UNIVERSIDAD DE PUERTO RICO, RECINTO DE CIENCIAS MÉDICAS PO BOX 365067 SAN JUAN PR 00936-5067 • TEL. 787-758-2525 EXT.1711

SECRETARÍA JUNTA ADMINISTRATIVA

2018-19
Certificación Número 99

YO, **NYDIA BONET JORDÁN**, Secretaria Ejecutiva de la Junta Administrativa del Recinto de Ciencias Médicas de la Universidad de Puerto Rico, **CERTIFICO**:

Que la Junta Administrativa en reunión ordinaria celebrada el **martes, 25 de septiembre de 2018**, tuvo ante su consideración la **Propuesta Académica para el Establecimiento del Programa de Doctor en Filosofía en Ciencias Farmacéuticas de la Escuela de Farmacia.** Luego de la discusión de rigor y de recibir el visto bueno de la Oficina de Presupuesto, la Junta Administrativa, unánimemente **ACORDÓ:**

> **ENDOSAR la Propuesta Académica para el Establecimiento del Programa de Doctor en Filosofía en Ciencias Farmacéuticas de la Escuela de Farmacia, según fuera sometida por la Escuela y endosada por el Senado Académico del Recinto de Ciencias Médicas en su Certificación 054, 2017-2018, SA-RCM.**
>
> **Esta certificación de la Junta Administrativa del Recinto de Ciencias Médicas que endosa dicha propuesta será enviada a la Oficina de Asuntos Académicos junto a todos los documentos sometidos para que siga el curso protocolario de rigor que se da en estos casos.**

Y para que así conste, para conocimiento del personal y de las autoridades universitarias que corresponde, expido esta Certificación bajo el sello del Recinto de Ciencias Médicas de la Universidad de Puerto Rico, hoy veintiocho de septiembre del año dos mil dieciocho.

Nydia Bonet Jordán, MD
Secretaria Ejecutiva

Vo. Bo.:

Segundo Rodríguez Quilichini, MD, FACS, FASCRS
Rector Interino

NBJ:SRQ:ynr

UNIVERSIDAD DE PUERTO RICO
RECINTO DE CIENCIAS MEDICAS

OFICINA DE PRESUPUESTO

PRESUPUESTO DE PROPUESTAS DE PROGRAMAS ACADEMICOS
PROGRAMA DOCTOR EN FILOSOFIA EN CIENCIAS FARMACEUTICAS DE LA ESCUELA DE FARMACIA

PARTE I. NARRATIVA

a. Título del Programa
Doctor en Filosofía en Ciencias Farmaceúticas.

b. Decanato y Departamento al cual o estará adscrito el programa
Escuela de Farmacia / Departamento de Ciencias Farmaceúticas.

c. Director
Dr. Joseph Bloom

d. Descripción breve del programa
Formará estudiantes que mejorarán la salud en las comunidades y de los individuos a través de la investigación interdisciplinaria que contribuya al avance del conocimiento científico y de la profesión de farmacia.

e. Grado que confiere o conferirá el programa
Ph.D. en Ciencias Farmaceúticas (DOCTOR EN FILOSOFIA EN CIENCIAS FARMACEUTICAS)

f. Certificación del Senado Académico que aprueba el programa
Certificación 054, 2017-2018, del Senado Académico.

g. Matrícula proyectada durante los primeros cinco años

Primer Año (admisiones)	+ 1 (admisiones)	+ 2 (admisiones)	+ 3 (admisiones)	+ 4 (admisiones)
6	12	18	24	30

UNIVERSIDAD DE PUERTO RICO
RECINTO DE CIENCIAS MEDICAS

PROGRAMA DOCTOR EN FILOSOFIA EN CIENCIAS FARMACEUTICAS DE LA ESCUELA DE FARMACIA

IMPACTO PRESUPUESTARIO RECURRENTE

PERSONAL DOCENTE

El programa requiere 13 facultativos a tiempo completo. La implementación de este Programa no conlleva impacto económico para la Escuela de Farmacia. No obstante, se desglosa el costo de la facultad adscrita al programa:

Catedrático	tres (3)	$	290,304.00
Catedrático Asociado	uno (1)		82,932.00
Catedrático Auxiliar*	ocho (8)		570,300.00
Catedrático Auxiliar - Nomb. Adjunto	uno (1)		73,548.00
	Presupuesto anual recurrente actual	$	1,017,084.00

*En proceso de reclutamiento de un Catedrático Auxiliar.
(1) cobra de economías

UNIVERSIDAD DE PUERTO RICO
RECINTO DE CIENCIAS MEDICAS

INGRESOS PROYECTADOS
PROGRAMA DOCTOR EN FILOSOFIA EN CIENCIAS FARMACEUTICAS DE LA ESCUELA DE FARMACIA

	FY 21	FY 22	FY 23	FY 24	FY 25
TOTAL	$ 35,346	$ 72,396	$ 84,096	$ 96,096	$ 100,296
ESTUDIANTES MATRICULADOS	6	12	18	24	30
COSTO MATRICULA ($225 por crédito)	$ 31,050	$ 64,800	$ 72,900	$ 81,000	$ 81,000
CUOTAS INSTITUCIONALES	1,296	1,296	1,296	1,296	1,296
CUOTAS ACADEMICAS	3,000	6,300	9,900	13,800	18,000

Nota: Ingresos estimados después de matrícula total por cinco años.

UNIVERSIDAD DE PUERTO RICO
RECINTO DE CIENCIAS MEDICAS

PRESUPUESTO CONSOLIDADO / FONDO GENERAL Y FONDOS EXTRAUNIVERSITARIOS

PROGRAMA DOCTOR EN FILOSOFIA EN CIENCIAS FARMACEUTICAS DE LA ESCUELA DE FARMACIA

	PRIMER AÑO		AF + 1		AF + 2		AF + 3		AF + 4	
	Fondo General	Fondos X	Fondo General	Fondos X	Fondo General	Fondos X	Fondo General	Fondos X	Fondo General	Fondos X
TOTAL	$ 1,302,331	$ 99,837	$ 1,302,331	$ 99,837	$ 1,302,331	$ 99,837	$ 1,302,331	$ 99,837	$ 1,302,331	$ 99,837
Servicios Personales	$ 1,047,924	$ -	$ 1,047,924	$ -	$ 1,047,924	$ -	$ 1,047,924	$ -	$ 1,047,924	$ -
Sueldos Docentes	1,017,084		1,017,084		1,017,084		1,017,084		1,017,084	
Sueldos No Docentes	30,840		30,840		30,840		30,840		30,840	
Bonificaciones										
Comp. Adicional No Docente										
Otros Gastos y Aport. Patronales	$ 254,407	$ 99,837	$ 254,407	$ 99,837	$ 254,407	$ 99,837	$ 254,407	$ 99,837	$ 254,407	$ 99,837
Viajes										
Equipo										
Materiales (Lab.) y Servicios	13,663	56,337	13,663	56,337	13,663	56,337	13,663	56,337	13,663	56,337
Aport. Patronales (1)	240,744		240,744		240,744		240,744		240,744	
Mantenimiento		20,000		20,000		20,000		20,000		20,000
Recursos Externos		4,000		4,000		4,000		4,000		4,000
Otros (Desarrollo Facultad)		19,500		19,500		19,500		19,500		19,500

X = Fondos provienen de los ingresos por concepto de matrícula, cuotas y costos indirectos.

(1) Véase detalle en Tabla de Aportaciones Patronales

UNIVERSIDAD DE PUERTO RICO
RECINTO DE CIENCIAS MEDICAS

APORTACIONES PATRONALES

PROGRAMA DOCTOR EN FILOSOFIA EN CIENCIAS FARMACEUTICAS DE LA ESCUELA DE FARMACIA

	PRIMER AÑO		AF + 1		AF + 2		AF + 3		AF + 4	
	Fondo General	Fondos X	Fondo General	Fondos X	Fondo General	Fondos X	Fondo General	Fondos X	Fondo General	Fondos X
TOTAL	$ 109,700	$ -	$ 109,700	$ -	$ 109,700	$ -	$ 109,700	$ -	$ 109,700	$ -
CARGOS POR BENEFICIOS (HRS)										
BONO NAVIDAD	9,164		9,164		9,164		9,164		9,164	
OBVENCION DOCENTE										
PLAN MEDICO	100,536		100,536		100,536		100,536		100,536	

X = Fondos provienen de los ingresos por concepto de matrícula y cuotas.

UNIVERSITY OF PUERTO RICO MEDICAL SCIENCES CAMPUS SCHOOL OF PHARMACY

Proposal for the establishment of a Doctor of Philosophy in Pharmaceutical Sciences degree

Department of Pharmaceutical Sciences	Approved: February 21, 2017
School of Pharmacy	Approved: March 20, 2017
Medical Sciences Campus Academic Senate	Certification
Medical Sciences Campus Administrative Board	Certification
University of Puerto Rico University Board	Certification #
PR Council on Higher Education PRCHE	Certification #

B. TABLE OF CONTENTS

PRESENTATION

A. Cover Page

B. Table of Contents

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I. INTRODUCTION

The School of Pharmacy of the University of Puerto Rico, originally established as a Department of Pharmacy, was founded on September 22, 1913 at the Río Piedras Campus, and in 1925 organized as the College of Pharmacy. The first twelve pharmacists graduated in 1915 from a two-year program. In 1928 the College implemented a four-year pharmacy program leading to the degree of Bachelor of Pharmaceutical Sciences. In 1932, the College was accepted as a member of the American Association of Colleges of Pharmacy. In 1949, the College began its five-year Bachelor of Pharmaceutical Sciences program, being the second in the nation to adopt such a program.

Pharmacy was the first health profession program to be offered at the higher education level in Puerto Rico, and the first to be accredited. The program was first accredited by the American Council for Pharmaceutical Education (ACPE) in 1952, and it has been accredited ever since. In 1989, the College changed its official name to School of Pharmacy.

The Bachelor in Sciences in Pharmacy program with a greater emphasis in clinical education was offered from 1981 to 2003. A Master of Science in Pharmacy program with options in Industrial Pharmacy and Pharmaceutical Sciences (Medicinal Chemistry) was established in 1988, providing highly trained individuals for the pharmaceutical industry in the Island. In 2001, the School of Pharmacy implemented the Doctor of Pharmacy program (Pharm D), required by the Accreditation Council for Pharmacy Education (ACPE), as the entry-level for the profession. The Pharm D is currently accredited by ACPE.

In 2001 a Pharmacy Practice Residency program, was established as a joint effort with Veterans Administration Caribbean Healthcare Center in San Juan. It is accredited by the American Society for Health System Pharmacists as a postgraduate year one pharmacy residency program. A postgraduate year one Community Pharmacy Residency program was established in 2012 as a joint effort between the School and four collaborating partners. The School of Pharmacy is also a provider of continuing education since 1979.

In order to contribute to the advancement of scientific knowledge and the pharmacy profession the School of Pharmacy at the Medical Sciences Campus of the University of Puerto Rico proposes the establishment of the academic program: **Doctor of Philosophy in Pharmaceutical Sciences**.

I. INTRODUCTION

A. Program Title and Proposed Academic Degree

Program title:

Doctor of Philosophy in Pharmaceutical Sciences (English)
Doctor en Filosofía en Ciencias Farmacéuticas (Spanish)

Academic degree:

Ph.D. in Pharmaceutical Sciences (English)
Ph.D. en Ciencias Farmacéuticas (Spanish)

Students that do not complete the full requirements of the PhD program, but complete the minimum requirements stipulated in paragraph VI.A instead, may obtain the degree of:

Master of Science in Pharmaceutical Sciences (English)
Maestría en Ciencias en Ciencias Farmacéuticas (Spanish)

B. Program Description

In accordance with the mission of the School of Pharmacy, the Doctor of Philosophy in Pharmaceutical Sciences program will educate students who will improve the health of communities and individuals through, interdisciplinary research that contribute to the advancement of scientific knowledge and the pharmacy profession. The Doctor of Philosophy in Pharmaceutical Sciences program aims to provide students with a comprehensive understanding of the discovery and development, and manufacturing of pharmaceutical drugs and their involvement in the treatment of disease. During the first, common year of core courses, the students will learn to understand biological mechanisms of disease, basic principles of medicinal chemistry, pharmacology, pharmacokinetics and pharmacodynamics, pharmaceutical analysis, drug formulation and delivery systems, drug manufacturing, and ethics in research.

The Doctor of Philosophy in Pharmaceutical Sciences is a daytime program of 60 credits for its completion distributed in four main components. The first component includes 22 credits in core courses related to the basic sciences of pharmacy. The second component comprises three different tracks of 14 credits each one. After the core courses, students will enter a mentor-driven, individualized program for their further development, in which they can acquire profound knowledge in one of three tracks. The student will select one of the tracks and carry out a competitive and innovative research project in the area, leading to a Doctoral Thesis. The three different tracks that will be offered are:

- Medicinal Chemistry and Pharmacognosy
- Molecular Pharmacology and Pharmacogenomics
- Pharmaceutics and Drug Delivery

The third component focuses on research and requires the approval of 21 credits. The last component includes three (3) credits in elective courses.

The proposed program has a duration of five years. The period of time from entrance to the program through completion of the degree requirements should not exceed eight years.

Description of tracks:

Molecular Pharmacology and Pharmacogenomics

The Molecular Pharmacology and Pharmacogenomics track focuses on the integration of biochemistry and genetics with pharmacology and pharmacokinetics. The focus will be on the investigation and understanding of the underlying molecular mechanisms of diseases, in order to be able to design new treatment strategies. This will include the application of pharmacogenetic and pharmacogenomic principles, which are the basis for the development of the upcoming field of personalized medicine. This track is directed towards students that are interested in understanding underlying principles of diseases and/or investigate direct clinical applications based on genetic predisposition of the patients.

Pharmaceutics and Drug Delivery

The Pharmaceutics and Drug Delivery track focuses on the design, development and optimization of dosage forms for small and large molecule drugs. Process development of Quality by Design (QbD) manufacturing procedures, combined with advanced Process Analytical Technologies (PAT) has become highly relevant to the pharmaceutical industry. Research will be carried out in materials sciences, nanotechnology, crystallization, and drug formulation. It also involves the application of physical and analytical chemistry, and engineering towards development of novel drug delivery systems. This track is directed towards students that are interested in modern manufacturing methods of active pharmaceutical ingredients and novel formulation approaches to final drug products.

According to the International Pharmaceutical Federation (FIP), the Pharmaceutical Sciences are defined as the "Sciences of Medicines"[1].

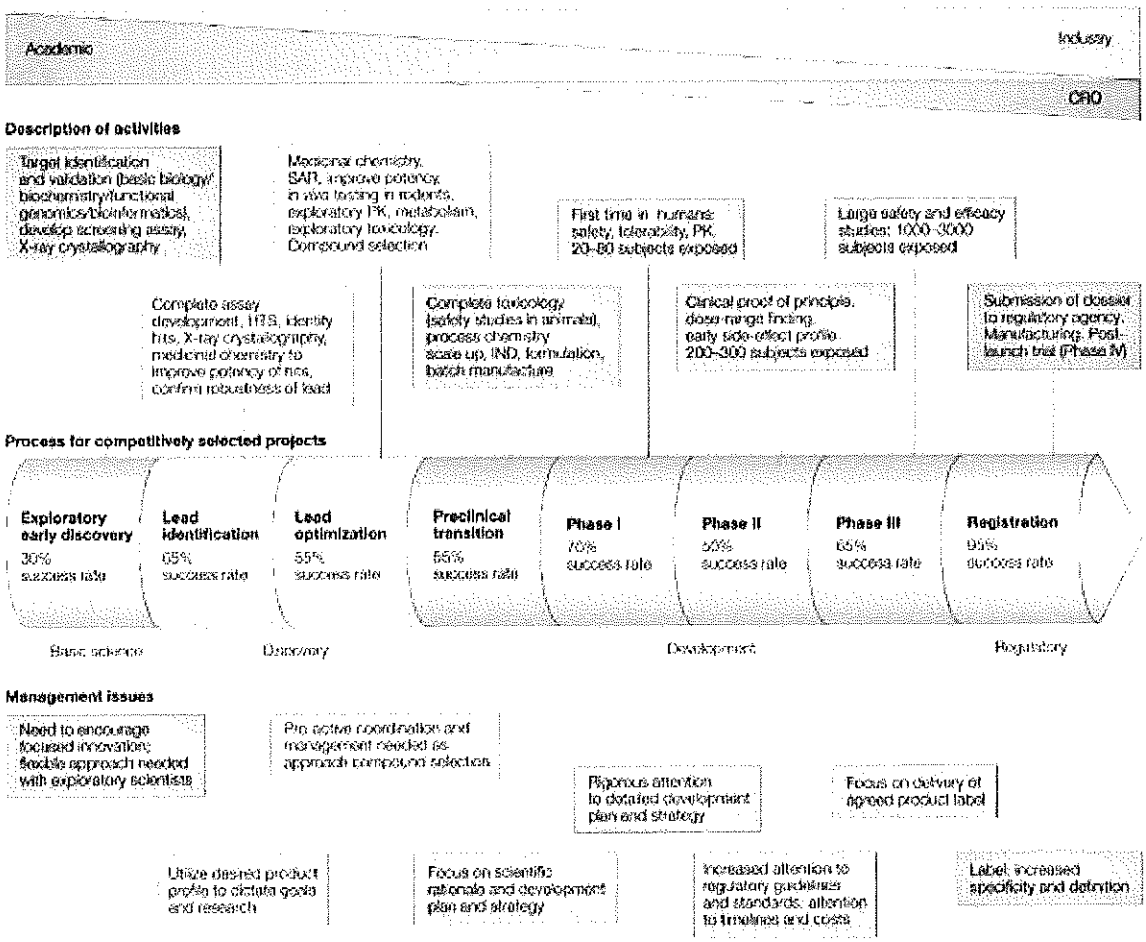
> "It is the science underpinning the **discovery, development, production,** and **use** of medicines — arguably **one of the most complex and sophisticated endeavours** of mankind."

The proposed **Ph.D. in Pharmaceutical Sciences program** in the School of Pharmacy will educate graduates in diverse disciplines of the Pharmaceutical Sciences, and contribute to the **ever-pressing need** to make drugs safer, and their development more efficient and cost-effective in order to provide society with affordable quality medicines to meet both unmet medical needs and improved drugs to replace existing suboptimal ones.[2]
The discovery and development towards the manufacturing, registration and market approval of new pharmaceutical drugs to make them available for patients is a costly and lengthy process. For efficient progression within and between the different stages of drug development, the involvement of highly educated multidisciplinary and interdisciplinary **Pharmaceutical Scientists** is needed. The involvement of Academia, where new investigators in the pharmaceutical sciences are educated, is highest in the early stages of the drug discovery process, while in later stages the role of Industry and Contract Research Organizations (CRO's) become more prominent (figure 1). The students of the Ph.D. in Pharmaceutical Sciences program will have the opportunity to carry out competitive research projects with activities in varying areas of

[1] International Pharmaceutical Federation (FIP). Impact of Pharmaceutical Sciences on Healthcare. The Hague: International Pharmaceutical Federation (FIP); 2012.
[2] International Pharmaceutical Federation (FIP). Changing the world by translating science into practice [pamphlet]. The Hague: International Pharmaceutical Federation; 2014. http://fip.org/files/fip/Pharmaceutical_sciences_change_the_world.pdf

discovery and development. The knowledge and experience obtained in interdisciplinary research prepares the graduates to advance scientific knowledge in pharmaceutical sciences in future positions within academia, industry or government.

Figure 1: *The discovery and development of a novel drug*[3]



The FIP[4] and the American Association of Pharmaceutical Sciences (AAPS)[5] have defined and described different areas within the Pharmaceutical Sciences. Prospective students will be exposed to the basic principles of all disciplines. In a further step, the students will obtain a specialization in one or two areas of their interest. The different areas in the Pharmaceutical Sciences have been defined as follows:

- **Drug Design and Discovery:** Find better compounds to treat both major and rare diseases, including those that continue to inflict misery and premature death in developing countries.

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[3] Solomon Nwaka & Robert G. Ridley, *Nature Reviews Drug Discovery* **2**, 919-928 (November 2003). doi:10.1038/nrd1230

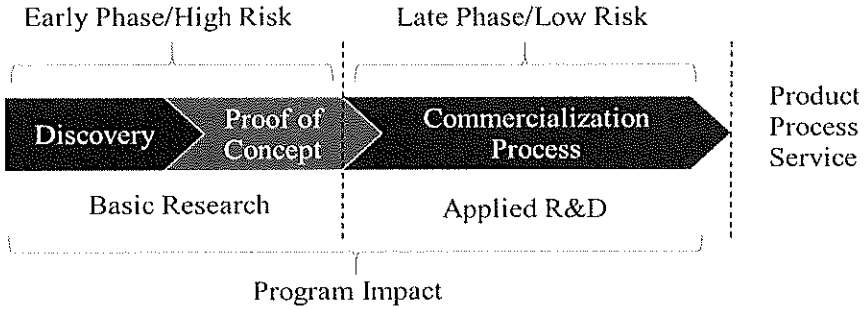
[4] International Pharmaceutical Federation (FIP). Changing the world by translating science into practice [pamphlet]. http://fip.org/files/fip/Pharmaceutical_sciences_change_the_world.pdf. The Hague: International Pharmaceutical Federation; 2014.

[5] http://www.aaps.org/uploadedFiles/Content/Sections_and_Groups/Sections/Sectionbrochure2014.pdf

- **Natural Products:** Help to isolate and identify the active components of traditional and herbal remedies and turn them into safer and more effective drugs.
- **Formulation Design and Pharmaceutical Technology:** Develop smart systems and materials more effectively and safely at an affordable cost.
- **PK/PD and Systems Pharmacology:** Apply joined-up quantitative thinking to understanding and predicting the fate and effects of drugs in the body for the selection of rational dosage regimens.
- **Translational and Personalized Medicine:** Bridge the gap between bench and bedside in bringing better drugs to the patient, and to realize the dream of tailoring drug therapy to the individual rather than the non-existent average patient.
- **Biotechnology:** Create exciting new medicines of the future based on proteins, nucleic acids and stem cell systems.
- **Analytical Sciences and Quality Control:** Ensure the purity and reproducibility of medicinal products and their ingredients
- **Regulatory Science:** Safeguard public health through critical appraisal of the safety and efficacy of new medicines
- **Pharmacoeconomics:** Improve the benefit-to-risk ratio of new therapies relative to current standards of patient care

In addition, the program offers the student the opportunity to evolve along the entire value chain of the development of the product of either small or macromolecule bio-pharmaceuticals (including biosimilars), which is unique of the program. The graduate, with his/hers acquired knowledge and skills through the research project developed in the Ph.D program can impact all areas of the production of a medication for patients, as can be observed from figure 2.

Figure 2: *Research & Development impact throughout the value chain development of a product*



The **basic principles** for all of the above-described areas will be taught in the first year to all students entering the program. In the second year, the students will select a Mentor and **specialize** in one or two overlapping areas. Via collaborative research activities, the students will also interact with investigators and be exposed to advances in other areas.

This is a unique program in its curricular content, the different tracks available for the students to pursue and the mentor-driving educational strategy used to develop the program. The program also fosters collaboration between academia and the pharmaceutical industry to strengthen the educational strategy towards knowledge development. Furthermore, this program will increase acknowledge of Puerto Rico in research and innovation globally through cutting-edge research by providing the human capital (scientists, researchers, entrepreneurs, professionals) that can address the new trends in the pharmaceutical industry such as continuous manufacturing, bio-pharmaceuticals, and personalized medication.

C. Classification

According to the classification of the Instructional Programs of the Integrated Postsecondary Education Data System (IPEDS, http://nces.ed.gov/ipeds/), the CIP Code that best describes the proposed program is:

CIP 51.2010

Title: Pharmaceutical Sciences.

Definition: A program that focuses on the basic sciences that underlie drugs and drug therapy and that prepares individuals for further study and/or careers in pharmaceutical science and research, pharmaceutical administration and sales, biotechnology, drug manufacturing, regulatory affairs, and related fields. Includes instruction in mathematics, biology, chemistry, physics, statistics, pharmaceutics, pharmacology and toxicology, dosage formulation, manufacturing, quality assurance, and regulations.

D. Teaching-Learning Modality

The Ph.D. in Pharmaceutical Sciences program is a Mentor-driven program. During the first year, all students follow the same core courses within the program. At the end of the first year, based on research and career interests, the students have to select a Mentor. Throughout the remainder of the program, the Mentor will guide this student both in the direction of their research project as well as in the selection of the track and courses to be followed by the student.

The Core Courses and Specialized Courses, which constitute more than eighty percent of the course-work, will be offered via conventional modalities of teaching and learning. These courses will be offered via interactive lectures in which there is a direct contact of the students with the Professors. The courses will be enhanced via educational technologies (i.e. Blackboard, iPad etc.), and will be complemented with case-studies, hands-on exercises, and other methods to enhance the learning experiences. In specific cases, based on the Mentor's advice, the student can take courses outside of the School of Pharmacy, either via attendance or via distance-learning. However, in order to obtain credits for this course, approval of the course by the Graduate Program Committee will be required.

The culmination of the program will be the presentation of results of the students' research project in the form of a Ph.D. Thesis and its defense. The Major Advisor as well as the Thesis Committee will have a key role to guide the student towards the accomplishment of this goal. Direct contact with the Major Advisor in the laboratory will impart the technical skills required to carry out competitive experiments. Furthermore, where possible, exchange with other investigators will be encouraged for collaborative research projects, both within the School or Campus, or with researchers from external institutions. Importantly, also communication skills to disseminate the findings of the research will be developed with the guidance of the Mentor, in the form of the presentations in national or international symposia, as well as the development of technical writing skills in the form of manuscripts for peer-reviewed publications.

The proposed program will not use non-conventional modalities.

E. Beginning Date

The proposed Ph.D. in Pharmaceutical Sciences program, will admit the first students in academic year 2020-2021.

F. Program Length and Maximum Time for Completion

The proposed program is designed to be completed in five years. The interval between admission to the program and completion of degree requirements cannot exceed eight (8) years.

In the first year of the **Ph.D. in Pharmaceutical Sciences** program, all students will participate in required Core Courses, and will have diverse laboratory experiences. By the end of the first year, they will be required to select one of the tracks of the program. In the second year, the students will participate in the specialized Mentor-driven courses that are recommended for each of the tracks. In addition, they will carry out research leading to their final thesis project. In years three and four, the students will be working full-time towards the completion of their thesis research.

Students that do not complete the full program requirements leading towards the Ph.D. degree, will have the opportunity to obtain a **Master of Science in Pharmaceutical Sciences** degree. At a **minimum**, they will need to have completed the first two years of course-work. In addition, they will need to complete further requirements as stipulated in paragraph VI.A.

