

**University of Washington**  
**School of Pharmacy**  
**Self-Study Report**  
**School of Pharmacy Academic Review**

**Degrees Offered (focus of this review):**

Master of Science in Pharmaceutics

Master of Science in Health Economics & Outcomes Research

Doctor of Philosophy in Medicinal Chemistry

Doctor of Philosophy in Pharmaceutics

Doctor of Philosophy in Health Economics & Outcomes Research

**Year of Last Full Review:** 2009-2010

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## **PART A – BACKGROUND INFORMATION**

### **SECTION I. Overview of the Organization**

#### **A. Mission & Organizational Structure**

##### ***School of Pharmacy Mission***

The School of Pharmacy (SOP), established in 1894, is the University of Washington’s (UW) third oldest school. The SOP’s **mission** as described in our [Strategic Plan](#) is:

- **Inspiring Education:** Develop exceptional, innovative and diverse pharmacy leaders and scientists;
- **Discovering Solutions:** Advance the science, development, implementation, and outcomes of safe and appropriate treatments;
- **Serving People and Communities:** Promote the health and well-being of the public, locally and globally.

The SOP **values** are a passion for discovery and learning; excellence in every endeavor; integration and synergy of research and education; quality and breadth of our academic programs; essential partnership of students, faculty and staff; cultivating strong, external collaborations; embracing diverse perspectives, beliefs and cultures; celebrating scholarship, achievements and successes; & serving for the greater good of society.

Our SOP academic enterprise includes over a dozen programs, centers, and the Comparative Health Outcomes, Policy, and Economics (CHOICE) Institute, the latter administratively based in the SOP Department of Pharmacy. The SOP is an integral part of UW’s health sciences campus that consists of the Schools of Pharmacy, Medicine, Nursing, Public Health, Dentistry and Social Work. UW Medicine consists of four hospitals—Harborview Medical Center, UW Medical Center-Montlake, UW Medical Center-Northwest, and UW Medicine-Valley Medical Center—a network of hospital-based and outpatient clinics, and the WWAMI Program, serving the states of Washington, Wyoming, Alaska, Montana and Idaho. Strong teaching and research affiliations also exist with Seattle Children’s, Fred Hutchinson Cancer Research Center, VA Puget Sound Health Care System, and Kaiser Permanente Washington Health Research Institute. The SOP ranks 7<sup>th</sup> in the country among schools of pharmacy in the U.S., according to the latest *U.S. News and World Report*. We rank #3 nationally for federal grant funding among US schools of pharmacy and #2 worldwide for research and publications by the Academic Ranking of World Universities. We rank #2 among U.S. schools/colleges of pharmacy for total research funding per faculty member. Our [2020 Impact Report](#) highlights additional notable achievements.

##### ***Degrees and Graduate Certificate Programs Offered by the SOP***

The SOP offers the following [graduate degree programs](#) that are the focus of this review:

- Master of Science (MS) in Pharmaceutics,
- MS in Health Economics & Outcomes Research (HEOR) (formerly called Pharmaceutical Outcomes Sciences),
- Doctor of Philosophy (PhD) in Medicinal Chemistry,
- PhD in Pharmaceutics, and
- PhD in HEOR.

The Department of Pharmacy also offers the [Master of Science in Biomedical Regulatory Affairs](#) (MSRA or BRAMS) as a fee-based program in conjunction with the Continuum College, UW. The BRAMS program underwent both a 5-year review by the Graduate School in 2013-2014 and an internal review by the School of Pharmacy in 2018. As decided at the charge meeting, this review will not evaluate the BRAMS program.

The SOP offers the Doctor of Pharmacy (PharmD) degree as its professional degree program. Concurrent degree options offered for select PharmD students are the PharmD-Master of Business Administration (MBA) in conjunction with the School of Business-Bothell, UW; PharmD-Master of Clinical Health Services (MCHS) in conjunction with the MEDEX Physician Assistant Program, School of Medicine, UW; and the PharmD-PhD leading to a PhD in Pharmaceutics. The Accreditation Council for Pharmacy Education (ACPE) accredits our PharmD program. The next ACPE accreditation review of our PharmD program is scheduled for March 2022. The PharmD program and the concurrent degree programs fall outside the purview of the current review. The SOP does not offer an undergraduate degree. The SOP, along with the Department of Health Systems and Population Health, offered the Graduate Certificate in Comparative Effectiveness Research, but it is in the process of officially being discontinued.

## **SOP's Support of Academic Services and Student Services**

### *Structure*

The SOP is led by the Dean, Sean D. Sullivan, PhD, BScPharm, and consists of three departments: Medicinal Chemistry (William Atkins, PhD, Chair), Pharmaceutics (Nina Isoherranen, PhD, Chair), and Pharmacy (H Steve White, PhD, BScPharm, Chair) ([Appendix A](#)). Each department offers graduate-level training. The Associate Dean for Research, Graduate Programs and New Initiatives (Andy Stergachis, PhD, BPharm) oversees those functions in a staff capacity. The Vice Dean for Professional Pharmacy Education (Peggy Odegard, PharmD) oversees our PharmD program. Briefly, the [Department of Medicinal Chemistry](#) provides instruction and conducts research in drug metabolism, drug design, bio-analytical chemistry and disease mechanism. The [Department of Pharmaceutics](#) provides instruction and conducts research in drug absorption, disposition and delivery. The [Department of Pharmacy](#), the SOP's largest department, provides instruction and conducts research in therapeutics, pharmacy practice, translational health, and health economics and outcomes. The Department of Pharmacy houses the CHOICE Institute where the HEOR graduate program resides. In the summer of 2017, the CHOICE Institute transitioned from the Pharmaceutical Outcomes Research and Policy Program (PORPP) to an Institute designation. Each graduate program has a Graduate Program Director (aka Coordinator) and a Graduate Program Advisor. Pharmaceutics also has an advisory Graduate Program Committee.

### *Faculty, Staff, and Students*

The SOP has 57 full-time equivalent faculty members. A total of 58 faculty are appointed as [Graduate School faculty](#) (includes SOP emeritus faculty and adjunct faculty who are associated with our graduate programs). A list of the SOP-based faculty with appointments as Graduate School faculty, including a link to their CV's, can be found in [Appendix B](#). Additionally, the SOP

has more than 1,050 clinical and affiliate faculty, 77 professional staff, 12 classified staff, 419 PharmD students, and 20 postdoctoral scholars. For the graduate programs under review, the SOP presently has a total of 67 students enrolled in our PhD programs and 12 enrolled in our MS programs. Detailed information on enrollment and graduation patterns for each of our degree programs being reviewed is found in the [Appendix C](#). Our faculty also mentor students enrolled in pharmacy residency programs, including over 25 residency positions offered by UW Medicine. The SOP employs graduate students as research assistants (RAs), and teaching assistants (TAs).

### *Facilities*

The SOP graduate programs are housed within the H-wing of the Health Sciences Building (HSB), with some wet laboratory and office spaces for faculty research and service activities found in other areas of the HSB. Our current wet laboratories are state-of-the art, permitting a full range of cellular, molecular and chemical studies in basic and translational research spanning the pharmaceutical sciences. Office spaces include wireless or cable internet access and contemporary support equipment. The SOP utilizes common classroom space in the HSB that can be secured through a central reservation service. We also have dedicated classroom space and departmental conference rooms that are used for some of our graduate courses. The SOP occupies approximately 62,000 square feet of space in the HSB, the majority is in four floors of the H-wing of the HSB, with additional space in the D-wing and T-Wing of the HSB and in the South Campus Center (SCC). The SOP was recently allocated 12,800 square feet of space in the F-wing, HSB, to meet priority space needs. Approximately 80% of this space is presently configured as wet labs. Prioritized proposals for space allocation and occupancy for the newly allocated F-wing space were developed and adopted and some of this new space has already undergone renovation. Additionally, construction is well underway for the Health Sciences Education Building (HSEB), which is slated to open in summer 2022. This 100,000 square-foot, four-story, \$100 million building will be connected to the HSB. The HSEB will be focused entirely on teaching, housing multiple large, medium and small active learning classrooms, as well as student gathering/study spaces.

### *Shared Governance*

The **Executive Committee** is advisory to the Dean on all issues related to the strategic direction of the School, including its instructional and research missions, budget and space allocations, general procedures and policies, and planning for future growth and development. It consists of the Dean, the three Department Chairs, Associate Dean for Research and Graduate Programs, Vice Dean for Professional Pharmacy Education, Associate Dean for Health Systems (who is also the Chief Pharmacy Officer for UW Medicine), Associate Dean for Advancement and Corporate Relations, and the Assistant Dean for Finance and Administration (ADFA). The **Elected Faculty Council** (EFC), comprised of elected faculty representatives from each of the three Departments, organizes quarterly all school faculty meetings and advises the Dean on matters of policy regarding faculty promotion and tenure, as well as priorities, resource and salary allocation, and budgets. The **Senior Leadership Committee** (SLC) is advisory to the Dean on tactical aspects of the implementation of the School's Strategic Plan and the Diversity,

Equity and Inclusion Plan. The SLC is a liaison to the faculty, staff and student bodies, and interfaces with academic and administrative units throughout the University. SLC consists of the Executive Committee, Chair of the EFC, and faculty, graduate student and PharmD student leadership representatives. Each Department, with input from their faculty, independently sets the admission, retention, and graduation criteria for their MS and PhD degrees, in consultation with SOP leadership and the Graduate School. Shared governance also occurs via the **Dean's Advisory Council of Students** (DACs) that includes graduate students; the School-wide **Curriculum Committee**; as well as regularly scheduled faculty and staff meetings held both at the Department-level and School-wide.

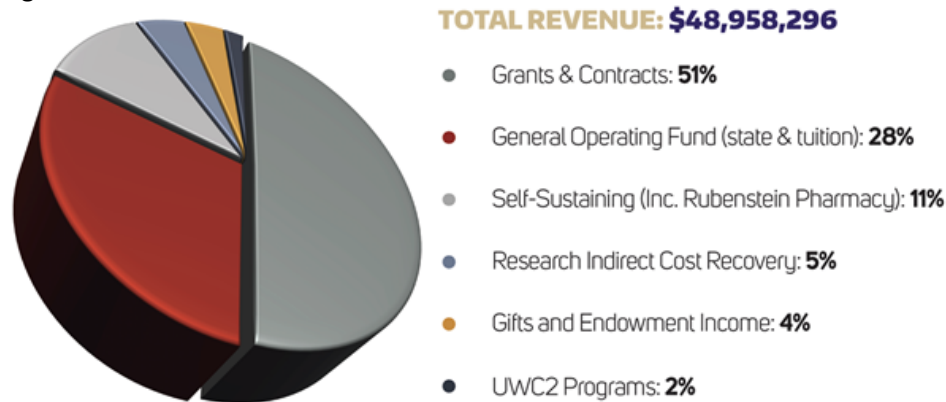
While not shared governance, the SOP makes extensive use of its **Corporate Advisory Board** (CAB), an external group of leaders from the pharmaceutical and biotechnology sectors, who provide advice and financial support, and are committed to advancing the SOP's research and graduate education. Now in its 21<sup>st</sup> year, the CAB meets annually with our faculty to advise us on key issues regarding research strategy, curriculum development, and fundraising and interacts directly with our graduate students and postdoctoral fellows, often assuming a mentoring and advising role. The SOP external **Executive Advisory Council** is yet another key advisory group that provides guidance to the School regarding its strategic mission, educational priorities and philanthropic goals.

## B. Budget & Resources

The School of Pharmacy has multiple funding sources that support our teaching, research, and service mission. The overall SOP budget for FY 2021 was approximately \$49 million. About half of the School's funding comes from grants and contracts, about 28% from central university activity support (including Activity-Based Budgeting (ABB)) revenues and indirect cost recovery (ICR), and the remainder from gifts, self-sustaining activities (e.g., Hall Health Center Rubenstein Pharmacy, Mass Spectrometry Facility, Pharmacokinetics Lab), and Continuum College fees that are returned to the SOP (Figure 1).

Expenditures are mostly personnel costs; salaries and benefits for faculty, staff, student employees and trainees are greater than 50% of SOP expenditures. Scholarships for students—graduate and PharmD students—total more than \$1 million annually. Other expenditures cover operations, facilities, and research indirect costs. A portion of our ICR and royalty returns is dedicated to the SOP Faculty Innovation Fund that annually provides financial support on a competitive basis for SOP faculty undertaking preliminary research that can be used in developing proposals for submitting for extramural funding. For a detailed budget summary, please refer to [Appendix D](#).

Figure 1. UW SOP 2021 revenue.



The School engages in budget planning based on comprehensive strategic initiatives, aligned with those of UW, involving engagement and information exchange with and between multiple internal stakeholders. These stakeholders include the Associate Dean for Finance & Administration (ADFA) (Kelly Campbell), departmental administrators and chairs, Associate Deans and Vice Dean, the EFC, and the DACS. The EFC and the DACS meet with the Dean and ADFA to review, discuss and provide input on budget assumptions used to develop the annual budget and the forecasts for future years. In addition, the DACS is presented with various scenarios that include possible adjustments to tuition, which impact the PharmD program but not the graduate programs, as graduate student tuition is determined centrally. Once the budget and narrative are final, the Dean and ADFA submits the materials to the UW Office of Planning and Budgeting. In collaboration with UW Central Advancement, the School of Pharmacy Advancement team supports the School with four full-time staff. We recently completed a 10-year campaign to raise current use and endowed funds for key college priorities including funding for our PhD and MS students; PharmD student scholarship support; and programmatic support for The CHOICE Institute and the Plein Center in Geriatric Pharmacy Research, Education and Outreach. We achieved more than 148% of our \$50M fundraising goal, completing the campaign at \$74M in private support.

