Pharmaceutical Chemistry Specialist Undergraduate Program

Self-Study

January 2018
# Table of Contents

1. INTRODUCTION AND CONTEXT .................................................. 3

2. FACULTY ........................................................................... 5

3 ACADEMIC PROGRAMS ........................................................... 14
   3.1 PROGRAM DESCRIPTION ............................................... 14
   3.2 PROGRAM OBJECTIVES ................................................. 14
   3.3 ADMISSION REQUIREMENTS ......................................... 17
   3.4 CURRICULUM AND PROGRAM DELIVERY ......................... 18
   3.5 ASSESSMENT OF LEARNING ............................................ 23
   3.6 STUDENT AWARDS & PROFESSIONAL DEVELOPMENT ....... 24
   3.7 STUDENT FUNDING ..................................................... 24
   3.8 QUALITY INDICATORS .................................................. 24
   3.9 QUALITY ENHANCEMENT ............................................. 28

4. RESEARCH ........................................................................ 28

5. ORGANIZATION AND FINANCIAL STRUCTURE ...................... 29

6. RESOURCES AND INFRASTRUCTURE .................................... 30

7. ACADEMIC SERVICES .......................................................... 35

8. INTERNAL AND EXTERNAL RELATIONSHIPS ......................... 35

9. PREVIOUS REVIEW RECOMMENDATIONS ............................... 36

10. FUTURE DIRECTIONS ............................................................ 36

11. LIST OF APPENDICES .......................................................... 37
1. Introduction and Context

The Pharmaceutical Chemistry (PHC) Specialist is an undergraduate program of study offered jointly by the Faculty of Arts and Science (A&S) and the Leslie Dan Faculty of Pharmacy (LDFP) that leads to a B.Sc. degree. The program does not reside in a department; rather it exists between the two collaborating faculties. There is no directly affiliated graduate program although both faculties offer graduate programs and many of the graduates of the Pharmaceutical Chemistry Specialist become Masters and PhD students in the Graduate Department of Pharmaceutical Sciences (Leslie Dan Faculty of Pharmacy’s sole graduate department).

The students in the Pharmaceutical Chemistry Specialist program receive education about the science, technology, and research methods underlying drug development and drug therapy. In addition to the coursework, all students must complete a one-year (two-semester) research course for which they must write a report and present their findings. Eligible students can elect to participate in a paid Professional Experience Year at pharmaceutical companies or academic research labs, lasting either 12 or 16 months at the end of the third year of study. The graduates of our program go on to graduate programs either in the Graduate Department of Pharmaceutical Sciences or elsewhere, professional programs (especially pharmacy), and to entry positions in the pharmaceutical industry. More detailed information about the program and course offerings is available at http://www.pharmacy.utoronto.ca/pharmchem. (Note that this information is also provided in Appendix 2.)

This is a relatively new program at the University of Toronto and as such this is the first review that it has undergone. Students first enrolled in the Pharmaceutical Chemistry Specialist in September, 2004 and the first cohort of students graduated in June 2007. We initiated the Professional Experience Year (PEY), in collaboration with the PEY program in the Faculty of Applied Science and Engineering, in 2006. We offer the PEY program together with the Department of Pharmacology and Toxicology.

The idea for this program arose from the fact that very few students in the Pharmacy professional program go to graduate school or work in the pharmaceutical industry. There was an unmet need for employees in the pharmaceutical industry. In addition, by mounting a non-professional undergraduate program, the faculty members in the LDFP would have access to a new source of graduate students. During the inception of the PHC program, we consulted widely with the Canadian pharmaceutical industry and investigated similar programs in other universities. Most of the non-professional pharmaceutical sciences programs at that time were in the UK and Europe, and three very small similar programs of study existed in the US.

The proposal for the Pharmaceutical Chemistry program was approved by both Faculties (A&S and LDFP) and the University and began accepting students in May of 2004. The first cohort began the one-year research course in September 2006 and several of the graduating students that year went on to graduate school in the LDFP and at other universities.
The PHC program is a four-year undergraduate program leading to a BSc degree. Students apply to the program after completion of the first year of university study. Those students accepted into the Pharmaceutical Chemistry Specialist program must then complete another three years of study to graduate. It is fairly small with approximately 20 – 30 students in each of the three years. Because of its size, we have had very good interaction between the faculty members and the students. In focus groups, the students identified the interaction with faculty members as one of the major strengths of our program. The students receive a broad-based education in the physical, biological, and pharmaceutical sciences important to this discipline. This research experience further enhances the interaction with the faculty. The student association, the Pharmaceutical Chemistry Student Union (PCSU), is very active and engaged with faculty for social and career-related activities.

As mentioned above, this program does not sit in a department, which is unusual at the U of T. Rather, the Program resides in the Faculty of Arts and Science while the Director of the Program and the professors have appointments in the Faculty of Pharmacy. The non-departmental structure creates challenges in initiating new projects or lab-based courses, as well as challenges related to the general administration of the program, including recruitment of students and alumni follow-up. Currently, the money transferred to the Leslie Dan Faculty of Pharmacy to operate the PHC program was fixed approximately 10 years ago when the University changed to a new model for funding between programs. Revisiting the funding would make it possible for the Pharmaceutical Chemistry Specialist program to develop new courses and streams.

The Pharmaceutical Chemistry Specialist program does not have an academic plan but benefits from, and is guided by, the academic plans of the two sponsoring faculties, the Leslie Dan Faculty of Pharmacy and the Faculty of Arts and Science. The faculty members in Pharmacy participated in the academic planning for the LDFP; the most recent academic plan was completed and implemented in the fall of 2016.

As part of this self-study, several faculty members, and current and former students have taken part in focus groups and have provided input into this document. We held two sessions to which we invited all of the students enrolled in the program. We had explained to them in the invitation that the program was undergoing a review and that we would be asking them for feedback and suggestions about their experiences. We asked the students who chose not to or could not attend to give us feedback via email. In total, about 25 students participated. Note that these feedback sessions are annual occurrences even when we are not undergoing a periodic review. The student organization (the Pharmaceutical Chemistry Student Union) also provided a document outlining the students’ impression of the program.

We involved professors in the feedback for the self-study. The overall organization was similar to that of the sessions with the students. We held two separate evenings and met with professors who teach in the program in order to get feedback from them about how they perceive the program and ways that they would like to see it change.
2. Faculty

The Specialist program in Pharmaceutical Chemistry does not sit in a department; rather it is a program taught by faculty members from the Leslie Dan Faculty of Pharmacy and from the Faculty of Arts and Science.

The faculty complement within the LDFP is made up of scholars from many academic disciplines relevant to the profession of Pharmacy. A relatively small fraction of the total faculty complement contributes to the teaching of the Pharmaceutical Chemistry program on a regular basis. Those who participate in the teaching have expertise in molecular pharmacology, pharmacokinetics, medicinal chemistry, drug delivery, and biopharmaceutics, for example. The students occasionally participate in research projects (PHC489Y) with professors in other research areas in the Leslie Dan Faculty of Pharmacy.

The following tables list the faculty members involved in the Pharmaceutical Chemistry specialist program:

**Tenure-stream faculty members**

<table>
<thead>
<tr>
<th>Name</th>
<th>Rank</th>
<th>Name</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christine Allen</td>
<td>Full</td>
<td>Ping Lee</td>
<td>Full</td>
</tr>
<tr>
<td>Stephane Angers</td>
<td>Full</td>
<td>Rob Macgregor</td>
<td>Full</td>
</tr>
<tr>
<td>Reina Bendayan</td>
<td>Full</td>
<td>Sandy Pang</td>
<td>Full</td>
</tr>
<tr>
<td>Rob Bonin</td>
<td>Assistant</td>
<td>Keith Pardee</td>
<td>Assistant</td>
</tr>
<tr>
<td>Tigran Chalikian</td>
<td>Full</td>
<td>Ray Reilly</td>
<td>Full</td>
</tr>
<tr>
<td>Carolyn Cummins</td>
<td>Associate</td>
<td>Alison Thompson</td>
<td>Associate</td>
</tr>
<tr>
<td>David Hampson</td>
<td>Full</td>
<td>Jack Uetrecht</td>
<td>Full</td>
</tr>
<tr>
<td>Jeffery Henderson</td>
<td>Associate</td>
<td>Jim Wells</td>
<td>Full</td>
</tr>
<tr>
<td>Jillian Koehler</td>
<td>Full</td>
<td>Peter Wells</td>
<td>Full</td>
</tr>
<tr>
<td>Lakshmi Kotra</td>
<td>Full</td>
<td>Shirley Wu</td>
<td>Full</td>
</tr>
</tbody>
</table>

**Teaching-stream faculty member**

<table>
<thead>
<tr>
<th>Name</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>David Dubins</td>
<td>Associate, teaching stream</td>
</tr>
</tbody>
</table>

**Other faculty members**

<table>
<thead>
<tr>
<th>Name</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marissa Battistella</td>
<td>Associate (Clinical)</td>
</tr>
<tr>
<td>Ian Crandall</td>
<td>Associate (part time)</td>
</tr>
<tr>
<td>Isadore Kanfer</td>
<td>Status</td>
</tr>
<tr>
<td>Rebecca Laposa</td>
<td>Contractually Limited Term Appointment (CLTA)</td>
</tr>
<tr>
<td>Peter Pennefather</td>
<td>Emeritus</td>
</tr>
<tr>
<td>Donald Weaver</td>
<td>Full (Status)</td>
</tr>
<tr>
<td>Gang Zheng</td>
<td>Full (Status)</td>
</tr>
</tbody>
</table>

1 Faculty CVs are provided in Appendix 7.
The faculty members who participate in the delivery of the PHC program have expertise in
pharmaceutics and drug delivery, pharmacokinetics, molecular imaging, biophysical chemistry,
molecular and systems pharmacology, neurobiology, global health, and research ethics. This
expertise is shown by peer-reviewed publications, membership of grant-application study
sections, serving as editors of peer-reviewed journals, etc. About 15 years ago, the Leslie Dan
Faculty of Pharmacy underwent a major expansion in the number of Pharmacy professional
students and consequently the number of tenure-stream professors. The faculty complement
has been relatively stable for the past 10 years. In the coming 10 years, it is likely that there will
be several retirements (although the number is uncertain because there is no mandatory
retirement age). The new hires will be chosen to maintain the Faculty’s expertise in the various
areas and to provide the ability to cover the teaching in all of the Faculty of Pharmacy’s
education programs, including the Pharmaceutical Chemistry program.

