

Beginning at the Beginning: Preparing Students in Pharmacy and Medical Schools to Become Leaders in Pharmacogenomics

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A long time ago in a galaxy far,
far away....

Current Landscape of Medical and Pharmacy Education

The Landscape: Pharmacy and Medical School Curricula

Pharmacy School

- ACPE Draft Standards 2025
 - Pharmacogenomics is a required curricular element in both Pharmaceutical Science and Pharmacotherapy
- Pharmacist Competencies in Pharmacogenomics
 - 30 competencies aligned with profession's Entrustable Professional Activities (EPAs)

Medical School

- Association of Professors of Human and Medical Genetics (APHMG) Core Competencies for Undergraduate Medical Education in Genetics and Genomics
 - Medical knowledge and patient care competency statements include pharmacogenetics

The Landscape: Pharmacy and Medical School Curricula

- Medical Schools
 - 86% of US and Canadian medical school survey respondents include PGx in curricula
 - ~50% of medical schools offer 3-4 hours, primarily in 2nd year; little to none on clerkships
 - Majority teach PGx as part of another course residing in Basic Sciences departments (e.g., pharmacology)
 - Most frequently covered topics: cardiovascular disease, hypersensitivity, and ADRs
 - Most frequently covered genes: *CYP2C19*, *CYP2D6*, *CYP2C9*
 - In most programs, personalized medicine teaching is limited to genomics

The Landscape: Pharmacy and Medical School Curricula

- All pharmacy schools offer pharmacogenomics
 - ~50% standalone required course
 - ~15% standalone elective course
 - ~30% as part of other courses
- Majority offered in second year
 - ~90% taught by basic sciences department faculty
 - ~50% taught by pharmacy practice department faculty
- Limited number of schools offer education to other HCPs, although students' confidence in communicating with other HCPs was most improved in interprofessional learning

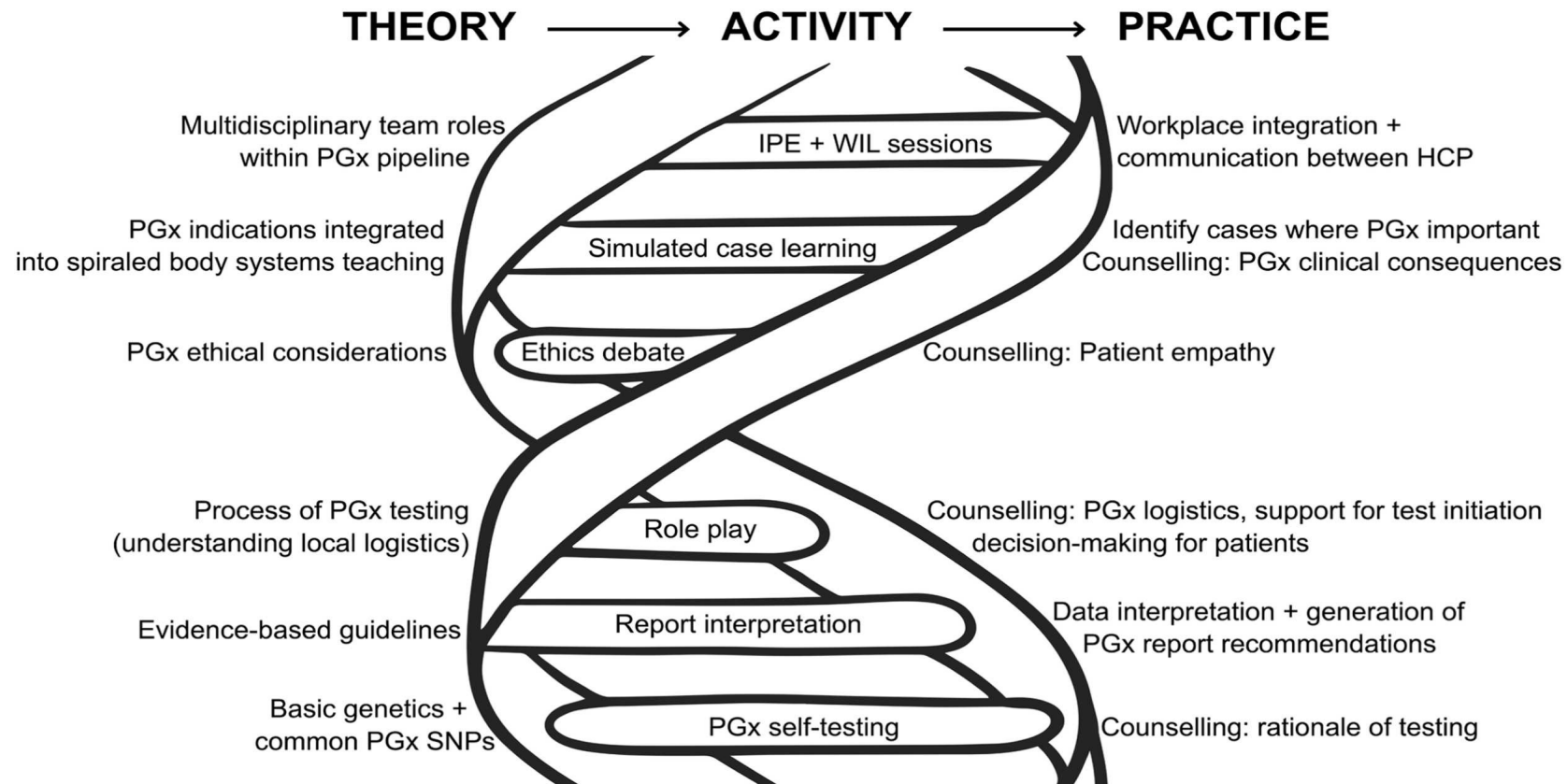
Pharmacy School Teaching and Learning Methods