### C. Diversity, Equity and Inclusion (DEI) in the School of Pharmacy

The School of Pharmacy is committed to diversity, equity, and inclusion in all facets – teaching, research, and service – and creating a positive and collegial environment for all faculty, staff, and students. Based on data from the Institutional Data & Analysis unit in the UW Office of Planning & Budgeting, the overall composition of the School’s race and ethnicity for faculty and staff is 50% White, 32% Asian, 10.5% who did not declare or declined to disclose, 2% two or more races, 3% Hispanic or Latino, 2% Black or African American, and 0.5% American Indian or Alaska Native. For faculty in the Department of Medicinal Chemistry, the composition is 34% White, 50% Asian, 8% American Indian or Alaska Native, and 8% who did not declare. For faculty in the Department of Pharmaceutics, the composition is 34% White, 58% Asian, and 8% who did not declare or declined to disclose. For faculty in the Department of Pharmacy, the composition is 47.5% White, 35.5% Asian, 11% who did not declare, 1% two or more races, 1%



Hispanic or Latino, and 4% Black or African American. Overall, the gender balance for the School – faculty and staff – is 56% female and 44% male. For Medicinal Chemistry, Pharmaceutics and Pharmacy, females composed of 25%, 42% and 64% of the faculty, respectively.

In 2017, the SOP revised its DEI Plan ([Appendix E](#)) to better align with the UW’s Diversity Blueprint and the School’s Strategic Plan. One key outcome of the School’s Diversity Plan was the creation of a Diversity, Equity, and Inclusion Council (DEIC) to lead SOP efforts on diversity, equity, and inclusion. The DEIC is composed of faculty and staff co-chairs as well as faculty, staff, and student (graduate and PharmD) members. The DEIC composition reflects the diversity within the School’s faculty, staff, and graduate and professional degree students. The DEIC meets regularly and has five workgroups (communication and community; curriculum and policy; recruitment, retention, and professional development; strategic planning; and training) to move forward on the priorities outlined in the School’s Diversity Plan. The SOP utilizes resources from the UW Office of Faculty Advancement to support recruitment of new faculty. This includes training for search committees and utilizing the Handbook of Best Practices for Faculty Searches. The School’s DEI webpage is found [here](#).

#### *DEI and our Graduate Programs*

In addition to School-level efforts to create an inclusive community, the graduate programs also have worked to create supportive environments through diversity committees and statements on diversity, equity, and inclusion posted on their websites (e.g., see CHOICE [Statement](#) on Diversity, Equity, and Inclusion). Our graduate programs utilize many of the resources provided by various UW offices to assist with recruiting and retaining diverse students. The graduate programs consult with the Graduate Student Equity & Excellence (GSEE) program (formerly GO-MAP) for best practices in recruiting and retaining traditionally underrepresented minority graduate students, and refer to GSEE’s Recruitment and Retention Guide as a resource. Our graduate programs’ initial recruitment efforts rely on GSEE-provided access to databases such as the National Name Exchange and California Diversity Forum to identify undergraduates from underrepresented backgrounds who are interested in graduate studies, including those who have expressed specific interest in UW programs. We are able to target program information to students who are interested in relevant areas of science. Institutional support such as the GO-MAP Research Assistantship Award (replaced in 2020-21 by the Graduate Excellence Award) and the recently implemented Provost’s PhD Fellowship Funds has proved crucial in our programs’ ability to recruit highly qualified students from underrepresented backgrounds. Moreover, we presently have two graduate students also supported by Achievement Rewards for College Scientists (ARCS) Diversity Fellowships that allows us to supplement graduate student stipends for ARCS Fellows in Year 1 of their program.

Our graduate programs use multiple outreach strategies to connect with underrepresented students. Faculty, sometimes accompanied by students, attend both the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) and Annual Biomedical Research Conference for Minority Students (ABRCMS) conferences to recruit underrepresented students. Faculty regularly speak at colleges and universities locally and

nationally, which raises awareness of and piques interest in our graduate programs. Recently, we have also involved our graduate students in outreach efforts such as presentations at local community colleges. The graduate programs advertise on the SACNAS Opportunities Board. For the current recruitment cycle, the CHOICE Institute sent their recruitment communication for the HEOR graduate program to over 500 Schools of Public Health and Schools of Pharmacy in the US, including a number of historically black colleges and Hispanic American serving institutions. Faculty members also administer and/or participate in initiatives targeting undergraduate or post-baccalaureate students from underrepresented or disadvantaged backgrounds such as the Pharmacological Sciences Summer Diversity Program (PD: Nath), UW-PREP (Post-baccalaureate Research Experience Program), GenOM ALVA (Alliances for Learning and Vision for Underrepresented Americans) and STAR (Stipends for Training Aspiring Researchers). Participants have gone on to enroll in our graduate programs or other highly ranked PhD, MD, and PharmD programs. Our students have been particularly active in the DEI space since the start of the COVID-19 pandemic, in efforts to improve climate and equity within the School and outside it, including the establishment of student-led racial equity discussion groups and peer mentoring networks, as well as organized outreach and tutoring efforts by students and postdocs.

## SECTION II. TEACHING AND LEARNING

While there are similarities between the SOP graduate programs, for ease of review each of the graduate programs prepared sections on Student Learning Goals and Outcomes. The curricula and links to student handbooks for each of the graduate programs that under review are summarized in the [Appendix F](#) & [Appendix I](#). There are commonalities across the graduate programs. For example, graduate students, regardless of their program of study, are offered instruction on [biomedical research integrity](#) and responsibility in the form of courses. Further, each PhD program requires assessments of students' progress throughout the graduate programs, the general examination for advancement to PhD candidacy, and a final examination (defense of the dissertation) for earning the degree. Moreover, the School of Pharmacy's Student Misconduct Policy and Procedure as well as our graduate programs' academic grievances and conflict resolution processes are described in the graduate student handbooks ([Appendix I](#)).

### A. Student Learning Goals and Outcomes

#### **Mitigation of the Effects of the COVID-19 Pandemic**

To mitigate the effects of the COVID-19 pandemic on graduate students' learning and research as well as faculty research, the UW issues [guidance documents](#) for safe instruction and conduct of laboratory and field-based research that get updated in accordance with the changing situation. For the SOP, this meant, for example, that return to research plans were developed (and updated) for each laboratory, accordingly. Additional support was provided by each of our graduate programs for graduate students in the form of scheduled online meetings, community town halls at the Department and SOP levels, along with frequent check-ins between students and their advisors. In addition, expectations for preliminary data at milestones such as the General Exam have been relaxed as a matter of course, both in light of potential disruption to

students' research activities in the lab and to reduce student stress. On numerous occasions during the COVID-19 pandemic, the SOP announced the availability of the COVID-19 Student Emergency Aid fund – both graduate students and professional degree students received such financial assistance upon request.

### **Graduate Program in Medicinal Chemistry**

#### ***Student Learning Goals and Curriculum – Medicinal Chemistry***

Our goal is for our students to understand and put into practice the elements of independent research and experimental science, including construction of meaningful hypotheses, design and execution of rigorous experiments, and interpretation of their discoveries in the context of previous knowledge. Students are expected to display expert knowledge of primary literature, critically evaluate existing paradigms, design novel approaches to validate or challenge these paradigms, construct and execute well-designed experiments, and clearly communicate their findings and the broader impact of their work. Research in medicinal chemistry encompasses questions related to drug metabolism and disposition, bio-analytical chemistry, drug design, and disease mechanism. Students' research programs focus on questions as diverse as the mechanism and kinetics of xenobiotic metabolism and transport, the mechanism of action and disposition of protein-based therapeutics, the structure and function of biomolecules relevant to viral or neurodegenerative disease, and the development of new analytical methods to profile and structurally characterize lipids, metabolites and glycoproteins. Regardless of specific project, our goal is for students to be able to navigate and solve health-related problems at the interface of chemistry and biology.

#### ***Assessing Student Learning and Satisfaction – Medicinal Chemistry***

For didactic courses, student learning is evaluated using in-class exams, take-home exams, written literature review papers, research proposals, and oral presentations. Mastery of fundamental concepts and of current literature is evaluated using written cumulative exams (in the 2nd year), a public literature seminar (also in the 2nd year) and journal club presentations to the entire department (at least 1/year). Early in their 3rd year, students present a public seminar on their anticipated project direction, which is immediately followed by a round-table discussion with all Medicinal Chemistry faculty. In addition to providing insight on student progression, this seminar helps focus the research project, guide committee selection and ensure that the General Exam is scheduled in a timely and productive fashion. In their 4th year, students again present a public seminar on their research in progress. Following each of their departmental seminars, students receive anonymized written feedback from other faculty and fellow students. The final dissertation defense exam determines whether the student has achieved the necessary skills and knowledge to earn the degree. In addition to these departmental activities, students present their current research to their respective research groups multiple times each year.

Student learning is also assessed via oral presentations or posters at national and international conferences, wherein our faculty and students receive input from others in the field. Every year, each student prepares a progress report, or Individual Development Plan (IDP), describing their scientific and professional accomplishments, and their goals for the upcoming

year; in response to this reflection and following discussion with the student, their advisor provides a written evaluation and guidance on individual development goals. Graduate student and postdoctoral students attend one faculty meeting per quarter, and can put forward agenda items for discussion, providing essential regular feedback on the student experience and involvement in decision-making. Beginning in 2021, students have the option of submitting annual feedback on the effectiveness of their faculty mentors. Additional structured feedback on student satisfaction is obtained via the Graduate School exit survey as well as (for didactic courses) written evaluation forms. Another important source of feedback is the exit survey from the T32 Pharmacological Sciences Training Program that supports students across the departments of Medicinal Chemistry, Pharmaceutics and Pharmacology (SOM). These same mechanisms are used to assess satisfaction of underrepresented students.

### ***Use of Assessment Findings – Medicinal Chemistry***

Our small size enables us to respond quickly to feedback from students and to implement changes in courses, other elements of our training program, and student learning outcomes. We are also aware of the need to tune the curriculum in response to changing external factors. Changes we have made to our didactic curriculum include the development of two new graduate courses, partly in response to student input, i.e., MEDCH 528 (Biophysical Enzymology & Biopharmaceuticals). This new course reflects the increase in students who are interested in biophysical and structural approaches, and the increased importance of large-molecule drugs in clinical settings. MEDCH 529 (Advanced Medicinal Chemistry) is another new course designed for graduate students that replaced the requirement for them to enroll in PharmD-focused courses (the former MEDCH 501–503 series). Student feedback, and the need to ensure timely progression, were also important factors in the redesign of the weekly seminar series (MEDCH 520), including the introduction of anonymous electronic feedback forms and the introduction of a round-table discussion with faculty following the 3rd-year seminar. The format of the departmental journal club (MEDCH 582) varies in response to student needs and input. Recent quarters focused on grant and fellowship application critiques, small group discussion, and a debate-style format. Furthermore, students expressed a desire to be more involved in departmental matters, and to this end, graduate students have been involved in the graduate admissions process, regular faculty meetings, and drafting updates to the Graduate Program Handbook. These changes have improved the students' sense of connection to the Department community and ownership over their own academic progress. In general, assessments indicate that our students achieve a remarkable breadth of knowledge, as required for a multidisciplinary field such as Medicinal Chemistry. Based on our trainees' high rate of success in searches for entry level positions in the pharmaceutical industry and biotechnology, or postdoctoral positions with highly regarded investigators in the field, we conclude that our students are well-prepared for future career paths.

### **Pharmaceutics**

#### ***Student Learning Goals and Curriculum – Pharmaceutics.***

The Department of Pharmaceutics trains research scholars in the fundamental aspects of xenobiotic or endobiotic (e.g., vitamin D, vitamin A) disposition, delivery, and action in humans and animals. Graduates of this program develop expertise in basic biochemical techniques,

quantitative analytical methods, and in the elaboration of mathematical models to describe the kinetics of drug/endobiotic disposition, delivery and action. Our graduates are capable of investigating the causes of inadequate drug disposition and delivery characteristics of a drug/metabolite including delivery to a target site, by taking into account multiple factors including variability in absorption, metabolism and transport processes that are affected by drug interaction, disease (e.g., hepatic/renal failure), physiological changes (e.g., pregnancy), genetics and the environment. In addition, our goals are to graduate students who are excellent experimentalists, independent learners and creative problem solvers capable of communicating and working in a multidisciplinary team be it academia, industry, regulatory or a research institution. Our graduate program has two tracks, PhD and the MS degree. Historically, the MS track was utilized for unusual circumstances (e.g., a student unable to proceed to the PhD track). The MS track has now been completely revamped to meet workforce needs as well as to recruit qualified, self-paying students (~3-4/ students annually).

### ***Assessing Student Learning and Satisfaction – Pharmaceuticals.***

For didactic courses, student learning is evaluated using in-class exams, take-home exams, written literature review papers, research proposals, and oral presentations. Beginning in the second year, PhD students present a seminar in the joint Pharmaceuticals/Medicinal Chemistry seminar series, with a maximum of three presentations by the time of graduation and are provided anonymous feedback from all in attendance, including faculty, students and post-doctoral fellows. Each student must prepare an IDP during Spring Quarter of their first year, review this with their doctoral advisor (or rotation lab PI) and submit to the Graduate Program Advisor. The IDP is updated by the student and reviewed by the student's advisory committee annually and revised as needed. In addition to course completion, grades and a general examination, PhD students are evaluated for progress in their research projects by yearly meetings with their PhD supervisory committee (where written feedback about progress and the IDP is provided to the student) and frequent meetings with their advisor. To graduate, students defend their dissertation by presenting their research to the faculty after which they undergo a rigorous examination by their PhD supervisory committee to earn the degree. Students are expected to have published at least one first-author paper and preferably should have all three data chapters (minimum) published or formatted as publishable units. The MS students are required to complete the same didactic courses as the PhD students. However, they choose their advisor before matriculating and do not take a general exam. To graduate (in ~2 years), they need to submit a thesis which should be approved by their committee. We recommend that their thesis research be a publishable unit. The Graduate Program Coordinator meets quarterly with first year graduate students to check in on their progress, answer questions/concerns and seek feedback. Our collegial, small department atmosphere facilitates informal and regular feedback from our student body including through the American Association of Pharmaceutical Sciences (AAPS) student chapter. In addition to the Graduate School exit survey, upon graduation students are asked to complete a comprehensive departmental Exit Survey. These same mechanisms are used to assess satisfaction of underrepresented students. We include questions in our Exit Survey about the intellectual climate, collegiality, and diversity. Students also meet one-on- one for exit interviews with our Graduate Program Advisor. Students have access throughout the program to the Chair, faculty,

as well as the Graduate Program Advisor, Department Administrator, and University-wide offices (e.g., Ombudsman) for comments, questions, and concerns.