It is important to note that the Pharmaceutical Chemistry Specialist program is not authorized
to hire new faculty members. Future hires are motivated by faculty members leaving, either to
join another university, or by retirement. The type of individual sought in those cases depends
on the teaching and research needs of the LDFP faculty at the time.

As shown in the list above there are many professors in the LDFP who participate in teaching in
the PHC program; however, the great majority of them also have teaching responsibilities in the
Professional Pharmacy program and in the Graduate Department of Pharmaceutical Sciences.
Only two of the professors’ teaching responsibilities are solely with the PHC program. One of
the ways we accommodate the additional teaching required for the PHC courses is to combine
the courses in different programs. Thus, for example, Pharmaceutics 1 (PHC240) is taught
together with the pharmaceutics course in the Professional Pharmacy Program (PHM141), and
Biomolecular Interactions and Thermodynamics (PHC421) is taught together with the graduate
course of the same name (PHM1130).

This system works well insofar as it is efficient and the mix of students from different programs
often encourages in-class discussion. Perhaps the biggest deficiency of the faculty complement
for our program arises from the different focus of the PHC program relative to that of the
Professional Pharmacy program. The focus of the PHC program is the understanding of the
concepts important for the conception, development, and manufacture of therapeutics. On the
other hand, the focus of the Professional Pharmacy program is the care and interaction
between the Pharmacist and the patient. However, the lack of more professors whose teaching
is exclusively with the PHC program limits the number and breadth of the courses that we can
offer.

Research & Scholarly Activity

Faculty Quality Indicators

On the following pages (and in Appendix 1) we present the Faculty Quality Indicators for the
Leslie Dan Faculty of Pharmacy provided by the Provost’s Office. These are rankings in terms of
publications and citations of the professors at the University of Toronto in three different fields:
Medicinal Chemistry; Pharmacology and Pharmacy; and Chemistry. The ranking in the Pharmacology and Pharmacy field is the most appropriate in this case. However, the ranking for the Pharmacology and Pharmacy field includes all of the professors in the LDFP, those in the Department of Pharmacology and Toxicology (Faculty of Medicine), and others working in the hospitals affiliated with the U of T.

More pertinent to the research of the faculty members involved in the PHC program is the research funding. The following table shows the funding received over the past several years.

i. Research Funding

Pro-rated to Grant Year (April to March)
Funding Amount Awarded – Pro-rated to Grant Year (April - March): Faculty who Teach in the Pharmaceutical Chemistry Specialist Program

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Three Councils</td>
<td>$1,972,781</td>
<td>$2,011,404</td>
<td>$2,467,592</td>
<td>$2,552,311</td>
<td>$2,922,889</td>
<td>$3,344,157</td>
<td>$3,329,965</td>
<td>$3,713,059</td>
</tr>
<tr>
<td>Institutional Initiatives</td>
<td>$678,781</td>
<td>$1,094,403</td>
<td>$780,651</td>
<td>$604,296</td>
<td>$1,192,216</td>
<td>$1,627,647</td>
<td>$2,547,466</td>
<td>$1,967,951</td>
</tr>
<tr>
<td>Government, Other Corporate</td>
<td>$267,425</td>
<td>$472,475</td>
<td>$157,580</td>
<td>$274,025</td>
<td>$188,058</td>
<td>$155,099</td>
<td>$203,687</td>
<td>$118,337</td>
</tr>
<tr>
<td>Not-for-profit</td>
<td>$1,070,559</td>
<td>$1,566,766</td>
<td>$1,956,399</td>
<td>$2,253,066</td>
<td>$1,648,650</td>
<td>$2,001,435</td>
<td>$2,141,839</td>
<td>$2,638,831</td>
</tr>
<tr>
<td>Grand Total</td>
<td>$4,189,062</td>
<td>$5,505,328</td>
<td>$5,668,164</td>
<td>$5,931,062</td>
<td>$6,330,837</td>
<td>$7,705,429</td>
<td>$8,906,089</td>
<td>$9,347,506</td>
</tr>
</tbody>
</table>

Active Award Count – Pro-rated to Grant Year (April to March): Faculty who Teach in the Pharmaceutical Chemistry Specialist Program

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Three Councils</td>
<td>30</td>
<td>32</td>
<td>36</td>
<td>35</td>
<td>39</td>
<td>40</td>
<td>38</td>
<td>42</td>
</tr>
<tr>
<td>Institutional Initiatives</td>
<td>10</td>
<td>11</td>
<td>14</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Government, Other Corporate</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Not-for-profit</td>
<td>27</td>
<td>32</td>
<td>36</td>
<td>37</td>
<td>39</td>
<td>43</td>
<td>46</td>
<td>42</td>
</tr>
<tr>
<td>Grand Total</td>
<td>82</td>
<td>93</td>
<td>102</td>
<td>94</td>
<td>103</td>
<td>104</td>
<td>107</td>
<td>107</td>
</tr>
</tbody>
</table>


Data are pro-rated.

From these data it is clear that the University, the LDFP, and the professors involved in teaching the PHC program are actively carrying out research that is funded, published, and recognized. This has an impact on the level of instruction we can provide to the students, especially in the
upper-level courses. Many of the professors are international leaders in their respective fields and can provide insight into the current state of the discipline and how it is likely to change in the near future. It is also beneficial for the research experience that the students receive during the fourth-year project. They can work in labs that are funded, equipped with modern instrumentation, and have interactions with graduate students and others in these labs.
ii. Publication and Citation Rankings

a. Field of Study: Chemistry, Medicinal (Thomson-Reuters Research Area category)

Chemistry, Medicinal includes resources emphasizing the isolation and study of substances with therapeutic potential. Topics of interest are quantitative structure-function relationships, structural characterization and organic syntheses of naturally occurring compounds, and chemical and analytical techniques used in rational drug design. See also the PHARMACOLOGY & PHARMACY category.

Scope notes: http://ip-science.thomsonreuters.com/mjl/scope/scope_sci/#DX
Journal list: http://science.thomsonreuters.com/cgi-bin/jrnlst/jresults.cgi?PC=K&SC=DX

Please note this includes all faculty at the University of Toronto who publish in the area of 'Pharmacology & Pharmacy'. It is not limited to faculty affiliated with the Pharmaceutical Chemistry Program.

<table>
<thead>
<tr>
<th>Publications Rankings (* indicates a tie)</th>
<th>Citations Rankings (* indicates a tie)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Institution Short Name</strong></td>
<td><strong>All Peers</strong></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Harvard</td>
<td>1</td>
</tr>
<tr>
<td>N Carolina - Chapel Hill</td>
<td>2</td>
</tr>
<tr>
<td>Minnesota</td>
<td>3</td>
</tr>
<tr>
<td>Vanderbilt</td>
<td>4</td>
</tr>
<tr>
<td>Kansas</td>
<td>5</td>
</tr>
<tr>
<td>Calif - San Diego</td>
<td>6</td>
</tr>
<tr>
<td>Michigan</td>
<td>7</td>
</tr>
<tr>
<td>Calif - San Francisco</td>
<td>8</td>
</tr>
<tr>
<td>Johns Hopkins</td>
<td>9</td>
</tr>
<tr>
<td>Ohio State</td>
<td>10</td>
</tr>
<tr>
<td>ALBERTA</td>
<td>*11</td>
</tr>
<tr>
<td>Florida</td>
<td>*11</td>
</tr>
<tr>
<td>Purdue</td>
<td>*11</td>
</tr>
<tr>
<td>TORONTO</td>
<td>14</td>
</tr>
<tr>
<td>Rutgers State</td>
<td>15</td>
</tr>
</tbody>
</table>
### b. Field of Study: Pharmacology & Pharmacy (Thomson-Reuters Research Area category)

Pharmacology & Pharmacy covers resources on the discovery and testing of bioactive substances, including animal research, clinical experience, delivery systems, and dispensing of drugs. This category also includes resources on the biochemistry, metabolism, and toxic or adverse effects of drugs.


Please note this includes all faculty at the University of Toronto who publish in the area of 'Pharmacology & Pharmacy'.

It is not limited to faculty affiliated with the Pharmaceutical Chemistry Program.