II. PROFESSIONAL ACCREDITATION AND PROFESSIONAL PRACTICE REQUIREMENTS

Professional Accreditation

The proposed program does not require professional accreditation, other than approval by the Council of Higher Education.

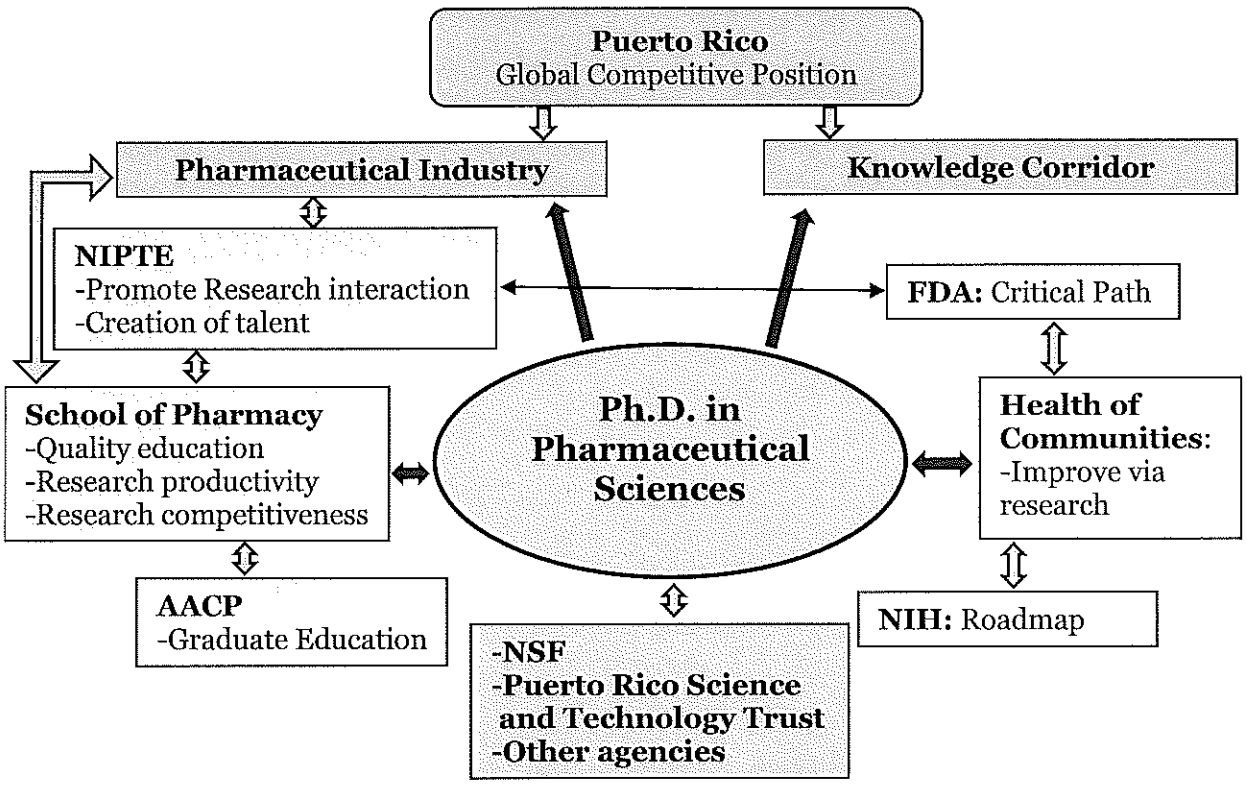
III. PROGRAM JUSTIFICATION

The Ph.D. in Pharmaceutical Sciences program will prepare professionals that will promote the advancement of research in pharmaceutical sciences and solutions of health problems for the benefit of mankind. The following paragraphs will describe how these students and future graduates will contribute to:

- Global Competitive Position of Puerto Rico
- Pharmaceutical Industry
- School of Pharmacy and University of Puerto Rico
- Health of Communities

The relation of the Ph.D. in Pharmaceutical Sciences program to these items is schematically represented in figure 3.

Figure 3: *Central position of the Ph.D. in Pharmaceutical Sciences program*



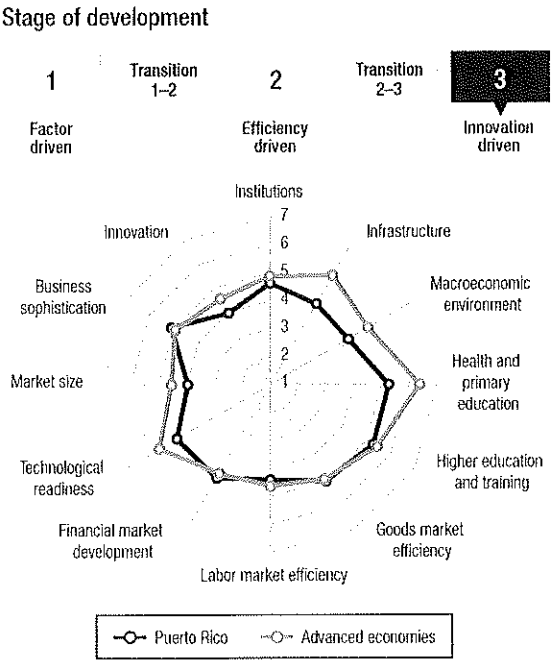
A. GLOBAL COMPETITIVE NEED

GLOBAL COMPETITIVE POSITION OF PUERTO RICO

In the Global Competitiveness Report 2014-2015 from the World Economic Forum, Puerto Rico ranks 32 among a total of 144 countries (figure 4)[6] [Puerto Rico was not included in the 2015-2016 and 2016-2017 reports; possibly for 2017-2018 they will be listed again[7]]. It was the second highest ranked economy in Latin America and the Caribbean. According to this report, Puerto Rico's competitiveness appears to be sustained by the ***Efficiency enhancers:*** Goods market efficiency (20th), Higher education and training (27th), and Financial markets (21st), in addition, to the **Innovation and sophistication factors**: Business sophistication (18th) and Innovation (29th).

Figure 4: *Global Competitiveness index Puerto Rico*

	Rank (out of 144)	Score (1-7)
GCI 2014–2015	32	4.6
GCI 2013–2014 (out of 148)	30	4.7
GCI 2012–2013 (out of 144)	31	4.7
GCI 2011–2012 (out of 142)	35	4.6
Basic requirements (20.0%)	68	4.6
Institutions	34	4.6
Infrastructure	58	4.3
Macroeconomic environment	99	4.2
Health and primary education	103	5.3
Efficiency enhancers (50.0%)	28	4.7
Higher education and training	27	5.3
Goods market efficiency	20	5.0
Labor market efficiency	46	4.4
Financial market development	21	4.8
Technological readiness	37	4.9
Market size	60	4.0
Innovation and sophistication factors (30.0%)	27	4.5
Business sophistication	18	5.1
Innovation	29	4.0



The Report classifies Puerto Rico in Stage 3 of development: **Innovation driven.** In this stage, innovation (pillar 12) is the key to development. Companies must produce new and different goods using the most sophisticated production processes (pillar 11). This requires sufficient investment in research and development, especially by the private sector, the presence of high quality scientific research institutions, extensive collaboration in research between universities and industry, and the protection of intellectual property. The competitive advantage of Puerto Rico in innovation is provided by the quality of scientific research institutions, university – industry research collaboration and availability of scientists and engineers. The Ph.D. in Pharmaceutical Sciences program will stimulate research, and educate the human resources that will drive and enhance innovation, required to increase international competitiveness.

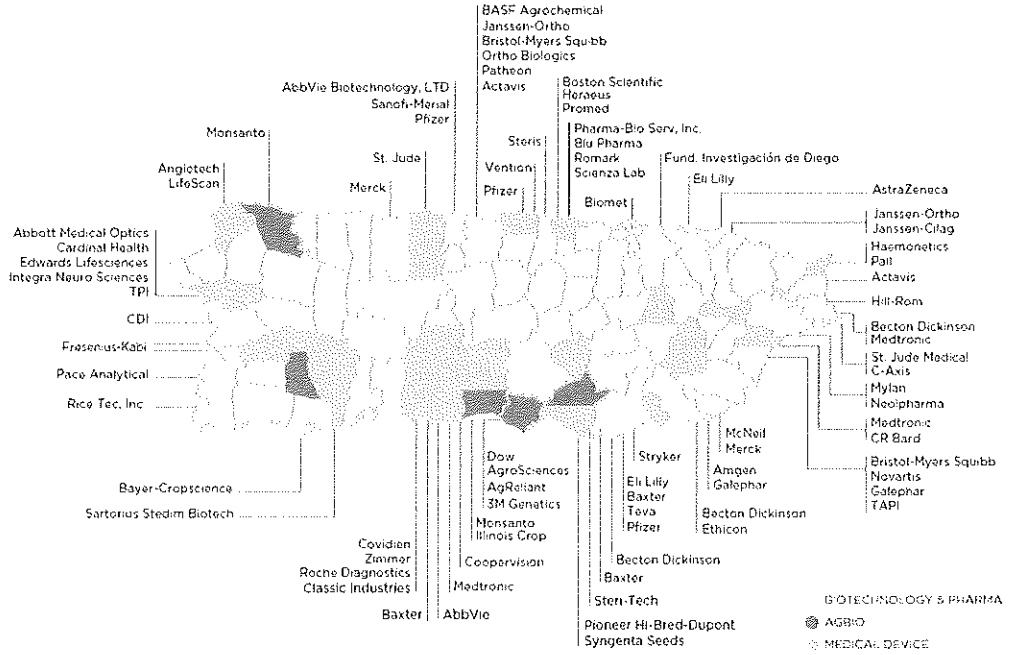
[6] http://reports.weforum.org/global-competitiveness-report-2014-2015/
[7] http://elvocero.com/posible-regreso-al-informe-de-competitividad-del-wef/

B. PROFESSIONAL NEED

PHARMACEUTICAL INDUSTRY

The **Pharmaceutical Industry** and related Life Sciences Industries are widely distributed across Puerto Rico (figure 5)[8], and constitute a significant part of the economy of the island. The biopharmaceutical industry represents **26.5%** of the island's Gross Domestic Product, 60% of all island imports and 98% of all island exports. The biopharmaceutical industry in Puerto Rico generates over **86,000** jobs on the island: **18,000** direct and **68,000** indirect[9]. The pharmaceutical industry is remains competitive via continuous innovation in new products and manufacturing technologies. According to the members of the Pharmaceutical Industry Association (PIA), there is a need for qualified personnel with the following skills: Problem-solving, critical thinking, communication, technical writing, and entrepreneurship mentality The Ph.D. in Pharmaceutical Sciences program will educate students to obtain these skills.

Figure 5: *Pharmaceutical and Life Sciences Industry in Puerto Rico*



The public policy of the Commonwealth of Puerto Rico is to promote and develop a knowledge based economy. To advance this policy, the **Knowledge Corridor** is being developed, which will host a "Science District" completely dedicated to the advancement of knowledge and innovation[10]. It will house state-of-the-art facilities for research, academic, and business initiatives. The University of Puerto Rico Medical Sciences Campus is one of the core research centers within the science district. Research activities carried out by faculty members and Ph.D. in Pharmaceutical Sciences students and graduates are expected to contribute to the further development of the knowledge based economy.

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[8] Healthcare and Life Sciences Review, PharmaBoardRoom, January 2016, p.9 http://pharmaboardroom.com/wp-content/files_mf/1454427075PuertoRicoHCLSReviewJanuary2016Pharmaboardroom.pdf

[9]http://www.piapr.org/index.php?submenu=BoardofDirectors&src=gendocs&ref=Board%20of%20Directors&category=Aboutus

[10] http://prsciencetrust.org/about-the-trust/science-city/

C. ACADEMIC NEED

SCHOOL OF PHARMACY AND UNIVERSITY OF PUERTO RICO

The **School of Pharmacy** strives to continually strengthen her educational programs, and to promote interdisciplinary research to improve the health of the community. To contribute to these goals, one of the objectives in the Strategic Plan of the School is to develop the Ph.D. in Pharmaceutical Sciences program. The Department of Pharmaceutical Sciences has been able to considerable increase the involvement of its faculty in research activities. New faculty members with the credentials to carry out independent research projects have been recruited in recent years. Of the twelve faculty members in the Department, at present eleven have fifty percent or more of their academic load assigned for research activities. For the vacant position, an additional candidate with research experience will be recruited. Further development of research activities by faculty and prospective Ph.D. students in the School of Pharmacy will be greatly expanded via the Ph.D. in Pharmaceutical Sciences program. *This is expected to lead to enhanced research productivity, resulting in* ***increased external funding via competitive research grants, peer-reviewed publications and patents.*** Development of intellectual property will open the road to new start-up companies, as exemplified by the fact that two faculty members of the Department of Pharmaceutical Sciences already have done so. Through licensing agreements, this could lead to income for the University of Puerto Rico, and provide local employment in the life sciences industry.

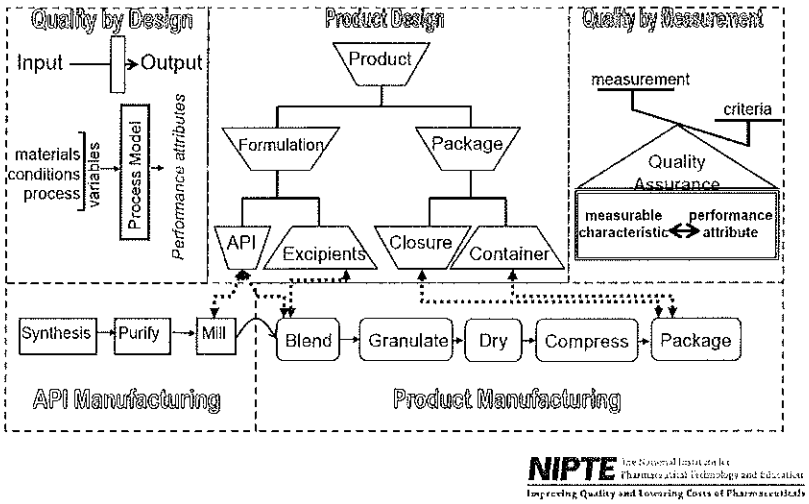
The Research and Graduate Affairs Committee of the **American Association of Colleges of Pharmacy (AACP)** on a regular basis publishes reports on the future of Graduate Programs in their journal, the American Journal for Pharmacy Education (AJPE). In their last report (2013)[11], it was stated that the future of pharmaceutical sciences is changing, and graduate programs should be revitalized to energize students and alumni to find and create jobs that continue to make a meaningful contribution in healthcare. There is a need for pharma to be more interdisciplinary and innovative, requiring increased collaborations among industries and with academia. This will require graduates that, besides quality science taught in the laboratory, also have additional skills such as in business, communication, teamwork, and leadership, among others[12]. The Ph.D. in Pharmaceutical Sciences program is designed to include these skills.

The School of Pharmacy is a core academic partner of the **National Institute of Pharmaceutical Technology Education (NIPTE)**. The mission of NIPTE is to improve human health through multi-university collaborative research to advance the quality, safety, affordability and speed to market of medicines through interdisciplinary research and education in pharmaceutical technology[13]. Faculty and researchers from eleven institutions collaborate with the FDA and industry to encourage innovation in product development and safe manufacture of pharmaceutical drugs. Concepts such as process analytical technology, quality by design, and design space have been widely discussed and initial attempts have been made to inject these concepts into practice. The **Research Agenda** of NIPTE includes the promotion of research interaction between industry, academia and government, and to develop an understanding of factors affecting variability in drug development, scale-up, quality, and manufacturing. The **Education Agenda** of NIPTE includes the creation of a "pipeline" of diverse talent that

[11] Susanna Wu-Pong, Jogarao Gobburu, Stephen O'Barr, Kumar Shah, Jason Huber, and Daniel Weiner. The Future of the Pharmaceutical Sciences and Graduate Education: Recommendations from the AACP Graduate Education Special Interest Group. *American Journal of Pharmaceutical Education* **2013**; 77 (4) Article S2.
[12] See Table 1 in the above reference for additional skills.
[13] http://www.nipte.org/

commences at the undergraduate level and continues throughout graduate, postgraduate, and continuing education, augmenting the available workforce in academia, industry, and government. To accomplish this, NIPTE advocates an interdisciplinary and constructivist roadmap for pharmaceutical Technology education (figure 6). The Ph.D. in Pharmaceutical Sciences program, especially within its Pharmaceutics and Drug Delivery track, will contribute to the mission of NIPTE and strengthen the Schools' position within the organization.

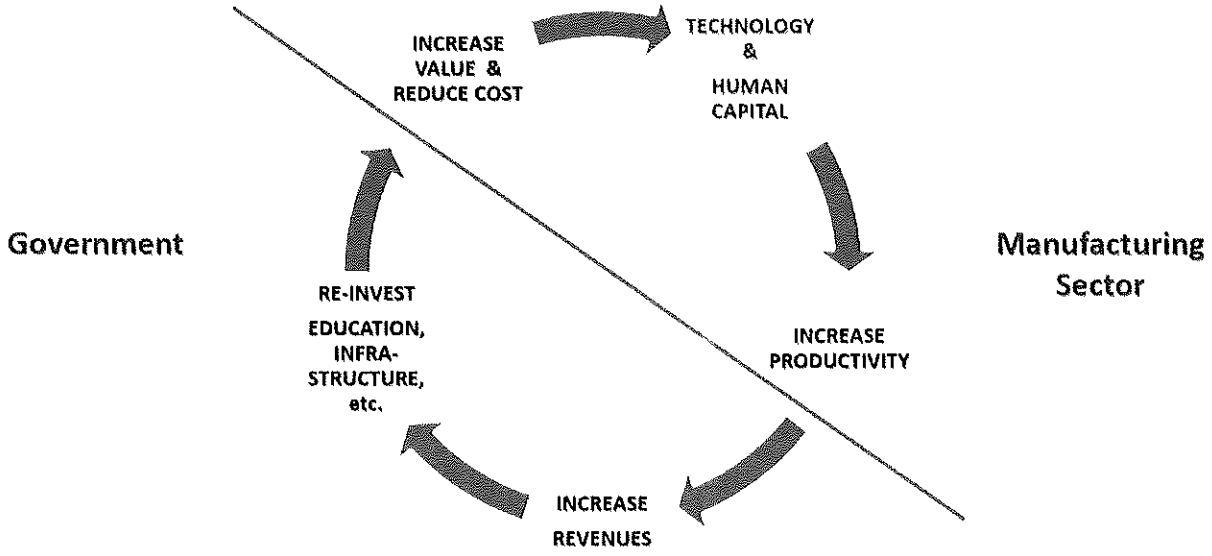
Figure 6: *Transforming the education paradigm*



The **University of Puerto Rico** will benefit greatly with the Ph.D. program because it expands the capabilities of obtaining external funds to perform research in the areas of interest, will acquire global recognition through the innovative and creative research, and will contribute to the growth of the socio-economic needs for Puerto Rico. The main contribution of the program will be the development of the human capital (scientist, researchers, professionals) needed to accomplish the goals mentioned through this unique program, focusing in creating leaders who will undertake the transformation of the pharmaceutical industry towards the new trends such as continuous manufacturing, biopharmaceuticals and personalized medication.

Furthermore, we can foster socio-economic development for Puerto Rico by promoting our Ph.D. in Pharmaceutical Sciences program through innovative research that can be applied to enhance the transformation of the pharmaceutical industry, thus improving our quality of life. In addition, the available pool of minority researchers in the Life Sciences will be increased. This change will attract investment and create jobs within the life sciences (Figure 7).

Figure 7: *Correlation between Higher Education and Manufacturing*



D. SOCIAL NEED

HEALTH OF COMMUNITIES

The mission of the School of Pharmacy includes the development of interdisciplinary research that contributes to the advancement of scientific knowledge leading to the improvement of health of communities and individuals. One of the means by which this can be accomplished is via the development and manufacturing of safe and novel pharmaceutical therapies or methods. To drive innovation in the scientific processes through which medical products are developed, evaluated, and manufactured, the Federal Drug Administration (**FDA**) has developed the **Critical Path Initiative**[14]. Similarly, the National Institute of Health (**NIH**) has presented its **Roadmap**[15] that currently via the **NIH Common Fund**[16] supports research that provides a scientific evidence base that will usher in an era where medicine is predictive, personalized, preemptive, and participatory.

The goal of these initiatives is to improve health via acceleration of both the pace of discovery in the life sciences, and the translation of bench to bedside[17]. In this paradigm, the development of new drugs and medical products adopts a bidirectional information flow and circular mode so that what is learned in practice flows back to basic science (figure 8). In addition, in a parallel dimension, the safety, medical utility and industrialization is progresses. This requires the development of knowledge base and skills necessary to understand and use the approaches of other disciplines, and the development of the skills necessary to work in an interdisciplinary research team, among others. The Ph.D. in Pharmaceutical Science program will educate the workforce needed to accomplish these goals, and to improve the health of the community.

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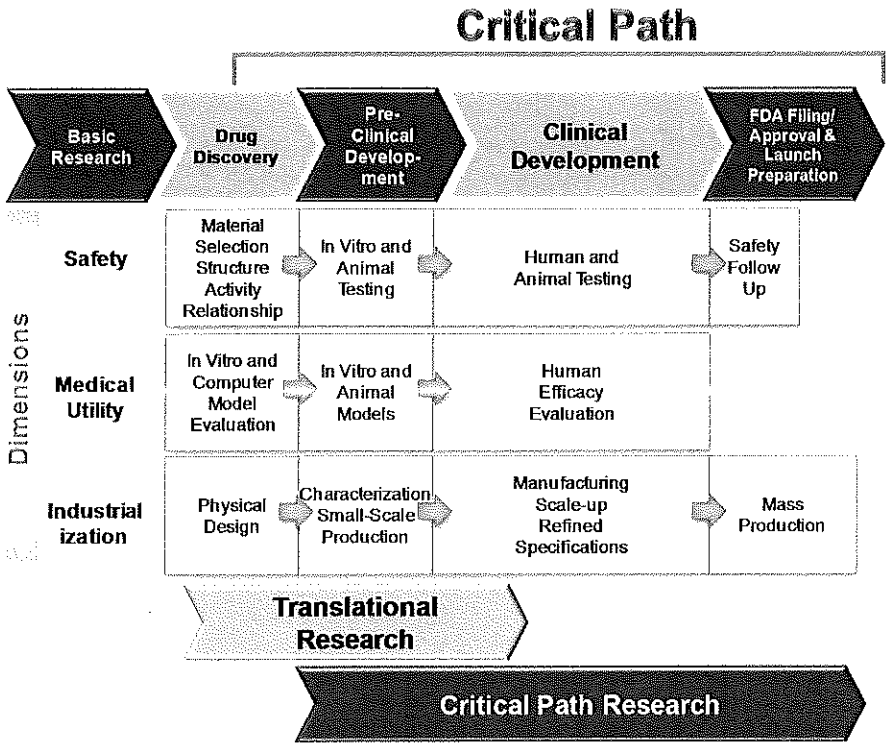
[14] http://www.fda.gov/ScienceResearch/SpecialTopics/CriticalPathInitiative/ucm076689.htm

[15] Zerhouni E Medicine. The NIH Roadmap. Science. 2003 Oct 3;302(5642):63-72.

[16] https://commonfund.nih.gov/

[17] William T. Back, Seth Y. Ablordeppey, William F. Ehmquist, Kimberly A. Gal, Daniel, C. Malone, Jeanine K. Mount, and Kenneth W. Miller, (2005) "Impact of the NIH Roadmap on the Future of Graduate Education in Colleges/Schools of Pharmacy", *American Journal of Pharmaceutical Education*, **69**(5)S1:1-14.

Figure 8: *Working in three dimensions in the critical path to new medicines*



CONCLUSIONS

The modernizing transformation of the present M.S. in Pharmacy program into the Ph.D. in Pharmaceutical Sciences program will educate students with the required up-to-date technical and soft skills to contribute to advancements in pharmaceutical sciences and health. Increased skills of the labor force in the pharmaceutical sciences will have a positive impact in the global competitiveness of Puerto Rico, especially with the pharmaceutical industry. In addition, the research activities within the School of Pharmacy will be greatly stimulated, leading to a greater research productivity as evidenced by grants, publications and patents of its faculty. The outcomes of the increased research activities within the School and in the future workplaces of the graduates will contribute to the improvement of health in the community.

E. Demand for the Program and Graduates

Several strategies were carried out to assess the demand for a Ph.D. in Pharmaceutical Sciences program and its future graduates. Among these are questionnaires, participation in fora such as the PharmaCluster of Induniv, and meetings with pharmaceutical industry representative in the School.

In the evaluation of the M.S. in Pharmacy program, a questionnaire was carried among active students, alumni, supervisors of the alumni, and faculty. The following opinions in a question related to the desirability of the establishment of a Ph.D. program were summarized in the report as follows[18]:

- Of the active students, 44% are interested and 25% would consider registering in a Ph.D. program. The areas indicated are Pharmaceutical Sciences (17%), Quality Control (17%) and Industrial Pharmacy (66%).
- Of the alumni, 45% are interested and 27% would consider registering in a Ph.D. program. The areas indicated are Process Development (20%), Industrial Pharmacy/Pharmaceutics (40%), either of the two options (40%).
- Of the supervisors, 3 of 4 indicate that their organization would benefit from personnel with a Ph.D. degree in any of the areas in Pharmacy. Only one indicates an area (Pharmaceutics). 1 of 4 supervisors indicates that in Puerto Rico the organization would not benefit, but in the area of R&D it would be of great benefit. Many of the professionals that finish a Ph.D. go to Academia.
- Of the faculty, 82% indicate that they consider that there is a need in the labor market in Puerto Rico for a Ph.D. in any area of Pharmacy (18% do not). The areas indicated are Pharmaceutical Sciences (33%), Both Pharmaceutical Sciences and Industrial Pharmacy (22%), Industrial Pharmacy/Pharmaceutics [drug delivery – Biotech – Nanotech] (33%) and Processes and Biotechnology (11%).

The Graduate Program Evaluation Committee, supported by the above questionnaire among other evidences, recommended the transformation of the M.S. in Pharmacy program into a Ph.D. program. This recommendation was accepted by the faculty of the School, and incorporated into its Strategic Plan.

To further evidence demand for the program and graduates, the School of Pharmacy has invited industry representatives, including members of the Pharmaceutical Industry Association (PIA). They affirmed the need for graduates in their companies, and via their feedback, desired skills and competencies have been included in the Graduate Profile (paragraph IV.D). In addition, faculty members of the School participate in the "Pharma Cluster", in which academia and the pharmaceutical industry are meeting regularly under the auspices of INDUNIV. An online questionnaire was distributed among participants of the Pharma Cluster (appendix 1). From the respondents, 24% indicated that they would recruit personnel with an advanced degree in Pharmaceutical Sciences, 36% were not sure, and 40% would not (appendix 2). In addition, 65% indicated that a Ph.D. degree would be most appropriate versus 35% for an M.S. degree. Unfortunately, the respondents were mainly from an academic background (70%), and only 15% from the industry. Benchmarking via direct interactions with members from the pharmaceutical industry indicated a much greater level of interest. In appendix 3 letters of support from industry representatives as well as from INDUNIV and the Puerto Rico Science Trust that support the development of a Ph.D. program are included. In addition, it is expected that the program will deliver graduates that will work in new start-up biotech companies, which could be related to novel intellectual property developed during their thesis research work.