### ***Use of Assessment Findings – Pharmaceuticals.***

Based on Graduate/Departmental Exit surveys, course evaluations, informal feedback from students, faculty regularly evaluate programmatic changes. To date, the exit surveys indicate extremely high student satisfaction. Based on all the above and as a consequence of changes in the PharmD curriculum (some PharmD courses are required courses in our graduate program, e.g., Clinical Pharmacokinetics), in Autumn Quarter 2019 we launched our substantially revised graduate program curriculum, reducing the total required graded core credits from 32 to 18. This allows students to spend more time on their research projects, reduce graduation time and increase individualization of their curriculum through electives. In addition, we launched our revamped self-paying MS program. For the PhD students, we eliminated the Cumulative Exams, as performance on these exams was not informative of future success. We have also reduced the number of required lab rotations in the first year from three to two, so that students who are ready to select a thesis or dissertation advisor may do so by the end of the Winter rather than the Spring Quarter (but the latter remains an option). These changes are too recent to determine if the intended improvements have been realized. Based on student input, we have also changed our PCEUT 583 Journal Club course to be more student-driven; e.g., students rotate in pairs each week to present articles, lead the conversation, and initiate discussion/questions for the rest of the class with a single faculty member serving as a guide. This gives students a more valuable experience and engagement, and increases participation, learning, and presentation skills. In addition, the Journal Topics have been expanded to include career development, intellectual rigor and research reproducibility, among others. Finally, Pharmaceuticals students have been actively involved in an ongoing departmental Strategic Planning effort, helping the faculty identify core values, current strengths and weaknesses and priority setting.

### **Health Economics & Outcomes Research (HEOR)**

#### ***Student Learning Goals and Curriculum – HEOR.***

The HEOR student learning goals encompass three domains: conceptual knowledge, factual knowledge, and execution of relevant methods. Our students develop in-depth knowledge in the theory, methods and application of health economics and outcomes research as applied to health technologies, interventions and programs. Specific areas of competence include epidemiology, pharmacoepidemiology, evidence synthesis, biostatistics, health economics, health policy, decision modeling, cost-effectiveness analysis, and data science. In accordance with the HEOR learning goals, students achieve expert-level knowledge of primary research literature within the discipline and develop the appropriate conceptual models to specify study constructs for research questions. They successfully conduct studies that extend knowledge in the field, and effectively communicate the results of their findings in both written and oral formats. Students develop proficiency in the application of appropriate analytical techniques to answer important research questions in the following disciplines: health economic and outcomes research; program evaluation; drug safety and surveillance; pharmaceutical regulation, markets and policies; U.S. health care system; U.S. and global

health technology assessment frameworks; and incentives and value within the system. We foster development of key interpersonal and professional skill sets among our students. Students learn to work collaboratively in teams within disciplines, across disciplines, and/or with a variety of stakeholders. Further, they learn to effectively communicate study questions, methods, findings, and implications through multiple modalities to appropriate professional, scientific, policy, and lay audiences. Lastly, at the core of our program mission is the importance of translating gained knowledge to policy and practice. This is achieved through domains such as evidence-based practice and policy, implementation science, translational research.

***Assessing Student Learning and Satisfaction – HEOR.***

Students are evaluated in didactic courses by combinations of in-class exams, take-home exams, policy papers, research projects, research proposals, discussions with advisors, the Graduate Program Coordinator, and the Institute Director, and through oral presentations. Student progress on independent research projects is informally evaluated by faculty and peer student colleagues at least once a year through a presentation at our weekly seminar series (HEOR 597). Students work closely on their learning and development with their faculty advisor. Students are assigned an academic faculty advisor upon admission to the program; this person becomes their mentor until a dissertation chair is identified. Students are expected to meet at least quarterly with their faculty advisor. We require the completion of IDPs, which are reviewed annually by the Graduate Program Coordinator at a CHOICE faculty meeting. Explicitly included in the IDPs is student feedback on the program and how the mentor helped the student achieve her/his goals for the program and areas that might be improved in the relationship with the mentor. Graduate students also provide feedback on the program via elected student representatives who participate, for example, in CHOICE faculty meetings. Moreover, the Graduate School administers a formal exit interview.

Students are evaluated for their knowledge of fundamental concepts and of current literature in three written cumulative exams covering the following subject areas: a) health economics and policy, b) epidemiology, pharmacoepidemiology, biostatistics and causal inference, and c) cost-effectiveness and outcomes research. The cumulative exams are administered at the end of the academic year wherein students have completed all required coursework. Students are given two opportunities to pass each exam. Successful passing of all three cumulative exams is required before beginning to develop their short dissertation proposal. Students who do not successfully pass any one of the three cumulative exams on the second try are offered the opportunity to earn a master's degree in HEOR. Those that pass, then progress to developing their research idea. The dissertation chair presents the short proposal at a faculty meeting and students are provided with feedback that they incorporate into their long dissertation proposal. After completing the long proposal, the dissertation proposal defense (General Exam) is used to evaluate the student's preparedness for PhD-level research, and involves a written and oral component. The PhD final defense exam determines whether the student has achieved the necessary skills and knowledge to earn the degree. Student learning is also assessed via oral or poster presentations at national and international conferences, wherein our students receive input from others in the field.

### ***Use of Assessment Findings – HEOR.***

Examples of how assessment findings are used include the recent establishment of a formal student body council, codified in response to students' needs. Two elected student representatives join the quarterly CHOICE faculty meeting to present any student concerns and ensure student feedback is heard. In 2018-19 we completed a strategic plan for the Institute and ensured a student representative was on the strategic planning committee. We hold an annual day-long retreat in May that is organized by rotating committees of students, staff, and faculty. Each retreat is centered on a theme and the event promotes continuing cohesion and communication within the Institute. In May 2019, our retreat was themed "Strategic Thinking". We continued strategic planning activities in the form of a strengths, weaknesses, opportunities, and threats (SWOT) analysis, which identified opportunities for improvement that we continue to address. One of these is a need for more "R" coding exposure and training. In response to this need we hosted a 3-day workshop on Decision Modeling in R with four outside instructors from the [DARTH](#) Working Group. We recorded the workshop and it is a standing resource for students and faculty. We also developed a MarketScan Claims Data Analysis Boot camp taught by senior doctoral students to the new master's students in the summer. It was a success and will be a continued practice. A section in the IDP solicits student feedback about the program. Examples of key topics raised include a request for guidance about navigating the transition from coursework to dissertation development and increased training/professional development seminar offerings on practical, non-research skills (e.g., time management, the grant application process, delivering compelling presentations, and successful collaboration across departments). The Exit Survey administered by the Graduate School for the CHOICE Institute shows that over the past 8 years, the overall quality of the program has been rated by MS and PhD graduates from Very Good to Excellent, with an average score of 4.7 out of 5 (n=36); this compares with an average score of 4.5 at our prior 10-year Graduate Program Review (2009). Areas of improvement cited from the exit survey include a potential need to improve inclusion of diverse perspectives in course discussions (rated only "Fair" at 33%; n= 12). We have mixed responses of "opportunities to collaborate across disciplines" with 24% citing this as poor or fair (n=13). This feedback has been included in discussions and action at our CHOICE faculty meetings and retreat.

### **Courses offered to undergraduates and non-major students by the SOP – School-Wide.**

For over 10 years, the School has offered the undergraduate course, PHARM 301: Medications and Health: It's Not All about Drugs. This popular course – now offered twice yearly - covers personal health promotion, treatment of illness, and health care and explores several medication-related topics, provides insight on drug development and efficacy, and serves as an introduction to students contemplating careers in health sciences, especially in pharmacy. We also offer MEDCH/PCEUT 327: The Science of Drugs, intended to introduce students to drug development, discovery and approval and spark their interest in pursuing a career in the pharmaceutical sciences. An additional undergraduate course, PCEUT201: Drug Discovery, Development and Beyond: Careers and Controversies, will be offered Spring quarter 2022 pending approval from UW Curriculum committee. Student achievement for these undergraduate courses is assessed through usual course assessments. Undergraduate research



courses (PCEUT 499 and MEDCH 499) offer the opportunity for UW undergraduate students to pursue independent study research with SOP faculty. The Pharmacological Sciences Summer Diversity Program (PSSDP) provides research opportunities for talented undergraduates from diverse social and cultural backgrounds to perform hands-on research in the Departments of Pharmaceutics and Medicinal Chemistry. Graduate students from other programs often enroll in our 500-level courses, including MEDCH 528 (Biophysical Enzymology and Biopharmaceutics) and MEDCH 541 (Biological Mass Spectrometry), PCEUT 506 (Concepts in Pharmacokinetics), PCEUT 513 (Basic Concepts in Pharmacogenetics and Toxicogenomics), HEOR 530 (Economic Evaluation in Health and Medicine, and HEOR 531 (Assessing Outcomes in Health and Medicine). In addition, we host MEDCH 530 (Integrated Pharmacology) each spring. This course is a required program-specific journal club for current pre-doctoral trainees on the T32 NIH Pharmacological Sciences Training Grant, described in Section C.

### B. Evaluation of Didactic Instructional Effectiveness

Each of our School's departments and graduate programs utilize numerous methods to evaluate the quality of instruction. These methods are used to improve teaching, courses, and for annual reviews, merit increases and promotion considerations. Standardized teaching evaluations completed by students are used in all didactic classes. Additionally, faculty are evaluated on their classroom teaching annually or biannually by a peer, and written feedback is shared with the instructor and the Chair. Results from student and peer evaluations are included in each faculty member's annual Professional Activities Update, upon which merit salary increases are based. Faculty have training opportunities in instructional methods and student progress/well-being offered through the UW and the SOP.

There are also opportunities for training through the UW in instructional methods for graduate students. Doctoral-level graduate students in Medicinal Chemistry and Pharmaceutics have required TA experiences (typically 1-2). HEOR graduate students interested in an academic career are provided opportunities to lecture or experience a formal TA position within the professional PharmD program, within the graduate program, or with our Health Economics Distance Learning Program, offered through the UW Continuum College. As TAs, our graduate students work closely with faculty on course development and curriculum delivery and receive feedback from the faculty as well as students in their class. Graduate students in Pharmaceutics and Medicinal Chemistry also have an opportunity to mentor and train high school and undergraduate students through various programs in which the Department participates (e.g., pre-doctoral Pharmacological Sciences Training Program (PSTP), STAR and NIDA Summer Research Internship Program). These programs support quarter- or year-long research experiences for undergraduate/post-baccalaureate students including from underrepresented or disadvantaged backgrounds.

### C. Teaching and Mentoring Outside the Classroom

**Medicinal Chemistry.** Mentoring of individual graduate students in their research programs is one of the most important components of the training that we provide. We are a small, collegial unit, and faculty members universally maintain an open-door policy for students from

their groups – and others – to discuss research problems, professional development issues, material from courses, etc. This ongoing and in-depth individual mentoring is supplemented by structured activities outside the laboratory and classroom. In addition to their presentations to faculty and peers in the MEDCH/PCEUT 520 seminar and the MEDCH 582 journal club, students have regular opportunities to interact with invited speakers from academia, industry and the public sector. As previously noted, students are required to participate in the Biomedical Research Integrity seminar series, and we have introduced summer “boot camp” discussions on topics such as peer review, literature management, and statistical rigor. In addition, the Department participates in collaborative NIH Training Grants in Pharmacological Sciences (with the Departments of Pharmaceutics and Pharmacology (SOM)), in Molecular Biophysics, in Environmental Pathology/Toxicology, and in Viral Pathogenesis. Trainees in these programs take part in annual retreats, which include student presentations or student-hosted seminar speakers, and in additional literature discussions or seminar series.

Our students are afforded opportunities to collaborate with and learn from colleagues in industry, fostered by our relationship with the SOP CAB. Depending on their research interests and dissertation topic, students have the option to complete 10–12 week summer internships at biotech/pharmaceutical companies. As a result of our regular interactions with the CAB, there is a high level of familiarity with industrial research projects, so students typically complete summer internships that are well matched with their dissertation work. These internships provide first-hand experience in the industrial research setting. We have also implemented an industry mentor program, where interested students are matched with a scientist working in a biopharma company for regular individual conversations about their professional development and career goals. Graduate students also have opportunities to practice their own mentorship and leadership skills, thanks to the department’s investment in undergraduate and postgraduate research. Working with these undergraduate and post-baccalaureate students enables graduate students to formulate and practice strategies to effectively train and mentor others in the laboratory. We have a strong alumni network as well as affiliate faculty ([Appendix H](#)) who are working in industry or research institutions.