<table>
<thead>
<tr>
<th>Institution Short Name</th>
<th>All Peers</th>
<th>Public Peers</th>
<th>U15 Peers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvard</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TORONTO</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>N Carolina - Chapel Hill</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Johns Hopkins</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pittsburgh</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>U Penn</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calif - San Diego</td>
<td>*7</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Duke</td>
<td>*7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michigan</td>
<td>9</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Calif - San Francisco</td>
<td>10</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Institution Short Name</th>
<th>All Peers</th>
<th>Public Peers</th>
<th>U15 Peers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvard</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TORONTO</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>N Carolina - Chapel Hill</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Calif - San Francisco</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Calif - San Diego</td>
<td>5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Michigan</td>
<td>7</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Duke</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Johns Hopkins</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pittsburgh</td>
<td>10</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>Rank</td>
<td>No.</td>
<td>Rank</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------</td>
<td>-----</td>
<td>------</td>
</tr>
<tr>
<td>Minnesota</td>
<td>11</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Florida</td>
<td>12</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Calif - Los Angeles</td>
<td>13</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>U Washington</td>
<td>14</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Vanderbilt</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ohio State</td>
<td>16</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>MCGILL</td>
<td>17</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>BRITISH COLUMBIA</td>
<td>18</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Emory</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MONTREAL</td>
<td>20</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>U Penn</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vanderbilt</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calif - Los Angeles</td>
<td>13</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Emory</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stanford</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yale</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minnesota</td>
<td>17</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Florida</td>
<td>18</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Indiana</td>
<td>19</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Kansas</td>
<td>20</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>
c. Field of Study: Chemistry, Organic (Thomson-Reuters Research Area category)

Chemistry, Organic includes resources that focus on synthetic and natural organic compounds, their synthesis, structure, properties, and reactivity. Research on hydrocarbons, a major area of organic chemistry, is included in this category.

Scope notes: http://ip-science.thomsonreuters.com/mjl/scope/scope_sci/#EE
Journal list: http://science.thomsonreuters.com/cgi-bin/jrnlst/jlresults.cgi?PC=K&SC=EE

Please note this includes all faculty at the University of Toronto who publish in the area of ‘Pharmacology & Pharmacy’.
It is not limited to faculty affiliated with the Pharmaceutical Chemistry Program.

<table>
<thead>
<tr>
<th>Institution Short Name</th>
<th>Publications Rankings (* indicates a tie)</th>
<th>Citations Rankings (* indicates a tie)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TORONTO</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Harvard</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Wisc - Madison</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Purdue</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>ALBERTA</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Mass Inst Tech</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>U Penn</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>N Carolina - Chapel Hill</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Calif - San Diego</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Minnesota</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Florida</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Calif - Davis</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Rutgers State</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Calif - Los Angeles</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>BRITISH COLUMBIA</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Michigan</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>Yale</td>
<td>*17</td>
<td></td>
</tr>
</tbody>
</table>

Please note this includes all faculty at the University of Toronto who publish in the area of ‘Pharmacology & Pharmacy’.
It is not limited to faculty affiliated with the Pharmaceutical Chemistry Program.
Data Sources:
Report Created: Jan 18, 2016. Includes Web of Science content indexed through 2015-12-12.
This data is reproduced under a license from Thomson Reuters.
Additional information on institution classification: University of Toronto

Definitions:

1. Publication counts (articles, notes, and reviews as found in Thomson Reuters-covered journals; other types of items and journal marginalia such as editorials, letters, corrections, and abstracts were omitted) published between 2010 and 2014.

2. Citation counts represent citations-to-date for papers published between 2010 and 2014, as at Jan 2016.

3. Each Research Area is defined by a set of journals indexed by Thomson Reuter.

4. Data in this file are limited to 76 institutions, all leading research universities in North America [members of the U15 and/or the Association of American Universities (AAU), plus UC San Francisco].

Notes:

1. The rankings are a measure of the performance of UT as a whole in this field. This may include scholars working in this field outside of the Program. Thus, it is not appropriate to use this data as a measure of the performance of the program’s specific faculty members.
3. Academic Programs

3.1 Program Description

The Pharmaceutical Chemistry Specialist is an undergraduate program of study offered jointly by the Faculty of Arts and Science that leads to a B.Sc. degree. Students enter this program after one year of university studies and continue in the PHC program for an additional three years. Thus, it is a four-year degree program; this timeline is standard for bachelor’s programs in the Faculty of Arts and Science. The PHC program is fairly small with approximately 20 – 30 students in each of the three years.

The students in the Pharmaceutical Chemistry Specialist program (PHC) receive education about the science, technology, and research methods underlying drug development and drug therapy. The courses required to graduate span the physical, biological, and pharmaceutical sciences. The courses in the physical and biological sciences are offered by the Faculty of Arts and Science and the courses in the pharmaceutical sciences are offered by the Leslie Dan Faculty of Pharmacy. In addition to the coursework, all students participate in laboratory-based practicum and must complete a one-year (two semester) research course. Eligible students may apply to participate in a paid Professional Experience Year at pharmaceutical companies or academic research labs, lasting either 12 or 16 months, at the end of the third year of study. To apply, the student needs to have CGPA of 3.0 or higher; application does not guarantee that the student will find a job placement. Participation in the PEY program gives the students a real-world application of their studies. The students learn how the material they have learned in courses is relevant to work in the pharmaceutical industry or in an academic research lab.

3.2 Program Objectives

The Faculty of Arts and Science Degree Objectives specify the overall learning objectives and requirements adopted by the Faculty (Appendix 4). Specifically, for the Pharmaceutical Chemistry Specialist program these are:

a. Depth of knowledge that cultivates critical understanding and intellectual rigour in at least one field of study.

The depth of the education offered to students in the PHC program is reflected in the number of courses they must take that are relevant to the discipline. The underlying premise of this program is that the students must learn as much of the fundamental science that underpins the field of drug development and delivery as possible. To this end, the program requires the students to take chemistry, physics, biology, and mathematics courses that will allow them to understand and work with the underlying concepts of pharmaceutical chemistry. Throughout the curriculum, the students are required to take at minimum 2.5 FCEs (Full Course Equivalent) in chemistry, 2 FCEs in biology, and 4.5 FCEs pharmaceutical chemistry courses. These courses
provide didactic learning in lectures and tutorials and hands-on learning opportunities in laboratory settings and provide the students with a deep understanding of the subject area.

b. Competencies in learning and applying knowledge that are fundamental to responsible and effective participation in the workplace, in the community, in scholarly activity, and in personal life:

i. Critical and Creative Thinking
These competencies are fostered in several courses throughout the four years of the PHC curriculum; however, they are emphasized in the third- and fourth-year courses. In the third-year course, Pharmaceutical Chemistry Lab (PHC340) and other lab-based courses, the students must interpret data. Examinations and problem sets in didactic courses challenge the students to analyze and interpret data to determine the correct answer. The largest component for most students comes during the student’s year in the research course (PHC489Y). Here the students work in a professor’s research lab and are expected to generate, analyze, and interpret new data. This experience draws on and enhances the students’ thinking process in a way that is difficult to emulate in a normal course setting.

ii. Communication
The majority of the communication undertaken by the students in this program is in the form of written reports for the laboratory courses. Some of the elective courses also have written or oral presentations as part of the syllabus (and some have both). Again, the research course, PHC489Y, provides in many ways a capstone for the whole program. Here, in addition to the day-to-day communication required for the students to work actively in a functioning research lab, the students have other significant communication components. These other components involve providing a written description of the project and discussing it with the course coordinator. At the end of the course, the students must submit a final paper in the format of a journal article to present their results and provide a discussion in light of the relevant literature. And, finally, the students must make an oral presentation of their work to the faculty and other students.

iii. Information Literacy
In the Pharmaceutical Chemistry Specialist program the students gain information literacy through readings, presentations, searching the scientific literature, and project design. The first two years of the program provide the students with the background they will need to begin to access and interpret the information they will need. The lectures and labs provide the students with relevant knowledge and show them the origins of the scientific underpinnings of Pharmaceutical Chemistry. Starting in the third year, the acquisition of the necessary background information shifts increasingly onto the student. For example, in Pharmaceutical Chemistry Laboratory (PHC340), in the second half of this teaching lab course the students must design, and carry out two small dosage form design projects on their own. There is still guidance and assistance available; however, the student is expected to find the relevant information pertinent to the project on their own. In the fourth year of the program, the year-long research project and the paper and presentation that go along with the course also provide ample opportunities for the students to become adept at searching appropriate
sources for necessary information. Most of the fourth-year electives also have term papers and/or journal-club-like presentations; these activities require the students to consult the literature.

iv. Quantitative Reasoning
This competency is learned and reinforced in the majority of the courses in the curriculum of the Pharmaceutical Chemistry program. One of the requirements for acceptance into the program is successful completion of a year of physics. This is often the first course where the students are directly confronted with the ability of mathematics to describe the natural world. This is continued in year two when the student takes two semesters of physical chemistry. In year two they take the first course in pharmaceutics, where we show them how the chemicals and biological processes can be described using mathematics. In the problem sets and exams, the students must solve problems that demonstrate their numeracy skills. The third and fourth years continue this exposure to mathematical and quantitative reasoning in several courses, especially Molecular Pharmacology (PHC301), Pharmaceutics 2 (PHC330H), Pharmacokinetics (PCL201), Pharmaceutical Chemistry Laboratory (PHC340Y), and other required courses and electives. This competency pervades most of the courses in the program.

v. Social and Ethical Responsibility
The impact of pharmaceutical manufacture, marketing, and medication use is discussed at several points in the curriculum. In Pharmaceutics 1 (PHC230H) the effect of manufacturing on the environment is discussed, as is the obligation to create medications that the patients will actually take. In Pharmaceutical Chemistry Laboratory (PHC340), a professor whose research area is ethics gives two lectures about issues surrounding drug development. Throughout their undergraduate program, the students are repeatedly made aware of the University of Toronto’s Code of Ethical Behaviour. We make them aware of what things might constitute academic offences and, importantly, why they are academic offences.

c. Breadth of knowledge across a range of knowledge areas that reflect the richness of the arts, the complexity of global cultures, and the varied structures, processes, and concepts of the social and natural world.