[18] Master of Science in Pharmacy Evaluation Report, July 2009, Graduate Program Evaluation Committee, page 11.

IV. CONCEPTIONAL FRAMEWORK

A. Vision and Mission

Vision

To be recognized as a leader in pharmaceutical sciences education and interdisciplinary research through innovative efforts to improve the quality of life in Puerto Rico and globally.

Mission

To educate students who will improve the quality of life of the community through interdisciplinary research that will advance scientific knowledge in pharmaceutical sciences.

B. Goals and Objectives

The goals, objectives and corresponding competencies of the program are summarized in table 1:

Table 1: *Goals, objectives and competencies of the Ph.D. program*

GOAL	OBJECTIVE At the end of the studies, the student:	COMPETENCY
1. Prepare scientists with the knowledge, skills and attitudes that will enable them to advance research in pharmaceutical sciences.	1a. Will be committed with the integrity and ethics principles of research in the pharmaceutical sciences.	Ethics
	1b. Will show an inquisitive and compelling spirit with the building of knowledge and continuous development of research skills	Self-learning
	1c. Will apply critical thinking in problem solving and decision-making in research	Critical thinking, problem-solving, decision-making
2. Prepare professionals that will contribute to the solution of health-related problems through systematic research	2a. Will develop innovative research projects in the pharmaceutical sciences area	Critical thinking
	2b. Will disseminate the findings of the research to contribute to the advancement of scientific knowledge in the pharmaceutical sciences	Communication and informatics
	2c. Will participate in interdisciplinary research endeavors with other public or private institutions and corporations in Puerto Rico or abroad	Ability to work independently or within a group
	2d. Will serve as a guide or mentor for future researchers	Leadership

C. Educational Philosophy

Ontology – Ideal student to develop

The School of Pharmacy is committed with the development of researchers that foster the advancement of knowledge in the pharmaceutical sciences. By means of the Doctorate in Philosophy in Pharmaceutical Sciences, the goal is to develop researchers that are inquisitive, analytical, critical thinkers and competent with knowledge, abilities, attitudes and values necessary to carry out novel research projects in the area of pharmaceutical sciences in an inter and multidisciplinary environment.

Epistemology – How to learn; role of the professor - role of the student

Starting from the understanding that the human being actively learns with experiences that promote discovery, the learning-teaching process is directed, from an interdisciplinary perspective to provide educational activities, experiences and research opportunities that promote learning by discovery and the generation of knowledge by the student.

Interdisciplinary and constructive curriculum

The role of the educator is to be a model researcher that guides the student in his or her research creating an environment where the student is able to develop his abilities in critical thinking, problem solving and decision making, communicating and using effectively electronic information. These abilities are to be used in collaborative and independent work that is geared towards self-learning with the dedication to the highest integrity in research and ethical principles. The teacher, as an agent of change, becomes mentor to the student in the development of research skills.

Axiology- Fundamental values that guide the curriculum

The program has the following fundamental values centered in the educational process: equality, dignity, liberty, justice, truth and integrity.

D. Graduate Profile

A student who has completed the Ph.D. degree in Pharmaceutical Sciences will have the knowledge, skills, and attitudes needed to carry out innovative research projects in the pharmaceutical sciences in an inter – multidisciplinary scenario, demonstrating the following competencies.

1. Critical thinking

a. Demonstrates critical thinking in the design and carryout of scientific inter or multidisciplinary research projects in the pharmaceutical sciences.
b. Develops or constructs knowledge at complex levels (with amplitude and depth or complexity) and from multiple perspectives assuming responsibility.
c. Creates conceptual knowledge that is transferred to a theoretical or scientific thesis work.
d. Evaluates the quality and truthfulness of the information, of the acts and accomplishments involved in the research.
e. Assumes a position when controversies or conflicts develop.
f. Assumes responsibility for the consequences of the critique rendered.

2. Problem solving and decision making

a. Design and carryout of scientific inter or multidisciplinary research projects in the pharmaceutical sciences.
b. Applies systematically the process of problem solving to research.
c. Uses relevant and reliable information from different sources for problem solving.
d. Solves research problems applying the fundamentals of pharmaceutical sciences.
e. Demonstrates creativity in problem solving and decision making.
f. Values the systematic use of the process of problem solving in research.
g. Implements a course of action as to obtain solutions during the research.
h. Assumes responsibility and accountability for the results obtained from the decisions taken and the course of action implemented.

3. Communication and informatics

a. Communicates knowledge effectively, oral and written, with peers and the scientific and professional community.
b. Uses informatics systems to collect, process, analyze, interpret and make decisions when carrying out research projects.
c. Integrate information resources in communication.
d. Demonstrates assertiveness when communicating with peers and the general public.
e. Values the importance of an effective communication with peers, professionals and the general public in advancing research.

4. Ethics

a. Demonstrates the highest commitment with research integrity and ethical principles.
b. Demonstrates transparency, integrity, and honesty in all actions.
c. Analyzes situations that present ethical dilemmas at the personal, professional and social context.
d. Incorporates moral process in decision making.
e. Evaluates the process and results of ethical decisions.
f. Assumes responsibility and accountability of the results obtained from ethical decisions.
g. Appreciates the influence of personal values in research and professional practice.

5. Ability to work independently and in group settings

a. Promotes interdisciplinary work among members of the work team by establishing a culture of communication.
b. Solves problems relating to the development of adequate interaction and social relationship in the professional scenario.
c. Appreciates the importance for effective work in groups, the significance of empathy, and assertiveness to comply with common charges, responsibility, cooperation, integrity, and credibility.
d. Values the collaboration of other researchers, and the interchange of information in the pursuit of research and knowledge.
e. Designs and carryout of scientific research projects in the pharmaceutical sciences.

f. Demonstrates an intellectual curiosity and inquisitive spirit to construct new knowledge through research.
g. Assumes responsibility and accountability for the execution of decision making in research.

6. Self-learning

a. Develops his/her competencies intentionally and systematically in a constant search for excellence.
b. Identifies areas of strength, and areas of improvement establishing strategies for betterment.
c. Applies the process of self-learning for documenting, informing and illustrating the new advances in science, and focusing on new challenges in scientific research.
d. Assumes responsibility and accountability for the results obtained in the interventions that lead to the search of new knowledge.
e. Values the importance of varied information sources and regularly incorporates them in the process of self-learning.

7. Leadership

a. Lead successfully in academia, government and industry scenarios.
b. Demonstrates capability for mentoring
c. Takes a long-term view and translates ideas and initiatives into workable projects by managing human, physical financial and technological resources.

E. Conceptual Model Coherence and Suitability

According to the Global Competitiveness Report 2014-2015 from the World Economic Forum, Puerto Rico ranks 32 among a total of 144 countries[19]. It is the second highest ranked economy in Latin America and the Caribbean. The Report classifies Puerto Rico in Stage 3 of development: **Innovation driven**. For Puerto Rico to compete in the global market it needs to strengthen the higher education system. The uniqueness of the Ph.D. in Pharmaceutical Sciences program, with its focus on increasing the human capital needed to obtain a competitive advantage in the global market through high quality research and innovation, will be of paramount importance to accomplish this goal. The educational strategy incorporates fostering a collaborative relation between the industry and academia.

The continuous innovation in the pharmaceutical industry maintains it competitive, through the development of new products and manufacturing technologies. The Ph.D. in Pharmaceutical Sciences program will stimulate research, and educate the human resources that will drive and enhance innovation, required to increase international competitiveness. The Pharmaceutical Industry Association has also mentioned that problem solving, critical thinking, decision-making, communication, technical writing, and entrepreneurship mentality are necessary skills for their personnel. The Ph.D. in Pharmaceutical Sciences program will educate students to obtain these skills.

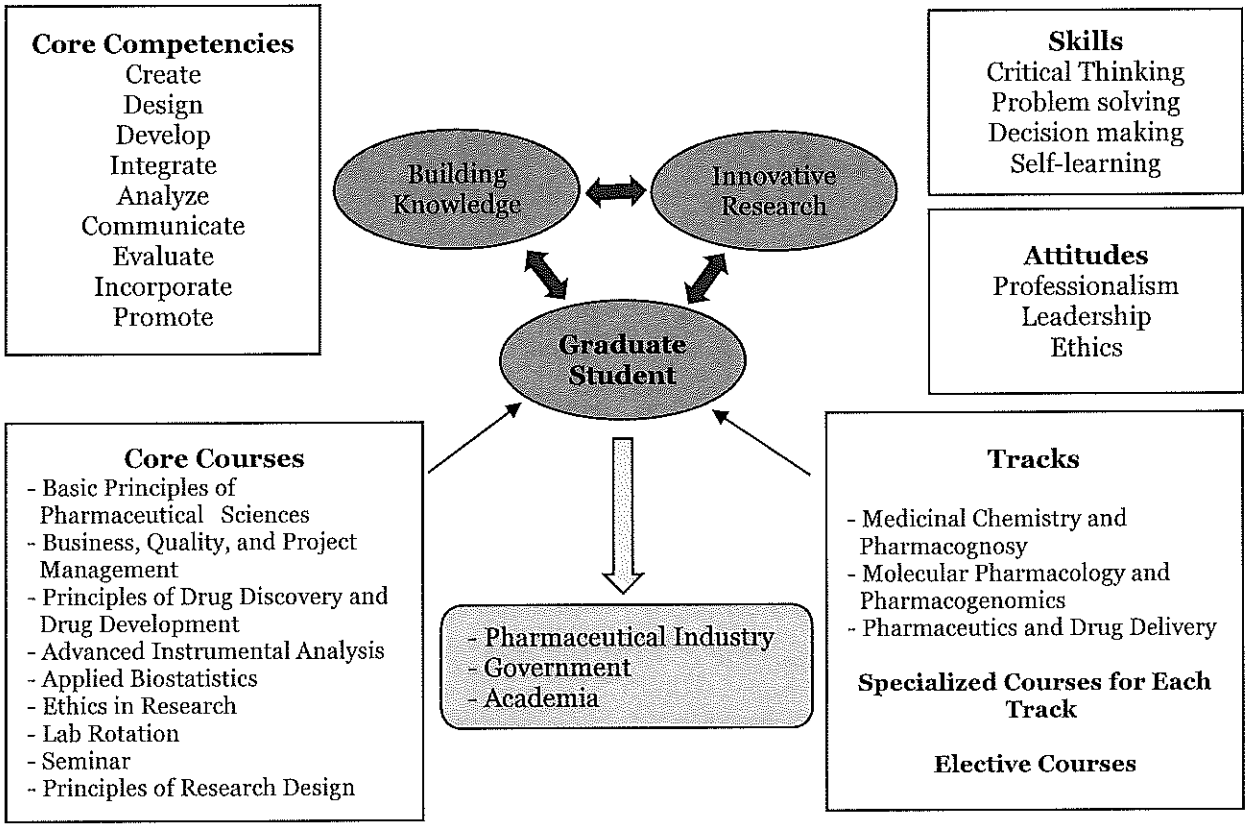
The doctoral graduate will broaden its knowledge and skills and expand the specific skills of applied research to meet these needs, find solutions to problems, and develop competencies for professional leadership in the community and pharmaceutical industry. The extent to which we

[19] http://reports.weforum.org/global-competitiveness-report-2014-2015/

are able to address the challenges make additional improvements in our community and the industry depends, in large part, upon the quality and preparedness of our graduate student, which, in turn, is dependent upon the education and training that our program will provide. The development of a Ph.D Pharmaceutical Sciences program at the University of the Puerto Rico School of Pharmacy will meet these needs.

Figure 9 shows the core components and curricular approaches of the three tracks, which emphasize a graduate profile that will develop leaders of innovation and research that can assist in the socio-economic needs of Puerto Rico. The Ph.D. program will provide the opportunity to develop a body of knowledge and skills needed to accomplish these goals through the competencies encompassed in this program.

Figure 9: *Conceptual Model for the Ph.D. in Pharmaceutical Sciences program*



V. PROGRAM'S RELATION TO INSTITUTIONAL MISSION AND STRATEGIC GOALS

A. The Relation of the Program's Mission to the Mission of the Medical Sciences Campus and the Mission of the School of Pharmacy

Doctor of Philosophy in Pharmaceutical Sciences To educate students who will improve the quality of life of the community through interdisciplinary research that will advance scientific knowledge in pharmaceutical sciences.
Medical Sciences Campus Prepare health professionals by offering academic programs at professional, undergraduate, graduate, post-graduate levels, and continuous education, to improve the health of citizens of Puerto Rico and the world, and strengthen patient care services via knowledge and innovation generated by research. [unofficial translation: Plan Estratégico RCM2017-2022]
School of Pharmacy To educate students, pharmacists and scientists who will improve the health of communities and individuals through the provision of pharmacist delivered patient care, interdisciplinary research and service; that contribute to the advancement of scientific knowledge and the pharmacy profession.

B. Relation of the Program's Strategic goals to the Strategic Plan of the University of Puerto Rico, the Medical Sciences Campus and the School of Pharmacy

As described in section IV. (Conceptional Framework), there are two main strategic goals for the Doctor of Philosophy in Pharmaceutical Sciences program. In table 2, these goals are reiterated, and brought together with the goals of the strategic plans of the University of Puerto Rico (Plan Estratégico 2017-2022), the Medical Sciences Campus (Plan Estratégico 2017-2022), and the School of Pharmacy, relevant to the Ph.D. program.

V. PROGRAM'S RELATION TO INSTITUTIONAL MISSION AND STRATEGIC GOALS

Table 2: *Strategic goals of the Ph.D. program, the UPR, The MSC, and the School of Pharmacy*

Doctor of Philosophy in Pharmaceutical Sciences • ***Goal 1.*** Prepare scientists with the knowledge, skills and attitudes that will enable them to advance research in pharmaceutical sciences. • ***Goal 2.*** Prepare professionals that will contribute to the solution of health related problems through systematic research
University of Puerto Rico – Plan Estratégico 2017-2022 [unofficial translation] • ***Strategic goal: Educational environment – Goal 1:*** Enrich the academic offerings with pertinent academic programs, differentiated and competitive with diverse modalities that respond to the evolution and requirements of the fields, the professions, and the labor market, both within Puerto Rico and globally; the recruitment of students and faculty while continuously attending the needs for professional development of human capital. • ***Strategic goal: Research and creation – Goal 1:*** Develop new knowledge via research and creation, making optimum use of human and physical resources, and the technological systems of the UPR. • ***Strategic goal: Research and creation – Goal 2:*** Increase the application and awards of external funds fot research and creation. • ***Strategic goal: Research and creation – Goal 3:*** Make the competencies and knowledge, and creation of services developed in the educational environment available to the diverse communities of the country.
Medical Sciences Campus Draft Plan Estratégico 2017-2022 [unofficial translation] • ***Strategic goal: Educational environment – Goal 1:*** Promote an innovative environment based on a learning model that responds to the evolution and requirements of the disciplines and the labor market that assures continuous improvement via assessment of the academic programs and student learning. • ***Strategic goal: Educational environment – Goal 1:*** Adjust the academic oferings and continuous education to emerging areas of knowledge in health sciences via continuous assessment. • ***Strategic goal: Research and creation – Goal 1, 2 and 3****: Identical to UPR Strategic goals (see above).*
School of Pharmacy • ***Goal 1.*** Provide excellent academic programs that will foster the School's leadership and competitiveness in Puerto Rico. • ***Goal 2.*** Promote interdisciplinary research to improve the health of the individuals and the community. • ***Goal 9.*** Strengthen collaborations with other schools of pharmacy and organizations at a national and international level. • ***Goal 10.*** Integrate the views of stakeholders from diverse perspectives and experiences in order to improve the academic program effectiveness.

An assessment was made to relate keywords present in the "Goals, Objectives and Competencies" of the Ph.D. in Pharmaceutical Sciences program from Table 1 to the objectives of the UPR, Medical Sciences Campus, and the School of Pharmacy. The objectives of the last three units ***relevant*** to the Ph.D. proposal are provided in Table 3, and the keywords from the Ph.D. proposal are highlighted in pink (UPR), blue (Medical Sciences Campus) and green (School of Pharmacy).

V. PROGRAM'S RELATION TO INSTITUTIONAL MISSION AND STRATEGIC GOALS

Table 3: *Objectives of the Ph.D. program, the UPR, The MSC, and the School of Pharmacy*

UPR

2. 2 To foster and support research and investigation, especially in those disciplines and areas of study where it is possible to garner competitive outside funding and where there is the potential for the research to generate contributions to society, culture, industry and public policy.

2.3 To stimulate and support continuous and systematic revision of academic offerings in order for programs and courses of study to keep abreast of developments within the various disciplines, to adapt to societal and cultural demands and the expectations of the job market, to be responsive to students' personal educational interests, and to take full advantage of the faculty's various areas of competency and expertise.

3.1 To promote competitive research, investigation, and creative work in all disciplines at a level that conforms to international standards of excellence.

3.2 To encourage the production of researchers and investigators in theoretical and applied disciplines by providing them with adequate equipment, exposure, working conditions, and administrative support.

3.3. To encourage research and investigation in disciplines and areas of study in which is it is possible to garner competitive outside funding and where there is the potential for the research to generate contributions to society, culture, industry, and public policy.

3.4 To establish research consortia with the public, private, community, and non-governmental sectors.

3.7 To effectively incorporate students into the faculty's research and investigation projects as a way of enriching the students' educational experience.

3.8 To encourage technology transfer, the commercialization of intellectual property, and research and investigation that will impact the social and financial development of Puerto Rico.

3.10 To strengthen the university community's publishing, particularly in juried and peer-reviewed journals.

7.7 To encourage our faculty and researchers to take part in professional exchange programs with universities and research centers outside Puerto Rico.

7.8 To support the international publication and presentation of the results of our faculty's and students' research and to sponsor academic and professional conferences and symposia to which the international community is invited and in which our own faculty and students, as well as international guests, take part.

Medical Sciences Campus

1.1 Foster and support research in diverse disciplines and areas with the potential to obtain external funds.

1.2 Diversify research support for the development of infrastructure, mentoring and planning, and execution of projects, publication of manuscripts, and dissemination at local, national and international level.

1.4 Strengthen interdisciplinary research and multidisciplinary teamwork.

1.5 Stimulate technology transfer, and commercialization of intellectual property and creative work.

1.6 Effectively integrate students in research activities.

3.5 Redirect the academic programs for the formation of up-to-date professionals towards the current needs in the Puerto Rican society.

8.1 Design and implement an effective recruitment program for talented students within and outside of Puerto Rico with the purpose to increase qualified applications of potential students, according to the academic standards of excellence.

V. PROGRAM'S RELATION TO INSTITUTIONAL MISSION AND STRATEGIC GOALS

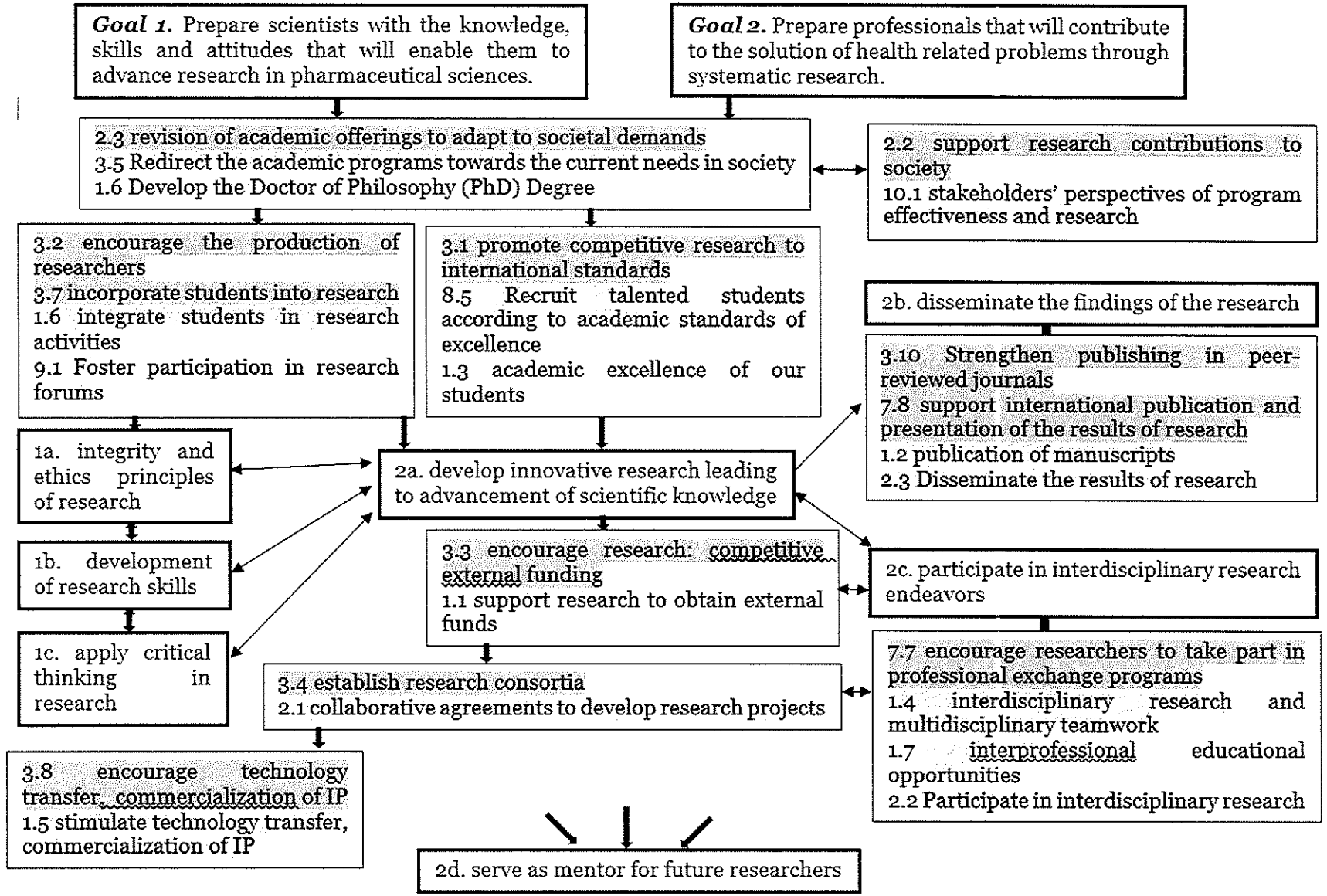
School of Pharmacy

1.3 Evidence the academic excellence of our students (Pharm D & Graduate Program).
1.6 Develop the Doctor of Philosophy (Ph.D.) Degree in Pharmaceutical Sciences as an academic offering of the Graduate Program.
1.7 Develop structured interprofessional educational opportunities in the curriculum.
2.1 Establish collaborative agreements with public, private, and community sectors to develop research projects.
2.2 Participate in interdisciplinary research within the university, locally, nationally, and internationally
2.3 Disseminate the results of research within the university, locally, nationally, and internationally.
9.1 Foster participation in student's organizations competitions and other research forums at national and international levels.
10.1 Gather stakeholders' perspectives at least once during the strategic planning cycle in a structured manner, on issues, priorities, and/or expectations that can impact policy decisions, foster future initiatives, or research, promote behavioral changes, synergies, and possible collaborations.

In figure 10, a schematic figure of the relationships of the goals and objectives of the proposed program with the goals and objectives of the UPR, Medical Sciences Campus, and the School of Pharmacy is provided. Keywords from the goals and objectives of the Ph.D. in Pharmaceutical Sciences program are summarized in white rectangles. The corresponding objectives from the UPR, Medical Sciences Campus, and the School of Pharmacy are highlighted in pink, blue and green respectively. It can be observed that the objectives from the Ph.D. program have a strong correlation with the objectives of the UPR, Medical Sciences Campus and the School of Pharmacy.

V. PROGRAM'S RELATION TO INSTITUTIONAL MISSION AND STRATEGIC GOALS

Figure 10: *Relation of the program to the Strategic Plans of the UPR, MSC and School of Pharmacy*



C. The Relation of the Program to Other Programs Inside and Outside the UPR

The Ph.D. in Pharmaceutical Sciences program of the School of Pharmacy will occupy a unique position in Puerto Rico. It will be the only graduate program in the island with an exclusive focus on the pharmaceutical sciences, and will substitute and enhance the current M.S. in Pharmacy program. Its focus on applied basic research with the potential for multidisciplinary research collaborations, and its relevance to the pharmaceutical industry are key benefits. Once the current Ph.D. proposal is approved, the current M.S. in Pharmacy programs (Industrial Pharmacy and Pharmaceutical Sciences) will be placed on a moratorium.

Medicinal Chemistry and Pharmacognosy track

In Puerto Rico, no other program is available that provides a similar curriculum with focus on the various aspects of drug action. Although many graduate programs in Basic Sciences (Chemistry, Biology etc.) exist, none of these programs integrate the disciplines that are directly relevant to the drug discovery and development process. Research in this area can directly lead to new intellectual property via the discovery of new biologically active compounds. As has been demonstrated, these compounds can be patented and potentially derive an economic benefit to the University.

Molecular Pharmaceutics and Pharmacogenetics

This track emphasizes the integration of biochemistry and genetics with pharmacology and pharmacokinetics. Although biochemistry and pharmacology programs are available in Puerto Rico, in the Ph.D. in Pharmaceutical Sciences program, an interdisciplinary and multidisciplinary approach to pharmaceutical research will be stressed. This track reinforces, and is complementary with the Medicinal Chemistry and Pharmacognosy track, and interdisciplinary research activities are greatly promoted and, as has been demonstrated, have been carried out previously and currently. In addition, this track includes a pharmacogenetics component, which is unique in Puerto Rico. Research results include prediction of drug efficacies and dosage, which can have a direct impact on the health of the community.

Pharmaceutics and Drug Delivery track

In Puerto Rico, no other Ph.D. program with a focus on Pharmaceutics and Drug Delivery is available. This track is targeted towards the pharmaceutical industry in Puerto Rico but also globally. Although, Puerto Rico's industry is mainly focused on manufacturing, process development has become more important due to the need of safer, greener, faster and more cost-efficient processes. To maintain a competitive edge, advancement of manufacturing methods and technologies are essential, to which graduates from this track will contribute. Despite complementary research of some faculty members at the Mayaguez Campus of the University of Puerto Rico in the Chemistry and Chemical Engineering Departments, only the presently proposed Ph.D. program provides a cohesive and fully integrated educational approach from pharmaceutical-related core courses to specific courses to research aspects. Increased collaboration between the proposed program and the faculties at the Mayaguez Campus are highly anticipated.