**Pharmaceutics.** Faculty members are involved in mentoring graduate students of the Department in multiple ways. First and foremost is the close mentoring of the graduate students by their advisors. This takes many forms including frequent one-on-one meetings and weekly or bi-weekly group meetings. Second, each faculty member is a member of multiple supervisory committees (besides those of their own students) and attends and provides feedback to graduate students. Third, each faculty member takes a turn to participate (on a quarterly basis) as the faculty advisor for the journal club (PCEUT 583) led by the students. Faculty have an open-door policy and students take advantage of this policy to seek their advice even when the faculty member is not their advisor or a member of their committee. From time to time, faculty members organize seminar presentations by visiting scientists (either within or outside of our regular seminar series). On such visits, the graduate students informally meet with the visiting scientist to discuss research and any number of topics including career options.

The faculty also organize in-house workshops at which the students can acquire skills beyond the didactic courses (e.g., in-house Simcyp or Simbiology workshops). Students are also supported by the Department to attend extramural workshops (e.g., Simcyp). Past students participated in an online population pharmacokinetics/pharmacodynamics course offered by SUNY-Buffalo; access remains. Students work closely with their advisors to participate in activities appropriate to their progress in the program; for example, students are encouraged to attend courses (e.g., Simcyp, MATLAB), or do a summer internship at a pharmaceutical company. Provided there is satisfactory progress, every PhD student is provided a re-appointment letter every June. If there are concerns, this is noted in the letter. If a student appears to be at risk (academically or personally), we work with the student for remediation, strategies for success, and offer support as needed through campus resources. Infrequently, despite this support, a PhD student who does not overcome deficiencies (identified prior to the General Exam) will be asked to terminate the program with an MS (with all the necessary steps followed as dictated by the Graduate School). Besides career mentoring by their thesis advisor, each student's committee annually reviews the student's IDP and provides guidance to the student on how best to position themselves for their desired career.

Faculty also notify the graduate students of summer internship opportunities in various pharmaceutical companies or at the Food & Drug Administration and many of our students take advantage of these unique career training opportunities. We have a strong alumni network as well as affiliate faculty who are working in industry, nonprofit organizations, or research institutions ([Appendix H](#)). The SOP has an annual CAB meeting attended by heads of drug metabolism and pharmacokinetics (DMPK) or clinical pharmacology departments of large and small pharmaceutical companies. At this meeting, graduate students have an opportunity to present a poster (or a podium presentation) and network with these leaders. Each PhD student, who is in their 2nd year or beyond, is paired with a CAB member who acts as their "career" mentor. Students seek advice from these mentors on developing their CV, interview techniques, and career choice (DMPK vs. clinical pharmacology, small vs. large companies, biologics vs. small molecules etc.). This mentoring program has been immensely popular with the students. Faculty also send their graduate students (MS and PhD) to national and international conferences (about 1-2 per year) where they help their student network with prominent scientists and hiring managers. Close to graduation, faculty members will work with students to identify and facilitate contact with prospective employers and prepare them for interviews. Our excellent training and mentoring have resulted in most of our PhD students having 2 to 3 offers in hand prior to graduation. Our revamped MS track is too recent to have statistics in employment or entry into PhD programs at UW or at other institutions.

**Health Economics & Outcomes Research.** Students are assigned a faculty academic advisor upon entry into the program. Their advisor assists the student with selection of courses and identification of independent research opportunities within the program, and collaborative arrangements with other departments at UW and outside research institutions. Students identify a dissertation advisor based on mutual interests during their second or third year. In addition to formal mentoring, opportunities also arise for teaching and mentoring outside the classroom through research projects. Our students serve as research assistants on unique

projects and work closely, meeting weekly or bi-weekly with the PI for that project. In addition, our graduate students participate in training programs, i.e., the AHRQ T32 in Health Services Research that the Department of Health Services shares with us (2 students per year are supported by it) and the NCI T32 in Developing Data Driven Cancer Researchers (3DCR) at Fred Hutchinson Cancer Research Center (FHCRC) (partially funds 2 students).

We have a strong sense of community in the CHOICE Institute. All faculty have an open-door policy, and the proximity of student and faculty offices facilitates informal interactions. We have a strong alumni network as well, with over 20 affiliate faculty who are working in industry, nonprofit organizations, or research institutions ([Appendix H](#)). These individuals and members of our CAB offer summer internships that are very popular with our students. These affiliate faculty and alumni are available to work with CHOICE students and provide mentorship; CHOICE faculty facilitate these opportunities. Further, graduate advisors are extremely proactive in helping students find suitable postdoctoral research positions. Many affiliate faculty members are highly engaged in the operations of the pharmaceutical industry and actively solicit information about open positions for dissemination throughout the Department. In addition, each year several students give a seminar or poster presentation at the annual CAB meeting, which provides excellent exposure to potential employers. Finally, most students annually attend one or more national/international conferences to network with potential academic or industrial employers.

### SECTION III. SCHOLARLY IMPACT

#### A. Impact of Faculty Research

Our faculty are leaders in biomedical sciences research, encompassing basic, translational and outcomes research. In 2020 alone, faculty members from our three departments produced a total of 470 peer-reviewed publications (average of 8 per faculty member). And together, the three departments host a total of 19 elected fellows of national academies or professional organizations.

**Medicinal Chemistry.** Faculty members hold national or international reputations in their respective fields. For example, Drs. Atkins and Rettie serve on the Advisory Boards of the International Conferences on Cytochrome P450s (ICCP) and/or Microsomes & Drug Oxidations. Dr. Atkins is a leader in the areas of allostery and promiscuity of drug metabolizing enzymes and transporters. In addition, he has championed the application of lipid nanodiscs to study these systems by previously intractable methods. Other high impact work includes the pharmacogenomics research of Dr. Rettie that has defined polygenic effects on warfarin drug response, which contributed to FDA labeling on the use of genetics to guide warfarin dosing. Another example is the work of Dr. Lee who has developed innovative structural biological tools that provide new insights into proteins and protein complexes that are particularly relevant to infectious diseases and vaccine development. The latter work has attracted the attention of the Bill & Melinda Gates Foundation (BMGF), which funded the Lee lab to serve as one of a handful of vaccine analysis “platforms” for HIV and non-HIV-related vaccine candidates. This diversity of faculty research, while retaining the core mission to, “understand how drugs and toxins

interact with their biological targets and with detoxifying enzymes and transporters, as well as to uncover the chemical and biochemical bases of cardiovascular, degenerative, developmental and infectious diseases”, distinguishes our unit from other Medicinal Chemistry departments at peer institutions. Since early 2020, Lee, Guttman and Bhardwaj have been involved in high-impact research on COVID-19 vaccine and therapeutic development. The Department organized the ACS 30<sup>th</sup> National Medicinal Chemistry Symposium in summer 2006 and has been invited to host the 38<sup>th</sup> National Medicinal Chemistry Symposium again in 2022. Dr. Totah will be the faculty co-Chair along with a scientist selected from industry. In recognition of the Department’s long-standing prominence in the fields of drug metabolism and toxicology, the Department hosted the 17<sup>th</sup> ICCP in summer 2013, where Drs. Atkins and Rettie were co-chairs. Atkins, Rettie, Totah and Lee serve, or have served, on Editorial Boards of *Chemical Research in Toxicology*, *Drug Metabolism and Disposition*, *JPET*, *Drug Metabolism Reviews*, *Arch. Biochemistry and Biophysics*, *Frontiers in Pharmacogenetics and Genomics* and *Frontiers in Microbiology*. Among Medicinal Chemistry programs, ours is one of only a few with a state-of-the-art graduate program with a major focus on drug metabolism and toxicity and so our graduate students are regularly recruited for this expertise by pharma and biotechnology companies. Junior faculty have received Young Investigator or Early Career awards from the National Institutes of Health (Xu) and the BMGF (Guttman). Other honors and awards are detailed in the CVs.

**Pharmaceutics.** Faculty are leading experts in the fields of drug metabolism, drug transport, drug delivery and pharmacokinetics. For example, they have been pioneers in the development of physiologically-based pharmacokinetic (PBPK) models of drug disposition (Unadkat, Isoherranen), and leaders in the field of drug-drug and natural product-drug interactions (Ragueneau-Majlessi, Thummel, Unadkat, Isoherranen). They operate Drug Interactions Solutions (Ragueneau-Majlessi, Isoherranen, Thummel, Unadkat), an essential drug discovery and development resource for the pharmaceutical industry and FDA, and an important revenue generator for UW. The Pharmaceutics faculty direct cutting-edge research across a spectrum of sub-disciplines in the pharmaceutical sciences and are Principal Investigators for multiple programmatic NIH grants including: Unadkat – “Pharmacology of Drugs of Abuse During Pregnancy”; Unadkat, Mao - “A Systems Pharmacology approach to predict the effects of pregnancy and infectious diseases on transporter-mediated drug disposition”; Ho – “Targeted Long- Acting Combination Antiretroviral Therapy”; Thummel – “Program on Genetic and Dietary Predictors of Drug Response in Rural and AI/AN Populations”. This work has generated highly novel, impactful findings that enhance our understanding of drug disposition mechanisms and therapeutic treatments of disease. Of similar impact is NIH-funded research from Dr. Kelly’s lab. He is a key partner in a multi-disciplinary research team seeking to develop human microphysiological systems (MPS or organs-on-a-chip) to better evaluate at the molecular level the effects of disease and toxins on organ function and drug disposition. Most recently, Dr. Kelly and his team sent a kidney MPS up to the International Space Station, where astronauts conducted an experiment to evaluate the effects of microgravity on renal mineral homeostasis. There is also ground-breaking research from Dr. Wang’s lab, studying solute transporter functions at the CSF-Brain barrier. Finally, at the translational level, Dr. Ho has been honored as one of the top 25 entrepreneurs in the Pacific Northwest for founding a number of

biotechnology and biopharmaceutical companies, including Impel BioPharma, a company that has developed a novel nasal drug delivery platform that was recently approved for marketing by the FDA. Dr. Ho is also the PI of a U01 grant from NIH that supports the Washington Entrepreneurial-Research Evaluation and Commercialization Hub (WE-REACH). WE-REACH was founded in December 2019 to invest and guide innovators throughout the UW to develop products that have the potential to improve health outcomes. The Pharmaceutics faculty also impact the field by providing significant service to national and international scientific organizations (e.g., AAPS, ASPET, ISSX, ASCPT, and AACP). Importantly, they have been invited to present or organize symposia at numerous scientific meetings and to serve on governmental advisory panels (FDA, NIH, the National Academies, and NASA). Most recently, Drs. Unadkat and Rettie co-Chaired the 21st North American ISSX Meeting in 2017; Dr. Wang organized and chaired a symposium on “Transporters at the blood-CNS barrier” at the annual meeting of ASPET in 2018; Dr. Mao will organize and chair a symposium on “Developmental Neurotoxicity of Cannabinoids” at the annual meeting of ASPET in 2022; and Dr. Isoherranen was a member of the organizing committee of the 21st International Symposium on Microsomes and Drug Oxidations in 2016 and 21st North American ISSX Meeting in 2017. Most of the Pharmaceutics faculty have served on journal editorial boards or been appointed Associate Editors. Some have been named Fellows to the Academy of Pharmaceutical Sciences, American Association for the Advancement of Science, American Association of Pharmaceutical Sciences, and the American Society for Pharmacology and Experimental Therapeutics. In addition, Dr. Ho received the AACP Volwiler Research Achievement Award in 2019, the Luminary Asian American Award from Chinese Institute of Engineering in 2018, and the AAPS Biotechnology Research Achievement Award in 2013. Dr. Thummel was President of ASPET between 2015-16 and chaired its Science Policy Committee between 2015-19. He also received the Rawls Palmer Progress in Medicine Award from ASCPT in 2016. Dr. Wang is the 2021 chair of the Division for Drug Metabolism and Disposition of ASPET. Dr. Unadkat received the Research Achievement Award in Pharmacokinetics, Pharmacodynamics and Drug Metabolism from AAPS in 2012 and was named a Council member of ISSX between 2019-21 as was Dr. Isoherranen (2020-22). Other honors and awards can be found in the faculty CVs ([Appendix C](#)).

**Health Economics & Outcomes Research.** Faculty research focuses on the development of innovative methods and generation of actionable evidence about the effectiveness, safety, and value of medical products and services that improve decision making in health care and policy. Research at the CHOICE has three main emphases: health economics, outcomes research, and policy evaluations. CHOICE faculty are principal investigators on numerous federally funded (NIH, AHRQ, CDC, USAID) projects (e.g., Basu, Stergachis, Veenstra, Devine, Gray, Bansal, Marcum). In addition to federal funding, CHOICE faculty are leading researchers on foundation and non-profit funded projects (ICER, PhRMA Foundation, Washington Research Foundation, BMGF) (e.g., Carlson, Hansen, Barthold, Bacci, Stergachis). Several CHOICE faculty have industry-funded projects, and the Institute receives funding from members of the SOP CAB through the biennial Health Technology Fund.