The breadth of knowledge in the PHC program is achieved through the successful completion of the “breadth” courses required for a degree from the Faculty of Arts and Science and by additional required and elective courses in the curriculum. The required courses in the PHC curriculum are described below in Section 3.4.

d. Integration of skills and knowledge developed in a student’s course of study within an inquiry-based activity in the upper years.

This degree objective is achieved in several ways. The students are responsible for developing and carrying out small dosage form designs in the third year teaching lab (PHC340Y). They are also required to either present or submit a written term paper for most of the fourth year courses. However, the largest learning activity to integrate the students’ skills and knowledge takes place during the one-year research experience (PHC489Y). This allows the students to use
the knowledge and skills they have acquired in the first three years of the program: accessing and evaluating relevant literature, laboratory skills, data analysis, incorporating their findings into the broader scientific context, and so on. Each student’s experience will depend on the laboratory in which the student is working; however, in all cases the research course provides the most significant educational activity, aimed at bringing all of the learning together.

3.3 Admission Requirements

This is a limited enrolment program. To be considered for admission in the program the student must have already completed three full courses (3.0 FCEs, or six half courses): two half courses in Physics, two half courses in chemistry, and two half courses in biology (respectively, PHY131H1 and PHY132H1 or PHY151H1 and PHY152H1; CHM136H1 or CHM138H1 and CHM135H1 or CHM139H1 or CHM151Y1; BIO120H1 and BIO130H1). The student must receive a grade of at least 60% in each of these courses and have an average of 70% in them. Students who have met the eligibility requirements are offered admission starting from those students with the highest grades. Because students can apply for more than one program, we always make offers to more than the 40 students we can accommodate. Thus, from year to year, the average grade of the students admitted into the program can change depending on the number of applicants and their CGPA’s. Typically, the lowest grade of a student admitted into the program is in the mid-70s. Although it is not unique, our grade requirement is not found for all programs of study in the Faculty of Arts and Science.

Similar to other undergraduate programs in the Faculty of Arts and Science at the U of T, students apply to (“request”) the Pharmaceutical Chemistry Specialist program after completing the first year of study. Students who have completed the first year of study at a university other than the St. George Campus of the U of T may also apply. Their transcripts and the suitability of the courses for transfer for credit at the U of T are evaluated centrally.

The subject matter in the PHC program strongly emphasizes quantitative reasoning so it is important that the applicants demonstrate that they have good capability in this area. This is the origin of the requirement for a year of physics. The chemistry and biology requirements in the first year are related to the importance of these two disciplines in the science of drug development. The students need to understand the structure and function of cells and cellular systems and they need to have a thorough understanding of the chemical principles in biology and material science. The year one courses are the foundations of their learning for the subsequent three years.

After completion of their first year of study, students then apply to the program of study of their choice. Every year we receive between 200 and 300 applications and due to space and resource limitations, we accept a maximum of 40 students into the program. (Note, however, that many of the students apply to several programs at once.) A small number, ~5%, of the applications are from students who have completed the second (or very rarely, third) year of study.
3.4 Curriculum and Program Delivery

The intention of the curriculum is to provide students with a broad background in the general field of Pharmaceutical Chemistry. We strive to expose the students to the fundamental sciences that underlie the more applied aspects of areas such as pharmaceutics. For that reason, the students must complete courses in chemistry and physics. In particular, there is an emphasis on courses that expose the students to quantitative models to describe phenomena.

Within the pharmaceutical sciences, the students learn relevant sciences such as molecular pharmacology from qualitative and quantitative points of view. They learn about drug receptors, how they elicit action on the cell, and how to quantitatively describe the interaction between the drug and the receptor from first principles, including concepts such as cooperativity. The other courses, e.g. Pharmaceutics, also take an approach that mixes quantitative and qualitative approaches to teaching the material to the students.

Because of its size, we have very good interaction between the faculty members and the students. In focus groups, the students identified the interaction with faculty members as one of the major strengths of our program. The students receive a broad-based education, that is, the physical, biological, and pharmaceutical sciences important to this discipline.

Program Requirements

Students in the Pharmaceutical Chemistry Specialist must successfully complete 13.0 required full course equivalents (FCE) or their equivalent, and this includes the 3.0 FCEs (two half courses in Physics, two half courses in chemistry, and two half courses in biology) in the first year. The required courses in the program are as follows:

First Year:
- BIO120H1, Adaptation and Biodiversity
- BIO130H1, Molecular and Cell Biology
- CHM135H1, Chemistry: Physical Principles
- CHM136H1, Introductory Organic Chemistry I
- CHM151Y1, Chemistry: The Molecular Science
- PHY131H1, Introduction to Physics I or PHY151H1, Foundations of Physics I
- PHY132H1, Introduction to Physics II or PHY152H1, Foundations of Physics II

Second Year:
- BCH210H1, Biochemistry I: Proteins, Lipids and Metabolism
- BIO230H1, From Genes to Organisms
- CHM220H1, Physical Chemistry for Life Sciences or CHM222H1, Intro. to Physical Chemistry
- CHM223H1, Physical Chemistry: The Molecular Viewpoint
- CHM247H1, Introductory Organic Chemistry II or CHM249H1, Organic Chemistry
- PHC230H1, Pharmaceutics 1
Third Year:
CHM217H1, Introduction to Analytical Chemistry
PCL201H1, Introduction to Pharmacology and Pharmacokinetic Principles
PHC300H1, Molecular Pharmacology 1
PHC301H1, Molecular Pharmacology 2
PHC320H1, Medicinal Chemistry
PHC330H1, Pharmaceutics 2
PHC340Y1, Pharmaceutical Chemistry Laboratory

Fourth Year:
PHC489Y1, Pharmaceutical Chemistry Research

Two full course equivalents (2.0 FCEs) from (in alphabetical order):
CHM317H1, (Introduction to Instrumental Methods of Analysis); CHM342H1 (Modern Organic Synthesis); CHM347H1 (Organic Chemistry of Biological Compounds); CHM379H1 (Biomolecular Chemistry); CHM410H1 (Analytical Environmental Chemistry); CHM414H1 (Biosensors and Chemical Sensors); CHM417H1 (Laboratory Instrumentation); PCL362H1 (Introductory Toxicology); PHC331H1 (Establishing the Bioequivalence of Pharmaceutical Products); PHC401H1 (Drug Transport across Biological Membranes); PHC420H1 (Application of Medicinal Chemistry to Pharmacology); PHC421H1 (Biomolecular Interactions and Thermodynamics), PHC430H1 (Recent Developments in Dosage Form Design); PHC431H1 (Selected Topics in Drug Development); PHC432H1 (Nanomedicines in Oncology); PHC435H1 (Pharmaceutical Data Acquisition & Analysis); PHC460H1 (Fundamentals of Drug Discovery); PHC462H1 (Clinical Drug Development); PHC470H1 (Global Pharmaceutical Policy); PSL300H1 (Human Physiology I); PSL301H1 (Human Physiology II)

Note that not all of the 400-series PHC courses are offered every academic year.

Qualified students may also participate in an optional 12- or 16-month Professional Experience Year (PEY) program. This is a project-based, paid, employment placement that occurs between the third and fourth years of undergraduate study. It provides the student with an opportunity to apply the knowledge acquired in the first three years of university to private- or public-sector settings. Placements are available in pharmaceutical and biotechnology companies, university research labs, university-affiliated organizations, or government research agencies. Students do not receive academic credit for completion of the PEY program; however, there is an annotation on the student’s transcript.

First-year courses

The courses in the first year focus on the basic sciences and breadth requirements for the eventual degree. These courses provide the foundational knowledge that is essential to the courses in the subsequent years. The requirements for admission into the PHC program are similar to those for most other science programs of study. Students may apply to the PHC program after completing the first year of study at a recognized university. Successful applicants will have completed three full courses during their first year with an average of at least 70% across these
courses and a grade of 60 or higher in each of the courses. The required courses in the first year are chemistry, physics, and biology. For the chemistry and physics courses the students may select either two half-year courses in each (two in chemistry and two in physics) or the “specialist” courses for chemistry and physics, which are full-year courses. The chemistry courses provide introductions to organic and physical chemistry: topics include, nomenclature, structure, stereochemistry, synthesis, phases, equilibria, acids and bases. The year-long course targeted at Chemistry majors and specialists covers similar topics but is deeper and assumes a basic knowledge of organic chemistry. These courses also include a laboratory. The physics courses are organized in a manner similar to chemistry. The two half-courses cover topics such as: classical kinematics and dynamics, momentum, work, power, angular momentum, fluids, viscosity, waves, sound, light, electricity, magnetism, and special relativity. The full-year (two-semester) courses intended for students who wish to receive a specialist degree in physics cover similar material but in greater depth.

Second-year courses

In the second year, the students have been accepted into the PHC program. The courses are intended to deepen their knowledge of the fundamental sciences of pharmaceutical chemistry and the students take the first course in the PHC curriculum.