V. PROGRAM'S RELATION TO INSTITUTIONAL MISSION AND STRATEGIC GOALS

Competitive edge compared with other programs

The current Ph.D. proposal was established after benchmarking with Ph.D. in Pharmaceutical Sciences programs at Colleges of Pharmacy in U.S. institutions. In table 4, different tracks or options for select institutions are summarized. The selected tracks for the proposed program in the UPR are based on areas of strength in research of its faculty members. The currently proposed tracks provide a similarly attractive competitive diversity of different research areas, from pharmacogenomics to molecular pharmacology, to drug discovery and development and pharmaceutics and drug delivery.

Table 4: *Tracks and options in Ph.D. programs in U.S. Colleges of Pharmacy*

University of Puerto Rico	Medicinal Chemistry and Pharmacognosy
	Molecular Pharmacology and Pharmacogenomics
	Pharmaceutics and Drug Delivery
Ohio State University	Medicinal Chemistry & Pharmacognosy
	Pharmaceutics & Pharmaceutical Chemistry
	Pharmacology
	Translational Science
University of California, San Francisco	Pharmacogenomics
	Pharmacology
	Computational Genomics
	Molecular Pharmacology
	Drug Development
University of North Carolina	Chemical Biology & Medicinal Chemistry
	Pharmacoengineering & Molecular Pharmaceutics
	Pharmacotherapy & Experimental Therapeutics
	Pharmaceutical Outcomes & Policy
Purdue University	Medicinal Chemistry & Pharmacology
	Industrial & Physical Pharmacy
	Pharmacy Practice
University of Kentucky	Clinical & Experimental Therapeutics
	Pharmaceutical Outcomes & Policy
	Pharmaceutical Chemistry & Engineering
	Medical Bioorganic & Computational Chemistry
University of Maryland	Chemical & Biological Discovery
	Translational Therapeutics
	Pharmacometrics
University of Texas – Austin	Chemical Biology & Medicinal Chemistry
	Molecular Pharmaceutics & Drug Delivery
	Pharmacology & Toxicology
	Pharmacotherapy
	Health Outcomes & Pharmacy Practice

V. PROGRAM'S RELATION TO INSTITUTIONAL MISSION AND STRATEGIC GOALS

In Puerto Rico, no other Ph.D. program is available that provides the students with such a broad base of disciplines within the Drug Discovery and Development process. During the evaluation of the current M.S. in Pharmacy program, faculty were requested to comment on the competitive edge of the Graduate Program compared with other graduate programs in the UPR system and private universities[20]. Summarized, our faculty indicated that the program is unique in Puerto Rico and is not available at other institutions.

When comparing with other programs within Puerto Rico, it is noticeable that the only other School of Pharmacy on the island, Nova Southeastern University does not offer a Ph.D. program in Puerto Rico. The proposed Ph.D. in Pharmaceutical Sciences program at the School of Pharmacy will strengthen the research capabilities and outcomes at the Medical Sciences Campus. The new program will be complimentary to the current Ph.D. programs in the Biomedical Sciences at the Medical Sciences Campus, providing for a more robust research program in the School of Pharmacy that will enhance collaborative potential. Already at this moment, faculty members from the School of Pharmacy have established successful collaborative research projects with faculty members at the School of Medicine. It is expected that these collaborations, and therefore the potential to obtain external research funds will be increased.

[20] Master of Science in Pharmacy Evaluation Report, July 2009, Graduate Program Evaluation Committee, page 12.

VI. CURRICULAR DESIGN

This section describes the curricular sequence for each of the tracks within the Ph.D. in Pharmaceutical Sciences program. The descriptions of the core courses, the Mentor-driven courses for each track, and elective courses, as well as their alignment with the mission, objectives and goals, and the Graduate Profile are provided. In addition, teaching methodologies and a (student) assessment plan are provided.

A. Curricular Components and Course Distribution

In the **first year** of the program, all students will follow common Core Courses. After completing laboratory rotation in the first semester, students will be required to select a Major Advisor for their Thesis Research project. In this mentor-driven program, the Major Advisor will advise the students on selection of one of the available tracks, and courses that need to be completed.

Most of the courses presented below are adaptations of trimester courses that are currently provided in the M.S. in Pharmacy program of the School of Pharmacy. The M.S. in Pharmacy courses are combined and redistributed in semester courses, and renewed to include the most up-to-date knowledge in their respective areas. The total amount of credits for completion of the Doctor of Philosophy in Pharmaceutical Sciences program is 60 credits.

Core Courses		***Total: 22 Credits***
▪ PHSC XXXX	Principles of Pharmaceutical Sciences	3 credits
▪ PHSC XXXX	Business, Quality, and Project Management	3 credits
▪ PHSC XXXX	Principles of Drug Discovery and Drug Development	3 credits
▪ PHSC XXXX	Advanced Instrumental Analysis	3 credits
▪ PHSC XXXX	Applied Biostatistics	3 credits
▪ PHSC XXXX	Ethics in Research	2 credits
▪ PHSC XXXX	Lab Rotation	1 credits
▪ PHSC XXXX	Seminar I	1 credit
▪ PHSC XXXX	Seminar II	1 credit
▪ PHSC XXXX	Principles of Research Design	2 credits

During the first year, students will be required to select a Major Advisor, who will serve as a Mentor for the further progress of the student. In collaboration, and with approval of the Mentor, the theme for the student's Thesis Research project will be selected. Based on the research topic, expertise, a Thesis Committee will be established, which will need to be approved by the Graduate Program Committee. The Mentor will advise the student in the selection of one of the below tracks, of which short descriptions can be found in section I.B:

- Medicinal Chemistry and Pharmacognosy
- Molecular Pharmacology and Pharmacogenomics
- Pharmaceutics and Drug Delivery

The courses to be taken by the students in each of the tracks will be recommended by their Mentors. In the paragraphs below, the currently recommended Mentor-driven courses for each of the tracks are summarized. However, Mentors will have the flexibility to propose alternate courses in order for their students to comply with the requirements.

Depending on the selected track, the following currently proposed Mentor-driven Courses and Elective Course will need to be successfully completed during the **second year** of the program for each of the tracks. Based on each of the Mentor's recommendations to their specific students, currently listed courses may be substituted with other courses with an equivalent number of credits.

Medicinal Chemistry and Pharmacology track: ***14 Credits***

▪ PHSC XXXX	Advanced Medicinal Chemistry and Pharmacognosy I	3 credits
▪ PHSC XXXX	Advanced Medicinal Chemistry and Pharmacognosy II	3 credits
▪ PHSC XXXX	Advanced Molecular Biochemistry	3 credits
▪ PHSC XXXX	Advanced Methods in Synthetic Organic Chemistry	3 credits
▪ PHSC XXXX	Seminar III	1 credit
▪ PHSC XXXX	Seminar IV	1 credit

Molecular Pharmacology and Pharmacogenomics track: ***14 Credits***

▪ PHSC XXXX	Advanced Pharmacology I	3 credits
▪ PHSC XXXX	Advanced Pharmacology II	3 credits
▪ PHSC XXXX	Advanced Molecular Biochemistry	3 credits
▪ PHSC XXXX	Pharmacogenomics/ Pharmacogenetics	3 credits
▪ PHSC XXXX	Seminar III	1 credit
▪ PHSC XXXX	Seminar IV	1 credit

Pharmaceutics and Drug Delivery track: ***14 Credits***

▪ PHSC XXXX	Advanced Biopharmaceutics and Pharmacokinetics	3 credits
▪ PHSC XXXX	Pharmaceutical Engineering and Unit Operations	3 credits
▪ PHSC XXXX	Pharmaceutical Formulation and Drug Delivery	3 credits
▪ PHSC XXXX	Regulatory and Manufacturing Practice	3 credits
▪ PHSC XXXX	Seminar III	1 credit
▪ PHSC XXXX	Seminar IV	1 credit

Elective Courses

In the Mentor-driven program at least one additional elective course is required. Students will be encouraged to take elective courses from other tracks within the program. Alternatively, courses in other units of the UPR system or other Universities can be qualified, when these courses are approved by the Graduate Program Committee.

▪ PHSC XXXX	Elective Course	3 credits

Research and Thesis (All tracks): ***Total: 21 Credits***

▪ PHSC XXXX	Research	6 semesters x 3 credits = 18 credits
▪ PHSC XXXX	Thesis	1 semester x 3 credits = 3 credits

In order to complete the **Doctor of Philosophy in Pharmaceutical Sciences** program, students will need to complete, all core courses, the qualifying examination, all mentor-driven and elective courses from the selected track, at least six semesters (18 credits) in Research and one semester in Thesis (3 credits).

VI. CURRICULAR DESIGN

In order to complete the **Master of Science in Pharmaceutical Sciences** program, students will need to complete all core courses, all Mentor-driven and elective courses from the selected track, and at least three semesters (9 credits) in Research. The Qualifying Examination is not needed. The students will be required to present their research as a capstone project.

Research Proposal

As part of the Core Course PHSC XXXX (Principles of Research Design), students must prepare and present a research proposal (NIH/NSF style proposal) – The student and his/her Major Advisor will determine the topic for the research proposal. The student will prepare a research proposal using the NIH Guidelines for a Ruth L. Kirschstein National Research Service Awards for Individual Predoctoral Fellows (Parent F31). http://grants1.nih.gov/grants/guide/pa-files/PA-11-111.html. When more appropriate, as determined by the Major Advisor, an NSF style proposal will be required.

Qualifying Examination

At the end of the second year of the study program, all students will need to take a Qualifying Examination. The student will be permitted to take the Qualifying Examination after all the Core Courses and the Mentor-driven Courses for the selected track have been completed successfully. Typically, the Qualifying Examination will be taken in the month of June, after the student has completed the fourth Semester. If the student does not pass the Qualifying Examination in the first attempt, a second opportunity to take the exam will be offered in July or August before the fifth semester starts. The Assistant Dean of Graduate Programs will ensure that the Graduate Program courses are completed. The qualifying examination will consist of two components:

Written Examination: The written examination will consist of an independent research proposal, following the format of an NIH style proposal, developed by the student. The proposal topic must be within the student's specialty area and must be different from his/her dissertation research project. The student's Thesis Committee will approve the topic of the proposal before the student develops the proposal. The written proposal will be evaluated by the members of the student's Thesis Committee and a unanimous vote of the Committee will constitute an approval of the written examination and will allow the student to schedule the oral examination component of the Qualifying exam. If a unanimous vote for the student's approval of the written examination cannot be reached, the Thesis Committee will meet with the student to discuss necessary improvements to the proposal. A second and final proposal will be prepared by the student following the Committee's recommendations.

Oral examination: The oral examination should take place within one month after the approval of the written examination. The oral examination will last no more than two hours and will be conducted by the student's Thesis Committee. It will consist of the student's defense to his/her proposal presented in the written examination. The student will give a short, approximately 15 minute presentation of the proposed research to the Committee. For the remainder of the exam, the Thesis Committee will formulate questions to the student to assess his/her understanding of the proposal and also will ask questions related to the student's coursework. The Thesis Committee should reach a unanimous vote for the approval of the oral examination. If a unanimous vote is not reached, the Committee will discuss with the student the evaluation results and recommendations for improvements. A second and final attempt will be given to the student for the approval of the oral examination. Upon approval of the oral examination, the student will be considered a Ph.D. Candidate.

Doctoral Thesis

Students must prepare and orally defend a Ph.D. dissertation - The most important experience in the education of a graduate student is the completion of a Ph.D. dissertation. Each student must present a dissertation that represents the culmination of the selected major research project. The dissertation must be a well-reasoned, original contribution to knowledge in the field of study and should provide evidence of high scholarly achievement. The Major Advisor is the primary source of guidance in the planning and preparation of the dissertation. However, other members of the Thesis Committee may be involved in the process as well. All core members of the Thesis Committee must have the opportunity to read a near-final draft of the dissertation prior to signing the Dissertation Approval Form. It is the responsibility of the Thesis Committee to make suggestions for revisions before the Final Examination. A majority of the Thesis Committee core members must indicate that the form and substance of the dissertation are adequate to justify the scheduling of the Final Examination.

The Final Examination on the dissertation may not be scheduled without the signatures of a majority of the Advisory Committee's members on the Approval Form. A Dissertation Defense Evaluation Form is completed by the Advisory Committee and Outside Examiner upon completion of the defense. The style and form of the dissertation must be in conformity with the instructions prepared by the Graduate School. The Final Examination includes a defense of the written dissertation and may be as comprehensive as the Advisory Committee desires. An expanded, 5-member Advisory Committee chaired by the Mentor of the student's Dissertation Advisory Committee conducts this exam. The dissertation presentation is a public event, and its time, date and place are published and announced in advance. Any member of the University community may attend. At least **eight weeks** prior to the Final Examination, the graduate student should submit the "Notification of Intent to Schedule a Final Doctoral Examination". Upon electronic approval by the DGS, the Graduate Dean appoints an Outside Examiner as an official member of the Advisory Committee. The Graduate program must be informed of the specific time and date of the examination at least two weeks prior to the actual examination. The Final Examination must take place no later than eight days prior to the last day of classes of the semester in which the student expects to graduate. After the Final Examination is passed, the final version of the dissertation is prepared, incorporating the changes required by the Advisory Committee. Final copies are signed by the Mentor and the Director of Graduate Studies, and are submitted to The Graduate School. The dissertation in its final form must be received in The Graduate School office within 60 days of the Final Examination. If this deadline is not met, the candidate must obtain an official waiver from the Graduate program or must undergo a second examination

The Doctor of Philosophy Degree - The Ph.D. degree is intended to represent the demonstration of independent and comprehensive scholarship in a specific field. Both the student's mastery of subject matter and the capacity to do research must manifest such scholarship. The degree of Doctor of Philosophy is conferred upon a candidate who, after completing graduate work devoted to study of a special field of knowledge, (1) passes comprehensive examinations in the chosen field and the dissertation subject, (2) presents a satisfactory dissertation, and (3) shows evidence of scholarly achievement.

B. Course Descriptions

PHSC XXXX Principles of Pharmaceutical Sciences 3 credits
This course includes introduction to the fundamental principles of physical pharmacy, application of the chemical to pharmaceutical dosage forms and drug delivery systems. The course also deals with the interaction with biological and physicochemical combination related to drug effectiveness (dissolution and bioavailability) and dosage form design.

PHSC XXXX Principles of Drug Discovery and Drug Development 3 credits
This course is designed to provide the student with an in depth understanding of how academic institutions, pharmaceutical and biotechnology companies discover, develop and characterize new drug candidates for clinical trials. The course will focus on the development of small molecule and biological drugs and will follow the discovery path through identification of a disease, selection of biological targets and identification of a potential candidate to the preclinical characterization of the drug necessary for the development.

PHSC XXXX Advanced Instrumental Analysis 3 credits
In this problem-based course the practical and theoretical principles of analytical techniques utilized in the qualitative and quantitative analysis of drugs, metabolites, excipients, and endogenous substances in biological fluids and other matrixes will be discussed. The student will acquire the knowledge of the different techniques that will be used to analyze compounds in complex matrices; for example drug development, biological fluids, tissue, environmental samples, and others. The student will be exposed to various situations in which he/she can used their own judgment to select the most appropriate technique to be used according to the situation. In addition, the principles and concepts of analytical method validation for the instrumental techniques will be discussed. The competencies to be developed will be: critical thinking, problem solving, self- learning, and communication. The development of these competencies will be obtained by utilizing active learning and cooperative learning, and self-learning instructional methodologies. It is expected that the student will be prepared for discussion and interchanging ideas in and out of the classroom.

PHSC XXXX Applied Biostatistics 3 credits
Basic concepts in Statistics are discussed including descriptive statistics, graphs, probability and inferential statistics. Several statistical methods for univariate and multivariate analysis are discussed in the context of pharmaceutical sciences and health.

PHSC XXXX Ethics in Research 2 credits
Through lectures and group discussions this course presents and analyzes specific issues related to scientific integrity such as authorship and publication, scientific record keeping, data ownership and management, peer review and mentorship. Behaviors related to Research Misconduct will be analyzed in depth. This course also presents and analyzes specific issues related to intellectual property and the protection of human participants in scientific research. The course is intended to instruct students about ethical issues in research in order to accomplish ethical behavior throughout their career.

PHSC XXXX Lab Rotation 1 credit
In this laboratory experience the student will rotate through three different research facilities and will work on projects under the supervision of a faculty member. This hands-on experience will expose the student to different research topics within the pharmaceutical sciences area. In

addition, the student will acquire introductory training in diverse laboratory techniques and will apply the concepts of experimental design in a real scenario. It is expected that at the end of this course the student will be able to choose a thesis project topic and a major advisor.

PHSC XXXX Business, Quality, and Project Management 3 credits
The purpose of the course is to lay the foundation and principles for a solid understanding of business, quality and project management and introduces the concept of entrepreneurship to life in their profession. The course covers key competencies for planning and controlling projects, leading quality improvement initiatives and understanding interpersonal relationships that drive successful project outcomes. Focusing on the introduction of new products and processes, the course discusses the project management life cycle, defining project parameters, matrix management challenges, effective project management tools and techniques, and the role of a project manager. The principles of Lean Manufacturing will be an integral portion of the course. Students will develop knowledge and skills necessary to manage their teams, schedules, risks, and resources to produce a desired outcome.

PHSC XXXX Seminar I/II/III/IV 1 credit
Research is an ongoing process in which one is expected to stay on top of the relevant developments in the discipline. The principal objective of this course is to provide the student knowledge and skills in a variety of areas to strengthen personal, academic, and research competencies to succeed in the graduate program. The seminar introduces the student, through conferences, oral presentations, seminars, colloquiums, and forums, to a process of academic research and allows to have an open mind to problem-solving strategies based on formal inquiry and detailed research. Students are expected to engage in active questioning and discussion as part of the presentations.

PHSC XXXX Principles of Research Design 2 credits
This course focuses on understanding and applying the essentials for the student to develop and write a research proposal with scientific merits. Students will be introduced to the full range of designs available to address research aims, moving from descriptive to experimental and quasi-experimental. The students will develop the skills for writing a successful research proposal including abstract, introduction, statement of problem, specific aims, hypothesis, background, significance, design of experiments, experiment planning, analysis of the data, special requirements, timeframe, referencing, among the basic concepts. Also, the course will supply the students with helpful hints for preparing a research proposal.

PHSC XXXX Advanced Medicinal Chemistry and Pharmacognosy I 3 credits
In this course the disciplines of medicinal chemistry and Pharmacognosy are integrated to facilitate understanding of the relationship between the physical and chemical properties of a drug and pharmacological effect, action in the living organism, the isolation and structural determination of compounds with pharmaceutical, medicinal and biological activities derived from plants. In addition, knowledge of basic and biomedical sciences is integrated. It will be incorporated to the lecture/discussion, active learning methodologies.

PHSC XXXX Advanced Medicinal Chemistry and Pharmacognosy II 3 credits
In this course of the second graduate year will continue with the development and study of drug concept from synthetic drugs or medicinal plants. Disciplines of medicinal chemistry and Pharmacognosy are integrated to facilitate understanding of the relationship between the physical and chemical properties of a drug and pharmacological effect, action in the living organism, the isolation and structural determination of compounds with pharmaceutical, medicinal and

biological activities derived from plants. In addition, knowledge of basic and biomedical sciences is integrated. It will be incorporated to the lecture/discussion, active learning methodologies.

PHSC XXXX Advanced Molecular Biochemistry 3 credits
This course focuses on the structure and function of biomolecules, including proteins, enzymes, nucleic acids, lipids, carbohydrates, vitamins, and hormones. It also deals with the transformations, interactions and energy changes of these biomolecules (metabolism) in the different cells of the organism and how these reactions are regulated. The origin of high-energy compounds is described in relation to mitochondrial function and their participation in energy requiring processes. In addition, the course will present the characteristics of the human genome, the replication and repair of the genetic material, the transcription and translation of genetic information, the alteration of genetic material (mutations), and its consequences (genetic diseases), and the modern methods and techniques of molecular biology (such as: recombinant DNA technology, gene therapy and cloning).

PHSC XXXX Advanced Methods in Synthetic Organic Chemistry 3 credits
This advanced course in organic synthetic methods is designed for students in their second year of M.S. and Ph.D. in Pharmaceutical Sciences. The main goal of this course is to provide students with a stimulating learning experience and modern studies on aspects of organic chemistry. This course will provides students with an advanced knowledge in theory, concepts and methodologies related to organic synthesis, and a methodical construction of organic molecules. The course will covers topics from stereochemical and conformational analysis, formation of carbon-carbon bonds, oxidation and reduction of functional groups, organometallic reactions, and total synthesis of complex molecules. After completing this course, students should be prepared to implement these concepts in medicinal chemistry and natural products research with high relevance in the design and synthesis of organic molecules whose properties and characteristics are of interest in medicinal applications.

PHSC XXXX Advanced Pharmacology I 3 credits
In this course, the second year students will be exposed to the advanced principles of pharmacology and the modern aspects of pharmacokinetics, pharmacodynamics and pharmacogenomics. In addition, students will be exposed to different drug classes, discussion will be divided by organ system and clinical conditions. Specifically, discussion will focus on the mechanism of action, therapeutic applications and adverse reactions; including toxicity and the appropriate treatments and major drug-drug interactions. Emphasis will be given to the principles of absorption, distribution, metabolism and excretion (ADME). Knowledge of the basic and biomedical sciences will also be integrated. Active learning methodologies will be used in addition to lecture/discussion sessions.

PHSC XXXX Advanced Pharmacology II 3 credits
This course presents a broad overview of the principles of advanced pharmacology and modern aspects related to drug effects in the human and other organisms. In addition, the course emphasizes the clinical use of each drug in the Central Nervous Sytem (CNS). Lectures highlight the mechanisms of action, drug toxicities and interactions, botanical preparations, and treatment strategies for diseases in the CNS. The course content also presents clinical applications and major concepts of gene therapy. Active learning methodologies will be used in addition to scientific article discussions.

PHSC XXXX Pharmacogenomics/ Pharmacogenetics 3 credits
This course is aimed at covering the fundamentals of Pharmacogenomics in order to enhance the safety and benefits of a therapeutic intervention, as part of the personalized healthcare paradigm.

Students will acquire relevant information for better understanding of the potential benefit and/or risk of a drug product in a particular population. This course pursues to bring together interplaying disciplines such as genetics, pharmacokinetics and therapeutics. The course will discuss concepts regarding pharmacogenomics, genetic polymorphism, population and individual variability and metabolic interactions. Both instructive and didactic lectures, case-study discussions, following participatory strategies of learning and informatic technology logistics, will be used. This course involves the therapeutic implications of population genetic differences in order to explain why some people respond well to a drug whereas others do not receive the expected benefit or develop undue adverse events.

PHSC XXXX Advanced Biopharmaceutics and Pharmacokinetics 3 credits
This course expands the basis of the Biopharmaceutics and Pharmacokinetic principles and procedures in order to reinforce and enhance the knowledge on critical concepts such as drug product, bioavailability, dosing regimens, ADME and their applications in clinical settings. The students will acquire relevant information for better understanding of the potential benefit related to the safety and effective use of drug product. It is aimed at enhancing the students' skills in developing and assessing formulations based on the relationship between the drug, drug delivery system, dosing regimen and the living system. It brings together disciplines like pharmacokinetics, biopharmaceutics, physical pharmacy, compounding, and therapeutics. It strengthens concepts related to the optimization of drug products by identifying factors determining untoward responses and poor bioavailability. Active learning strategies and methodologies will be used, as well as lectures and case discussions.

PHSC XXXX Pharmaceutical Engineering and Unit Operations 3 credits
Presents unit operations and engineering principles involved in the manufacture of pharmaceuticals, from the isolation and purification of active pharmaceutical ingredients (API) to the final production of drug products. Regulatory issues include quality by design (QbD) and process analytical technologies (PAT) of unit operations, such as distillation, extraction, crystallization, filtration, drying, milling, blending, granulation, and tableting.

PHSC XXXX Pharmaceutical Formulation and Drug Delivery 3 credits
This course provides the students with the fundamental concepts and their practical applications in the development and production of different dosage forms. This course also, introduce the students the students to product design, formulation, manufacturing, evaluation, stability studies and recent advances in different dosage forms. A core element in the course is linking the performance attributes of the different dosage forms to formulation design and manufacturing process. Topics such as emulsion, semisolids, suppository and suspension will be included in the course overview. The course also, deals with the interaction with biological and physicochemical combination related to drug effectiveness (dissolution and bioavailability) and dosage form design.

PHSC XXXX Regulatory and Manufacturing Practice 3 credits
This course will provide to the student the fundamentals behind the regulatory guidelines and regulations related to pharmaceuticals throughout its life cycle. Including the development of a medication and/or pharmacological treatment, submission and clinical trials, manufacturing process development, and commercial manufacture. The student will learn through interactive lectures and class discussions the regulations and guidelines developed and/or embraced by the Food and Drug Administration, such as Code of Federal regulations (CFRs), FDA Frameworks and Guidelines, and the International Conference on Harmonization (ICH), and also the European Medicines Agency (EMA) regulations.

PHSC XXXX Special Topics in Pharmaceutical Sciences 1-3 credits
This course is an umbrella course in which selected, innovative and timely important subjects in the pharmaceutical sciences will be discussed. The faculty member(s) participating in this course will prepare a specific outline for the content that will be discussed, together with evaluation criteria. In the Mentor-driven program, the students' Mentor will advise the students on whether, depending on the topics discussed, participation in this course will be beneficial for their development. Students are permitted to register more than once, when the course content is different. Teaching strategies can include interactive lectures, student oral presentations and scientific article analysis.

C. Curricular Sequence

The curricular sequence for each of the three tracks is presented in Tables 5, 6 and 7 respectively. In the first year, almost all of the core courses are offered. During the second year, the currently recommended specialty courses for each of the three initially offered tracks are scheduled to be offered. However, in this Mentor-driven program, both the recommended specialty courses, as well as the course sequence might vary in order to be able to respond to new developments in each of the fields. Mentors will guide the students and will select the optimum course profile to best serve the students' research interests. Therefore, over the years, the curricular sequence in each of the tracks might be subject to modifications to maintain in concert with new developments.