Our faculty have served on editorial advisory boards or been appointed Associate Editor or Editor of numerous journals: *Value in Health*, *Health Economics*, *Journal of the American*

*Pharmacists Association, Annals of Pharmacotherapy, Journal of the American Geriatrics Society, and Healthcare: The Journal of Delivery Science and Innovation.* Our faculty also serve in leadership roles and working committees for numerous societies, such as the American Society of Clinical Oncology Value Frameworks Methodology Working Group, ISPOR Health Science Policy Council and Task Forces, PhRMA Foundation Value Initiative Review Group, Premera Blue Cross P&T Committee, Academy Health's Methods and Data Council, and National Academy of Medicine. Three of our faculty have served as ISPOR President: Drs. Ramsey, Sullivan, and Garrison. The immediate past President, Dr. Grueger, serves as an Affiliate Professor of Pharmacy. Dr. Sullivan is the current ISPOR treasurer and Dr. Devine is a current member of the ISPOR Board of Directors. The contributions and excellence of the CHOICE faculty is often recognized by peers. Dr. Basu was selected for the Research Excellence Award for Methodological Excellence (ISPOR) (2016). He was also appointed a Fellow of the American Statistical Association (ASA) (2016) and awarded the Mid-Career Excellence Award from the Health Policy Statistics Section of the ASA (2018). Drs. Stergachis and Sullivan are elected members of the National Academy of Medicine and Dr. Stergachis is Fellow, American Pharmacists Association-Academy of Pharmaceutical Research and Science; Fellow, International Society for Pharmacoepidemiology; and Fellow, Washington State Pharmacy Association. Dr. Garrison was named a 'Change Agent' in the PharmaVOICE-100 honorees (2017). Dr. Sullivan was awarded the 2014 Stephen G. Avey Lifetime Achievement Award from AMCP (2014), the 2015 APhA APRS (2015), and was named an ICON of Pharmacy from his alma mater, Oregon State University (2019). Dr. Marcum was selected as the first pharmacist to ever receive a Paul B. Beeson Emerging Leaders Career Development Award (K76) from the National Institute on Aging (NIA) and The John A. Hartford Foundation (2019). Dr. Devine was elected to the membership of the Society for Research Synthesis Methodology (2013) and is presenting serving on the Methods and Data Council of Academy Health. Most recently, Dr. Devine was selected as a Fulbright Scholar to teach and conduct research at the University of Murcia in Spain for the 2021-22 academic year. Dr. Bansal received the ISPOR 2020 Bernie O'Brien New Investigator Award, Dr. Devine received the ISPOR 2020 Health Economics and Outcomes Research - Application Award, and Dr. Basu received the ISPOR 2020 Bernie O'Brien New Investigator Award. Other honors and awards can be found in the attached faculty CVs ([Appendix C](#)).

## B. Graduate Student Accomplishments

**School-wide.** In the 2016-2017 academic year, the SOP initiated an annual graduate program awards program, consisting of an Outstanding Dissertation Award, an Outstanding Mentor Award (faculty), and three Graduate Student Leadership Awards (one per department).

**Medicinal Chemistry.** Graduate students in Medicinal Chemistry regularly attend national and international scientific conferences and are often selected to give oral presentations. Some examples include Eric Evangelista who was selected from a pool of national students to spend a summer conducting research at Genentech (2018), and Hannah Baughman who won travel awards that year from the Protein Society and from the Gordon Research Conferences. In 2019, Christi Cho won best poster award and oral presentation at the AAPS-Rocky Mountain Discussion Group meeting, Dylan Ross was selected to give an oral presentation at 67th ASMS

Conference on Mass Spectrometry and Allied Topics, Tianwei Shen was selected to give an oral presentation at ASM-Microbe 2019, and John Kowalski was selected to give an oral presentation at the ICCP450 meeting in Brisbane. In 2020, Hayli Larsen and Eleanor Vane both won travel awards to attend the Biophysical Society Annual Meeting, while Drake Russell was selected to give a talk at the Society for Redox Biology and Medicine meeting.

**Pharmaceutics.** Over the past 5 years, numerous graduate students in Pharmaceutics have received awards for poster presentations, invited podium presentations, as well as other external awards and honors. Awards were as follows: Weize Huang, Annual ASCPT meeting, selected for Top Poster Ribbon and Presidential Trainee Award, 2020. Leticia Salvador Vieira, Levy Award. 2020-2021, Antonio Lopez Quinones, Shen Award, 2020-2021, King Yabut, Bradley Award, 2020-2021, Kendan Jones Isaac, Bradley Award, 2020-2021, Mengyue Yin, Ji-Ping Award, 2020-2021, Francine Cesar, Ji-Ping Award, 2020-2021, Leticia Salvador Vieira, Magnuson Award, 2020-2021, Nathan Alade, Institute for Translational Health Sciences Award 2020-2021, Aditya Kumar, Institute for Translational Health Sciences Award 2021-2022, Of significant note, on January 17, 2020 Kendan Jones-Isaac was honored at the UW Health Sciences Martin Luther King Tribute for his outreach work.

**Health Economics & Outcomes Research.** We have an active ISPOR Student Chapter and our now-alumnus Dr. Blythe Adamson served as the global ISPOR student president (2016). Dr. Adamson was also selected as Husky 100 student (2016). Our 2021 ISPOR student president, Jacinda Tran received the ISPOR Distinguished Service Award for her contributions to the ISPOR Student Network in 2020-2021 as a student leader globally and president of the UW Student Chapter. She will serve as Co-Chair for the ISPOR Student Network's Publications Committee for 2021-2022. Our PhD students are highly sought out to serve as research assistants, due to their expertise in cost-effectiveness analysis, programming, and data analysis. PhD alum Nathaniel Hendrix founded our active student blog, *Incremental Thoughts* (<https://choiceblog.org/>). PhD alum Lauren Strand was named as a Magnuson Scholar for 2019-20. PhD student Woojung Lee was awarded a PhRMA Foundation Pre-Doctoral Fellowship in HEOR in 2021 and was recently awarded the Graduate School's UW Retirement Association Patricia Dougherty Fellowship in Aging. PhD student Rachel Wittenauer received the Elmer M. Plein Endowed Research Fellowship, an award established to encourage, promote and support research and innovative practice in pharmacy. PhD student Sara Khor was awarded best poster presentation at the 2021 Western Pharmacoeconomics Conference and MS student, Eunice Kim received best podium award.

### C. [Postdoctoral Fellow Participation in Research & Teaching](#)

For **Medicinal Chemistry**, each active research lab typically includes 1–3 postdoctoral fellows. They are an intrinsic part of the teaching mission as day-to-day mentors to graduate students. They also serve as important leaders within the department community and extramurally. However, practically all didactic teaching in the graduate professional degree programs is done by regular faculty, with very occasional exceptions. In **Pharmaceutics**, all of the faculty with active research programs engage postdoctoral fellows or visiting scientists. They play a critical role in the research training of graduate and undergraduate students. When interested,



postdoctoral fellows are provided opportunities to serve as instructors in graduate, and occasionally, undergraduate classes. As an example, Dr. Katrina Claw, a member of the Navajo Nation, received post-doctoral training in Dr. Thummel's lab supported by a NIH F32 grant, taught in *Pharmacogenetics and Toxicogenomics* (Seattle campus) and *Medicine of the Future* (Bothell campus), attended multiple national and international scholarly workshops and was recently hired as an Assistant Professor-tenure track at the University of Colorado. The **CHOICE Institute** (and its predecessor, PORPP Program) has hosted twelve post-PhD fellows over the past decade, all of whom participated actively in our program and are now pursuing careers in academia, health-systems and consulting. Post-docs have been funded through various sources such as Pfizer, NHLBI, Eli Lilly, PhRMA Foundation, and ICER, and their research with faculty is critical to our program. For example, the work of CHOICE postdoctoral scholar, Dr. Gujral (mentor Dr. Basu) has highlighted drastic mortality impact of rural hospital closures, and has gained national attention in mainstream media outlets. Faculty in the CHOICE Institute have also hosted several visiting scholars, including a Fulbright Scholar from Naresuan University Thailand - Dr. Dhippayum was hosted by Dr. Devine (2018-2019).

#### D. Impact of Alumni

Many **Medicinal Chemistry** program graduates go on to leadership roles in the pharmaceutical industry, academic institutions and regulatory agencies. We leverage this, in part, via our CAB that is composed of many of our alumni. This provides both programmatic counsel and the opportunity for new scientific collaborations. The [Appendix H](#) highlights the employment outcomes of some of our graduates. For example, Dr. Larry Wienkers, was Executive Director of Pharmacokinetics and Drug Metabolism, Amgen (retired); Dr. Brenda Nieslanik is Provost and Dean of Gustavus Adolphus College; Dr. Michael Adams is Dean of the College of Pharmacy & Health Sciences at Campbell University. Graduates also hold director-level positions at other major pharmaceutical companies. In addition, we continue to place postdoctoral fellows and graduate students back into academic appointments. Recent examples include Dr. Ho Han Kiat, Vice Chair, Teaching Academy, National University of Singapore; Dr. Arthur Roberts, Associate Professor, University of Georgia; and Dr. Cathy Yeung, Associate Professor, Department of Pharmacy, UW.

Many **Pharmaceutics** graduates go on to leadership roles in the pharmaceutical industry, academic institutions and regulatory agencies ([Appendix H](#)). Some examples of Pharmaceutics graduates and their current professional roles are as follows: Dr. Megan Gibbs, Vice-President, Clinical Pharmacology, Astra Zeneca; Dr. Donovan McConn, Entrepreneur In Residence for Takeda Ventures, Inc; Dr. Anita Mathias, Vice President, Clinical Pharmacology & Development, Gossamer Bio; Dr. Tove Tuntland, Head of Global DMPK at Ferring Pharmaceuticals; Dr. John Hoekman, Co-Founder and Chief Scientific Officer, Impel NeuroPharma; Dr. Deanna Kroetz, Professor and Chair Department of Bioengineering and Therapeutic Sciences, University of California–San Francisco; Dr. Mary Paine, Professor, Washington State University; Dr. Amber Dahlin, Assistant Professor, Harvard University; and Dr. Ping Zhao, Senior Program Officer, BMGF.

**HEOR** graduates enjoy successful careers in academia, consulting, industry and the non-profit sector ([Appendix H](#)). For example, Dr. Jon Watanabe '12, received the UW Pharmacy Alumni Association Distinguished Alumni Award in Pharmaceutical Science and Research (2019), was selected as the National Academy of Medicine Anniversary Pharmacy Fellow (2016), and subsequently recognized as a NAM Emerging Leader in Health and Medicine. Business Insider named Dr. Blythe Adamson one of “30 leaders under 40” transforming US healthcare. Dr. William Canestaro was selected as a “40 under 40” by the Puget Sound Business Journal and was recently awarded the Health Innovator of the Year by Health Innovation NW (both 2019). Dr. Veena Shankaran, '12 received Seattle Business Magazine “Leaders in Health Care Gold Award: Achievement in Medical Research”. In addition, she was recently appointed the new co-director of the Fred Hutchinson Institute for Cancer Outcomes Research (HICOR).

#### E. Key Influences on SOP's Research, Scholarship & Creative Activity

Historically, **Medicinal Chemistry** was heavily focused on drug metabolism and toxicity research with many important contributions emanating from the unit. As this area matured, it became apparent to us, beginning ~20 years ago, that some diversification was needed. Since then, newer trends in omics-based and translational research have solidified, infectious disease research has become increasingly urgent, and drug development approaches have shifted substantially towards biologics over small molecule drugs. Regardless of the specific research area(s), bioanalytical mass spectrometry (now revolving around H/D exchange, lipidomics and complex post-translational glycan modification) is a continuing theme in the Department. Since 2009, several changes have occurred in faculty composition, such that only Drs. Atkins, Rettie and Totah remain from the previous review period. These three PIs provide the bulk of research opportunities in drug metabolism and toxicity. New additions to the faculty (Lee, Nath, Xu, Guttman and Bhardwaj), all hired at the assistant professor level, now provide expertise and graduate research opportunities in infectious disease (Lee), biologics (Nath, Guttman), lipidomics (Xu) and computational peptide drug design (Bhardwaj). Moreover, several of the latter (Nath, Xu, Guttman) have made contributions in the drug metabolism/toxicity area since joining the department. Consequently, current faculty research mirrors changing trends in research and funding patterns, while maintaining expertise and research opportunities in drug metabolism/toxicity research.

For **Pharmaceutics**, the *omics* revolution and advances in computational biology, microfluidics, nanotechnology and cell imaging have been translated into new applied technologies for the pharmaceutical sciences. These include PBPK modeling of drug disposition and response, transgenic mice and transformed cell models for elucidating drug metabolism, transport and response mechanisms, human microphysiological organ systems for predicting drug clearance, organ toxicity and effective disease treatments, high throughput -omics screening platforms, including proteomics. All these models/systems are used to more comprehensively and accurately characterize the biological basis of inter-individual differences in drug disposition and response, and novel lipid nanoparticles for long acting and tissue-specific delivery multi-drug combinations in the treatment of disease (HIV and cancer). To advance these and other research initiatives, the Pharmaceutics faculty has expanded its program (P01, U01, and UM1) and center grant funding portfolio, while trying to maintain a healthy level of individual R01

funding. Graduate research and training in Pharmaceuticals has benefited substantially from this influx of new, cutting-edge research approaches and knowledge; graduates are better prepared for inter-disciplinary jobs in academia, industry and government that await them.

For **CHOICE and the HEOR graduate program**, key influences in the field of HEOR include: 1) big data, real-world evidence, and machine learning; 2) increased demand for individuals trained in HEOR; 3) increasing use of HEOR in managed care in US; 4) the aging population, and 5) clinical and scientific advances in areas such as gene therapies and genomics. **CHOICE** faculty and students are leading efforts in most of the categories of ISPOR's "*Top 10 HEOR Trends*". Work for the Institute for Clinical and Economic Review (ICER) (led by Dr. Carlson) has become front and center in our program over the past five years; many of our students learn both methods and application in a real-world policy environment by participating in these projects. Managed care decision-making has continued to evolve and is now captured within the broad global initiative called Health Technology Assessment (HTA). Drs. Garrison and Devine have taught HTA workshops at ISPOR. Drs. Garrison and Carlson both teach a highly popular ISPOR Short Course on Performance-based Risk Sharing. Led by faculty advisor Dr. Veenstra, our faculty support UW SOP PharmD students as they achieve national recognition in the national AMCP Pharmacy & Therapeutics Competition, bringing home first place in 2019. The field of evidence synthesis has evolved significantly with advances in quantitative meta-analysis and network meta-analysis. Collaborating with Oregon Health & Science University, Dr. Devine is site-PI of the AHRQ-funded Pacific Northwest Evidence Based Practice Center (2014- ). Faculty are active in the Real-World Evidence (RWE) space, leading RWE projects funded by our Health Technology Fund since 2016. Guided by input from our Corporate Advisory Board and students, we are currently developing a graduate degree option in Data Science; many of our students are already taking some of these courses. We are also finding synergies with the Plein Center for Geriatric Pharmacy Research, Education and Outreach (Drs. Gray, Marcum, Devine, and Barthold). Our faculty continue to contribute advancements in personalized medicine and global medicines. Dr. Veenstra's work in precision medicine and genetic testing and Dr. Bansal's work in biomarker surveillance are but two examples of advancements in personalized medicine. Global medicine examples include key postmarketing studies on the safety of antimalarial medicines used during pregnancy and studies on the use of antimicrobials in low- and middle-income countries and on the global burden of antimicrobial resistance. Our long-standing, PharmD-MS fellowship program has expanded from two fellows to six fellows now funded by five industry partners. This expansion is in response to the increased demand for HEOR-trained PharmD's, as guided in part by our CAB. Finally, in response to this increased demand, we have a distance learning certificate program in Health Economics and Outcomes Research, which attracts both domestic and international students; the revenue from this program supports our PhD students.