Students who are accepted into the Pharmaceutical Chemistry Specialist program begin taking courses directly related to their program in the second year. Because of the broad scope of the field, there are still, in the second year, many courses general to the discipline. These include a full year of physical chemistry and organic chemistry. Two more courses in biology: From Genes to Organisms (BIO230H), and From Genomes to Ecosystems (BIO220H), are required. In year two the students also take Pharmaceutics (PHC230H), as their first introduction to the science of dosage form concepts and design. It is recommended that the students take an additional course in math (Multivariable Calculus, MAT235Y, or Advanced Calculus, MAT237Y).

Third-year courses

In year three, courses are mostly related to pharmaceutics and drug therapy.

Molecular Pharmacology 1 and 2 (PHC300H1 and PHC301H1) offer an introduction to the biochemistry of drug therapy. These courses deal with the interactions between drugs and their target molecules and the effects of the interactions on the cell. The material that is presented is quantitative and qualitative. There is emphasis on the mathematical description of equilibrium and kinetics of ligand interactions with proteins and nucleic acids. Medicinal Chemistry (PHC320H1), introduces modern medicinal chemistry to the students. They learn about the role of structure, modelling, and simulation in the process of drug discovery. PHC330H1 is a second course in Pharmaceutics. Here we go into greater depth for concepts that are essential to understanding the science behind the development of dosage forms. Specifically, the course deals with: transport phenomena and methods to measure them; the properties of transdermal formulations; polymeric materials in dosage forms; liposomes; thermodynamics and drug stability. Pharmaceutical Chemistry Laboratory (PHC340Y1), is a
year-long practical course to expose the students to some of the methods used to manufacture and assess formulations. There is also a lecture component to this course in an effort to make the link between the theory and the application. Two lectures every year are dedicated to introducing research ethics to the students.

The other two courses of year three are: Analytical Chemistry (CHM217H1), and Introduction to Pharmacology and Pharmacokinetics Principles (PCL201H1). Analytical chemistry is a fundamental part of pharmaceutical science and it offers to the students an opportunity to learn concepts of measurement and get practical hands-on experience with instrumentation. The pharmacology course is concerned with the quantitative aspects of drug absorption, distribution, metabolism, and elimination.

Fourth-year courses

In the fourth year, the students must complete the research course and they have the opportunity to take courses that they find interesting or potentially useful.

In the final year of the PHC program there is one required course, Pharmaceutical Chemistry Research (PHC489Y). This full-year course gives the students the experience of working on a large question in a research environment. The students must find a supervisor based on their interest and the availability of the professor among the members of the Graduate Department of Pharmaceutical Sciences, and together with the supervisor they propose a research topic. The student then works in the professor’s group for an academic year (two semesters) and at the end of the course submits a written report formatted like a journal article, and makes an oral presentation of the results to the other students in PHC489Y1 and their professors. In the fourth year there are also a number of “selective” courses, that is, a list of courses from which the student must complete 2 full-course-equivalents. Electives round out the course load in the fourth year. The courses in this year are intended to allow the student to achieve a certain amount of specialization in some aspect of Pharmaceutical Chemistry. Thus, some students take additional chemistry courses, some take more courses on formulation, and some take business courses.

Professional Experience Year

An important component of our curriculum that is well received by students is the Professional Experience Year (PEY). The PEY provides the students with real-world experiences in which to apply what they have learned in their courses. The participants work in a pharmaceutical company or pharmaceutical research lab at a university, actively contributing to the work there. They learn first-hand how these organizations function, what is expected of employees, and how their work is important to its success.

Students who have a 3.0 CGPA at the end of the third year can apply to participate in this program, in which they spend from 12 to 16 months in a pharmaceutical company or a research lab. This experience is paid and the current minimum is $35,000 per year. The specialist programs in Pharmacology and Toxicology and Pharmaceutical Chemistry cooperate in finding
sites for potential students and then the administrative aspects of the Professional Experience Year are delivered by the PEY Office of the Faculty of Applied Science and Engineering at the U of T. Interested and eligible students apply to the PEY program. They can then apply and interview for the available positions. Successful applicants then leave the University for 12 to 16 months. During this time, they must register as a part-time student, and after successfully completing the program they receive a notation on their transcript stating that they participated in the PEY. There are typically between 3 to 5 PHC students who have positions in the PEY program each year. We have had PEY locations in Toronto, and throughout Canada. There have also been some positions in the US and in Europe. Most of the positions have been in the pharmaceutical industry; however, there have been a few in research labs in Toronto and the US. The students are quite attracted to the PEY and access is limited mostly by our ability to attract sites. From its inception, the Pharm/Tox/PHC PEY program has been run by professors; however, we are currently looking at having a staff member permanently assigned to the role of recruiting sites.

The entire curriculum of the PHC specialist program, including a brief description of all of the courses, is given in Appendix 2.

The courses that the students take provide a multidisciplinary overview of the science of drug discovery and development. There is particular emphasis on quantitative analysis and interpretation of information and data. Modern drug development is strongly dependent on the broad integration of biology, genetics, material science, organic and physical chemistry, and other disciplines. While this program does not touch on all of the fields that are relevant to the pharmaceutical industry, e.g., pharmaco-economics, it does give the students the education and tools they will need to contribute to the pharmaceutical industry today and in the future.

One of the most significant aspects of this program is its size. Because it is fairly small, and because of the research component in the fourth year, it will remain small, and the students have many opportunities to interact directly with the professors. This interaction allows us to guide the students’ learning more directly than would be possible in a larger program.

The Professional Experience Year requires a bigger commitment on the part of the student and the industrial site but it also allows the students to gain a more realistic impression of the nature of the work they may encounter in the workplace. The students who return from a PEY placement always have a much clearer idea of their career path when they return for the fourth year of studies. Although not all of the students participate in the PEY, the “mode of instruction” at the placement site is nearly ideal. The student learns about the industry or a research lab, they see how their learning in courses is applied, and they learn valuable lessons about working.

As stated above, the students can interact with the professors in the program on a regular basis during their time in the program; this provides a path to passive and un-programmed forms of learning and student engagement. The student organization, the Pharmaceutical Chemistry Student Union (PCSU), arranges for people from academia and the industry to discuss their career path and how the students should prepare themselves for their future. These events are
held in the evening, we provide food and refreshments, and they are well attended. In addition to the career nights, the PCSU also arranges a research seminar series given by the professors in the LDFP; generally, they invite faculty members who are not directly involved in the PHC program. These seminars provide a good way for the students to learn about the research in the Faculty and for the faculty members to have exposure to the students.

3.5  Assessment of Learning

Depth and breadth of knowledge are important aspects of the education in the PHC program. The students are required to take several courses in chemistry and pharmaceutical sciences. They also must complete courses in cognate sciences such as biology and biochemistry. The option of taking additional elective courses allows them to deepen their knowledge in a particular area of interest.

In the Pharmaceutical Chemistry courses the students take part in different types of evaluations. The nature of the evaluation depends on the nature of the knowledge being assessed. In the didactic courses the students must complete problem sets, quizzes, oral presentations, and written exams. In some of the elective courses, the students make presentations of journal articles relevant to the course and must write term papers. In the teaching labs, the students participate in practical exercises and then submit lab reports that provide data analysis and discussion. The teaching labs also include lecture components that are examined.

The courses in the last year try to achieve two objectives. The first is to provide an opportunity for the students to take courses in areas of pharmaceutical chemistry in which they are interested. And secondly, they bring together what they have learned in the courses in the first three years. The fourth-year courses expose the students to the state of the art of the respective discipline. For example, the course Recent Developments in Dosage Form Design (PHC430H) builds on the students’ knowledge from the previous courses to bring them to the current state of the design of novel dosage forms. Another example, Fundamentals of Drug Discovery (PHC460H) exposes the students to the whole scope of the development of drugs, from initial discovery to clinical testing. These courses make the students integrate the learning from each of the previous years’ courses.

All of the students in the program must complete the two-semester research course (PHM489Y1). In this course the student participates actively in the research of one of the professors in the Graduate Department of Pharmaceutical Sciences. At the beginning of the course, each student meets with the course coordinator to discuss and defend the research topic, the methodological approach that will be taken, and the approximate time-line for the work. There is a written evaluation submitted by the student’s supervisor and the student at the mid-point of the course. At the end of the course, the student must submit a written report in the format of a scholarly journal article that presents the results of the student’s work and discusses the findings in relation to the existing body of literature. The students also must present their data in an oral presentation to other students and faculty members.
3.6 Student Awards & Professional Development

At this time, there are no student awards specifically for the students in the Pharmaceutical Chemistry Specialist; however, they may receive awards through their colleges.

Professional development opportunities include the Professional Experience Year (PEY, discussed above) and extra-curricular activities that are sponsored by the University, such as the Career Centre, and career events sponsored by the Faculty of Arts and Science and the Pharmaceutical Chemistry Student Union (PCSU). (The Pharmaceutical Chemistry program office provides partial financial support to the PCSU events.)

The University has in place an office that tracks student involvement in extra-curricular activities, called the Co-curricular Record (CCR, https://ccr.utoronto.ca/home.htm). Students who actively participate in organizations such as the PCSU receive annotations on their CCR. This fosters a sense of attachment to the activities that the student participates in and provides a permanent record of their involvement and contribution.

3.7 Student Funding

There is no specific student funding available in this program. Some students have funding opportunities through their college or other university-wide initiatives.