Table 5: *Medicinal Chemistry and Pharmacognosy track*

Year 1

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Principles of Pharmaceutical Sciences	3	PHSC XXXX	Business, Quality, and Project Management	3
PHSC XXXX	Applied Biostatistics	3	PHSC XXXX	Advanced Instrumental Analysis	3
PHSC XXXX	Principles of Drug Discovery and Development	3	PHSC XXXX	Ethics in Research	2
PHSC XXXX	Laboratory Rotation	1	PHSC XXXX	Research	3
PHSC XXXX	Seminar I	1	PHSC XXXX	Seminar II	1
Total		**11**	**Total**		**12**

Year 2

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Adv. Medicinal Chemistry and Pharmacognosy I	3	PHSC XXXX	Adv. Medicinal Chemistry and Pharmacognosy II	3
PHSC XXXX	Advanced Molecular Biochemistry	3	PHSC XXXX	Adv. Methods in Synthetic Organic Chemistry	3
PHSC XXXX	Principles of Research Design	2	PHSC XXXX	Elective course	3
PHSC XXXX	Seminar III	1	PHSC XXXX	Seminar IV	1
PHSC XXXX	Research	3	PHSC XXXX	Research	3
Total		**12**	**Total**		**13**

Year 3

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Research	3	PHSC XXXX	Research	3
Total		**3**	**Total**		**3**

Year 4

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Research	3	PHSC XXXX	Thesis (or Research*)	3
Total		**3**	**Total**		**3**

Year 5/6/7/8

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Research*	0	PHSC XXXX	Thesis*	0

** If needed*

Table 6: *Molecular Pharmacology and Pharmacogenomics track*

Year 1

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Principles of Pharmaceutical Sciences	3	PHSC XXXX	Business, Quality, and Project Management	3
PHSC XXXX	Applied Biostatistics	3	PHSC XXXX	Advanced Instrumental Analysis	3
PHSC XXXX	Principles of Drug Discovery and Development	3	PHSC XXXX	Ethics in Research	2
PHSC XXXX	Laboratory Rotation	1	PHSC XXXX	Research	3
PHSC XXXX	Seminar I	1	PHSC XXXX	Seminar II	1
Total		**11**	**Total**		**12**

Year 2

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Advanced Pharmacology I	3	PHSC XXXX	Advanced Pharmacology II	3
PHSC XXXX	Advanced Molecular Biochemistry	3	PHSC XXXX	Pharmacogenomics/ Pharmacogenetics	3
PHSC XXXX	Principles of Research Design	2	PHSC XXXX	Elective course	3
PHSC XXXX	Seminar III	1	PHSC XXXX	Seminar IV	1
PHSC XXXX	Research	3	PHSC XXXX	Research	3
Total		**12**	**Total**		**13**

Year 3

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Research	3	PHSC XXXX	Research	3
Total		**3**	**Total**		**3**

Year 4

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Research	3	PHSC XXXX	Thesis (or Research*)	3
Total		**3**	**Total**		**3**

Year 5/6/7/8

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Research*	0	PHSC XXXX	Thesis*	0

** If needed*

Table 7: *Pharmaceutics and Drug Delivery track*

Year 1

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Principles of Pharmaceutical Sciences	3	PHSC XXXX	Business, Quality, and Project Management	3
PHSC XXXX	Applied Biostatistics	3	PHSC XXXX	Advanced Instrumental Analysis	3
PHSC XXXX	Principles of Drug Discovery and Development	3	PHSC XXXX	Ethics in Research	2
PHSC XXXX	Laboratory Rotation	1	PHSC XXXX	Research	3
PHSC XXXX	Seminar I	1	PHSC XXXX	Seminar II	1
Total		**11**	**Total**		**12**

Year 2

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Advanced Pharmaceutics and Pharmacokinetics	3	PHSC XXXX	Regulatory and Manufacturing Practice	3
PHSC XXXX	Pharmaceutical Engineering (Unit Operations)	3	PHSC XXXX	Pharmaceutical Formulation and Drug Delivery	3
PHSC XXXX	Principles of Research Design	2	PHSC XXXX	Elective course	3
PHSC XXXX	Seminar III	1	PHSC XXXX	Seminar IV	1
PHSC XXXX	Research	3	PHSC XXXX	Research	3
Total		**12**	**Total**		**13**

Year 3

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Research	3	PHSC XXXX	Research	3
Total		**3**	**Total**		**3**

Year 4

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Research	3	PHSC XXXX	Thesis (or Research*)	3
Total		**3**	**Total**		**3**

Year 5/6/7/8

First Semester			Second Semester		
Course #	**Course name**	**Cr**	**Course #**	**Course name**	**Cr**
PHSC XXXX	Research*	0	PHSC XXXX	Thesis*	0

** If needed*

D. Coherence and Sufficiency of the Curriculum

The competencies that students will acquire as described in the Graduate Profile are attended throughout the all the courses of the Program. Summarized in tables 8 to 10 are the courses in which each of the competencies will be addressed.

Table 8: *Matrix of Competencies and Core Courses*

Courses / Competencies	Principles of Pharmaceutical Sciences	Applied Biostatistics	Principles of Drug Discovery and Development	Laboratory Rotation	Business, Quality, and Project Management	Advanced Instrumental Analysis	Ethics in Research	Seminar	Principles of Research Design
1. Critical thinking	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Problem solving and decision making	✓	✓	✓	✓	✓	✓	✓		✓
3. Communication and informatics	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Ethics		✓		✓	✓		✓		
5. Ability to work independently and in group settings				✓		✓	✓	✓	
6. Self-learning	✓	✓	✓	✓		✓	✓	✓	✓
7. Leadership						✓	✓	✓	

Table 9: *Matrix of Competencies and Courses in the Medicinal Chemistry and Pharmacognosy, and the Molecular Pharmacology and Pharmacogenetics tracks.*

	Medicinal Chemistry and Pharmacognosy track					Molecular Pharmacology and Pharmacogenetics track			
Courses / **Competencies**	Adv. Medicinal Chemistry and Pharmacognosy I	Adv. Medicinal Chemistry and Pharmacognosy II	Adv. Methods in Synthetic Organic Chemistry	Research or Thesis	Advanced Molecular Biochemistry	Advanced Pharmacology I	Advanced Pharmacology II	Pharmacogenomics/ Pharmacogenetics	Research or Thesis
1. Critical thinking	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Problem solving and decision making	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Communication and informatics	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Ethics				✓	✓			✓	✓
5. Ability to work independently and in group settings				✓	✓				✓
6. Self-learning	✓	✓	✓	✓	✓	✓	✓	✓	✓
7. Leadership				✓					✓

Table 10: *Matrix of Competencies and Courses in the Pharmaceutics and Drug Delivery track*

Courses / Competencies	Advanced Pharmaceutics and Pharmacokinetics	Pharmaceutical Engineering (Unit Operations)	Pharmaceutical Formulation and Drug Delivery	Regulatory and Manufacturing Practice	Research or Thesis
1. Critical thinking	✓	✓	✓	✓	✓
2. Problem solving and decision making	✓	✓	✓	✓	✓
3. Communication and informatics	✓	✓	✓	✓	✓
4. Ethics					✓
5. Ability to work independently and in group settings		✓		✓	✓
6. Self-learning	✓	✓	✓	✓	✓
7. Leadership		✓			✓

E. Educational Approach and Instructional Strategies

In the pharmaceutical sciences, nine different disciplinary areas have been identified (see paragraph I.B). In order to be prepared to carry out interdisciplinary activities, the students will need to have at least a basic understanding of each of these areas. In the first year of the program, these foundations are integrated within the curriculum. In the second year, in a Mentor-driven approach, the students will select the track of their interest, where the specialty areas will be studied more deeply. At the same, time the student will start with their research project leading to their Thesis presentation.

The teaching-learning process will be reinforced through collaborative and cooperative learning. Virtually all courses will be provided in a class-room setting with direct contact with the Professors. Since the groups are relatively small (approximately five students), there is a good opportunity for learning interaction and delivery of knowledge between Professors and students. In the classroom setting, the following teaching strategies will be applied:

Case-studies
In case-studies the students will be challenged to apply there acquired knowledge towards the solution of a particular problem. Case-studies will contribute to the competencies of problem-solving and critical thinking.

Clickers
The use of clickers (or similar technologies) provide an immediate assessment of the status of knowledge of the student in the classroom. It will provide a feedback mechanism to improve the teaching-learning process.

Collaborative learning
In collaborative learning, students will be challenged to work in a group to solve a problem. Collaborative learning will contribute to the competency of the ability to work in group settings. In addition, problem-solving and critical thinking will be challenged.

Computer-based instruction
In computer-based instruction, specialized software, or online exercises will be used to expand the learning experience of the students. These can be administered in the classroom or as homework assignment. Computer-based instruction can thus contribute to the competencies of self-learning and the ability to work independently.

Electronic platform support
Most courses will be supported via an electronic platform such as Blackboard. This will provide the opportunity to post reading assignments etcetera. Use of an electronic platform will contribute to the competency of self-learning.

Group discussions
In group discussions, students will be challenged by the Professor and each other to discuss a selected, potentially controversial topic. Group discussions will contribute to the competencies of ethics and communication.

Hands-on wet-laboratory
In a hands-on wet-laboratory, students will be present in the laboratory and carry out experiments themselves. This will provide the students with practical skills, which can later be utilized in their research project.

Independent study
In independent study, students will be required to study assigned lesson material at home. In class, they can either ask questions, or be challenged in quizzes or exams. This will contribute to the competency of self-learning.

Interactive lectures
Via interactive lectures, the Professor will teach new materials in a direct manner via Powerpoint or similar software. Since the groups are small, students will be challenged to interact directly with the Professor via questions related to the material.

Problem-solving
In problem-solving, students will be administered a problem, and they are required to solve it either by themselves or in a group. These can be administered either as a graded quiz, homework or as assessment exercises. This will contribute to the competency of problem-solving.

Scientific article analysis
In scientific article analysis, students will be required to search for, read and understand manuscripts published in the peer-reviewed scientific literature. This will contribute to the competencies of informatics, self-learning and critical thinking.

Socrative method
In the socrative method, the Professor has a dialogue of inquiry and discussion with the students. Questions will be asked and answered to stimulate critical thinking and to generate novel ideas. The socratic method will contribute to the competency of critical thinking.

Student presentations
Students will be required to make an oral presentation in the classroom of a select topic from the course, or the scientific literature. This will contribute to the competencies of self-learning and communication.

Team-based learning
In team-based learning, a group of students with different skill-set will be assigned a task that they need to complete as a team. Students are evaluated both on the results, as well as their contribution to the team. Team-based learning will contribute to the competencies of communication and ability to work in group settings.

Troubleshooting
In troubleshooting, students will be exposed to a real-life occurrence where an established (manufacturing) process did not go as planned. Students will be required to analyze the problem, and make suggestions to remediate the situation. Troubleshooting exercises will contribute to the competencies of problem-solving and critical thinking.

Writing exercises
In writing exercises, students will be required to write a (small) paper or review on a select topic. These exercise will improve the competency of communication, especially in the technical writing acspects.

Tables 11 to 13 provide matrices that demonstrate in which of the courses the above teaching activities are applied.

Table 11: Matrix of Teaching Strategies in Core Courses

Courses / Teaching Strategies	Principles of Pharmaceutical Sciences	Applied Biostatistics	Principles of Drug Discovery and Development	Laboratory Rotation	Business, Quality and Project Management	Advanced Instrumental Analysis	Ethics in Research	Seminar	Principles of Research Design
1. Case-studies	✓		✓			✓	✓		
2. Clickers						✓	✓		
3. Collaborative learning	✓	✓	✓			✓	✓		
4. Computer-based instruction	✓	✓	✓			✓	✓		
5. Electronic platform support		✓	✓			✓	✓	✓	✓
6. Group discussions	✓	✓			✓	✓	✓	✓	
8. Hands-on wet-laboratory				✓					
9. Independent study	✓						✓	✓	
10. Interactive lectures	✓	✓	✓			✓	✓		✓
11. Problem-solving	✓	✓	✓			✓	✓		
12. Scientific article analysis	✓		✓			✓	✓	✓	✓
13. Socrative method	✓		✓			✓	✓		
14. Student presentations			✓		✓	✓	✓	✓	✓
15. Team-based learning	✓				✓	✓	✓		
16. Troubleshooting		✓							
17. Writing exercises	✓				✓	✓	✓		✓
18. Other					✓			✓	

Table 12: Matrix of Teaching Strategies in Courses in the Medicinal Chemistry and Pharmacognosy, and the Molecular Pharmacology and Pharmacogenetics tracks.

	Medicinal Chemistry and Pharmacognosy track				Molecular Pharmacology and Pharmacogenetics track		
Courses / **Teaching Strategies**	Adv. Medicinal Chemistry and Pharmacognosy I	Adv. Medicinal Chemistry and Pharmacognosy II	Adv. Methods in Synthetic Organic Chemistry	Advanced Molecular Biochemistry	Advanced Pharmacology I	Advanced Pharmacology II	Pharmacogenomics/ Pharmacogenetics
1. Case-studies	✓	✓	✓				✓
2. Clickers							
3. Collaborative learning			✓	✓	✓	✓	✓
4. Computer-based instruction			✓				
5. Electronic platform support	✓	✓	✓	✓	✓	✓	✓
6. Group discussions							
7. Hands-on wet-laboratory							
8. Independent study	✓	✓					✓
9. Interactive lectures	✓	✓	✓	✓	✓	✓	✓
10. Problem-solving	✓	✓	✓				✓
11. Scientific article analysis	✓	✓	✓	✓	✓	✓	✓
12. Socrative method			✓				
13. Student presentations			✓	✓	✓	✓	✓
14. Team-based learning	✓	✓					
15. Troubleshooting							
16. Writing exercises							
17. Other							

Table 13: Matrix of Teaching Strategies in Courses in the Pharmaceutics and Drug Delivery track

Courses / Teaching Strategies	Advanced Pharmaceutics and Pharmacokinetics	Pharmaceutical Engineering (Unit Operations)	Pharmaceutical Formulation and Drug Delivery	Regulatory and Manufacturing Practice
1. Case-studies	✓	✓	✓	✓
2. Clickers				
3. Collaborative learning	✓	✓	✓	✓
4. Computer-based instruction				
5. Electronic platform support	✓			
6. Group discussions	✓	✓	✓	✓
7. Hands-on wet-laboratory				
8. Independent study	✓			
9. Interactive lectures	✓	✓	✓	✓
10. Problem-solving	✓	✓	✓	✓
11. Scientific article analysis		✓	✓	✓
12. Socrative method	✓	✓	✓	✓
13. Student presentations	✓	✓	✓	✓
14. Team-based learning		✓	✓	✓
15. Troubleshooting				
16. Writing exercises		✓	✓	✓
17. Other	✓			

F. Student Learning Assessment

The Student Learning Assessment Plan is an approach designed to gather information and evidence of the activities carried out for the learning assessment of the graduate student. This plan will help the professors evaluate what are the students learning and how well they are assimilating the course materials. The purpose of the plan is to monitor and evidence the progress of the students towards achieving the desired graduate profile as described in section IV-D. These results will help identify possible adjustments in the curriculum in order to improve the program. The professor will adjust evaluation criteria for each of areas according to the assessment strategies used. The Student Learning Assessment Plan is represented in Table 14.

Each section considers the areas of the of the graduate profile (critical thinking, problem-solving and decision-making, communication and informatics, ethics, ability to work independently and in group settings, self-learning and leadership). Evaluation criteria for each area will be adjusted according to the assessment strategies used by the professor.

In the first five years of the program, the following methods will be undertaken to assess student learning:

- Electronic survey to be completed by the students at the end of each course
- Electronic survey to be completed by the participating faculty at the end of each academic year
- Focus group with students by Assistant Dean for Graduate Programs at the end of each academic year

Table 13 shows how the assessment plan evaluates the progress in each of the competencies.

Table 14: *Student Learning Assessment Plan*

Graduate Profile Areas	Assessment Methods	Evaluated by	Frequency and Timing
1. Critical Thinking	Descriptive rubrics to assess oral skills in presentations, discussion groups of case studies, in-class exercises, research proposals, seminars and critique essays.	Course instructors Dissertation advisor	One assessment in courses
2. Problem Solving and Decision-making	Descriptive and analytical rubrics to assess knowledge in class exercises, lectures and discussion groups of case studies	Course instructors	One assessment in courses
	Student self-assessment of improvement (interview in focus group and/or survey)	Assistant Dean	End of academic year
3. Communication and Informatics	Descriptive rubrics to assess oral skills in presentations, discussion groups of case studies, monographs, critique essays, draft articles and research proposals.	Course instructors Dissertation advisor	One assessment in courses
	Descriptive rubrics *to assess* writing skills of specialized knowledge in monographs, critique essays, draft articles and research proposals.	Course instructors Dissertation advisor	One assessment in courses
	Record of paper or presentations of research findings	Assistant Dean	Bi-annual
4. Ethics	Student self- awareness, rubrics to assess knowledge in class discussions (interview in focus group and/or survey)	Assistant Dean	End of each academic year
5. Ability to work independently and in group settings	Survey	Course instructors	
6. Problem-solving	Analytical and descriptive rubrics to assess knowledge in applied exercises, content in oral presentations, draft articles, monographs and protocols.	Course instructors	One assessment in courses
	Student self- assessment of improvement (interview in focus group and/or survey)	Assistant Dean	End of each academic year
7. Leadership	Analytical rubrics to assess skill in teamwork, discussion groups of case studies, lectures, seminars	Course instructors	Two assessments in one course
	Self assessment tools: Change style indicators and Leadership practice inventory	Course instructors	Two assessments in one course

G. Course Syllabi

See Appendices

VII. ADMISSION, ENROLLMENT AND GRADUATION

A. ADMISSION REQUIREMENTS

Applicants must meet the general doctoral program admission requirements:

1. A **Bachelor of Science** degree, or **Master of Science** degree from an institution recognized by the international academic community is required. The applicant should be a major in one of the following fields:

   - Biology
   - Biochemistry
   - Chemistry
   - Chemical Engineering
   - Cellular and Molecular Biology
   - Pharmacy
   - Pharmaceutical Sciences

   In special cases, Bachelor or Master's degrees in other, related fields can be considered. In these cases, before submission of the application, the student will be encouraged to request approval from the Assistant Dean for Research and Graduate Programs. Students with a **Pharm.D. degree** also qualify for admission.

2. **Required Courses**: During the undergraduate program of the candidate student, the following courses should have been completed successfully:

   - Organic chemistry
   - Calculus I
   - Physics

3. **Recommended Courses:**

   In addition to the required courses, students interested to pursue a specific track are recommended to take the below courses for the specified track. Although not required for enrollment, these courses will better prepare students to be successful for the track they will select.

   Medicinal Chemistry and Pharmacognosy
   - Biology

   Molecular Pharmacology and Pharmcogenomics
   - Biology
   - Biochemistry
   - Genetics

   Pharmaceutics and Drug Delivery
   - Calculus II/III
   - Thermodynamics or Physical Chemistry

4. Students must have a **grade point average (GPA)** of 3.0 or above (on a 4.0 point scale) or its equivalent. International students are required to submit a World Education Services (WES) Credential Evaluation (http://www.wes.org/students/) or equivalent.
5. Students must have completed an official **Graduate Record Examination (GRE®)** revised general test within the last three years. Although no minimum acceptable scores will be applied, a better performance will increase overall score in the admissions formula, thereby increasing the likelihood the student will be accepted.

6. International applicants from non-English speaking countries will be evaluated for proficiency in English based on:

   - Evaluation of English skills in the written Statement of Purpose
   - Evaluation of English skills in the Interview
   - Students can voluntary submit the results of the Test of English as a Foreign Language (TOEFL)

For the application procedure, the following documents will need to be submitted:

a. Official academic transcripts (rated to the US system)
b. Curriculum vitae
c. GRE scores
d. TOEFL, if available
e. Three letters of recommendation that follow the format approved by the Graduate Program Committee. Letters should be requested from professors who are able to comment on the applicant qualifications for graduate studies.
f. Statement of Purpose – In a 300-500 word assay the applicant must discuss (1) Professional goals; (2) Reason of interest for the Program; (3) Research experience and accomplishments; and (4) Awards and publications.

Qualified candidates will be selected by the Graduate Program Committee for an interview.

B. ENROLLMENT PROJECTION

The Ph.D. Program in Pharmaceutical Sciences projects admitting six (6) students every year. Table 15 shows the number of students to be admitted for a five-year period and the total number of students per year. It is anticipated that students will need five years to complete the program. With twelve to thirteen faculty members involved in competitive research efforts, on **average** there will be **two (2) Ph.D. students per Major Advisor**. However, depending on variations of student interests, as well as availability of external funds to support the research projects in the laboratory of the Major Advisor, this could vary between zero (0) to six (6) students.

Table 15: *Enrollment projection*

Academic Year	Number of Students Admitted	Total Number of Students
I	6	6
II	6	12
III	6	18
IV	6	24
V	6	30

We anticipate that students will require approximately five years to complete all graduate program requirements, including the dissertation. Therefore, this total should remain stable as students who began in academic year I complete all graduation requirements.

C. ACADEMIC REQUIREMENTS FOR DEGREE AWARD

In order to obtain the **Doctor of Philosophy in Pharmaceutical Sciences Degree**, the student must have completed all **60 credits** of the Program **and** comply with the following requirements:

- Have completed all Core Courses: **22 Credits**
- Have completed all Mentor-driven Courses and Elective Courses for each Track: **14 Credits**
- Have completed the required Elective Course: **3 credits**
- Have completed the required Research credits: **18 Credits**
- Have completed writing and oral defense of the Thesis: **3 Credits**
- Have completed the Research Proposal
- Have completed the Qualifying Examination
- Have successfully completed a competitive research project
- Have presented the results of their research activities in local or international symposia
- Have published at least one manuscript, and submitted one other manuscript for publication in peer-reviewed journals

Specific norms

Grades

Students are required to approve all courses with A or B (no less than B).

Average Grade Point Average (GPA)
Students that have completed 12 or more semester credits of course work need to maintain a GPA of 3.0 or higher. If the GPA is less than 3.0, the student is placed on scholastic probation and has one semester or equivalent (9 semester credits) to remove the probation by attaining a cumulative GPA of 3.0. Students that are after this semester are still not able to meet the requirement of a minimum GPA of 3.0, will automatically be withdrawn from the program. Students that obtain two grades of F will automatically be withdrawn from the program.
Students on probation are not eligible for tuition scholarships.

Time limit
Students are expected to graduate within five years from their starting date. At the end of each academic year, the student has to complete a progress report approved by the Major Advisor and Thesis Committee. The progress report has to include a timeline for graduation. The maximum time allowed for completion of the program is eight (8) years. Only in special circumstances, the student can request an extension. This extension will require approval by the Graduate Committee.

VIII. FACULTY

A. Faculty Profile

The Department of Pharmaceutical Sciences has thirteen full-time faculty positions. In order to increase the research capacity within the Department, since 2014, four new faculty members with a substantial background have been recruited with a promising potential to carry out competitive research. At this moment twelve positions are occupied by tenured and tenure-track faculty members at various academic ranks, and there is one vacancy. Almost all courses will be coordinated and delivered by the faculty members of the Pharmaceutical Sciences Department of the School of Pharmacy. At this moment, all faculty members of the Department dedicate a considerable part of their academic load to the current Master of Science in Pharmacy program. As this program will be phased out and transformed into the proposed Ph.D. in Pharmaceutical Sciences program, these loads will be eliminated, and replaced with courses in the new program.

Table 16 provides a list of current faculty members of the Department of Pharmaceutical Sciences, their academic degree, and a summary of other relevant academic positions.

Table 17 provides the courses in which each of the faculty members will participate. Note that some courses involve the participation of multiple faculty members.

VIII. FACULTY

Table 16: *Faculty profile*

Name	Position/years at UPR	Degree	Other relevant past experiences (post-doc etc.)
Joseph Bloom, Ph.D.	Full Professor Tenured/22 years	Ph.D. in Chemistry University of Puerto Rico, Rio Piedras	- Postdoc, Medical University of South Carolina - Assistant Director Crime Laboratories, PR - Assistant Dean Graduate Programs, School of Pharmacy (current)
Eduardo Caro, Ph.D.	Assistant Professor	Ph.D. in Organic Chemistry University of California San Diego	- Postdoc Scripps Institute of Oceanography - Postdoc Arena Pharmaceuticals, San Diego
José Colón, Ph.D.	Assistant Professor Tenure-Track/2 yrs	Ph.D. in Pharmacology University of Minnesota	- Postdoc Neurobiology, NIEHS - Postdoc Structural and Molecular Biology, UPR Rio Piedras
Sunita Dahiya, Ph.D/	Assistant Professor Tenure-Track/1 yr	Ph.D. in Pharmaceutics Gautam Buddh Technical University, Lucknow, Uttar Pradesh, India	- Professor and Head of Department, Globus Collegeof Pharmacy, Bhopal Madya Pradesh, India
Jorge Ducongé, Ph.D.	Full Professor Tenured/12 years	Ph.D. in Pharmaceutical Sciences University of Havana. Cuba	- Associate Professor, University of Havana. Cuba
Rafael Garcia, MPH	Assistant Professor Tenured/26 years	B.S.Ph. School of Pharmacy, UPR	- MPH, School of Public Health, UPR
Eliud Hernández, Ph.D.	Associate Professor Tenured/11 years	Ph.D. in Chemistry University of Puerto Rico, Rio Piedras	- Postdoc, School of Pharmacy, UPR
Magaly Martínez, Ph.D.	Assistant Professor Tenure-Track/5 years	Ph.D. Alabama A&M University	- Postdoc Cancer Biology, Vanderbilt University Medical Center (2003-2007)
Darlene Santiago, Ph.D.	Assistant Professor Tenure-Track/4 years	Ph.D. in Chemical Engineering, University of Puerto Rico Mayaguez	- Engineer Pharmaceutical Industry
Torsten Stelzer, Ph.D.	Assistant Professor Tenure-Track/3 years	Ph.D. Chemical Engineering, Martin Luther University, Germany	- Postdoc Chemical Engineering, MIT - Assistant Professor, Martin Luther University
Bianca Torrres, Ph.D.	Assistant Professor	Ph.D. in Pharmacology, University of Puerto Rico, Medical Sciences Campus	- Postdoctoral Master in Clinical Sciences, UPR, MSC
Cornelis Vlaar, Ph.D.	Full Professor Tenured/15 years	Ph.D. in Chemistry Vrije Universiteit Amsterdam, the Netherlands	- Postdoc, Louisiana State University, LA - Postdoc, The Scripps Research Institute, CA - Director Department of Pharmaceutical Sciences
VACANT- Under recruitment	Currently interviewing candidates	PhD Biochemistry	----------

VIII. FACULTY

Table 17: *Estimated participation of faculty members in courses*

Name	Courses	Academic load	Other Academic load
Joseph Bloom, Ph.D.	Advanced Instrumental Analysis	8%	- Pharm.D. Program - Research
Eduardo Caro, Ph.D.	Principles of Drug Discovery and Development Adv. Medicinal Chemistry and Pharmacognosy I/II Adv. Methods in Synthetic Organic Chemistry	4%	- Pharm.D. Program - Research
José Colón, Ph.D.	Advanced Pharmacology I/II	8%	- Pharm.D. Program - Research
Jorge Ducongé, Ph.D.	Advanced Pharmaceutics and Pharmacokinetics Pharmacogenomics/ Pharmacogenetics Advanced Pharmacology I/II	8% 8% 4%	- Pharm.D. Program - Research
Rafael Garcia, MPH	Applied Biostatistics	8%	- Pharm.D. Program - Research
Sunita Dahiya, Ph.D.	Principles of Pharmaceutical Sciences Pharmaceutical Formulation and Drug Delivery	8% 2%	- Pharm.D. Program - Research
Eliud Hernández, Ph.D.	Principles of Drug Discovery and Development Adv. Medicinal Chemistry and Pharmacognosy I/II Adv. Methods in Synthetic Organic Chemistry	3% 6% 4%	- Pharm.D. Program - Research
Magaly Martínez, Ph.D.	Advanced Molecular Biochemistry	4%	- Pharm.D. Program - Research
			-
Darlene Santiago, Ph.D.	Pharmaceutical Engineering (Unit Operations) Pharmaceutical Formulation and Drug Delivery	4% 3%	- Pharm.D. Program - Research
Torsten Stelzer, Ph.D.	Pharmaceutical Engineering (Unit Operations) Pharmaceutical Formulation and Drug Delivery	4% 3%	- Pharm.D. Program - Research
Bianca Torres	Advanced Pharmaceutics and Pharmacokinetics Pharmacogenomics/ Pharmacogenetics Advanced Pharmacology I/II	8% 8% 4%	- Pharm.D. Program - Research
Cornelis Vlaar, Ph.D.	Principles of Drug Discovery and Development Adv. Medicinal Chemistry and Pharmacognosy I/II Adv. Methods in Synthetic Organic Chemistry	3% 3% 4%	- Pharm.D. Program - Research
Actively recruiting	Advanced Molecular Biochemistry		-
	Ethics in Research		

Alternating by different faculty members, combined in some cases with outside resources	Principles of Research Design		
	Regulatory and Manufacturing Practice		
	Business, Quality, and Project Management		

B. Faculty Development

Enhancing faculty professional development is a primary consideration for the University of Puerto Rico, the Medical Sciences Campus, and the School of Pharmacy. The UPR promotes faculty development through various means, such as continuing education activities, travel funds, tuition exemption, and release time to attend courses offered within the UPR System and other Higher Education Institutions in Puerto Rico. In addition, the campus Office of the Dean of Academic Affairs coordinates and offers a faculty development program in the areas of teaching, assessment, and educational methods. Courses and workshops in the areas of curriculum design, computer literacy, audiovisual techniques, research and evaluation, and academic administration are offered periodically.