Method	Comments
Didactic Lectures	Primary method but alone does not lead to long-term knowledge gains Should be supported by case-based exercises on implementation and clinical care
Personal genotyping	>10 studies; earliest in 2009 Improves engagement, participation, students' understanding of patient experience Randomized controlled trial did not show increase in knowledge, comfort, and attitudes Use of own data associated with greater improvements in knowledge and confidence compared with mock data
Simulation Activity	Increases knowledge and confidence with long-term knowledge retention; costly
Interprofessional	Potentially increases understanding of different disciplines role in precision medicine
Combination	Increases knowledge, provides long-term retention of knowledge Increases competency and confidence in pharmacogenomics
Practice-Based Activity (e.g., APPEs)	Optimal although requires foundational knowledge Best preparation for clinical practice, although limited offerings

Wu JQ et al. Curr Pharm Teach Learn. 2024;16:221. Gammal RS et al. Am J Pharm Educ. 2020 Dec;84(12):ajpe8031.

Soueid R. Am J Pharm Ed. 2024;88:100668.

Pharmacy School Teaching and Learning Methods



Practice-Ready Pharmacists and Physicians?

- Pharmacy faculty perception
 - ~10% of faculty responding to surveys believe pharmacists possess appropriate knowledge
 - >90% agreed other HCPs lack appropriate knowledge
- Physicians' and pharmacists' confidence in practice
 - Majority of pharmacists and pharmacy students express low level of confidence in applying PGx testing to practice
 - While many physicians believe PGx testing is clinically useful; few feel confident or that they have adequate training;
 - Physician attitudes, knowledge, and confidence dependent on specialty area
 - Low level of confidence repeatedly identified as barrier to implementation

*Emerging Trends in
Pharmacogenomics Education*

Interprofessional Education Models

- University of Georgia and Medical College of Georgia
 - Teaching and Learning Model
 - Students divided into groups of 6-8 of M3 and P3 students
 - M3 student identified clerkship patient on 3 or more drugs and presents to group
 - Group discussion of all aspects of pharmacotherapy, including pharmacogenomics
 - Meetings were held in-person or electronically depending on groups' preferences
 - Students met for 1-2 hours once or twice
 - Results/Conclusions
 - Did not significantly improve students' perception of benefit of interprofessional care
 - Unequal participation due to grading, differences in clinical application knowledge
 - Recommend equal external motivation and equivalent level of medical knowledge