#### F. Collaborative and Interdisciplinary Efforts

**Medicinal Chemistry** faculty participate in numerous interdisciplinary endeavors at the UW through a long running NIH-supported Pharmacological Sciences Training Program, currently directed by Dr. Atkins and housed within the Department since the Program started in 1982. The PSTP has been critical in fostering interactions within SOP, as Medicinal Chemistry and

Pharmaceutics faculty are heavily involved both in mentoring students and in administering the program. As noted above, faculty are also involved in several other Training grants on campus, including Molecular Biophysics, Environmental Pathology/Toxicology and Viral Pathogenesis. Faculty also participate in the Biological Physics, Structure & Design; Molecular & Cellular Biology; and Molecular Engineering & Sciences graduate programs, as well as the Institute of Translational Health Sciences. Several faculty members collaborate with and have access to valuable Core Facilities in the EDGE Center that explores how the interactions of genetics, epigenetics and environmental factors contribute to diseases of public health importance. Faculty also collaborate extensively with members of Departments of Genome Sciences, Biological Structure, Chemistry, Biochemistry, the Institute for Protein Design, Cardiovascular Research Health Unit and many other UW units too numerous to elaborate in detail here. Regarding outside institutions, Dr. Rettie has longstanding collaborations in the P450 arena with colleagues at the Heinrich-Heine University in Dusseldorf, while Dr. Totah has P450 collaborators in Arizona, Australia, and Finland. Dr. Xu collaborates with Colorado Children's Hospital on Smith-Lemli-Opitz syndrome. Dr. Nath collaborates on various aspects of protein misfolding and aggregation with the University of Pennsylvania, Amgen, Seattle Genetics and Takeda Pharmaceutical Co. Dr. Atkins collaborates on P450 projects with Professors Mike Bowman and John Hackett at the University of Alabama and Virginia Commonwealth University, respectively. Dr. Lee's connections with the BMGF have fostered laboratory collaborations with the Aaron Diamond AIDS Research Center, NIH Vaccine Research Center, and Scripps Research Institute, to name but a few. Through these interdisciplinary efforts, Medicinal Chemistry faculty offer diverse, cutting-edge opportunities for graduate student training and funding mechanisms.

**Pharmaceutics** has a history of strong collaborations with SOP faculty in the Departments of Medicinal Chemistry and Pharmacy and faculty outside the SOP and the UW. This includes faculty participation in program grants administered by the Department of Pharmaceutics [Program on Genetic and Dietary Predictors of Drug Response in Rural and AI/AN Populations (Thummel, Rettie, Xu, Veenstra); and the Natural Products Drug Interactions Center (Thummel, Unadkat, Rettie)], as well as collaborations between individual faculty supported by R01 type grants (Wang and Xu, Kelly and Yeung, Isoherranen and Hebert, for example). Outside of the SOP, individual faculty have a strong record of collaboration with research and training programs in Biostatistics (Thummel), Environmental and Occupational Health Sciences (Kelly and Isoherranen), Bioengineering (Ho), Microbiology (Hu, Arnold), Genome Sciences (Thummel), Nursing (Lin), Reproductive Medicine (Isoherranen and Unadkat), Infectious Diseases and Global Health (Unadkat, Arnold), Radiology (Unadkat) and Nephrology (Kelly and Isoherranen), among others. Notable instructional collaborations are the PHARBE program (Kelly, Lin) run by Bioengineering and the BRIDG program (Lin) run by Nursing. In addition, Pharmaceutics faculty conduct collaborative graduate research that utilizes resources in the UW Institute of Translational Health Sciences (all faculty; with TL1 training grant support for individual graduate students), the Interdisciplinary Center for Exposures, Diseases, Genomics and the Environment (Kelly, Lin, Thummel, Rettie, Mao, Ho, Isoherranen, Unadkat), the FHCRC (Wang, Hu), Washington National Primate Research Center (Hu, Unadkat, Ho, Isoherranen), Center for AIDS Research (Unadkat, Hu, Ho), the Nutrition and Obesity Research Center

(Isoherranen, Wang), Diabetes Research Center (Thummel, Isoherranen), Center on Human Development and Disability (Unadkat, Ho, Isoherranen), Center for Emerging and Reemerging Infectious Diseases (Arnold), and the Male Contraceptive Research Center (Isoherranen). Pharmaceutics faculty also have extensive collaboration outside the UW and they are all not all listed here. For example, Dr. Unadkat, through his P01, is collaborating with University of Colorado and Madigan Army Hospital, WA, on quantifying human fetal exposure to cannabinoids. Drs. Unadkat and Mao, through their newly funded R01, are collaborating with Dr. Vera Lucia Lanchote at the University of Sao Paulo in Brazil, on predicting transporter-mediated drug disposition in pregnant women with infectious diseases. A positive consequence of this multitude of collaborations is a tremendous enrichment in the graduate student learning environment, with additional mentoring and research experiences coming from collaborating faculty and their lab staff, postdocs and students. Indeed, student dissertations are often a product of cross-disciplinary training.

The work of **Health Economics & Outcomes Research** is interdisciplinary in nature, and our ties to colleagues within the UW, across the Puget Sound region, nationally and internationally are strong. Dr. Devine recently completed a study exploring the feasibility of using pharmacogenomics-guided prescribing to residents of retirement communities in the Seattle area. Dr. Veenstra is collaborating with investigators at Vanderbilt University and Geisinger to study the cost effectiveness of population-level genomic screening. Drs. Veenstra and Devine are co-investigators in two large NIH-funded consortia – Clinical Sequencing Evidence-Generating Research (CSER2) and the Electronic Medical Records and Genomics (eMERGE IV) Network. Dr. Stergachis, other faculty and graduate students collaborate with numerous international agencies and organizations in the area of global health, e.g., COVAX, Liverpool School of Tropical Medicine, PATH, Management Sciences for Health USP. We partner with the UW Department of Health Systems & Population Health, School of Public Health, to host the weekly Program in Health Economics and Outcomes Methodology (PHEnOM). Noted speakers at this seminar have included Drs. Chuck Phelps, Peter Neumann and Jens Grueger, as well as colleagues from across the country. CHOICE faculty also collaborate with colleagues and many hold joint, adjunct or affiliate appointments in Health Systems & Population Health, Global Health, Surgical Outcomes Research Center, Institute of Translational Health Sciences (NCATS-CTSA), Seattle Children’s Hospital, Kaiser Permanente Washington Health Research Institute, the Health Services Research & Development Center (Puget Sound VA), BMGF, PATH, and the FHCRC. Crucially, SOP centers and programs such as the Plein Center for Geriatric Pharmacy Research, Education & Outreach and the Program on Pharmacokinetics of Drugs of Abuse during Pregnancy (UWPKDAP) foster interactions and collaborations across the SOP.

**G. Promotion and Tenure Policies and Mentoring and Supporting Early Career Faculty**  
School-wide, we follow the promotion policies and practices detailed at <https://ap.washington.edu/ahr/actions/promotions-tenure/>. As a result of the circumstances associated with COVID-19, the UW [offers](#) automatic extension of the promotion and/or tenure clock for up to 2 years for eligible faculty who request the waiver of the 2019-20, 2020-21, and/or 2021-22 academic years. At every stage of their career, the School strives to convey to faculty what is expected of them with regard to instruction, research and service. The SOP is

presently developing School-based guidelines for promotion & tenure (P&T) in order to provide transparent communication to faculty up for review about what to expect from the process and guide P&T committee deliberations. It is intended as a single, comprehensive guidance document that covers all appointment tracks and ranks currently used in the School. With this approach, the intention is that the faculty clearly understand expectations around instruction, research and service at each career stage. In addition to the written policies, expectations and guidance for instruction, research and service is provided to faculty by each department chair during annual (at least) meetings that typically accompany merit evaluations to support salary increases. These occur more frequently (typically biannually) for Assistant Professors, but at least annually for all faculty. Assistant Professors also undergo a mandatory third-year review by senior colleagues, roughly halfway between recruitment and a mandatory tenure decision. Written feedback on strengths and weaknesses is provided, with the opportunity for junior faculty to respond. In addition, expectations are communicated through departmental faculty meetings and the Dean/Dean's office communicates expectations during School-wide meetings, and on an ad-hoc basis. All members of the Dean's office are available to faculty seeking input on any aspect of their professional development and scholarly activities. The Dean meets over lunch with all Assistant Professors annually to discuss their research and other career aspirations and is available to all faculty members seeking input on any aspect of their scholarly activities. The School of Pharmacy places a high priority on ensuring the success of our junior faculty by providing funding, teaching opportunities and consistent mentoring by senior faculty. At the Department and School level, we follow the processes detailed by the UW Office of Academic Personnel. Each new faculty member is paired with one or more senior colleagues who provide guidance and mentorship on research, seeking external funding for research, professional development, and service opportunities at local, regional and national levels. Junior faculty are provided with adequate start-up support to establish research infrastructure and are typically relieved of classroom teaching duties for one to three years after initial appointment. The practice has been not to over-burden junior faculty with committee appointments and teaching duties, so they can concentrate more in the initial phase of setting up a research laboratory and recruiting postdoctoral fellows and graduate students.

We strive for a balance in faculty teaching and service responsibilities that fosters collegiality and promotes individual and collective scholarship. Appointment to the Graduate School faculty follows [guidance](#) from the Graduate School. Briefly, all members of the Graduate Faculty within each department vote on proposed nominations. For the endorsement to chair doctoral supervisory committees, voting is restricted to Graduate Faculty members within each department who hold that endorsement. Given the large number of recent and upcoming retirements, the School of Pharmacy as a whole has a growing proportion of junior faculty. The mentor/mentee relationship works well to create a mutually beneficial communication channel that continues to evolve with the needs of faculty, departments and the School. Junior faculty are well-supported and highly productive, evidenced by their publication records, extramural funding success, student progress, and promotion statistics. This success brings with it challenges surrounding retention, however; in at least two cases over the past 10 years, productive and well-funded Assistant Professors have been recruited away by competing

institutions. Their decision to leave the UW was driven by the high cost of living in Puget Sound and much more substantive salaries elsewhere that could not be matched with retention offers.

#### **SECTION IV: FUTURE DIRECTIONS**

##### **A. What is the future of the SOP?**

Since 2015, we have deliberately and systematically managed our fiscal and human resources and guided investments in the School by closely adhering to the [2015-2021 Strategic Plan](#). Two of the key pillars of our strategic plan relate to **People and Infrastructure**, and we have made substantial progress and witnessed many successes outlined in a [slide set available to view](#). The new Husky Pharmacist PharmD curriculum, a 100,000 square foot modern interprofessional teaching facility, the sustained research enterprise supported by an additional 15,000 sq. feet of space, and the \$75 million SOP capital campaign outcome are but a few of our major successes. We have had a number of retirements that have allowed us to bring in new faculty and staff, and we currently have a number of newly opened faculty positions across the SOP. By all accounts, our new faculty are bringing energy, ideas and transformative thinking, teaching and science to the School. What follows is a summary of each Department's future directions.

In the last 5 years **Medicinal Chemistry** has recruited three new Assistant Professors to bring our faculty numbers to 8, all of whom have active research programs. With 3 full Professors, 3 associate professors and 2 assistant professors, the unit is young and vibrant with new recent research areas in peptide drug design, lipidomics and glycomics, complementing existing expertise in drug disposition and drug toxicity, computational drug design and biologics. Two retirements may occur in the next 5 years and so a priority for the unit will be to recruit faculty to maintain and advance our efforts in drug metabolism and toxicity. Recent new hires bring considerable expertise in small molecule or biologic drug development, reflecting our investment in these important new directions.

The graduate program in **Pharmaceutics** is vibrant and strong. We presently have 9 faculty members with active laboratory research, 20 PhD students, 7 MS students and 6 postdoctoral fellows. The total extramural funding of the Department is ~\$10.5 million per year (including indirect cost). Our training program is recognized nationally and internationally as one of the premier programs in drug disposition including drug metabolism and transport, drug interactions, pharmacogenetics, physiologically-based pharmacokinetic modeling and simulation (PBPK M&S) in both healthy, vulnerable and understudied populations. In addition, we have a significant presence in development of vaccines and targeted drug delivery for the treatment of HIV and cancer. Due to the translational nature of our training, our graduates are highly sought by the clinical pharmacology departments of pharmaceutical companies and elsewhere. However, due to outsourcing in their preclinical DMPK departments, such employment opportunities have diminished. Our faculty are all either full or associate Professors and one assistant professor (joint appointment with School of Medicine) with several retirements likely to occur in the next decade. Pharmaceutics is now embarking on recruitment for a new Position to bridge expected retirements with the expertise and research focus guided by the Department's strategic plan. Collectively, this puts us in an excellent

position to make strategic decisions about future direction of research and training while maintaining our well-established reputation in the areas of drug disposition and clinical/translational pharmacology.