3.8 Quality indicators

The total number of students enrolled in the Pharmaceutical Chemistry program has remained fairly constant over the past eight years. Prior to requesting the PHC program students must have been admitted to the University of Toronto. Each year there is a small number of students (between 2 and 5%) who have completed their first year of undergraduate study at a university other than U of T. As shown below and beginning on page 29 of Appendix 3, the quality of the students entering our program, as measured by their grade point average, has been consistently high over the past few years.

Number of Students and Mean Grade Average at Admission

This table shows the number of students enrolling for the first time in the PHC program and high school grade averages for those who graduated from Ontario high schools.

<table>
<thead>
<tr>
<th></th>
<th>Fall 2008</th>
<th>Fall 2009</th>
<th>Fall 2010</th>
<th>Fall 2011</th>
<th>Fall 2012</th>
<th>Fall 2013</th>
<th>Fall 2014</th>
<th>Fall 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students</td>
<td>19</td>
<td>24</td>
<td>23</td>
<td>36</td>
<td>32</td>
<td>24</td>
<td>24</td>
<td>28</td>
</tr>
<tr>
<td>enrolling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Average</td>
<td>91.4</td>
<td>89.1</td>
<td>89.4</td>
<td>90.0</td>
<td>90.3</td>
<td>90.4</td>
<td>91.0</td>
<td>90.3</td>
</tr>
</tbody>
</table>
The following table shows that the academic achievement of the students at the end of their program is good and has remained consistent over the years that the PHC program has existed.

Reviewing the number of students who graduate from the PHC program each year, with the exception of the 2011–12 and 2012–13 academic years, there are between 14 and 24 students who successfully complete the program.

From the data in these two tables we can see that over the years for which we have full data sets (i.e. Fall 2009 intake to Spring 2015 graduation), 127 students were accepted into the PHC program and 63, or 50%, graduated. The data are best averaged in this manner because not all of the students complete the program in four years. The biggest drop in enrolment occurs during or after year two. Anecdotally, the students change enrolment largely because of the requirement that they complete a full year of physical chemistry. The two half-course equivalents challenge the students’ mathematical abilities and many change to majors that do not require as much physical chemistry, such as Pharmacology. In addition, there are students who enter the PHC program with the intention of applying to the Professional Pharmacy program, which requires only one half course (one semester) of physical chemistry. These students also often leave the program during the second year because of the need to maintain a high grade average in order to be accepted in the Professional program.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CGPA Avg.</td>
<td>3.07</td>
<td>3.13</td>
<td>3.30</td>
<td>3.25</td>
<td>3.19</td>
<td>3.07</td>
<td>3.23</td>
<td>3.10</td>
</tr>
</tbody>
</table>

Source: Program Enrolment at Graduation Cube

Quality of the educational experience and teaching

The data relevant to the teaching evaluations administered by the Program is presented beginning on page 32 of Appendix 3. The data show that the students surveyed rated their courses generally on par with those in the Faculty of Arts and Science as a whole. In the focus groups, the students identified the breadth of the curriculum as a strong point that was very

² The relationship between the grading systems at the U of T is on page 48, Appendix 3.
important to them. This made the program intellectually stimulating; they gained insight and
knowledge of many disciplines. They also said that the number of teaching-lab courses helped
them greatly in understanding the didactic material. The atmosphere for learning is aided by
the ready access to the faculty.

The relatively low number of students in the program greatly facilitates the ability of the faculty
members and the students to interact on a one-on-one basis. This has consistently been one of
the major strengths of our program.

The University of Toronto also surveys all of its undergraduate students to better understand
how engaged students are at the University. The National Survey of Student Engagement
(NSSE) is intended to facilitate comparison between similar programs in different universities or
different programs at the same university. Although the comparisons are generally obvious and
straightforward, this is not the case for the Pharmaceutical Chemistry program. There are few
or perhaps no directly comparable programs in Canada; consequently the PHC program was
grouped together with the “other” category of Pharmacy-related codes in the NSSE system.
This group includes “Pharmacy, pharmaceutical sciences and administration, other\(^3\).” The
programs in this group would not include the diverse and rich course offering in the PHC
program, which spans physical, biological, and health sciences. Nevertheless, the data from the
NSSE survey completed by students in this program are included in Appendix 3, page 32.

Despite the ambiguity surrounding the comparator groups, it is clear from the data that
another strength of the program is the students’ engagement in research and professional
activities. Because of the required fourth-year research course and the optional PEY, all of the
students take part in at least one activity that is called a “High-Impact Practice” by the National
Survey of Student Engagement (NSSE survey). The participation rate is shown in the following
table.

<table>
<thead>
<tr>
<th>NSSE</th>
<th>High-Impact Practices</th>
<th>U15 (PHC)</th>
<th>U of T All disciplines</th>
<th>U15 All disciplines</th>
<th>Ontario All disciplines</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>One HIP</td>
<td>30.8%</td>
<td>27.8%</td>
<td>25.1%</td>
<td>26.7%</td>
</tr>
<tr>
<td></td>
<td>Two or more HiPs</td>
<td>61.5%</td>
<td>72.2%</td>
<td>49.7%</td>
<td>53.8%</td>
</tr>
<tr>
<td></td>
<td>Total who participated in at least one HIP</td>
<td>92.3%</td>
<td>100.0%</td>
<td>74.8%</td>
<td>80.5%</td>
</tr>
</tbody>
</table>

Certain undergraduate opportunities are designated “high-impact.” High-Impact Practices (HiPs) share several traits: They
demand considerable time and effort, facilitate learning outside of the classroom, require meaningful interactions with
faculty and students, encourage collaboration with diverse others, and provide frequent and substantive feedback.
The following activities are defined as High-Impact Practices:

11a. Internship, co-op, field experience, student teaching, or clinical placement
11c. Learning community or some other formal program where groups of students take
two or more classes together 11d. Study abroad
11e. Work with a faculty member on a research project

In North America the particular grouping of material covered in the PHC curriculum is rare; therefore there are few comparator programs. To the extent that they exist at all, undergraduate programs of the same name at other universities tend to focus on chemistry and in particular the chemistry related to polymers and drug synthesis. They also tend to be grouped as specialty chemistry programs. The following are examples from Canadian universities:

University of Ontario Institute of Technology offers a program called Pharmaceutical Chemistry; however, the students are required to take one course in pharmacology and toxicology. The remainder of the courses in this BSc program are chemistry.

The University of Guelph offers a bachelor’s program called Biological and Pharmaceutical Chemistry, which, as the name implies, combines biology courses with chemistry. This program also requires a course in pharmacology.

In the US, there are Pharmaceutical Chemistry undergraduate programs at the University of California at Davis and Michigan Technical University. Both focus on the chemical courses with a pharmacology course to provide the pharmaceutical context. The University of California offers an undergraduate program in Pharmacological Chemistry again, the requirements involve successfully completing a single course in pharmacology. There are also a few Medicinal Chemistry undergraduate programs e.g. at the University of Michigan, the University at Buffalo, and Drake University. Judging from the program descriptions, courses on pharmaceutical concepts are neither required nor electives.

The programs cited above do not constitute an exhaustive list of the offerings in North America; however, there are very few other undergraduate programs that we could find.

In Europe there are more and more varied programs, some similar to the U of T’s Pharmaceutical Chemistry Specialist degree. Examples include those at the University of Huddersfield and the University of Brighton. At these two universities, the programs include courses such as: pharmaceutics, pharmacokinetics, microbiology, etc. They also have a research or industrial experience year. There are also programs in the Netherlands that are similar to ours. In all cases, however, the programs outside of North America do not require any arts or humanities courses; the curricula are made up of science courses. This reflects the different structure of the educational systems there.

As has been described above, the Pharmaceutical Chemistry program provides a broad introduction to the science that underlies the conception, synthesis, manufacture, and delivery of chemical therapeutic agents. The students are also required to successfully complete courses in the arts and humanities as well as several elective courses. The breadth and depth of the education the students receive in the PHC program compares favourably with that at other institutions.
3.9 Quality enhancement

The first students enrolled in the PHC program in September, 2004. Some courses offered in the PHC program are also offered jointly to students in the professional pharmacy program. Changes to the format of some courses offered in the program occurred five years ago when two of the joint Pharm Chem/Pharmacy courses were significantly revised to accommodate changes in the structure of the professional pharmacy program. These courses were Pharmaceutics and Molecular Pharmacology. In both cases, the courses were changed from full-year (two semester) courses to one semester courses in the Pharmacy program; however, they remained full-year courses in the Pharm Chem program. Thus, for example, Pharmaceutics (PHC330Y1) became Pharmaceutics 1 and 2 (PHC230H1 and PHC330H1, respectively). Although the first half of the pharmaceutics and molecular pharmacology courses were still delivered together with the pharmacy professional students, the curriculum of the second semester was changed to be more closely aligned with a science-based program.

In addition to this change, we continually attempt to enhance the breadth of the elective offerings. In the past academic year (2015 – 2016) we introduced two new courses, Nanomedicines in Oncology (PHC432H1) and Pharmaceutical Data Acquisition and Analysis (PHC435H1).

