e. Participate in pharmacoepidemiologic and pharmacosurveillance programs
f. Promote safe medication use
g. Serve as a resource for primary and secondary disease prevention strategies
h. Collaborate with other public health agents in public health programs addressing key areas (e.g., environmental and occupational health, communicable diseases, behavioral health, emergency preparedness and response)
i. Provide appropriate emergency services (e.g., CPR, emergency triage/referral, access to poison control and treatment information)
j. Design and evaluate the impact of a public health program on the behaviors and health outcomes of program participants

B. Develop public health policy

1. Foundational competencies

a. Identify and describe the roles of governmental bodies and nongovernmental stakeholders (including pharmacists) in creating and implementing public health policy
b. Describe the organization, financing and regulation of public health
services involving the public and the private sectors

2. Applied competencies

a. Collaborate with health agencies in local communities to identify and prioritize health care needs of the community
b. Recommend ideas that represent a pharmacist’s perspective to others involved in public health policy development
c. Integrate the perspectives of other stakeholders in developing and implementing public health policy
d. Defend public health policy recommendations with literature-based evidence
e. Apply pharmacoeconomic principles in development of public health policies and programs.
f. Apply knowledge of pharmacy law in development of public health policy
g. Develop and implement ethical public health policies and programs