Within the **CHOICE Institute and our HEOR graduate program**, we see an increasing focus on data science-driven policy research as a result of increasing access to healthcare data of different types and advanced analytic methods. We also believe the use of cost-effectiveness analysis in policy decisions in the US, primarily in the private sector, will continue to increase. Reflecting on the self-study from 10 years ago, we are proud of the goals we have accomplished. One goal was to focus on the recruitment and retention of junior faculty. We have successfully recruited a diverse and strong group: Carlson, Bansal, Hansen, and Marcum. Dr. Basu has served as our Institute Director since his recruitment into that position in 2016. We were also successful in growing our NIH and other federal funding, as our federal funding in dollar terms is notably higher than 10 years ago. The CHOICE Institute's strategic plan (at the time it was PORPP) led to development of its mission, values and vision and several initiatives, including the proposal for the establishment of Institute status within UW. Moreover, current faculty recruitments are designed to address current and future needs in RWE evaluation and HTA.

Within the **Department of Pharmacy**, in recent years the recruitment of several junior faculty with an interest in translational research has broadened the research mission of the Department beyond that of the CHOICE Institute, and is providing a growing opportunity for graduate training in translational pharmacy research. In addition to the highly successful work being conducted in the Obstetric-Fetal Pharmacology Research Unit (Hebert), members of the Department of Pharmacy faculty are investigating the mechanisms underlying kidney disease in the hope of finding new therapies for this patient population (Yeung), expanding our understanding of antimicrobial resistance (Werth), furthering the discovery and characterization of novel approaches for the treatment of therapy-resistant epilepsy (Barker-Haliski and White) and advancing transgender and gender diverse research (Cirrincione). Department of Pharmacy faculty members who identify as translational science researchers are federally funded through primarily NIH or DOD projects (White, Werth, Barker-Haliski, Hebert, Yeung) and from foundation sources (Cirrincione). There is a strong interest in these faculty members to capitalize on the expertise in the Department and School to expand our graduate and post graduate training to include an emphasis on translational research. Discussions in future months will focus on how best to capitalize on the interest and expertise of these and other interested faculty and formalize a graduate and post graduate NIH-sponsored training program. Faculty recruitments at the assistant professor level are underway in health economics (tenure eligible) and health decision sciences. A faculty recruitment is also about to begin in the Department of Pharmacy in the area of clinical/translational science.

#### **B. What opportunities does the unit wish to pursue and what goals does it wish to reach?**

The Department of **Medicinal Chemistry** has established a record of accomplishment in cutting-edge bioanalytical techniques relevant to the pharmaceutical sciences, encompassing mass spectrometry, structural biology and biophysical techniques. This



reputation results from the research programs of the individual faculty as well as the capabilities of our mass spectrometry core facility. A major goal of the Department is to maintain our leadership in this area, as technology advances and the scientific landscape evolves. Opportunities to enhance both the Department and the School arise when new bioanalytical technology is developed and we can implement it in core facilities, ensuring that we remain at the forefront of, for example, mass spectrometry applications. In this regard, we recently upgraded instruments used for H/D exchange analysis of proteins and ion mobility-mass spectrometry and are pursuing mass spectral imaging technologies. These capabilities are complemented by expertise in structural biology and biophysics methods such as cryo-electron microscopy and single-molecule spectroscopy. We aim to further establish ourselves as the leading exponents of the benefits posed by these very fast moving, powerful, methodologies. Importantly, the new technologies synergize with the research of our most recent faculty hires. These research directions and technological advances organically impact the graduate student experience. Specifically, faculty interests in lipidomics, glycomics and computational biology means that graduate students are gaining training and expertise in data science. The rising profile of biologic drugs leads to students who are familiar with both large- and small-molecule drugs. We aim to continuously update our graduate curriculum to formalize and deepen training in these areas. Naturally, the profile of graduate students admitted to Medicinal Chemistry also evolves with faculty research interests. Regarding our graduate training culture, we will continue to strive for diversity among trainees and faculty. We consistently send faculty and students to diversity recruitment conferences (ABRCMS and SACNAS). In addition, in line with NIH guidance, we will explore opportunities to provide training in entrepreneurship and leadership, and in rigor and reproducibility. We are collaborating with several NIGMS predoctoral training grants on campus to establish these aspects of graduate training. In combination with our innovative industry internship and mentorship programs, training in these professional skills will better prepare our trainees for a wide range of careers.

The Department of **Pharmaceutics** goals are not only maintain its international reputation in the areas of drug disposition/clinical/translational pharmacology but also to expand it into the area of drug delivery (small and large molecules) as well as disposition of biological drugs. An essential element to achieve this goal is to have a well-funded graduate program. These goals are outlined in detail below (and will be informed by the strategic planning that the faculty are currently undertaking):

- Anticipated announcements of retirements within the next decade will impact our ability to maintain our international reputation in the area of drug disposition. Thus, through new faculty hires, we wish to maintain our training and research in the areas of drug disposition, pharmacometrics and clinical/systems pharmacology.
- Drug delivery (e.g., nanomedicine) is a burgeoning area of research in pharmaceutics which can attract extramural support. Though we have a significant presence in this field through Dr. Ho's research, to elevate our prominence in this domain, we wish to build a critical mass of faculty with research and teaching expertise in this area. In addition, this direction compliments our current strengths in drug disposition and those of other departments on

campus such as Bioengineering with whom we could partner. To this end, in December 2019, Dr. Mauro Ferrari, a prominent Global Nano/drug delivery scientist and innovator, and current President of the European Research Council and Chief Architect of the Alliance for Nanotechnology in Cancer joined the Department as an Affiliate Professor.

- The area of biological drugs is rapidly expanding beyond protein and peptide drugs and now encompasses siRNA, gene therapy, and a variety of immunotherapies (e.g., CART). While we have research ongoing in the area of HIV vaccine development (Dr. Hu), we wish to expand research in biologics through new faculty hires to build a critical mass of researchers in the area of disposition and delivery of biologics. Such hires will also compliment the growth in this area in the Department of Medicinal Chemistry (and other units on campus) and thus increase opportunities for joint extramural programmatic funding (e.g., P01).
- Our graduate students are primarily funded (year 2 onwards) through the faculty NIH grants with some graduate students receiving funding from pharmacological science (PSTP) or other training grants. We have no centrally funded TA lines. Year 1 students are funded by the Department and currently cost about ~\$200,000. These departmental funds, which are accrued through faculty salary recapture and indirect cost, are highly vulnerable to dips in NIH funding. The highly competitive NIH funding is the single most important reason that our graduate student population is limited to ~20. We have faculty and laboratory capacity to graduate more students who are in demand by future employers such as pharmaceutical industry, academic institutions and regulatory agencies. To reduce our vulnerability and dependence on a single source of graduate student funding (NIH), we wish to diversify this funding, including that of Year 1 students.

The **CHOICE Institute and its Health Economics & Outcomes Research** graduate program is currently incorporating elements of data science into our research and teaching missions, including a focus on machine learning in HEOR as we seek to increase our profile in this emerging discipline. We see an opportunity to continue the development and application of CEA methods in managed care decision making. We also see a role for Evidence Synthesis, specifically as it applies to HEOR. Separately, one of the key challenges for our graduate program lies within the difficulty of committing student financial support for a full four-year commitment at the point of recruitment. Some of our competitors have been able to achieve this through external endowments. While none of our students go without funding during their tenure in the PhD program, research assistant (RA) positions for students' 3rd and 4th years usually come from grants and contracts, which remain variable. We are working toward raising money to meet this challenge. For example, we have used a private gift fund (Health Tech Fund) to create an endowment that would support one year of a graduate fellowship. We are continuing to build upon our existing endowment portfolio to support students with active contributions made by current faculty and CHOICE graduates.

#### C. How does the unit intend to seize these opportunities and reach these goals?

To pursue the above outlined goals, **Medicinal Chemistry** will need to:

- Strategically invest in new faculty hires, balancing the need to maintain expertise in drug metabolism and toxicity with the importance of staying current with the evolving scientific landscape. In the medium term, the Department will need to replace one recent

retirement and two others that may take place in a ~5-year timeframe. Supporting these new hires and start-up packages will require the Department to combine resources from the Department and School levels, other units at the UW, and potentially extramural support from industry or other partners.

- Update the graduate curriculum, ensuring that core and elective courses for PhD students adequately reflect the research areas and techniques available to them. We continually evaluate and adjust elements of our graduate training including course content, the organization of departmental seminars and journal clubs, and the format of cumulative and general exams.
- Reduce volatility in graduate student funding, which currently is highly dependent on NIH-funded training grants and faculty research grants. One potential approach is to expand undergraduate course offerings (which generate revenue through the UW's activity-based budgeting). In collaboration with Pharmaceuticals, we have recently instituted an undergraduate course (MEDCH/PCEUT 327, The Science of Drugs) that has attracted significant interest. We are exploring the possibility of a minor and/or B.S. program in Pharmaceutical Sciences. A second avenue is to attract funding explicitly for graduate student training from industry partners (through the School's CAB) and non-NIH funding agencies.

To pursue the above outlined goals, **Pharmaceuticals** will need to:

- Strategically and systematically invest, over time, in new faculty hires (through retirements and new faculty lines) in the above broadly outlined areas. To do so, the Department will need resources for new faculty lines, start-up funds and laboratory space. Some of the faculty lines will be freed up through retirements, but these will need to be deployed to hire new faculty to maintain our reputation in the area of drug disposition. Expansion into the area of drug delivery and biologics will need deployment of additional funds by the UW and the legislature and through partnership with other units on campus (e.g., joint appointments).
- Plans to reduce our vulnerability in graduate student funding: Our University functions on activity-based budgeting. That is, for every fee-paying student (graduate, undergraduate or PharmD) who attends courses we teach, the Department receives a portion of this revenue. In fall quarter 2020, we admitted students to a new fee- and thesis-based MS in pharmaceuticals. This offering has multiple purposes. It will generate revenue for the School. Second, these students will form a pipeline of "vetted" students for our PhD program. Third, the course requirements for the MS program duplicate that of our PhD program. This duplication will reduce our need to fund Year 1 students who spend most of their time taking courses. In addition, the Department (in collaboration with Medicinal Chemistry) is now offering an undergraduate course in Science of Drugs (PCEUT/MEDCH 327, 3cr, enrollment of 47). We will expand such offerings in the future to allow students who are majoring in biological sciences to earn an undergraduate minor in pharmaceutical sciences. In the future, we will consider whether a BS in Pharmaceutical Sciences or course-based MS in Pharmaceuticals is cost-effective. A third source of revenue for our graduate students is to diversify

our funding to sources other than NIH. We are making progress in this direction through funding from FDA (e.g., ORISE fellowship), foundations (e.g., BMGF) and building our endowments through our extensive alumni network. In addition, the department receives annual revenue from the Experiential College (PHARBE program instruction) that can be allocated to support graduate education, including stipends and tuition.

- The above plans will be enriched (or added to) through the strategic planning the faculty and graduate students are currently undertaking.

This year, the **CHOICE Institute and its Health Economics & Outcomes Research** graduate program is:

- Launching a strategic initiative in Healthcare Data Science, recognized as a degree ‘option’, which will include core coursework from the Data Science discipline, an elective focused on the application of Data Science to HEOR, and a research project assessing the strengths and weaknesses of machine learning approaches for analyzing healthcare claims data.
- We have embarked on recruitment for a new position, i.e., endowed Assistant Professor of Health Decision Sciences.
- This recruitment is in addition to the other one that we have launched, i.e., Assistant Professor of Health Economics (tenure eligible).
- The Data Science initiative is being pursued in collaboration with our CAB. Additionally, we hope to engage our PharmD professional students through the creation of additional electives which could help build pathways for our skilled professional students to gain exposure to research and to our field.
- We continue our collaboration with ICER and the AHRQ EPC, and pursue novel similar opportunities. We will also collaborate with managed care entities to improve utilization of information that estimates the value of new technologies and will continue to develop novel methods in these disciplines.

#### D. Unit’s current benefit and impact regionally, statewide, nationally, and internationally.

The Department of **Medicinal Chemistry** enjoys an international reputation in the area of drug metabolism and toxicology and a growing national reputation in bioanalytical mass spectrometry. Individual faculty are leaders in their respective fields of research at the national and international levels, as described in Section III. Discoveries made by Medicinal Chemistry graduate students and faculty are disseminated in high-impact journals and at prestigious conferences. Strategic investments in new faculty hires and up-to-date instrumentation will ensure that Medicinal Chemistry continues to generate globally impactful discoveries. The mass spectrometry center has obvious impact at the local, regional and national levels. It is a highly valued resource, particularly for UW labs and for small Seattle-area biotech companies. Having access to state-of-the-art mass spec instrumentation and training directly benefits the local scientific ecosystem: we can provide access to insights that would normally be prohibitively expensive for startups or individual labs, both in terms of expertise and instrumentation. As long as we are able to keep the instrumentation current and the center well-staffed, our mass spectrometry center will continue to positively impact academic and industrial science in the Seattle area. Alumni go on to leadership positions in academia and

industry, nationally and internationally. Improving our graduate curriculum and training efforts in response to the changing scientific landscape will ensure that future generations of alumni are similarly well equipped for success. Students, postdoctoral fellows and faculty play roles in science outreach and education in the Seattle area, with an impact out of proportion to our small size. Students play leadership roles in organizations such as the UW SACNAS chapter and Science on Tap, and faculty regularly speak at universities and community colleges in Washington and across the nation. These efforts are important in recruiting students into STEM programs in general, and into our PhD programs in particular. Medicinal Chemistry must continue to foster and encourage such civic engagement.