Other opportunities for faculty development include attendance at professional meetings, seminars and workshops outside of Puerto Rico. Travel funds to cover registration, hotel or housing arrangements, transportation and other expenses, will be available for the Ph.D in Pharmaceutical Sciences program faculty and are considered in the budget plan. The distribution of the faculty development budget will be according to faculty needs and interests. The Ph.D in Pharmaceutical Sciences program faculty, including part-time and adjunct faculty, have an Annual Faculty Review with the Chair of the Pharmaceutical Sciences Department at the end of each academic year. In conversation with the Chair, the faculty members express their development interest for the next academic year. The plan would specify the areas for improvement, and the projected activities, including date, place and estimated cost (see Table 17).

The Ph.D in Pharmaceutical Sciences Program faculty will participate in defining faculty needs and in recruiting faculty to teach in the Program in accordance with University policy. Each participating faculty member will demonstrate a record of scholarship and/or professional achievement appropriate to the stage of their academic career, their role and responsibilities associated with the Program, and the Program's mission and goals (paragraphs IV.A and IV.B). Faculty will be required to submit on a yearly basis at least 1 abstract for oral or poster presentation at a professional meeting. In recent years, the number of articles published in peer reviewed journals by the Department members is between 10 and 15 per year. With the implementation of the Ph.D. in Pharmaceutical Sciences program, it is expected that the average of approximately one article per year per faculty member, will increase to two or more publications per faculty member totaling ~30 publications per year. The individual faculty development plan summarized in table 18 will help each faculty establish or further advance their scholarship in research and teaching. The budget plan described in section XIV includes $1,500 per faculty member per year to support the development of the faculty members participating in the program. Additional costs will be assumed by the faculty members or via other resources.

The UPR School of Pharmacy is committed to enhance and sustain an active research development program contributing to the knowledge base of pharmaceutical sciences disciplines. The proposed articulated research agenda that is attainable for faculty, given the university's intensive teaching focus, will result in an increase overall faculty and student research activity (see figures 13-15).

Table 18: *Faculty Development Plan*

Name	Strengthen Areas	Projected Activities	Year and Place	Estimated Cost
Dr. Eliud Hernandez	Dissemination, networking, develop national and international research collaboration	• 256th American Chemical Society National Meeting & Exposition • Annual Drug Discovery Chemistry Meeting • Annual World Preclinical Congress • National Medicinal Chemistry Symposium	2018, Boston Massachusetts 2019 2020 2021	$1,500 $1,500 $1,500 $1,500
Dr. Magaly Martínez	Dissemination, networking, develop national and international research collaboration	• Training at Dr. Lu's lab, University of Notre Dame, mouse model American • Association for Cancer Research (AACR) Annual Meeting • Society for Basic and Urological Research (SBUR) Annual Meeting • American Society for Biochemistry and Molecular Biology (ASBMB)	2017 2018 2019 2021	$2,000 $2,500 $2,000 $2,000
Dr. Jorge Duconge	Dissemination, networking, develop national and international research collaboration	• CSHL 2017 Advanced Sequencing Technologies & Applications course • Precision Medicine Conference, University of Florida (UF)/ Workshop • CPIC-PGRN/ ASCPT Annual meeting • APhA Annual Meeting and Exposition • World Pharmacists & Clinical Pharmacy Annual Congress	2017, Nov-Dec, Cold Spring Harbor, NY 2018, March, Orlando, FL 2019, Washington DC 2020, tbd 2021, tbd	$1,500 $1,500 $1,500 $1,500 $1,500
Dr. José Colón	Dissemination, networking, develop national and international research collaboration	• Society for Neuroscience • Society for Neuroscience • Society for Neuroscience • Society for Neuroscience • Society for Neuroscience	2017, Washington, DC 2018, San Diego, CA 2019, Chicago, IL 2020, Washington, DC 2021, Chicago, IL	$2,500 $2,500 $2,500 $2,500 $2,500

VIII. FACULTY

Name	Strengthen Areas	Projected Activities	Year and Place	Estimated Cost
Dr. Darlene Santiago	Translational research, strengthening collaborations with researchers outside of PR, Publishing	• Obtain post-doctoral MS in clinical and translational research • Attend, network, and present my work in: • The Association for Clinical and Translational Science (ACTS) • The American Association of Pharmaceutical Scientists (AAPS) • The American Institute of Chemical Engineers (AIChE)	2017 2018 2019 2020 2021	$2,000 $2,000 $2,000 $2,000 $2,000
Prof. Rafael Garcia	Quality Control Statistics, Experimental Designs in Pharmaceutics, Clinical Trials	• To collaborate with fellow faculty in charge of other Statistics Courses within Graduate Program in order to fine tuning content and optimize time and content of Statistics courses • To acquire pertinent textbooks and software in the subject • To attend complementary activities in the subject	2017: 4th International Conference on Clinical Trials, San Antonio, TX (Sept. 11-13) 2018-2019: Software and Textbooks acquisition	$2,500 $2,500
Dr. Torsten Stelzer	Dissemination, networking, develop national and international research collaboration	• World Congress of Chemical Engineering (WCCE) • Larson Workshop • American Institute of Chemical Engineering (AIChE) Annual Meeting • International Symposium on Industrial Crystallization (ISIC) • International Workshop on Industrial Crystallization (BIWIC)	2017 2018 2019 2020 2021	$2,000 $1,000 $1,500 $2,000 $1,500
Dr. Cornelis Vlaar	Dissemination, networking, develop national and international research collaboration	• American Chemical Society National Meeting • American Society for Pharmaceutical Scientists Annual Meeting • American Association for Cancer Research Annual Meeting • Gordon Conference • American Chemical Society National Meeting	2017, Philadelphia 2018, Washington 2019, tbd 2020, tbd 2021, San Antonio	$1,500 $2,000 $2,000 $2,000 $1,500

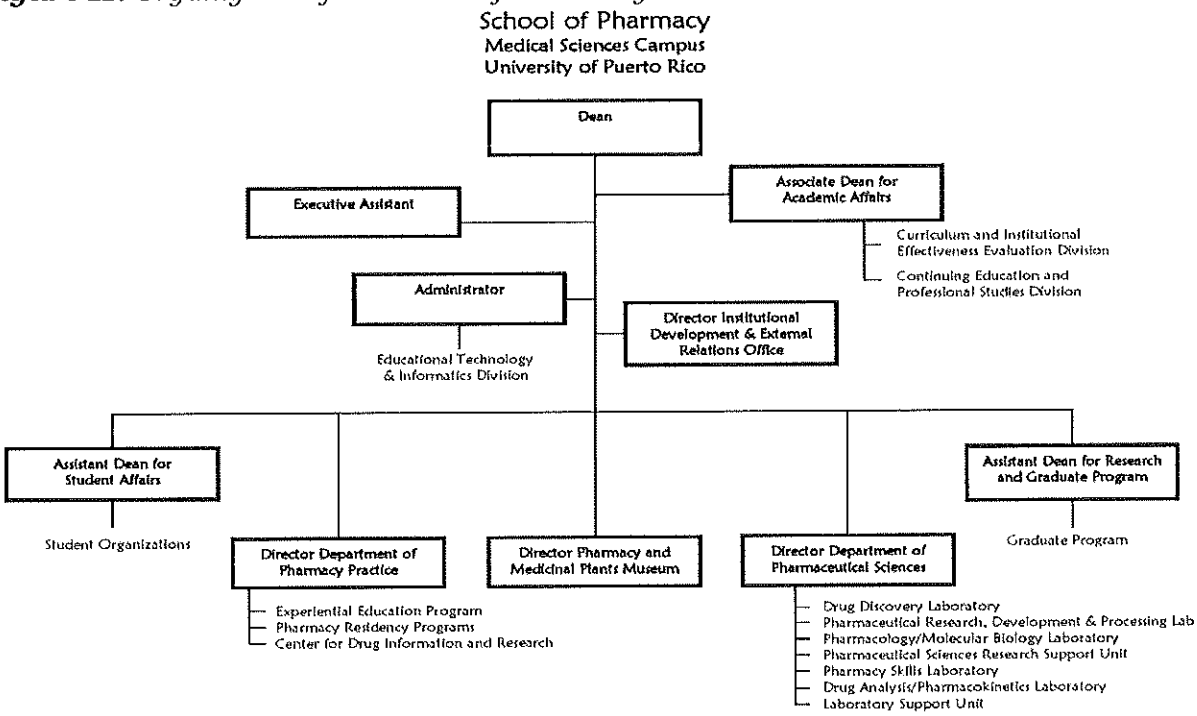
VIII. FACULTY

Name	Strengthen Areas	Projected Activities	Year and Place	Estimated Cost
Dr. Joseph Bloom	Dissemination, networking, develop national and international research collaboration	• Pittcon • American Association of Pharmaceutical Sciences • American Society of Mass Spectrometry • IFPAC	2018 2017 2020 2019	$1,500 $2,000 $1,500 $500
New recruitments	Develop grant writing skills, networking, and research collaborations	• Grant writing workshop • Appropriate Society Meeting		$2,000 $2,000

IX. PROGRAM ADMINISTRATION

The Ph.D. in Pharmaceutical Sciences program will assume the administrative structure of the current M.S. in Pharmacy program. Therefore, **no change in the administrative structure** of the School of Pharmacy will be required. The current organigram of the School of Pharmacy is represented in figure 11.

Figure 11: *Organigram of the School of Pharmacy*



The main administrative responsibilities for the Ph.D. in Pharmaceutical Sciences program will be with the Assistant Dean for Research and Graduate Programs. The office has the availability of one Administrative Assistant, and is supported by the Graduate Program Committee, which is elected by the faculty. In addition, as almost all faculty members that participate in the program are members of the Department of Pharmaceutical Sciences, the program will have the availability of the support structure of the Department.

The responsibilities of the **Assistant Dean for Research and Graduate Programs** will continue to be as follows:

a. Be responsible for all academic and administrative activities directed to comply with the mission, goals and objective of the School in relation to the Graduate Programs (M.S. and Ph.D.)
b. Submit the application documents of all candidates for admission to the Graduate Program Committee for the corresponding evaluation.
c. Serve as academic advisor to the students until they select a Major Advisor.
d. Submit the members of the Thesis Committee of the students for approval to the Graduate Program Committee
e. Submit the status of the academic progress of the students at the end of each academic session to the Graduate Program Committee.

f. Submit an annual report from the Office of Research and Graduate Programs to the Dean.
g. Notify the courses that will be offered in each academic session to the Registrar's Office and to the Associate Dean of Academic Affairs.
h. Coordinate the Graduate Courses that will be offered in each academic session with the Directors of the Departments.
i. Submit a report about the participation of the faculty in the Graduate Programs to the corresponding Department Director.
j. Revise and develop the Graduate Programs, following the guidelines established by the University of Puerto Rico.
k. Manage the budget of the Graduate Programs.
l. Develop and maintain a support structure for research in the School Of Pharmacy.
m. Plan research development activities for student and faculty.
n. Facilitate the productivity of the faculty in the area of sponsored research, publications and patents.
o. Collaborate with the compliance with federal, local and University regulations for the responsible conduct and administration in the area of research.

For the Ph.D. in Pharmaceutical Sciences program, the Assistant Dean will continue to be supported by the **Graduate Program Committee**, which supports the current M.S. in Pharmacy program. The composition of the Graduate Program Committee is as follows:

- Four full-time faculty members, elected by the Faculty of the School of Pharmacy
- Student representative, elected by the students
- Assistant Dean for Research and Graduate Programs (ex-officio with vote)
- Assistant Dean for Student Affairs (ex-officio)
- Dean of the School of Pharmacy (ex-officio)

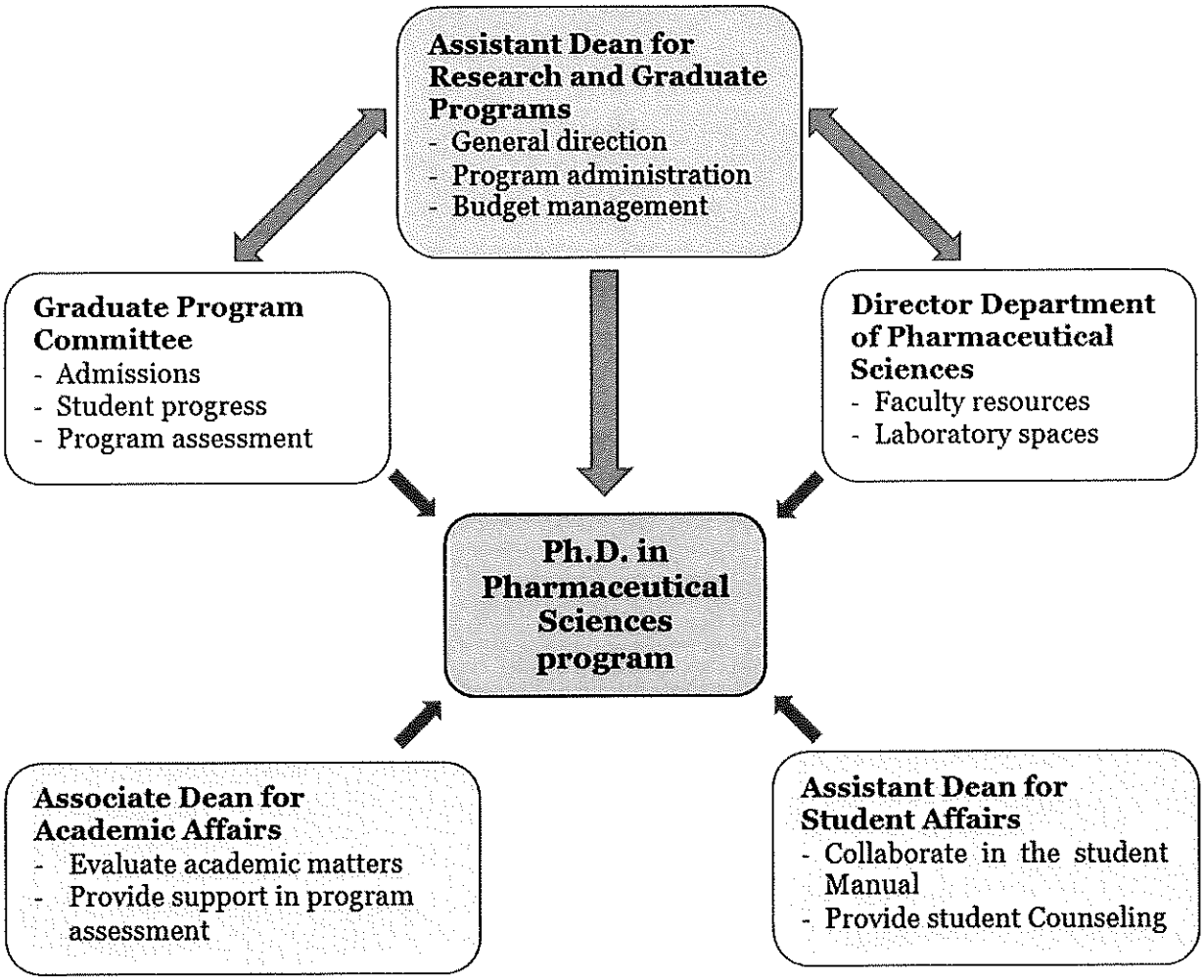
The responsibilities of the **Graduate Program Committee** are as follows:

a. Determine whether the candidates for the Graduate Program comply with the minimum admission requirements.
b. Interview candidates that comply with the minimum requirements, and recommend those who have the highest probability for success for admission.
c. Evaluate and determine course credits from other institutions than can be convalidated.
d. Approve the composition of the Thesis Committees of the students.
e. Consider petitions to carry out research outside of the Medical Sciences Campus.
f. Provide feed-back on the progress of the students as reported by the Assistant Dean for Research and Graduate Programs, and the Thesis Committee.
g. Submit recommendations to the Assistant Dean for Research and Graduate Programs regarding actions to take for students with academic deficiencies, including deficiencies in research.
h. Submit recommendations to the faculty, with approval of the Dean, with relation to students that have completed the requisites of the program, and are eligible to receive the degree of Ph.D. in Pharmaceutical Sciences or M.S. in Pharmaceutical Sciences.
i. Collaborate with the Assistant Dean for Research and Graduate Programs in the implementation of regulations and mechanisms to provide follow-up to the progress and mentoring of the students.
j. Provide feedback and evaluation of the program
k. Recommend changes in the curriculum and the program to the faculty.

IX. PROGRAM ADMINISTRATION

The main interactions of all the units within the School of Pharmacy that are involved in support of the Ph.D, in Pharmaceutical Sciences program are schematically represented in figure 12.
The Assistant Dean for Research and Graduate Programs will provide general direction, lead the administration, and manage the budget assigned to the program. In addition, the Assistant Dean will lead the Graduate Program Committee, members of which are elected by the faculty, together with an elected student representative. Recommendations regarding admissions, student progress, program assessment, and other relevant matters will be discussed in regular meetings. Furthermore, the Assistant Dean of Research and Graduate Programs will interact directly with the Director of the Department of Pharmaceutical Sciences to assign internal faculty resources to provide the courses of the program. In addition, the Department Director will be responsible to attest that faculty investigators have the appropriate laboratory space available for the students to be able to carry out their Thesis Research.
The Associate Dean for Academic Affairs will support the program in academic matters, and via the Office of Curriculum and Evaluation support the assessment of the program. The Assistant Dean for Student Affairs will provide student counseling and other related activities.

Figure 12: *Involvement of units of the School of Pharmacy in the Ph.D. in Pharmaceutical Sciences program.*



X. LEARNING AND INFORMATION RESOURCES

Access, Support, and Effectiveness

The Conrado F. Asenjo Library is the main health sciences information resource in the Island and contains one of the most complete collections of its kind in the Caribbean. The library offers a full range of information resources and services to students, faculty and preceptors. Resources and services are also available to the Puerto Rico Medical Center hospital personnel, as well as to the staff of the University of Puerto Rico Hospital in Carolina. It also serves practicing health professionals and the community at large.

The library is affiliated with the National Network of Libraries of Medicine (NNLM) of the National Library of Medicine (NLM). As part of this network, the library participates in the network's document delivery program to share resources with other libraries. It is also a member of the Consortium of Southern Biomedical Libraries (CONBLS). Through these programs, materials that are not available in the collection are obtained from other health sciences libraries using the ARIEL software for electronic interlibrary loan transmittal. The CFA Library is also a member of the Medical Library Association and the Association of Academic Health Sciences Libraries, and has established collaborative agreements with the San Juan Veterans Administration Hospital Library, the UPR-Río Piedras Campus Natural Sciences Faculty Library, and other units of the University of Puerto Rico Library System.

The collection comprises 45,586 print titles (including local theses), 2,286 electronic books (including Clinical Key eBooks) and 3,658 active journal subscriptions (local and through the UPR Libraries Consortium) covering the fields offered by the campus academic programs, and 1,336 multimedia resources.

There is a liaison librarian for each school on campus. Most are members of the schools' curriculum committees. The liaison librarian is responsible for collection development of his/her school using faculty input in the selection of information resources. Liaison librarians keep the faculty informed of new services and library resources and keep the library informed of new courses and trends in the schools.

To provide better and more efficient access to its resources and more comfortable spaces and new services, the library's physical facilities were remodeled recently. There are computers available throughout the building, as well as two multi-use rooms and several discussion group rooms on the third floor. The library opens weekdays from 7:00 am to 9:00 pm and on Saturdays from 9:00 am to 5:00 pm. It is closed on Sundays and holidays. Full services, including reference, and virtual reference are available only on weekdays. Circulation services are available during weekdays and Saturdays. The library's Veranda area opens 24/7 as a reading room. Users have wireless access to electronic resources while on campus and may access them remotely by means of the proxy server.

Reference librarians offer one to one interventions and workshops on information search skills, the use of databases, preparation of bibliographies, and use of evidence based practices, among other topics. Through the library's web page users have access to the LibAnswers based Virtual Reference Librarian Service through chat or e-mail, Monday through Friday from 8 am to 4 pm. Reference services are offered until 9:00 pm. The Circulation Section loans iPad and laptops to students during regular hours and maintains an electronic reserve service.

X. LEARNING AND INFORMATION RESOURCES

The HORIZON Information Management System is used for the library's online catalog, which is shared with other University of Puerto Rico Library System libraries. The online public access catalog is available through the Internet at the library's web page http://rcm-library.rcm.upr.edu. Also, there is a wide range of databases covering health sciences disciplines, including full text articles, through the UPR Libraries Consortium. Online databases such as PubMed, Science Direct, Best Practice, and other databases included in the Library's webpage also offer broad access to scientific literature

The library's webpage contains numerous information resources, including those especially selected/purchased by the institution and many referenced on the page for user convenience. The page includes a proxy server option that allows users remote access using their institutional email identity.

In terms of the overall information system architecture and user access points, all resources except those in the Institutional Historical Archives and some materials in the Special Collections section are available in the library webpage. This includes serials, which are cataloged. PubMed citations are linked to the serials print collection (green buttons) and to full text online journals (turquoise buttons). Other full text databases are linked accordingly. As mentioned earlier, users may access the page through the campus wireless service or remotely by means of a proxy server.

Available resources may change over time as contracts with vendors are renegotiated, new products become available for trial periods, and other products are discontinued. For the most current listing of resources, users must access the library's web page at: http://rcm-library.rcm.upr.edu.

XI. TEACHING, RESEARCH AND SERVICE INFRASTRUCTURE

A. Facilities, Laboratories and Equipment for Teaching

The new facilities of the School of Pharmacy building are located in the UPR-MSC, where the School occupies 40,000 sq ft. The classrooms and laboratories, the School of Pharmacy multi-purpose areas, the administration offices, and the support facilities are distributed among the four floors of the new building. Some laboratories are located at the Guillermo Arbona Irizarry Building in the UPR-MSC, for a total of 58,959 sq. ft, among the two buildings, and the Museum of Pharmacy and Medicinal Plants.

The facilities at the School of Pharmacy Building consist of seven (7) classrooms with capacity for 290 students through all seven classrooms, forty (40) faculty offices, three (3) conference rooms, personnel and faculty lounge, a student lounge, a student study room, educational technology rooms, an informatics center, and additional offices for administrators and staff. These accommodations for faculty, staff, administrators and students provide an acceptable environment for interaction and interprofessional collaboration. All faculty offices provide sufficient privacy to permit accomplishment of responsibilities. The School of Pharmacy's Center for Drug Information and Research (CDIR) located on the fifth floor of the UPR-MSC Library, serves as the focal point for drug information, research, education, and service.

All classrooms are equipped with computers, digital image projectors, projector screen, sound system, WiFi internet connection, desk power and desktop Ethernet outlets for each student, and at least three classrooms are equipped with Apple TV and touch screen (Smart Board) systems. The School's informatics center-lab with capacity of 40 students, is located in the second floor of the School of Pharmacy and is used as a study room and occasionally for some class sessions. A total of twenty (20) computers and 50 laptops have the most commonly used programs (Office 2007 and 2010) and connections to the Internet (WiFi, desk power and desktop Ethernet outlets for each student) that facilitate remote access to UPR-MSC library databases as well as other resources available online. Also, the informatics center is equipped with an image projector, screen projector, touchscreen (Smart Board), Apple TV, sound system, and video monitor. The School's informatics center-lab is staffed with an informatics technician, who provides assistance to faculty and students and strengthens informatics services at the School.

The faculty offices (90-123 sq ft) are located on the third and fourth floor. Faculty offices are all adjacent to each other, thus allowing interaction and collaborations. All faculty members have been provided with personal computers with access to the Internet. The internet connection in the faculty offices is 100 Gbps of speed (LAN) and connectivity is through an independent server located at the UPR-MSC Main Building. All faculty offices are provided with WiFi access as well.

Three laboratories, including the Drug Discovery Laboratory (1,868 sq ft), Drug Analysis and Pharmacokinetics Laboratory (892 sq ft), and The Pharmacology and Molecular Biology Laboratory (1,056 sq ft), are located on the second floor of the MSC building and are currently in use by faculty members of the Department of Pharmaceutical Sciences. The Pharmaceutical Research, Development and Processing Laboratory (1,605 sq ft) is located at the MSC building basement which is also utilized for teaching experiences (FARM 7137 Compounding and Manufacturing of Dosage Forms I). Two faculty members have been assigned Bench space in the Molecular Sciences Research Building, and one faculty member has her laboratory in the Comprehensive Cancer Center.