4. Research

The Specialist Program in Pharmaceutical Chemistry is not administered as a department within the Faculty of Arts and Science; the professors who participate in the program are faculty members both in the Leslie Dan Faculty of Pharmacy and the Faculty of Arts and Science. In addition, because it is not administered through a department, there is no graduate program and hence no research directly attributable to the PHC program. However, the “PHC” courses are taught by professors who are members of the Leslie Dan Faculty of Pharmacy and they do have active and successful research programs. There is a wide range of expertise among the faculty members in Pharmacy, a fraction of which is relevant to the PHC program. Thus, there are LDFP faculty members who teach required courses, some faculty members who only teach elective courses, some who have only been involved in supervising students in the fourth-year research project, and there are also many faculty members in the LDFP who have never been involved in the PHC program. Almost all of the professors who contribute to the teaching in the PHC program also teach in the pharmacy professional program (PharmD) and in the graduate program (MSc and PhD).

This section of the self-study on Research concerns itself only with those professors in the Leslie Dan Faculty of Pharmacy who are (or have been) involved in the Pharmaceutical Chemistry Specialist undergraduate program. A list of those professors can be found in Section 2 and in Appendix 5. The research of the faculty members most actively involved in the delivery of the
PHC program are divided into two groups: Biomolecular Pharmaceutical Sciences, and Clinical, Social, and Administrative Pharmaceutical Sciences.\footnote{These are the two fields in our Faculty as defined by the School of Graduate Studies. This is simply a convenient and consistent way to group the faculty members; however, there is no administrative link between the PHC program and the Graduate Department of Pharmaceutical Sciences.}

We do not have benchmarks of research success, per se; however, the impact and recognition of each professor’s research is evaluated annually through the University of Toronto’s Progress-Through-the-Ranks process. During this time the research of each faculty member is compared with that of the other members of the Faculty as one part of the basis for awarding compensation.

A list of recent scholarly publications of each faculty member who participates in the program can be found in Appendix 5. The research funding data, also presented in Appendix 5, include information for all of the LDFP faculty members, not just those who participate in the PHC program. The value of the research funding brought in by the “PHC” faculty was shown in Section 2 (above) and in Appendix 5. Although comparative data are not available it is evident that those professors have successfully competed for research funding over the past several years.

The research activities and knowledge generated by the research of our professors becomes part of the educational program in several ways. Active involvement in research means that the professors have a deep and advanced knowledge of the material they teach to the students. This knowledge allows them to modify material to reflect the latest discoveries in their lectures.

Showing students recent advances and being able to incorporate these changes into the existing knowledge is crucial for demonstrating the importance and value of life-long learning to the students. The clearest way that the PHC students benefit from the research expertise of the faculty is in the year-long research project (PHC489Y) that they must successfully complete. Working with the professor’s research group, the students gain first-hand experience in knowledge creation. This reinforces what they have learned in classroom settings and it makes them acutely aware of the magnitude of the research endeavor.

5. **Organization and Financial Structure**

The Pharmaceutical Chemistry Specialist program is extra-departmental; it is offered by the Faculty of Arts and Science. The students receive their degrees from the Faculty of Arts and Science so ultimately it has responsibility for the operation of the program. Locally, the program is overseen and the day-to-day operations are managed by the Program Director and the Assistant Registrar of the LDFP. There is a program committee consisting of faculty members from the LDFP that meets to discuss and decide on major changes or problems.
Course and program changes receive final approval from the Curriculum Committee of the Faculty of Arts and Science.

The financial resources for the operation of the PHC program come the Leslie Dan Faculty of Pharmacy and the Faculty of Arts and Science. The funding received by the Leslie Dan School of Pharmacy from the Faculty of Arts and Science was determined approximately 10 years ago when the University changed the method by which the divisions of the university interact with each other financially. However, this initial funding model has not been revisited since that time and in order for the PHC program to evolve and grow, we will need a re-consideration of this agreement.

The current administrative structure poses many challenges. Presumably, the primary cause of these challenges has to do with the fact that the PHC program is not administered from a department in the Faculty of Arts and Science. However, the Faculty recently created a position called the Vice-Dean, Academic Planning and Strategic Initiatives. One of the roles of the Vice-Dean will be to ensure there is communication and cooperation between the many departments and programs in the Faculty of Arts and Science.

6. Resources and Infrastructure

Classrooms and Labs

The PHC courses are offered in the Leslie Dan Pharmacy Building. This is a 10-year-old structure that includes lecture halls, classrooms, small group rooms, teaching laboratories, research laboratories, and administration space. The building is occupied by the faculty and staff of the Leslie Dan Faculty of Pharmacy, the students in the PharmD program, the students in the Graduate Department of Pharmaceutical Sciences, and the students in the Pharmaceutical Science Specialist program. The space is well-suited to our needs.

In the teaching labs, the students have available to them several types of tools and instruments that they would encounter in pharmaceutical research and development labs. These include the usual spectrophotometers, pH meters, balances, etc. and also tablet press, etc. The space for the labs is sufficient to allow us to offer a greater variety of courses and hands-on experiences; however, we are limited by the availability of new instruments and instructors.

Academic Offices

A total of 1,053 net assigned square metres (nasm) of academic office space is available in the Leslie Dan Faculty of Pharmacy (LDFP) building. The approved faculty complement is 55.53 Full-time equivalents (FTE). Of these, one FTE faculty member has office and research laboratory space at the University Health Network. In addition, there are six 0.5 FTE Clinician

---

5 This section was taken almost in its entirety from the 2015 report by the Faculty to the Canadian Council for the Accreditation of Pharmacy Programs.
Scientist/Educator faculty who have offices and clinical practice/research sites at the Toronto Area Health Sciences Network (TAHSN) hospitals. Each of the remaining faculty members has been assigned an office close to his/her research laboratory and graduate students.

Full-time faculty and others with appointments equal to or greater than 0.5 FTE are allocated a private office. Persons with appointments less than 0.5 FTE share an office. In addition, there are six offices that may be assigned to “other” faculty, including visitors and emeriti, on a shared basis. Each of these 69 offices is 13 nasm, in accordance with the guidelines of the Council of Ontario Universities. The building also has offices for a number of positions beyond the approved complement; these include space for two endowed chairs and office space for the PharmD Director and PharmD clinical faculty.

Non-Academic Offices

There are 26 FTE non-academic positions approved for funding. In addition to the positions paid from the operating fund, there are 4 FTE (the Assistant Dean, Advancement, Senior Development Officer, Alumni Relations Officer, and the Manager of Marketing and Communications) that are paid for by Advancement. A Dean’s suite provides office and meeting space for the Dean and the Chief Administrative Officer.

Faculty and Staff Support Space

An array of departmental support space is available in the LDFP building including faculty and staff lounge space, administrative meeting space, office machines space and administrative storage space.

The Leslie L. Dan Pharmacy Building

Opened in 2006, the Leslie L. Dan Pharmacy Building is a state-of-the-art 167,000 square foot teaching and research facility and the gateway to the University of Toronto. The LDFP is committed to its mission of internationally significant innovation in the discovery and mobilization of pharmaceutical knowledge in the pursuit of health. The vision of the LDFP is to be a preeminent centre for pharmaceutical knowledge and practice, through advancements in research, teaching and service. The new LDFP building, which opened in 2006, supports the mission and vision of the LDFP. Space and facilities are allocated in the building to support the following programs:

- PharmD (240 students in each of four years in the program)
- BSc in Pharmaceutical Chemistry (20 students in each of three final years of the program)
- PharmD for Pharmacists Program (40 students in the program)
- MSc and PhD in Pharmaceutical Sciences (~150 Students in two year (MSc) or four year (PhD) programs)

The Office of Continuous Professional Development (CPD), which includes the International Pharmacy Graduate (IPG) program, is located on the fourth floor of 256 McCaul
Street, a total of 358 square meters.

**Accessibility, Access and Security**

The University of Toronto is fully committed to ensure that its buildings and services including the LDFP are accessible to persons with disabilities. The existing building regulations (Ontario Building Code) clearly define the minimally acceptable level necessary to accommodate persons with disabilities and the LDFP building has incorporated enhancements into the design wherever possible.

**Computing and Communications Services**

Given the nature of the undergraduate and graduate programs, and the research and development work undertaken by the LDFP, a significant amount of voice and data communications services is required throughout the building. Some research installations have major concentrations of high-end computer workstations or instrument arrays. The building’s computing and communications infrastructure accommodates the expected level of use and is flexible enough to meet the needs of the continuously evolving multi-disciplinary academic and research programs. In common with other buildings on the St. George Campus, the building has a 1GB network connection service through the University’s backbone.

The University of Toronto has, until this year, used Blackboard as its learning management system; however, we are currently in the process of defining a new system. In addition to centralized support for faculty and staff, the Faculty has a dedicated Blackboard specialist, who is able to support faculty to effectively utilize and understand aspects of the learning management system for their respective courses.

**Resource Centre/Study Space**

The Apotex Resource Centre in the Leslie Dan Building is an information and communication technology resource and study space that serves students in the BSc in Pharmacy and BSc in Pharmaceutical Sciences programs; it is designed to allow students to obtain, print, store, and discuss information in the pursuit of studying and learning. There are carrels with computers and carrels with power and data connections to support laptop use. Students can access the internet, various software applications, and specific databases. There are rooms for collaborative group work and rooms for quiet study or computer work. Facilities for printing and photocopying are provided.

**Teaching Space**

The LDFP building has two large lecture theatres, one with capacity for 300 students, while the other seats 240. The 300-seat classroom can accommodate a combined class of one entire year of students in the BSc in Pharmacy program and one year of students in the BSc in Pharmaceutical Chemistry program, since some courses are common for these students. Both lecture theatres provide a state-of-the-art technology-enhanced learning environment with LCD
computer projection, overhead projectors and access to internet resources from the podium, including the capacity to audio-tape lectures synchronized to presentation slides.