The Department of **Pharmaceutics** enjoys an international reputation in the area of drug disposition and translational pharmacology. Our graduate training program is considered a premier training program and our graduate students typically have highly-remunerated 2-3 offers in their hands before their dissertation defense. Employment of our graduates in the Puget Sound region and nationally provides significant benefit to the for-profit and non-profit organizations that they join. In addition, the department Pharmacokinetics Lab provides analytical and data interpretation services to regional and national investigators through its fee-for-service operation. Drug Interactions Solutions, which is also operated through the Pharmaceutics department, provides an invaluable service to the national and international pharmaceutical and biotechnology industries, supporting the development of novel drugs.

Faculty in the **CHOICE Institute** enjoy an international and national reputation in health economics, outcomes and translational research. Our graduate program is considered a premier training program, and we attract well-qualified students from throughout the world. Upon graduation, our students often receive multiple job offers from the pharmaceutical industry and governmental organizations. We also have regional and statewide recognition in the area of managed care, where we serve as a resource for these health technology assessment bodies. At a national level, we are one of the leading academic institutions supporting the work of the Institute for Clinical and Economic Review. Internationally we are developing methods that are applicable across a variety of healthcare settings. Reaching our envisioned future will strengthen our ability to provide data-driven healthcare policy insights.

## **PART B – UNIT-DEFINED QUESTIONS**

### **Composition and National Reputation**

- 1. Please comment on the standing or reputation of the School's graduate programs as compared to peer institutions in the US and globally. How can our graduate programs best be positioned and differentiated from our peer institutions? What are our major strengths and weaknesses and how should any weaknesses best be addressed?*

Historically, **Medicinal Chemistry's** reputation for excellence in drug metabolism research set us apart from the majority of peer departments, which typically focused on drug design and synthesis. However, the funding landscape and faculty research interests have both shifted, meaning that much less of the department's research portfolio involves classical drug

metabolism work. Nevertheless, our “brand” remains intact: potential employers, particularly in industry, expect that graduates will be familiar with drug metabolism research and be able to hit the ground running. Should the Department maintain exposure and training in this area of historical strength, even for students whose interests diverge from drug metabolism – and if so, how? The Department’s ongoing investments in bioanalytical, structural and biophysical capabilities distinguishes us from most of our peers, and positions us to interrogate fundamental aspects of biologics and large molecule drugs. How best to leverage this investment and establish a programmatic reputation for excellence in this area? In many ways, the small unit size of the Department relative to our peers is both a major strength and a weakness. On the one hand, it fosters an extremely collegial and highly collaborative environment, and enables us to respond agilely to shifts in the scientific landscape. On the other hand, the small numbers involved mean that volatility – whether in funding, faculty hiring or graduate student recruitment – must be continuously managed and accounted for.

**Pharmaceutics** has an international reputation in research and training in the area of drug disposition. However, this field is maturing and many of its research principles have been “codified”. In addition, much of this work (except perhaps on transporters) is being outsourced to contract research organization both within and outside the USA. This change has reduced the number of our graduate students being hired in preclinical drug metabolism and pharmacokinetics departments of these companies but employment in their clinical pharmacology departments remains vibrant. For this reason, maintaining our research and training in the areas of translational and systems pharmacology is essential. However, how should we better position ourselves for the changing landscape in the areas of preclinical DMPK and pharmaceutical sciences in general? Should we broaden our research and training footprint in the areas of drug delivery and biologics? These issues, which will affect our faculty composition and national reputation, are being considered as part of the department's ongoing strategic planning effort.

**The CHOICE Institute and its graduate program in Health Economics and Outcomes Research**, integrates content from multiple disciplines across the health sciences including epidemiology, biostatistics, health services, policy, economics, and decision sciences. Few institutions offer a similar PhD program. Among those that do, we believe that we are in the top tier of programs offered that are based within a school of pharmacy. Our major strengths include a strong and recognized faculty, federal research support, and excellent graduate students who are widely sought after for employment after graduation. Moreover, we are housed in a major academic center that includes schools of public health, medicine, nursing, dentistry, and social work. We also have close ties to research colleagues at renowned institutions outside of UW but within the Puget Sound area - the Fred Hutchinson Cancer Research Institute, Seattle Children’s Hospital, Kaiser Permanente Washington Health Research Institute, Kaiser Permanente Center for Health Research (Portland), and Puget Sound VA. Each of these enriches our research and training environments. Looking forward, there is increasing demand from the pharmaceutical industry to incorporate data science more fully into our curriculum, and to train additional PharmD students in HEOR by offering additional industry-supported fellowships.

## Current and Future Research Agenda

- 2. The School has expanded its scope of research emphasis in recent years. Are there other areas of research that the School should pursue with respect for funding and training in order to remain competitive with respect to eventual employment opportunities for our graduate students in academia, pharmaceutical industry, and elsewhere? How can we better prepare our students to become leaders in the field?*
- 3. What are the emerging scientific opportunities and challenges that will likely shape the future directions of our School's basic and translational pharmaceutical sciences and its health economics/outcomes research?*

As described above, there is an expectation in industry that our **Medicinal Chemistry** graduates are drug metabolism experts, and this is reinforced every year in face-to-face meetings with the CAB. Recent graduates and alumni continue to be recruited and to do well in industry PKDM departments, suggesting that our training in this area remains effective and should be continued even as we evolve our curriculum and other research interests. The Department is repositioning to tackle protein-based therapeutics, and – with our most recent faculty hire – peptide drugs. However, newer and more complex modalities continue to enter the pharmaceutical pipeline. Can we keep up with shifts in technology, without diluting our research and training too far? A related question is to identify the core skills that will best position our graduates to navigate these shifts in technology – do they need a baseline level of competence in bioanalytical methods, systems approaches or data science? In other words, what is the optimal skill profile of a medicinal chemistry graduate over the next 10–20 years?

Since its founding in the late 1970's, the Department of **Pharmaceutics** has not expanded its research emphasis outside of drug disposition science. Though we have added faculty with research in the area of drug transporters and drug delivery, this expansion has hewed closely to our core strength, namely drug disposition. As indicated above, how should we better position ourselves for the changing landscape in the areas of preclinical DMPK and pharmaceutical sciences in general? Should we broaden our research and training footprint in other areas of research? Besides the area of drug delivery and biologics, are there other areas that the committee would recommend that Pharmaceutics consider?

Within the **CHOICE Institute and its HEOR graduate program**, data science is becoming more and more integral to what we do. Our planned degree option in Data Science will ensure we are at the leading edge of this aspect of our research and training. Our biostatistician, Dr. Bansal, is positioned to lead us in this effort from both the research and training perspectives. Other research agendas are referenced above in the context of the ISPOR top 10 HEOR trends. Within the Department of Pharmacy CHOICE faculty actively conducting research that intersects many of these emerging scientific areas, we are well positioned to continue at the leading edge of each of these trends - from personalized medicine to value frameworks, from real world evidence to drug pricing, and from curative therapies to the aging population. Further, there is

a growing number of faculty in the Department of Pharmacy with internationally recognized expertise in translational research and future efforts will be focused on securing a NIH-funded training grant to support their desire to be more actively engaged in disease-specific translational research graduate and postdoctoral training.

#### Culture and Environment

4. *How can our graduate programs continue to attract and retain high quality graduate students from a diverse array of backgrounds?*

**Medicinal Chemistry** has seen positive signs in the diversity and quality of our applicant pool. Over the past three cycles, 14–31% of our US-based applicants were from underrepresented or disadvantaged backgrounds, as were 29–40% of our interviewees and 29–50% of candidates offered admission. Since 2019, 3/13 (23%) of incoming students have been from URM or disadvantaged populations. Support from GSEE, the Seattle Chapter of the ARCS Foundation, and the Provost’s PhD Fellowship are all critical in enabling us to make competitive offers to our top candidates, who are in high demand. The cost of living in Seattle relative to the stipend level is a virtually universal concern among our applicants. Particularly during the COVID-19 pandemic, new students have also experienced difficulty establishing social connections and peer support networks upon moving to Seattle. A mentoring network of senior graduate students and postdocs has been successful in alleviating these barriers to the extent possible, and will continue to strengthen our community moving forward.

The Department of **Pharmaceutics** has also recently observed a change in our applicant pool with many more applicants of color. For example, for entry into our program in 2021, we had 8 underrepresented applications in a pool of 18 US-based applicants. In addition, of those applicants rated sufficiently high for interviews, 45% were from underrepresented students and of the students admitted, 50% are from underrepresented backgrounds. However, the cost of living in Seattle continues to be an obstacle to attracting many of these students. Student stipends have not kept up with the increase in cost of living in Seattle.

Recruiting a diverse student body is a current priority for the **CHOICE Institute’s** graduate program admissions. Although our niche field tends to rely on internal networks for recruitment, we are working on building targeted pathways for recruitment among our peer institutions in Pharmacy, Health Services, and Economics. Additionally, we are utilizing the numerous diversity-based recruitment networks to promote our program and get our name out there, such as SACNAS, GSEE, Graduate School Recruitment fairs, and the National Name Exchange. Our recruitment efforts in 2020 were successful and we saw a 19% increase in number of applications from the previous year. We have several diversity-based fellowships available to our program which can assist in recruiting strong candidates. We are guided by the School’s diversity plan and council, as well as our own internal diversity statement. Finally, we value the student voice in our program and are feedback driven through channels such as our ISPOR student chapter and graduate student council. We take full advantage of available



funding for our graduate students, including awards that rotate among the three departments in the UW School of Pharmacy - ARCS and the Magnuson Scholar award. We also appreciate the newly available funding from the UW Provost's Initiative to recruit top scholars.

### School of Pharmacy in the Context of the Broader University

5. *We rely on heavily on NIH funding and training grants to support graduate students and these funds are not keeping up with UW costs for stipends and tuition. Please comment on the extent to which sufficient resources are available to support the graduate programs.*

[Appendix G](#) depicts the SOP Current Graduate Student Funding Models. The Departments of **Pharmaceutics and Medicinal Chemistry** have no TA lines and fund only their first-year students through salary and indirect cost recapture. Consequently, our funding structure puts us at a competitive disadvantage with respect to other schools and limits the size of our graduate program. Given the heavy reliance on NIH funding (which is volatile), how should we better diversify our graduate student funding? The Pharmaceutical Industry is an obvious source, but due to contraction in preclinical DMPK departments, this source has diminished to the point where it is non-existent. In addition, NIH training grants have not kept up with UW stipend and tuition. Thus, these training grants need to be supplemented from departmental funds, further straining departmental resources.

With careful stewardship of our endowments, federal research dollars, training grants, university-based top-off funds, and through the generosity of our industry partners, the **CHOICE Institute** has been able to ensure funding for graduate students for four years. Even so, we continue to identify additional resources and plan for additional endowments so that we can continue to attract the best students. We have noted that the stipends for NIH/AHRQ training grants lag those of other sources, causing us to use scarce departmental funds to offer competitive packages.

6. *How integrated are our graduate student research activities with other research units on campus and beyond? Do these interactions serve to enrich graduate education? How can we best leverage and align our major strengths with others at the UW and beyond to enrich graduate education?*

The Department of **Medicinal Chemistry** continues to benefit from long-running collaborations with UW colleagues in the basic, translational and clinical sciences. As noted above, faculty participate in interdisciplinary umbrella programs including Biological Physics, Structure & Design (Lee [Co-PD], Atkins, Bhardwaj, Guttman, Nath, Xu); Molecular & Cellular Biology (Atkins, Lee); Molecular Engineering & Sciences (Atkins, Bhardwaj, Guttman, Nath); and the Center for Exposures, Diseases, Genomics and Environment (Rettie, Totah, Xu). Faculty also serve as mentors in several NIH-funded T32 training programs (Pharmacological Sciences [PD: Atkins], Viral Pathogenesis, Molecular Biophysics, Environmental Pathology/Toxicology) that foster interdisciplinary collaboration. These interactions provide

our graduate students with access to expertise, facilities and scientific perspectives beyond the scope of what is traditionally considered medicinal chemistry. Collaborative relationships with colleagues at the UW, allied units such as FHCRC and the Institute for Protein Design, and beyond will continue to be a core feature of our department's culture for the foreseeable future.

The Department of **Pharmaceutics** continues to emphasize research that is translational. Many faculty members have affiliation and collaborative research across many disciplines both within and without UW. For example, both Drs. Ho and Unadkat have extensively collaborated with School of Medicine in the area of HIV therapy. Drs. Thummel and Unadkat are heading P01 grants that have significant involvement from faculty in the UW School of Medicine and researchers outside of UW. Drs. Kelly, Isoherranen and Lin have collaborative NIH-funded projects with faculty in the School of Medicine. Many of these multidisciplinary and collaborative projects involve graduate students and thus enriching their training. However, such multidisciplinary training could be broadened. For example, broadening our research footprint (e.g., drug delivery and biologics) would enhance opportunities to collaborate with other departments on campus such as Bioengineering and Biochemistry, Physiology & Biophysics.

Faculty in the **CHOICE Institute** collaborate widely across the UW Health Sciences campus and throughout the Puget Sound Area. We have listed these entities above in question #1 (Composition and National Reputation). These collaborations are highly beneficial to students, whose student years are enriched by the research opportunities and funding support these collaborations provide.

## **PART C – APPENDICES**

[Appendix A: School of Pharmacy Organizational Chart](#)

[Appendix B: CV's of SOP-Based Faculty with Appointments as Graduate School Faculty](#)

[Appendix C: Enrollment and Graduation Trends by Degree Program](#)

[Appendix D: Budget Summary](#)

[Appendix E: Diversity, Equity and Inclusion Plan](#)

[Appendix F: Curricula for Graduate Programs](#)

[Appendix G: Current Graduate Student Funding Models](#)

[Appendix H: Employment Outcomes](#)

[Appendix I: Graduate Student Handbooks](#)

[Appendix J: SOP Strategic Plan Accomplishments](#)