Interprofessional Education Models

- Manchester University and Indiana University Medical School
 - Teaching and Learning Model
 - P3 and M1 students assigned to teams of 2-3 students for a 3-hour experience
 - Optional for pharmacy students; required for medical students
 1. PGx-focused patient case discussion (pharmacy students teach medical students) with five PGx-focused patient cases
 2. If drug therapy changes were recommended, M1 student wrote prescription verified by P3 pharmacy student
 3. Optional student genotyping for *CYP2C19* *2
 - Results
 - Both student groups: Significantly more agreed or strongly agreed that they could
 - Provide genotyping results
 - Explain genotyping results and phenotypes
 - Discuss incidental findings
 - Discuss gene-drug interactions

Interprofessional Education Models

- Ferris State University and Western Michigan University
 - Teaching and Learning Model
 - 2-hour telehealth-focused team-based learning exercise
 - Groups of 2 P3 and 6 M1 students
 - Students presented with pain management case
 - Large group discussions of ethics of pain management; small groups for drug therapy plan and pharmacogenomic analysis; P3 plan communicated in writing to M1 students
 - Results
 - Medical and pharmacy students reported significant positive changes in attitudes and perceptions of responsibility and accountability, shared authority, interprofessional education, and PGx confidence
 - Significant increase in medical student support for pharmacist qualifications and expertise and in medical students' confidence with PGx data interpretation although medical students had no instructor-delivered PGx component (i.e., students learned from each other)

Increasing Pharmacogenomics Education for Other Health Professions

- Survey of genetic counseling training programs
 - ~50% have genetic counselor affiliated with their program that provides PGx counseling
 - Nearly 60% have non-genetic counselor faculty member with pharmacogenomic expertise
 - Almost all respondents stated their genetic counseling programs provide didactic education on pharmacogenomics, usually <7 hours
 - >80% agreed that:
 - Students graduating from their program should be able to independently counsel patients on PGx test results
 - PGx is a growing specialty within genetic counseling
 - Genetic counseling programs should be required to provide PGx education

Increasing Pharmacogenomics Education for Other Health Professions

- Survey of 266 advanced practice nurses
 - ~50% reported having pharmacogenomics in their curriculum but most reported being unfamiliar with pharmacogenomics and lacking confidence
 - Most had never used CPIC guidelines
 - Low levels of pharmacogenomic test ordering attributed to lack of knowledge and confidence
- Limited mention of pharmacogenomics in advanced practice nursing school accreditation standards

Considering Race-Conscious Teaching in Pharmacogenomics/Genomic Medicine

- Race-based versus race-conscious awareness in pharmacogenomics and genomic medicine
 - Race-conscious medicine
 - Use evidence-based resources and personalized medicine
 - Consider social determinants of health when making medication-related decisions (as apposed to using race or ethnicity as a biological marker in medical therapy)
 - PharmGKB employs Standardized Biogeographic Classification System to reflect genetic diversity in world populations
 - Use of race alone as a focal point of a patient case can unintentionally reinforce ideas that mislabel concepts of ancestry and culture and create unconscious bias

Lipscomb J et al. Am J Pharm Ed. 2023;87:100077.

Bakkum MJ et al. Clin Pharmacol Ther. 2023;113(3):600.

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- Recognized as 1 of 3 programs of merit around Institutional Excellence and Innovation in Interprofessional Education and Collaborative Health Care by the Association of Schools for Allied Health Professions (ASAHP)
- Launching Distinction for Excellence in Interprofessional Healthcare in Precision Medicine in Fall 2025
- Developing educational initiatives and guidelines for writing race-conscious patient cases in College of Pharmacy in 2023-2025



Key Points

- Progress
 - 100% of pharmacy schools include pharmacogenomics in their curricula
 - Coverage of pharmacogenomics in other disciplines remains inadequate but awareness is increasing
- Identified Needs:
 - Further explore effective models for teaching and learning pharmacogenomics in pharmacy school that result in increased confidence in applying PGx test results (e.g., practice-based teaching, APPEs)
 - Increased pharmacogenomics education in medical and advanced practice nurse training programs
 - Explore role of interprofessional education in pharmacogenomics
 - Explore applications of race-conscious teaching of genomics and pharmacogenomics in medical and pharmacy schools