In addition to these lecture theatres, there are two classroom pods which accommodate 60 or 30 students, respectively, for smaller group sessions or elective courses.

There is a classroom/seminar space on the 8th floor which can accommodate 100 students. PharmD and graduate-level seminars are frequently held in this space. Additionally, it is used for conference break-out rooms and for “overflow” requirements in some Pharmacy Professional courses (e.g. optional tutorials). Graduate level courses commonly are taught to small groups of students (10-15 students) and the pods or other smaller seminar rooms available on each floor are used for these. Graduate student seminars as well as invited seminars from visiting scientists/professors are held in the pods or in the 8th floor seminar area. There are five Professional Practice Seminar Rooms in the Herbert R. Binder Professional Practice Lab (described below).

Teaching Laboratories: Pharmaceutics/Pharmaceutical Analysis

In the Pharmaceutics Laboratory, students in the BSc in Pharmacy as well as in the BSc in Pharmaceutical Chemistry programs learn the physical and chemical properties of the materials used in dosage form design. They also gain experience in the compounding and formulation of drugs. The pharmaceutics teaching laboratory in the LDFP building occupies 337 nasm and provides modern instrumentation in a separate adjacent room for pharmaceutical analysis.

Research space

Research at the LDFP encompasses two Fields: i) Biomolecular Pharmaceutical Sciences and ii) Clinical, Social and Administrative Pharmaceutical Sciences. Professors in the Biomolecular Pharmaceutical Sciences field conduct laboratory-based research aimed at understanding disease biology, the discovery of new medicinal agents, diagnostic tools or drug delivery systems, and evaluation of their effectiveness and adverse effects. Professors in the Clinical, Social and Administrative Pharmaceutical Sciences field conduct non-laboratory based research aimed at understanding the use of drugs in the health care system including economic, social and ethical, policy and professional aspects. They are also involved in pharmacy practice-site research aimed at enhancing the role of the pharmacist in the health care system as well as education of health professionals.

There is laboratory and office space for 28 scientists in the Division of Biomolecular Pharmaceutical Sciences, 20 of whom are housed in the Pharmacy building; the remaining eight are housed in the University Health Network, MaRS Discovery District, and the Department of Chemical Engineering and Applied Chemistry (Wallberg Building). Research space for the Clinical, Social and Administrative Pharmaceutical Sciences field primarily includes office space for scientists and their graduate students. Researchers in the Pharmacy Practice (e.g. clinician scientists and clinician educators) have office space at the TAHSN hospitals and their research environment is their particular practice site at the hospitals.
Graduate students and other research staff, including postdoctoral fellows, research associates, research assistants and technicians are housed in Personnel Rooms located close to the professor’s office with whom they work. These rooms accommodate eight such personnel for faculty in the Biomolecular Pharmaceutical Sciences, nine spaces at the University Health Network and five such personnel for every Social and Administrative Pharmacy and Pharmacy Practice areas.

**Student Use and Common Space**

This category includes undergraduate student lounges and recreation facilities and service. There is 276 nasm available at the LDFP for this purpose. Student Use and Common Space includes office and meeting space for student associations and student clubs. There is also other meeting space available for student organizations across campus. The ground floor atrium is home to the student lounge and furnished with comfortable circular ottomans and tables to encourage meeting and discussion. The atrium space sits beneath a prominent architectural feature, the large pod, and overlooks a large expanse of open, grassed space on Queen’s Park Circle. A café is located at the north end of the atrium. A courtyard to the north of the building is a component of the University’s open spaces program and provides a beautifully designed, mid-building space for student activities. For example, the Undergraduate Pharmaceutical Society (UPS) hosts and organizes an Orientation Barbeque in this space each September. Seating is provided at perimeters and throughout the courtyard, providing outdoor study and conversation areas. Bicycle racks are available for use to the east of the building.

Each student in the Pharmacy Professional program is provided with a locker which he/she will retain throughout their studies at the Faculty. Students in the Pharmaceutical Chemistry Specialist program are provided a locker starting the second semester of their second year. (This is the first semester that these students have courses in the Leslie Dan Pharmacy Building.) Locker areas are located in space adjacent to the large lecture theatres on B1 and B2 (below the main level) and close to the student lounge, meeting room, Undergraduate Pharmacy Society office and storage room.

The student lounge on B2 (basement level) is accessible to the students in the Pharmacy Professional program by a Card Reader, which each student purchases for a minimal cost. The lounge has comfortable seating, a kitchenette, microwaves, vending machines, a television, DVD player and stereo system. In addition, the space houses various recreational amenities. The student meeting room is located on B1 with access available to UPS executives. The UPS Office is also located on level B1 and is equipped with necessary desks, computers, filing cabinets, etc. A storage room has been provided on level B1 and is supplemented by locked storage cabinets adjacent to the UPS office.

Display cases in the atrium of the LDFP serve as ‘museum space’, to display the life of the Faculty and Pharmacy in general, historically, through the present and into the future. This small ‘museum’ located here is intended to benefit the occupants of the building as well as visitors to the Faculty.
7. Academic Services

The University of Toronto and the Faculty of Arts and Science provide an array of academic support services for undergraduate students (see Appendix 6). In addition to the academic services offered to the students at the University, those in the PHC program have access to some of the facilities and services at the Leslie Dan Faculty of Pharmacy. The students are provided access to enter the Pharmacy Building, they have access to the Resource Centre in the Pharmacy Building, and are given a locker. The Faculty of Pharmacy provides space for the Pharmaceutical Chemistry Student Association to hold events.

The Assistant Registrar of the Faculty of Pharmacy is the first point of contact for helping and supporting students who need assistance for problems such as questions about program policies, missed exams, locker and fob assignments, booking rooms for student events, and so on.

The program director and the Assistant Registrar offer on-site counselling and other assistance to the students. If need be, they also direct them to services provided by the Faculty of Arts and Science and the University.

8. Internal and External Relationships

The Pharmaceutical Chemistry Specialist program has ties with several departments in the University by virtue of its students taking courses as part of the program. The closest ties (the most common courses) are with the Pharmacy Professional program and the Graduate Department of Pharmaceutical Sciences. These courses are cross-listed between the Pharmacy program, the Graduate Department, and the Pharmaceutical Chemistry program. In addition, the students have access to lockers and study space in the Leslie Dan Pharmacy Building. Through the Professional Experience Year our program interacts with the Department of Pharmacology and Toxicology.

We are connected to the Pharmaceutical Industry by the Professional Experience Year and by other assistance provided by people working in the industry. Industrial professionals come to give lectures, participate in career events to our students (often together with the students in the Pharmacology program), and they graciously offer tours to our students of local development and manufacturing sites. Once a year, the students have half-day tours of the facilities at Patheon, Inc., in Mississauga, Ontario. The company provides background information about the company, where it sits in the industry, and the types of processes they will see during the tour. There is also opportunity for a Q&A and lunch. For the past several years, the students have toured Patheon; in previous years Glaxo Welcome, Apotex, and Taro also offered tours.

Advancement is one of the areas that is an ongoing concern for us. The program is not part of any advancement campaign to the best of our knowledge. The Faculty of Pharmacy does not take responsibility for the advancement of the program, nor does the Faculty of Arts and
9. Previous Review Recommendations

This is a relatively new program at the University of Toronto and as such this is the first review that it has undergone.

10. Future Directions

The program we offer is one of two non-professional programs at the University of Toronto that deals generally with scientific underpinnings of drugs and drug therapy, with the other being Pharmacology and Toxicology. There is interest from the students for these programs and there is a need in industry, academia, and government for non-professional trainees in this field. Our biggest opportunities lie in expanding our program. Given how the program is currently configured the most attractive route for enhancing the program would be to increase the number and variety of electives offered, especially lab-based electives. Ideally we would like to offer a sufficient breadth of courses so that the students may choose between different streams within the program. There are many possibilities that would significantly enhance the students’ experience. These include an advanced dosage form design course, a course on industrial methods in the industry that focusses on the instrumentation and machinery involved in drug manufacture, a course that exposes students to the methods of computer assisted drug design, and so on. For us to enhance the program through a broader course offering we would need the financial resources to hire additional staff to teach these courses.

Student and faculty awards would also benefit the program. In other A&S programs, the faculty are members of the A&S; however, the PHC faculty are members of the Leslie Dan Faculty of Pharmacy. For this reason, they are not eligible for A&S teaching awards.

It would be valuable if the graduates were tracked. We currently have only anecdotal evidence of the success of our students. It would be advantageous to maintain contacts with the graduates and to encourage them to participate in events with current students.

Although we do not have quantitative data, from discussions with undergraduate and graduate students it seems as though there is demand for programs related to the pharmaceutical sciences. With additional resources and the cooperation of the A&S and the LDFP, we could provide undergraduate programs in A&S under an umbrella called “Pharmaceutical Sciences.” We envision that this could include the PHC program, Pharmacology and Toxicology, and new areas such as pharmaceutics, medicinal chemistry, pharmaco-economics, pharmaco-epidemiology, etc.
11. List of Appendices

This self-study includes the following appendices:

1. Faculty
2. Calendar Entry
3. Standardized Data Set
4. Undergraduate Degree Objectives
5. Research
6. Academic Services
7. Faculty CVs