The School has some space that still needs to be developed. On the third floor of the School of Pharmacy building two laboratories spaces are available and located in the third floor and occupy a total of 3,442 sq. ft. In the available space, laboratory benches, fume hoods etcetera need to be installed to provide needed research space for the faculty members.

The Human Research Subjects Protection Office (HRSPO) is located on the second floor of the UPR Medical Sciences Campus, Main Building. As per Assurance (FWA 00005561), the HRSPO is committed to guarantee that all research involving human subjects or analysis of data gathered from human subjects, regardless of funding status, be reviewed by the IRB prior to implementation of any research activity.

The animal facilities of the Medical Sciences Campus are fully accredited by the American Association for the Accreditation of Laboratory Animal Care (AAALAC) and approved by the United States Department of Health and Human Services Office of Laboratory Animal Welfare (Animal Welfare Assurance #A3421-01). The Animal Resources Center (ARC), located on the 10th and 11th floors of the main Medical Sciences Campus building, has temperature and light controlled rooms for the housing of rodents and lagomorphs, isolation wards with laminar flow ventilation systems and hoods, procedure and treatment rooms, an examination room, a necropsy room, and administrative offices.

The list of equipment available for research in the School of Pharmacy includes:

- Bruker 400MHz NMR spectrometer
- Agilent 6930 GC/MS system
- 2 Agilent GC/FID systems
- Infrared spectrophotometer
- CEM Microwave synthesizer
- Rotary evaporators
- Fume Hoods
- Biological hood for cell culture
- CO2-incubator
- UV-Vis plate-reader
- water baths
- balances
- 8 HPLC systems (different manufacturers)
- Particle Size Analyzer, Malvern (Serial No. 7297)
- Differential Thermal Analysis and Thermo-Mechanical Analyzer, Thermogravimetric Analyzer, Mettler 30000
- Hanson Paddle Dissolution Apparatus 2
- Hanson USP- 8 Kettles Dissolution Apparatus
- USP IV Dissolution apparatus
- Extruder/Marumerizer, LUWA Corporation
- V- Blender, Patterson Kelley
- High Shear Mixer, Glatt
- Near Infrared Diffuse Reflectance Spectroscopy, Bruker
- Hardness Tester, Erweka
- Spray Dryer, Yamato, Model GS310
- Korsch Instrumented tablet Press
- Rheomat Viscometer, Bookfield

- UV-Visible Spectrophotometer , Beckman DV 520
- V- Blender, Big Size
- Viscometers, Brookfield
- Planetary Mixer
- Helium Pycnometer (Regular)

The Puerto Rico OMICS Center (PROMIC) was created in August 18, 2016 and is governed by a Memorandum of Understanding (MoU) between the Research Centers in Minority Institutions (RCMI), the Center for Collaborative Research in Health Disparities (CCRHD), the Puerto Rico Clinical and Translational Research Consortia (PRCTRC), the Genomics Translational Research Unit (GTRU), the Institutional Development Award (IDeA) Networks of Biomedical Research Excellence (INBRE) Program and the University of Puerto Rico Comprehensive Cancer Center (UPRCCC).
The following instruments were relocated to the laboratory #6 at the UPRCCC and are available for pharmacogenomics research projects.

- Affymetrix Microarray that includes: a Gene Chip® Scanner 3000, Gene Chip® Fluidics Station 450, DELL Computer (Precision 490), Hybridization oven 645
- Ion Personal Genome Machine® (PGM™) System that includes: an Ion PGM Sequencer, Server and Unipower.
- E-Gel Electrophoresis System
- Ion Proton™ System
- Air Clean® 600 PCR workstation
- Ion One Touch™ 2 System
- Pippin Prep
- Bioruptor™ UCD-200
- Barnstead™ Easypure™ RoDi
- Qubit® 2.0 Fluorometer
- IKA Vortex 3
- IKA MS 3 digital Vortex
- Pioetus Hirshmann
- VWR Ion Proton Centrifuge

Faculty of the School also has laboratory space in the Comprehensive Cancer Center. From grant funds the following equipment was purchased:

- -20 Freezer 19' and Refrigerator 19'
- Shaker Labnet Pro30
- -150C Cryogenic Chest Freezer
- NanoDrop2000 Spectrophotometer
- Fiber Optic Illuminator
- Stereo 1x 3x Microscope
- Slide staining station
- FACS Muse Cell Analyzer
- Step One Plus Real Time PCR System
- Sonicator

Further equipment available in the main laboratory space include:

- real time PCR i-Cycler, 2 PCR machines
- dissecting microscope
- bead sterilizer
- bacterial and tissue culture incubator
- microscopes (1 upright, 2 inverted)
- spectrophotometer
- immunohistochemistry station
- centrifuge
- molecular biology equipment (PAGE, transblot, vacuum oven, UV transilluminator,etc.)
- fully equipped cell culture facility with two laminar flow hoods and CO2 incubators
- cold room
- dark room with x-ray machine
- chemical room with chemical hood
- wash room with autoclave and water purification system
- equipment room with -80°C freezers
- room with histology processing equipment.
- light and fluorescence microscopes with a digital camera
- FACS caliber
- microplate reader
- Nano drop
- AlphaInnotech fluorchem
- 550 BioRad microplate reader

In addition, faculty members of the School of Pharmacy has equipment available for research at the Molecular Sciences Research Center located two miles from the School. Researchers from multiple disciplines across the UPR system work within the facility, which provides an unique pool of expertise fostering collaboration among researchers as well as with federal agencies (FDA) and the private industrial sector (biopharmaceutical industry), to collaborate and solve their challenges. A further feature of the MSRC is the ease of excess to shared analytical equipment necessary to conduct research. Full-time Ph.D. scientists manage the analytical equipment's that encompasses:

- Millipore water purification system
- Several rotary evaporators
- Differential scanning calorimetry (PerkinElmer)
- Thermal gravity analysis (PerkinElmer)
- Raman spectroscopy microscope (ThermoScientific)
- Fourier transform infrared spectrometer (FTIR) microscope (ThermoScientific)
- Bruker FTIR
- X-ray diffraction system SmartLab Rigaku for powder diffraction, thin film diffraction, SAXS, in-plane scattering, high temperature and atmosphere control (pressure and gases) diffraction
- Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) PerkinElmer Optima 8000 with auto sampler
- VG-Fisons Autospec High Resolution MS System with GC / MC, DIP, FAB, LSIMS, EI and CI modes

- VG-Fisions Quatro MS / MS system with GC / MS, HPLC / MS, Ei and CI modes, APCI and direct sample introduction options
- Hewlett Packard 5995A with GC / MS (capillary and package columns), DIP, thermal and packed columns), DIP thermal disorption sample introduction
- Hewlett Packard MSD GC / MS system
- Matrix-assisted laser desorption/ionization MALDI TOF/TOF
- High Resolution XPS
- Electrochemical Atomic Force Microscopy (EC-AFM)
- Potentiostat/Galvanostats with Electrochemical Impedance Spectroscopy (EIS) capabilities
- Bruker 700 MHz NMR
- Bruker Avance DPX-300 MHz NMR
- Bruker Avance DRX-500 MHz NMR
- Bruker Avance AV-500 MHz NMR
- Scanning Electron Microscopes (SEM) with X-ray fluorescence detection (EDAX)
- High energy resolution X-ray photoelectron spectroscopy (XPS) Multi-technique System
- Digital Instrument Nanoscope IIIA Atomic Force (AFM) and Scanning Tunneling (STM) Microscopes,
- JASKO 1500 Circular Dichroism with peltier box
- Malvern DLS-Zeta Potential
- Confocal Microscopy (Zeiss)

B. Practicum Sites

Not required for the program

XII. STUDENT SERVICES

A. Student Support Services

The School's Student Affairs Office is devoted to improving the quality of student life through the different services it offers, helping students maximize their academic achievements, and serving as a liaison between students, faculty and administration. It is directed by the Assistant Dean for Student Affairs, who is a Full Professor with a Bachelor of Science in Pharmacy, a Master in Public Health, and a Doctorate Degree in Education, with a specialization in Educational Leadership. The Assistant Dean for Student Affairs is responsible for overseeing and coordinating the student services of the School with the collaboration and support of the office staff.

The Student Affairs Office's staff also includes a counselor with a Bachelor Degree in Social Sciences with a major in Psychology and a Master Degree in Rehabilitation Counseling, a Student Affairs Official, and an Administrative Assistant. The School counselor offers personal, academic, professional counseling and orientation. She also arranges and coordinates workshops and activities to help students adapt to the School's environment, and offers orientation to prospective students. The MSC Deanship of Students and the Student Center for Counseling and Psychological Services (CECSI) are an additional resource available to students (http://cecsi.rcm.upr.edu/). CECSI offers counseling and psychological services, and referrals to psychiatric services if needed. The Deanship of Students also has a Quality of Life Office that develops programs to promote a healthy and safe environment, fostering the wellbeing of the university community (http://de.rcm.upr.edu/CalidadVida/CalidadVida.aspx). Academic and professional advising and information about post graduate education is also provided through the student's mentors (faculty member), and School's job fairs.

The Student Affairs Office staff provides information regarding norms, regulations, guidelines, timelines, and graduation requirements, among other matters. The office coordinates internships, career days and job recruitment activities with national and local institutions. It also collaborates, organizes and/or offers activities such as conferences, workshops, and seminars related to academic and professional life in the School. In addition, it collaborates and participates in the activities offered by the MSC Deanship of Students. The Office refers students to professional services at the Medical Sciences Campus and outside agencies when the need arises.

The orientation process for newly admitted students at the School of Pharmacy takes place in June, every year. The orientation process provides information and advice regarding norms, regulations, school and institutional policies, financial aid, and counseling services. In addition, workshops related to stress, change and time management, leadership, professionalism and teamwork are offered to help new students adjust to the doctoral program.
Current and prospective students have direct access to the Medical Sciences Campus policies, norms and other documents through the MSC Student Manual, available at (estudiantes.rcm.upr.edu/docs/manual_estudiantes_rcm.pdf). This manual offers access to valuable and comprehensive information about the UPR-MSC vision, mission, values, financial aid, advising, health care, and disability accommodation process, among other information.

All students are oriented regarding healthcare, as health insurance is mandatory for all students. Enrollment in the program is conditioned to the student's fulfillment of these health insurance requirements. Students may carry private insurance or the university insurance plan, which covers primary care, referrals to specialists, emergency room services, hospitalization, maternity, and mental health services, among others. For academic year 2016-2017, the annual cost of basic

health insurance was $1004.00. This coverage included generic medications with a co pay of $8.00 (http://de.rcm.upr.edu/Docs/SME/Plan_Medico/COSTOS-PLAN-MEDICO.pdf). It is a requisite for all enrolled students to comply with vaccinations, (TdaP, MMR, varicella, and Hepatitis B), PPD test, Chest X-Ray, V.D.R.L. test, and a physical exam. The Students Health Record is confidential and kept at the Medical Sciences Campus Health Service Office. The School of Pharmacy Experiential Program requires that all enrolled students present a Health Certificate and a copy of their immunization records. This information is required annually from all students before they start their practice experiences. In the event of an accident or health problem on campus, students may go to the Health Service Office or to an outside clinic. Information regarding medical services available to the students is offered during orientation and can be found in the MSC Student handbook and at: http://de.rcm.upr.edu/ServiciosMedicos.aspx.

The School of Pharmacy abides by the University of Puerto Rico and Medical Sciences Campus Family Educational Rights and Privacy Act of 1974, as amended (93-380, Section 438 FERPA). This law protects the privacy of students' educational records and establishes the student's right to examine his/her files. Students have access to FERPA policy and to the Institutional Policy of the Privacy of Student Records at the Registrars Manual (Manual del Registrador: http://estudiantes.rcm.upr.edu/Docs/Reg/manual_registrador_2010-11.pdf.

When a student is enrolled at the MSC the Office of the Registrar maintains an academic record with the final grades and official transcripts. Financial aid history is kept at the MSC Office of Financial Aid located at the Deanship of Students Building. The records include financial information provided by student and parents, such as loans, scholarships and school debts. It also includes compliance with debt management activities. Health records are kept at the MSC Health Service Office. The information kept includes vaccination records and all health requirements of the Campus.

Access to student records must be requested at the appropriate offices. "Under FERPA, a school must annually notify eligible students in attendance of their rights. The annual notification must include information regarding an eligible student's right to inspect and review his or her education records, the right to seek to amend the records, the right to consent to disclosure of personally identifiable information from the records (except in certain circumstances), and the right to file a complaint with the Office regarding an alleged failure by a school to comply with FERPA". The process to have access to the academic record is at Registrar Manual *(Manual del Registrador, http://estudiantes.rcm.upr.edu/Docs/Reg/manual_registrador_2010-11.pdf.* Any student currently or formerly enrolled who wishes to examine his/her record should go to the Office for Student Affairs or Academic Affairs for this purpose. All records are examined in the presence of a staff member at the office (Assistant Dean for Student Affairs, Associate Dean for Academic Affairs, Counselor, or Director of Experiential Education).

Dean, Associate Dean, Pharmacy Counselor have access to student's records as required to perform their functions. The Student Affairs Office developed a form to request student records. Currently enrolled student's records are kept in a locked file that only the Assistant Dean for Student Affairs of designee may access. Graduated student records are maintained in alphabetical order and organized by graduation year in a secure, limited access locked file in a storage room in the Students Affair Office. Counseling information is kept confidential in the counselor office located in the Student Affairs Office organized by alphabetical order in a secure locked file. Only the student counselor has access to these records. Experiential student records are kept in a secure locked file in the Experiential Office. Administrative and clerical staffs in the offices have access to such student records, as their particular responsibilities requires.

The University of Puerto Rico non-discrimination policy is established in the Board of Trustees Certification No. 58 (2004-2005)

(http://graduados.uprrp.edu/images/pdf/Cert_058_2004_05_JS.pdf). The University of Puerto Rico does not discriminate based upon gender, race, place of birth, age, physical or mental impairments, origin or social condition, political or religious beliefs, sexual preference, ethnicity, veteran status, or for being a victim or perceived as a victim of domestic violence, sexual assault, or stalking. This policy extends to all activities and functions within the university and its institutions such as employees and students selection, academic offerings, services, and financial aids. Applicants for academic admission or employment and students or employees, who feel they have been discriminated against for any of the reasons previously stated, may file a written complaint with the Chancellor.

Each syllabus contains a statement notifying students how to apply for reasonable accommodation.

> ***"Students who present a condition or health status that qualifies under the law to receive reasonable accommodation, has the right to make a request in writing to the Dean, Associate Dean, or Assistant Dean for Students Affairs, following the procedure laid down in the document: Proceso de Tramitación de Acomodo Razonable del Recinto de Ciencias Médicas. Copy of this document is obtained in the Deanship of Students of the MSC. The request does not release the student of meeting the requirements of the academic programs".***

The process for reasonable accommodation is coordinated by the MSC Deanship of Students and is found at ***http://de.rcm.upr.edu/Docs/Impedimentos/Solicitud-Acomodo-Razonable.pdf*** The student is interviewed by a counselor at CECSI and once all required documentation is completed the application is sent to the School. The Associated Dean for Academic Affairs coordinates with the student and the faculty how the accommodations will be implemented. A written communication with the reasonable accommodation agreement is signed and sent to the corresponding faculty.

B. Financial Aid

As a state supported institution of higher education, the University of Puerto Rico offers the residents of the island quality education at moderate cost.

The Office for Financial Aid at the UPR-MSC is responsible for helping students in matters related to financial aid, such as scholarships, federal loans, study and work programs, etc. Each School of the Medical Sciences Campus has a financial aid official assigned to help and counsel students about these matters. Students are educated about these services when they are admitted to the programs, during the Orientation Day of the Medical Sciences Campus Deanship of Students and the School orientation for newly admitted students that take place in June. A detailed description of all available financial aid options is available at http://de.rcm.upr.edu/AsistenciaEconomica/AyudasEconomicas.aspx.

There are several types of financial aid available to students, including scholarships, loans, work study, and assistantships. These financial aids include federal, state, and institutional sources of funds. The Financial Aid Office of the Office of the Dean of Student Affairs oversees the distribution of these aids, except assistantships.

The Medical Sciences Campus also offers its students teaching and research assistantships funded by institutional monies earmarked for that purpose. Criteria for granting the awards are based on

merit, rather than strictly financial need, and a committee chaired by the Campus Associate Dean of Academic Affairs of which the Assistant Dean for Graduate Programs of the School of Pharmacy is a member makes awards. Research assistantships far outnumbered teaching assistantships, and Ph.D. students are ranked in the highest priority to receive these assistantships. In addition to the research assistantships via the "Programa de Ayudantia" of the Medical Sciences Campus, students will be able to obtain assistantships via research grants of their faculty mentors. Alternatively, students can apply for research fellowships to national and international programs. A more detailed account of financial support for students is available in paragraph XIV. Budgetary Plan.

XIII. BULLETIN AND PUBLICATION

On the next two pages, please find the brochure to be distributed for promotion of the Ph.D. in Pharmaceutical Sciences program. In addition, in order to attract both local as well as international students, a webpage with more complete information, including course descriptions will be established and maintained. Further promotion of the program will take place via social networks such as Researchgate, Linkedin, Facebook etcetera.

SCHOOL OF PHARMACY
UNIVERSITY OF PUERTO RICO

Ph.D. in PHARMACEUTICAL SCIENCES

Contact information:
http://farmacia.rcm.upr.edu/
Assistant Dean for Graduate Programs
Phone: +1(787)758-2525 ext. 5509/5510
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programa_graduado_farmacia.rcm@upr.edu

Program

The Doctor of Philosophy in Pharmaceutical Sciences program aims to provide students with a comprehensive understanding of the discovery and development and manufacturing of pharmaceutical drugs, and their involvement in the treatment of disease.

Mission

To educate students who will improve the quality of life of the community through interdisciplinary research that will advance scientific knowledge in pharmaceutical sciences.

Graduate Profile

1. Critical thinking
2. Problem solving and decision making
3. Communication and informatics
4. Ethics
5. Ability to work independently and in group settings
6. Self-learning
7. Leadership

Employment opportunities

Through its graduate profile, the Ph.D. program will develop leaders of innovation and research in the pharmaceutical sciences. The program will provide the opportunity to develop the body of knowledge and skills needed to be successful in future employment in:

- Pharmaceutical industry
- Government
- Academia

Admission requirements

Minimum requirements: B.S. or M.S. degree from an internationally recognized institution. The applicant should be a major in one of the following fields: Biology, Biochemistry, Chemistry, Chemical Engineering, Cellular and Molecular Biology, Pharmacy or Pharmaceutical Sciences. In special cases, Bachelor or Master's degrees in other, related fields can be considered. In these cases, before submission of the application, the student will be encouraged to request approval from the Assistant Dean of Graduate Programs.

Required Courses: Organic Chemistry, Calculus I, Physics. Please check the webpage for further recommended courses.

Additional requirements: Average GPA of 3.0 or above; Completion of a GRE examination within the last three years; Three letters of recommendation; Proficiency in English; Interview by the Graduate Committee (when invited).

The program consists of 60 credits as follows:

- Core courses 22 credits
- Specialized courses 17 credits
- Research 18 (6 semesters x 3 cr)
- Thesis 3 credits

Core Courses		Total: 22 Credits
PHSC XXXX	Principles of Pharmaceutical Sciences	3
PHSC XXXX	Business, Quality, and Project Management	3
PHSC XXXX	Principles of Drug Discovery and Drug Development	3
PHSC XXXX	Advanced Instrumental Analysis	3
PHSC XXXX	Applied Biostatistics	3
PHSC XXXX	Ethics in Research	2
PHSC XXXX	Lab Rotation	1
PHSC XXXX	Seminar I	1
PHSC XXXX	Seminar II	1
PHSC XXXX	Principles of Research Design	2

After completion of the core courses, students will enter a mentor-driven, individualized program for their further development, in which they can specialize in one of three tracks. The student will select one of the tracks and carry out a competitive and innovative research project in the area, leading to a Doctoral Thesis. The three different tracks that initially will be offered are:

- Medicinal Chemistry and Pharmacognosy
- Molecular Pharmacology and Pharmacogenomics
- Pharmaceutics and Drug Delivery

Currently recommended specialty courses for each of the tracks are provided below. Based on Mentor input, these are subject to change.

Medicinal Chemistry and Pharmacognosy

The Medicinal Chemistry and Pharmacognosy track focuses on the discovery of potential novel drugs that function via interaction with biologically relevant proteins that are involved in human diseases. This will be accomplished via the synthesis of new small-molecule compounds, or via discovery and/or modification of biologically active natural products, when applicable supported by computational tools for optimization of activities. This track is directed towards students that are interested to apply basic chemistry knowledge towards the development of potential clinical therapies

Specialized Courses		**Total: 17 credits**
PHSC XXXX	Advanced Medicinal Chemistry and Pharmacognosy I	3
PHSC XXXX	Advanced Medicinal Chemistry and Pharmacognosy II	3
PHSC XXXX	Advanced Molecular Biochemistry	3
PHSC XXXX	Advanced Methods in Synthetic Organic Chemistry	3
PHSC XXXX	Seminar III	1
PHSC XXXX	Seminar IV	1
Elective Course		3

Molecular Pharmacology and Pharmacogenomics

The Molecular Pharmacology and Pharmacogenomics track focuses on the integration of biochemistry and genetics with pharmacology and pharmacokinetics. The focus will be on the investigation and understanding of the underlying molecular mechanisms of diseases, in order to be able to design new treatment strategies. This will include the application of pharmacogenetic and pharmacogenomic principles, which are the basis for the development of the upcoming field of personalized medicine. This track is directed towards students that are interested in understanding underlying principles of diseases and/or investigate direct clinical applications based on genetic predisposition of the patients.

Specialized courses		**Total: 17 credits**
PHSC XXXX	Advanced Pharmacology I	3
PHSC XXXX	Advanced Pharmacology II	3
PHSC XXXX	Advanced Molecular Biochemistry	3
PHSC XXXX	Pharmacogenomics/ Pharmacogenetics	3
PHSC XXXX	Seminar III	1
PHSC XXXX	Seminar IV	1
Elective Course		3

Pharmaceutics and Drug Delivery

The Pharmaceutics and Drug Delivery track focuses on the design, development and optimization of dosage forms for small and large molecule drugs. Process development of Quality by Design (QbD) manufacturing procedures, combined with advanced Process Analytical Technologies (PAT) has become highly relevant to the pharmaceutical industry. Research will be carried out in materials sciences, nanotechnology, crystallization, and drug formulation. It also involves the application of physical and analytical chemistry, and engineering towards development of novel drug delivery systems. This track is directed towards students that are interested in modern manufacturing methods of active pharmaceutical ingredients and novel formulation approaches to final drug products.

Specialized courses		**Total: 17 credits**
PHSC XXXX	Advanced Pharmaceutics and Pharmacokinetics	3
PHSC XXXX	Pharmaceutical Engineering and Unit Operations	3
PHSC XXXX	Pharmaceutical Formulation and Drug Delivery	3
PHSC XXXX	Regulatory and Manufacturing Practice	3
PHSC XXXX	Seminar III	1
PHSC XXXX	Seminar IV	1
Elective Course		3

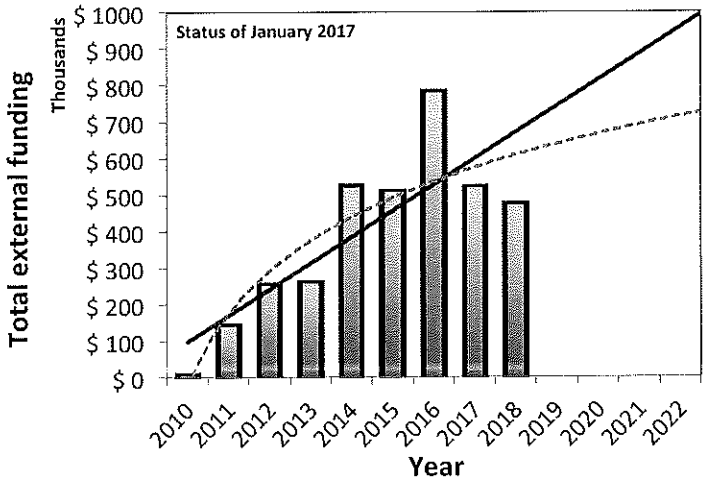
XIV. BUDGETARY PLAN

The establishment of a new academic program generally requires substantial institutional support during the first years of its development. However, **the proposed Ph.D in Pharmaceutical Sciences program is a logical advancement of the already existing Master of Science in Pharmacy program** at the Department of Pharmaceutical Sciences at the School of Pharmacy. Due to the presence of the M.S. in Pharmacy program, the infrastructure for administration of the Ph.D. program is already available. The proposed program takes full advantage of the already established research and educational infrastructure of the M.S. program, which leads to a significant reduction of the budget needed to support the proposed doctoral program in the starting phase of five years This includes the administrative offices with an Assistant Dean for Graduate Programs and an administrative assistant, research laboratories and instrumentation, and faculty offices. Thus, no additional financial support is required for research equipment, educational material, or computer resources since they are already in place. The participating faculty will shift their academic load from the M.S. program to the Ph.D. program, thus obviating the need for additional recruitment. Therefore, for the implementation to the Ph.D. program, no significant additional costs are anticipated. Better yet, the Ph.D. program will place the faculty and the Department in a much more favorable position to increase its research productivity and competitiveness to obtain external funds to support the program.

Prospective increase of external funds

The faculty members that will actively participate in the program and supervise the doctoral students in their thesis research have already successfully proven to be capable to independently support their research with external funds. Between 2010 and 2016, the Department of Pharmaceutical Sciences has been able to acquire approximately $4.2 million through federal (i.e. NIH or NSF), state (Puerto Rico Science Trust), or private agencies (i.e. Susan Komen foundation), as well as via collaborations with the private sector. These grants provided funds for research materials, acquisition of instrumentation and assistantships for graduate students. As a consequence of prioritizing the development of research activities in the Department of Pharmaceutical Sciences, there has been a continuous growth in funds granted until 2014, as demonstrated in Figure 13. However, during 2014-216, the external funding raised by our investigators reached a plateau at around $600,000. The limited time that students in the M.S. program are required to participate in research activities, is prohibitive for further growth (blue dashed line in figure 13). In order to continue to grow, the implementation of the proposed Ph.D. program will foster an intensive focus on the development of competitive research. The participation of full-time registered Ph.D. students in the faculty research projects will increase productivity as measured by the number of peer-reviewed publications and presentation in international conferences, which will consequently improve the success in competitive grant applications for external funds. The recent recruitment of four (4) young research faculties with promising potential to carry out competitive research activities will contribute to further growth. By establishing the proposed Ph.D. program, and assuming a linear growth (red line in figure 13), it is expected that within five years of its implementation, the external funds received will have almost doubled to $1,000,000.

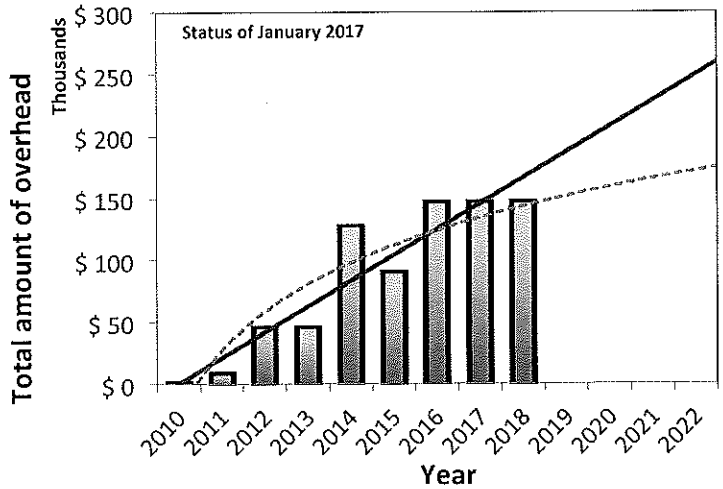
Figure 13: *External funding acquired by faculty members of the Department of Pharmaceutical Sciences between 2010 and 2018 (Status January 2017).*



The blue broken line indicates the trend line of the external funding acquired through the research capacity of the current M.S. program with estimation after five years (starting 2018). The red line indicates the trend line of external funding estimated considering the proposed Ph.D. program.

The above-described external funding has also brought overhead for facilities and administration to the University of Puerto Rico. Similar as with the overall external funding, there has been a continuous growth in the overhead until 2014. However, due to the aforementioned limitation of the M.S. program, the overhead through external funding (figure 14), raised by our faculty members, reached a plateau at a around $120,000 (average 2014-2016). However, with the establishment of the proposed Ph.D. program, assuming a linear growth, it is estimated that within five years, the indirect costs will have more than doubled to $260,000.

Figure 14: *Indirect costs (overhead) through external funding acquired by faculty members of the Department of Pharmaceutical Sciences between 2010 and 2018 (Status January 2017).*



The blue broken line indicates the trend line of the overhead acquired through the research capacity of the current M.S. program with estimation after five years (starting 2018). The red line indicates the trend line of overhead estimated considering the proposed doctoral program.

Budget perspective:
The implementation of the Ph.D. program is expected to lead to a considerable increase of external funds to support the research activities of the faculty members of the Department. Whereas currently it appears that a plateau has been reached, transformation of the M.S. into the Ph.D. program predicts a doubling of both direct and indirect costs awards via grant applications.

Infrastructure investment ($600,000)

There is an urgent need for laboratory space for the researchers in the School of Pharmacy. In recent years, the School has lost laboratory space, while at the same time, new investigators have been recruited. On the third floor of the new School of Pharmacy Building, an empty shell space of ~3,500 sq.ft. is available for development into a research area for 3-4 faculty members of the Department of Pharmaceutical Sciences. It needs to be furnished to increase the productivity and research capacity of the proposed doctoral program. A recent quotation estimated the purchase and installation of furniture, as well as connecting the facilities at $600,000. Regardless of the implementation of the Ph.D. program, this laboratory space is needed by the faculty investigators.

Required Annual Budget

Expenses
From its inception, the current M.S. in Pharmacy program has had an annual budget of $150,000, although in recent years due to budget cuts this has declined to $125,888. The annual costs are summarized in table 19. The costs for compensation of the Assistant Dean ($10,505) and the Administrative Assistant/Secretary V, including fringe benefits ($44,922) will be the same as in the budget for the current M.S. program. The annual costs for maintenance and laboratory materials ($90,000) are also similar as the current spending and budget of the program. Funds ($4,000) are requested in order to be able to invite guest lecturers to provide specific expertise in courses or seminars. A new item to the budget are the faculty development costs, based on $1,500 per faculty member per year with 13 faculty members. The success of the program depends on a well-prepared faculty, and the utilization of the funds is described in section VIII.B "Faculty Development".

Sources of income

To cover the expenses, the School of Pharmacy will dedicate its current annual budget (100% enrollment cost +$ 53,000 assignments from the general fund) available for the M.S. in Pharmacy program completely to the Ph.D. in Pharmaceutical Sciences program. The School of Pharmacy must receive 100% of the cost of enrollment from each student that get enrolled in this program. In addition, a $500.00 annual academic fee per student will be implemented to cover electronic platforms, electronic books and research support materials. This fee may be increased according to program needs. Moreover, the program will be supported by distribution of the indirect costs from research grants to the Department and the School which, according to the latest certification[21] of the Administrative Board (Junta Administrativa) are 10% and 7%, respectively. This initially adds approximately 17% of $120,000 = ~$20,000 to the budget, and as explained above, should double within the five years of the start of the program. These additional funds can be used to support students travel to participate in conferences, workshops, and seminars at the national and international level. This will enrich the students' educational and research experiences and expertise in areas related to their doctoral dissertation while contributing to the "big picture" of their respective research supervisor. In consonance with the Strategic Plan 2017-

[21] Certificación Número 178, 2015-16, JA-RCM

2022 of the UPR, the program will strive to attract international students. The increased tuition of these students will provide an additional source of income.

Table 19: *Projected budget for the proposed program for the first five (5) years*

Description/Year	**1**	**2**	**3**	**4**	**5**	**Total**
Assistant Dean (compensation)	$10,505	$10,505	$10,505	$10,505	$10,505	$52,525
Administrative Assistant/Secretary V	$30,840	$30,840	$30,840	$30,840	$30,840	$154,200
Fringe benefits	$14,082	$14,082	$14,082	$14,082	$14,082	$70,410
Maintenance[a]	$20,000	$20,000	$20,000	$20,000	$20,000	$100,000
Laboratory materials[b]	$70,000	$70,000	$70,000	$70,000	$70,000	$350,000
External resources[c]	$4,000	$4,000	$4,000	$4,000	$4,000	$20,000
Faculty Development[d]	$19,500	$19,500	$19,500	$19,500	$19,500	$97,500
Expenses	**$168,927**	**$168,927**	**$168,927**	**$168,927**	**$168,927**	**$844,635**

a. Includes maintenance for equipment, such as cryoliquids for the NMR system, hood certifications, repairs and maintenance on other instrumentation when needed.
b. Provides materials for Graduate students to carry out their research, and who work with new faculty or faculty in-between grants.
c. For specific courses, external resources can be hired to provide their expertise to the students
d. Based on 13 faculty members at $1,500 per year

Student support

Funds for stipends

As described in the enrollment projection (section VII.B), it is expected to enroll six students per year into the program within the first five years. These students may qualify for "ayudantia" and tuition waivers will be applied as per applicable University certifications.

Source of funding for stipends

The stipends for the students will be sourced via:

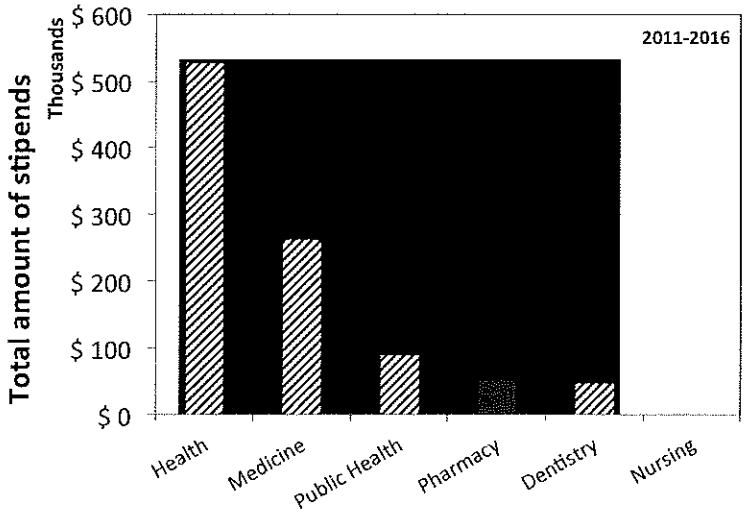
a. Programa de Ayudantias (student assistantship program at the MSC)
b. Faculty Research proposals
c. Student fellowships

Although initially the program will have a greater reliance on internal resources within the Campus or Institution, the long-term goal is that eventually the program will be able to support students via external funds.

a. Programa de Ayudantias

Funding for assistantship for the students of the proposed Ph.D. program is available through the "Programa de Ayudantias" of the Medical Sciences Campus (Certification Num. 50). This program provides stipends for graduate students, in which Ph.D. students are the first priority, level one for 3rd and 4th year students, and third priority, level one for 1st and 2nd year students. Figure 15 demonstrates the distribution of funds received per school of students that have research or teaching assistantships for the period between 2011 and 2016. It is clear that the School of Pharmacy is highly underrepresented due to the fact that its M.S. program is listed in the third priority, level two. However, by establishing the proposed doctoral program, our students will be automatically rated with a higher priority and thus ease their access to assistantships via the "Programa de Ayudantias". The annual average total budget of the "Programa de Ayudantias" between 2011 and 2016 amounts to $1,300,000 of which on average only $250,000 per year was distributed for assistantship for students conducting graduate thesis research. Therefore, the proposed Ph.D. program will help to satisfy the top priorities in the funds allocation, and will be able to provide substantive support to the students enrolled in the program.

Figure 15: *Total funding for assistantship provided by the "Programa de Ayudantias" at the UPR-MSC organized by schools.*

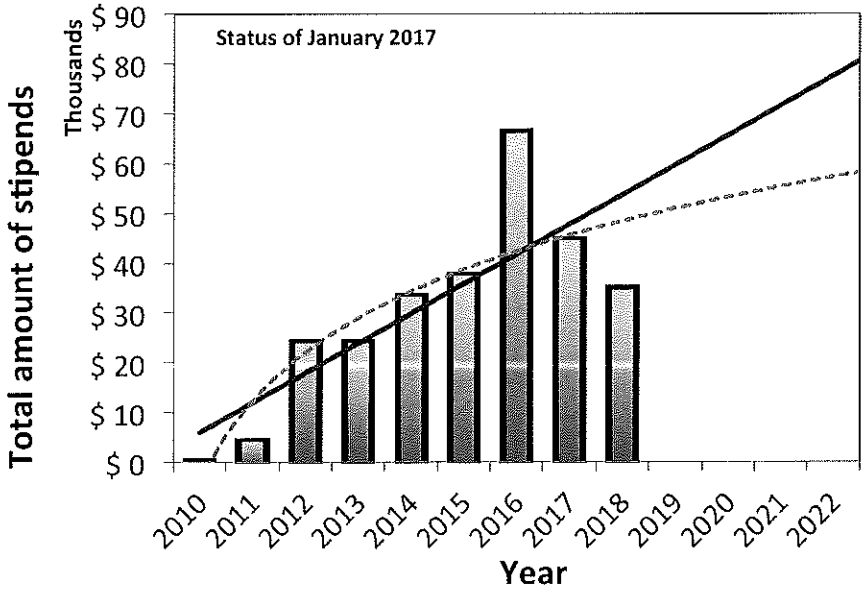


Health stands for the School of Professions related to Health and Public Health stands for the Graduate Program at the School of Public Health.

b. Faculty Research proposals

Through external research grants, faculty members of the Pharmaceutical Sciences Department have been able to support some of their students. Between 2013 and 2016 on average approximately $40,000 per year was available for student stipends from external funds (Figure 16). This would support three Ph.D. students per year. This indicates the strong ability of the faculty to successfully apply for external funding to subsidize graduate students conducting research in their laboratories. It is anticipated that this amount will significantly increase once the proposed doctoral program is established and the research active faculty members can apply specifically for funding for doctoral students in their proposals.

Figure 16: *External funding for stipends acquired by faculty members of the Department of Pharmaceutical Sciences between 2011 and 2018 (Status January 2017).*



The blue broken line indicates the trend line of the assistantships acquired through the research capacity of the current M.S. program with estimation after five years (starting 2018). The red line indicates the trend line of assistantship estimated considering the proposed doctoral program.

c. Student fellowships

Students will be encouraged to apply for graduate student fellowships, both via the MBRS-RISE program as well as via external programs such as the American Association of Pharmaceutical Scientists, NIH, NSF, pharmaceutical industry and others. While fellowship opportunities for our current M.S. students are highly limited, Ph.D. students will have access to a much wider variety of programs available. The Thesis advisors and mentors will aid the students with their applications.

Summary Budgetary Plan

Despite the minor investments needed for the establishment of the proposed program, the cost-effectiveness of it is priceless. Since **with relative little financial resources our current M.S. in Pharmacy program can be transformed into a Ph.D. in Pharmaceutical Sciences program (first of its kind in Puerto Rico), which will have a tremendous impact in the global competitiveness of UPR's academic and Puerto Rico's socio-economic standing**. To have this impact we need the best, innovative, and advanced education in the world, which we want to achieve with the proposed doctoral program in Pharmaceutical Sciences. By establishing the proposed program, we will also increase the direct income of the UPR through indirect costs, acquired through external funding by our successful faculty members.

XV. ASSESSMENT AND EVALUATION PLAN

Given that program evaluation is defined as the systematic collection of information about the activities, characteristics, and outcomes of programs to make judgments about the program, improve program effectiveness, and/or inform decisions about future programming (Patton, 1997)[22], the assessment and evaluation plan of the proposed doctoral program is based on a commitment to continuously improve the quality and evaluate the impact of the program activities. The assessment and evaluation of student learning and curricular effectiveness are part of the conceptual framework for the Ph.D. in Pharmaceutical Sciences evaluation plan, which follows Daniel Stufflebeam's (2003)[23] CIPP evaluation model *Context, Input, Process, Output, Product (known today as Outcome).* This model is a comprehensive framework for guiding evaluations of programs, projects, personnel, products, institutions, and systems[24].

The plan is developed to provide evidence on the attainment of the program's mission, goals, and objectives through data gathered using qualitative and quantitative methods. The main four types of evaluation that comprise CIPP functions[25][26] presented as part of the plan are described as follows:

1. *Context evaluation* serves planning decisions by identifying unmet needs, unused opportunities and underlying problems that prevent the meeting of needs or the use of opportunities;
2. *Input evaluation* serves structuring decisions by projecting and analyzing alternative procedural designs;
3. *Process evaluation* serves implementing decisions by monitoring project operations;
4. *Product (Outcome) evaluation* serves recycling decisions by determining the degree to which objectives have been achieved and by determining the cause of the obtained results.

Within each area there are specific components that will be addressed in the evaluation process. The evaluation of these areas is expected to examine and analyze the effectiveness of the program, from its implementation to their impact on society. The areas considered in the formative and summative evaluation plan, include the activities corresponding to the assessment program focused doctoral students' learning experiences and achievements. Figure 17 illustrates the conceptual framework for the evaluation of this program.

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[22] Patton, Q. M. (1997). Utilization focused evaluation: The new century text (3rd Ed.), London: Sage Publications.

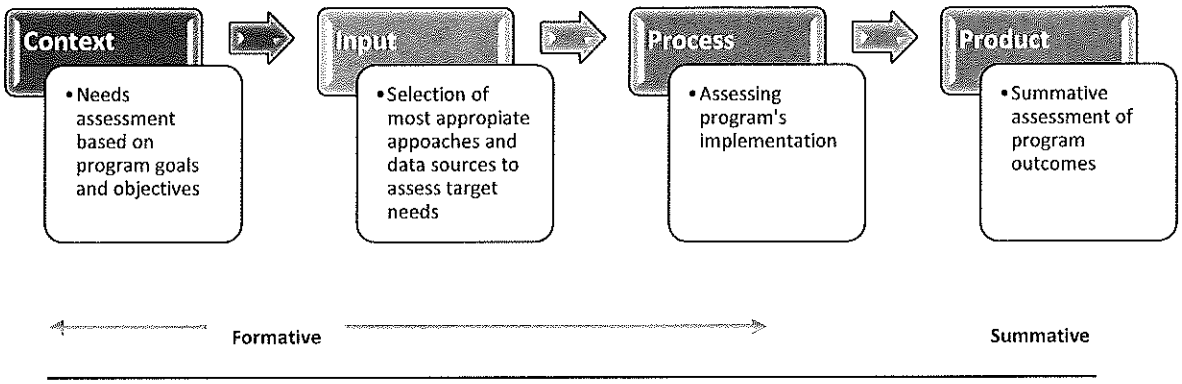
[23] Stufflebeam, D. (2003). The CIPP model of evaluation. In T. Kellaghan, D. Stufflebeam & L. Wingate (Eds.), Springer international handbooks of education: International handbook of educational evaluation.

[24] CIPP EVALUATION MODEL CHECKLIST. [Second Edition]. https://www.wmich.edu/sites/default/files/attachments/u350/2014/cippchecklist_mar07.pdf

[25] Stufflebeam, D. L. (1971a). The use of experimental design in educational evaluation. Journal of Educational Measurement, 8(4), 267-274

[26] Applying the Context, Input, Process, Product Evaluation Model for Evaluation, Research, and Redesign of an Online Master's Program. http://www.irrodl.org/index.php/irrodl/article/view/1485/2536

Figure 17: *Conceptual framework for the evaluation of the program*



The evaluation plan will be in tune with the already established assessment and evaluation policies and processes. The Assistant Dean for Graduate Programs will monitor the training-related progress of each student. The program will be evaluated annually, during the first five years, taking into account the following criteria: demand for the program, students' achievements, retention, number of graduates, external funding obtained by the faculty to subsidize their research, number of presentations and publications, operational costs of the program, physical resources, and success of the graduates being employed.

This evaluation plan will be monitored and implemented by the Graduate Committee of the School of Pharmacy, in collaboration with the School of Pharmacy's Curriculum and Institutional Effectiveness Evaluation Division (CIEED) that will support evaluation procedures as well as data collection and analysis.

The evaluation process performed under the CIPP model is designed to assist in making informed decisions, and to improve and achieve accountability in educational programming through a "learning-by-doing" approach (Zhang et al., 2011)[27]. This will reinforce evaluation activities in a continuum of quality assessment and improvement. These evaluation activities will provide the necessary feedback to determine the course of action needed based on recommendations and the progress assessed. This process is derived as part of the Program Evaluation Plan, and presented in Table 21.

[27] Zhang, G., Zeller, N., Griffith, R., Metcalf, D., Williams, J., Shea, C. & Misulis, K. (2011). Using the context, input, process, and product evaluation model (CIPP) as a comprehensive framework to guide the planning, implementation, and assessment of service-learning programs. Journal of higher education and outreach engagement 15(4), 57 – 83.

Table 20: *Program Evaluation Plan*

AREAS			DATA SOURCES/ STRATEGIES	FREQUENCY
FORMATIVE EVALUATIONS	CONTEXT	Mission, Goals, and Objectives	Annual Report, Assessment Plan, Findings Report	Continuously
		Work plan	Documents review	Continuously
		Content	Course evaluations, Course syllabus reviews	Each semester
		Budget	Budget reports, Financial statements, Approved grants	Annually
		Facilities and equipment	Course evaluations, Student perception survey, Faculty perception survey	Every 2 years
		Learning resources	Resource inventory	Annually
		Faculty profile	Curriculum Vitae	Every 2 years
		Graduate profile	Curriculum Vitae, Academic records	Annually
		Stakeholders profile	Curriculum Vitae	Every 2 years
	INPUT	Student perception of the program	Student perception survey	Annually
		Faculty perception of the program	Faculty perception survey	Annually
		Stakeholders perception of the program	Stakeholders perception survey	Annually
		Student progress reports	Faculty reports on students' progress, Academic records, Academic advising and counseling	Each semester
		Admissions and enrollment projections	Admission committee report	Annually
		Curricular design	Perception survey, Course syllabus reviews, Curriculum committee reports	Annually
	PROCESS	Program Administration	Annual Report, Assessment Plan, Findings Report	Annually
		Integration of academia and industry	Research projects, Internships	Each semester
		Teaching	Course evaluations, Student perception survey, Faculty perception survey	Annually
		Research	Research projects, Internships, Publications, Presentations	Annually

		AREAS	DATA SOURCES/ STRATEGIES	FREQUENCY
		Course effectiveness facilitating student learning	Teaching Strategies, Assessment Plan, Student perception survey, Curriculum Committee reports	Annually
		Students participation program decision making process	Students in Committees, Professional association participation, Students associations participations	Every 2 years
		Continuous Quality Improvement	PLAN-DO- CHECK-ACT assessment strategy, Annual Report, Perception surveys, Findings Report, Stakeholders forums	Every 3 years
SUMMATIVE EVALUATIONS	PRODUCT (OUTCOME)	Achievement of stated level of abilities (outcomes)	Formative and Summative assessments, GPA, Dissertation approvals	Annually
		Graduation rates on target date	Class cohort, Number of graduates on target date	Annually (From the graduation of the first cohort onwards)
		Academic relevance of the program in the industry	Number of graduates employed within first 6 months	Annually (From the graduation of the first cohort onwards)
		Presentations and publications	Peer reviewed publications, Peer reviewed posters, Peer reviewed presentations	Annually
		Service	Internships, Community service projects, Service in professional associations, Other external agreements	Annually
		Impact:		
		Alumni satisfaction with the program	Alumni philanthropic support, Alumni perception surveys	Annually (From the graduation of the first cohort onwards)
		Employers' satisfaction	Number of graduates employed within first 6 monts, Employer perception survey	Annually

XVI. DEVELOPMENT PLAN

For new academic program proposals, the University of Puerto Rico requires a developmental plan. This plan should address the process utilized to develop the evaluation reports for the program. The timeframe for these reports are annually for the first five years, and every five years thereafter.

During the first five years, the proposed Ph.D. program will be evaluated taking into account the following criteria:

- demand for the program
- student achievements
- student retention
- number of graduates
- external funding obtained by the faculty to subsidize their research
- number of presentations
- number of peer-reviewed publications
- operational costs of the program
- physical resources
- success of the graduates in the labor market

This evaluation plan as described in section XV will be monitored and implemented by the Graduate Committee of the School of Pharmacy. For the data collection and analysis to support evaluation procedures, the Graduate Program Office will work together with the Curriculum and Institutional Effectiveness Evaluation Office. The program is designed based on a desired Graduate Profile, so that students who complete a Ph.D. degree in Pharmaceutical Sciences will have the knowledge, skills, and attitudes needed to carry out innovative research projects in the pharmaceutical sciences in an inter – multidisciplinary scenario (section IV.D). The demand for the program will be evaluated by tracking the number of applications. Student recruitment will include current methods such as visits to local institutions, amplified by strong internet-based campaigns via a Homepage, Facebook, Linkedin, Researchgate etcetera, to be able to attract international students. We expect that student stipends and external funding obtained by faculty will increase the attractiveness of the program and the opportunities for the students. After the first semester in the Ph.D. program the student has to choose a mentor to facilitate his/her development of a research project and to guide the student in completing successfully all requisites toward the degree within the timeline proposed by the Ph.D. program.
enhanced

Revision of the program through student evaluation, statistics of student retention, and number of graduates will be conducted annually during the first five years. To determine job placement and employee satisfaction, a survey will be sent to the student and the employer to obtain data for analysis. The Assistant Dean of Research and Graduate Programs will be responsible for leading this effort, along with the Graduate Committee.

The faculty members of the proposed Ph.D. program have demonstrated to be able to secure external funds via available research grant opportunities from federal agencies, industry and other available sources (see figures 13 and 14). Identification of fellowships, scholarships, and internships from external sources will be a priority for the program administrator as outlined in the budget justification. With the enhanced research workforce through our graduate students of the proposed Ph.D. program, the opportunity to successfully obtain external funds for student fellowships will be greatly enhanced (figure 16). Faculty members are eager to continue to expand

collaborations with the industry, national and international academic research institutions, and other organizations to provide the students with a variety of scenarios with opportunities for growth.

Faculty members of the Department of Pharmaceutical Sciences that will participate in the proposed Ph.D. program are committed to expand and enhance their active research endeavors, which will increase their contribution to the knowledge of pharmaceutical sciences. The School of Pharmacy will offer financial support in different aspects to faculty (see section VIII.B, Faculty Development). In addition, educational support will be provided to students that will help them develop professionally, among others via the Seminar course that is part of the curriculum, and support for travel to attend international research symposia. In addition, the School of Pharmacy will work diligently to strengthen research opportunities with other institutions through joint research projects and student exchange with national and international investigators. Furthermore, the School will provide adequate research space, for the student to develop a research project capable of representing the mission and vision of the Ph.D. program (section IV.A). At the end of each year, productivity will be measured by the number of publications in peer-reviewed journals, review articles, book chapter and symposium abstracts.

The office of the Dean of the School of Pharmacy, together with the Assistant Dean of Graduate programs will facilitate development activities that improve the skills of faculty members and students to capacitate them for preparation of manuscripts for publication. This includes guidance to search electronic bibliographic data bases, citation management and technical writing competencies. A great effort will be focused on translating dissertation findings into presentations and publications. Students are expected to have at least one manuscript published and one submitted for review before their Thesis defense (section VII.C). Similarly, it is expected that the faculty members will be involved in competitive research activities, and submit at least 1-2 manuscripts for publication in peer review journals every year.

Faculty advisors are encouraged to discuss career opportunities with students during the course of their studies. The School of Pharmacy holds a Job-fair or career days on a regular basis, where students can have direct contact with potential employers. Employment opportunities are forwarded to students via email and posted on bulletin boards. In addition, copies of such opportunities will be available at the Graduate Program Office. Furthermore, the Student Affairs Office in collaboration with the Graduate Program Office coordinate internships for students for them to be able to obtain experiences in national and local institutions. They also collaborate, organize and/or offer activities such as conferences, workshops, and seminars related to academic and professional life in the School, and with pharmacy associations and organizations in Puerto Rico

A brochure with information about the proposed Ph.D. in Pharmaceutical Sciences program is available to prospective and enrolled students at the Student Affairs Office and at the Graduate Program office. This brochure will also be distributed during recruitment activities such as open houses and college or high school orientations, workshops and as well as national and international conferences. In addition, information about the School of Pharmacy and the proposed program can be found at: http://farmacia.rcm.upr.edu/. It will describe program goals, admission criteria and requirements, graduation requirements, program course sequence, description of courses, faculty information, and ongoing research activities. The information, including website and brochure are updated monthly or annually respectively, as needed.

APPENDICES

Appendix 1: Survey

Appendix 2: Survey Responses

Appendix 3: Letters of Support

Appendix 4: Course Syllabi