INDIANA UNIVERSITY
SCHOOL OF MEDICINE
Graduate Division

Sherry F. Queener, Ph.D.
Director of the Graduate Office, IUPUI
Associate Dean of the Indiana University Graduate School

July 25, 2010

Dear Dr. Queener,

Please find attached proposals for:

- A new M.S. degree in Translational Science
- A new certificate in Translational Science
- A new Indiana University Graduate School Ph.D. Minor in Translational Science

As you know, the M.S. degree is part of the specific aims of the funded NIH Clinical and Translational Sciences Institute (CTSI) grant that is coordinated by the Indiana University School of Medicine and also includes other IUPUI schools, Indiana University Bloomington, Purdue University West Lafayette, and the University of Notre Dame. This degree therefore represents a collaborative educational effort that will offer resources to students at three Indiana universities.

The proposals have been authored by Dr. R. Mark Payne of Pediatrics and his colleagues at the CTSI.

Please let me know if I or Dr. Payne can answer any questions.

Thank you for your consideration,

Simon J. Rhodes, Ph.D.
Associate Dean for Graduate Studies
Indiana University School of Medicine
srhodes@iupui.edu

Indiana University
Request for a New Ph.D. Minor Program

Campus: Indiana University – Purdue University of Indianapolis

Proposed Title of Ph.D. Minor Program: Minor in Translational Science

Projected Date of Implementation: Fall 2010

Faculty Member Developing / Submitting Proposal: R. Mark Payne

TYPE OF MINOR: (check one)

☐ UNDERGRADUATE MINOR

☒ **PH.D. MINOR**

I. Why is this Minor needed? (Rationale)

Over the last decade, a number of disciplines, including biochemistry, immunology, cellular and molecular biology, have experienced a rapid series of bold advances. In spite of these advances, there has been a 'lag time' between discovery and application of these new findings, which creates a high demand for a new breed of scientist with a hybrid training of basic science and clinical medicine who can bridge this gap. The proposed Minor in Translational Science provides an option for currently enrolled Ph.D. students to enhance their current scientific training with translational research techniques. This 12-credit hour Minor is designed to provide students with the opportunity to develop the necessary skills for future translational research. Locally and nationally, there is a high demand for translational researchers. According to the Bureau of Labor Statistics, employers in the research and development field require new doctoral employees to participate in extensive post-doctoral fellowships in order to develop the skills needed to design and conduct independent research. This program would provide our graduates with an edge by giving them some of that needed experience and knowledge. Graduates should experience increased opportunities for advancement and employment opportunities in university, industry, or government research settings.

II. List the major topics and curriculum of the Minor

A. **Requirements:** Minimum of 12 credit hours: 9 to 11 core credit hours, including Tools and Techniques in Translational Research (G667); Quantitative Aspects of Translational Research (New); Introduction to Research Ethics or Ethical and Policy Issues in International Research or Responsible Conduct of Research (RCR) (G504 / G505 / P555 / New); Biostatistics I or II (G651, G652, or approved equivalent). Credit may be given for up to 6 hours of student's pertinent graduate level coursework. Additional coursework (electives) is adapted to fit the needs of the student up to a total of 3 credits. Focus is on translational research training in the basic and clinical sciences for future research scientists. All required coursework is offered at the IUPUI campus.

B. **Completion Requirements and Procedures for Minor in Translational Science**

1. Total number of credits required: 12 credits

2. Specific course requirements **(Core Classes)**

✓	Tools and Techniques in Translational Research	(G667)	3 credits
✓	Quantitative Aspects of Translational Research	(New – Grad G668)	3 credits
✓	Introduction to Research Ethics or Ethical & Policy Issues in International Research or Responsible Conduct of Research (RCR)	(G504/G505/P555/New)	1 – 3 credits
✓	Biostatistics I or II	(G651, G652, or approved equivalent.)	3 credits
	Electives Credits (Graduate Level Courses – approved by the Program Director)		1 – 3 credits
	Total Credits		12 credits

- Minimum GPA requirements
  - ✓ Minimum overall GPA for all courses applied to minor. 3.0 GPA
  - ✓ Minimum grade for any course to be applied to minor. B-
- Maximum number of credits that may be transferred from another institution 6 credits
- Maximum number of credits from undergraduate level courses that may be used toward the degree 0 credits

Table 1: Required Courses for Ph.D. Minor

Course Title	*Course #*	*Credits*	**Ph.D. Minor**
Tools & Techniques in Translational Research	GRAD G667	3	X
Quantitative Aspects of Translational Research	New	3	X
Introduction to Research Ethics **or** Ethical and Policy Issues in International Research **or** Responsible Conduct of Research (RCR)	GRAD G504/ G505 or PHIL P555 or New	1 to 3	X
Biostatistics I or II (or approved equivalent)	GRAD G651 or G652	3	X
Electives (graduate level and approved by Program Director)	GRAD XXX	up to 3	X
Total Required Credits			12

Table 2: Potential Elective Classes for Translational Science

List of Potential TSPI Electives (Must be approved by student's Advisory Committee & must NOT be housed in the student's major department)	IUPUI	Credits
Advanced Biomedical Engineering Topics	BME 69600	1 to 6
Advanced Biomedical Polymers	BME 69500	3
Advanced Cardiovascular Physiology	G830	3
Advanced Morphologic Hematology	C802	2
Advanced Organic Chemistry	651	3
Advanced Topics in Molecular Biology	G825	2
Advances in Diagnostic Microbiology	C820	3
Angiogenesis	F713	1
Animal Models Of Human Disease	G727	1
Applied Multivariate Anal. in Pub Hlth w/Lab	PBHL E725	4
Basic Bone Biology	G 819	3
Behavioral Medicine in Rehabilitation	I614	3
Biochemical Mechanisms	636	3
Biochemistry:Structural Aspects	634	3
Bioinformatic Applications to Proteomics and Genomics	G848	2
Biological Membranes	BIOL 570	3
Biomedical Science I – Biochemical Basis of Biological Processes	GRAD G715	3
Biomedical Science II – Molecular Biology & Genetics	GRAD G716	3
Business of Life Sciences	X518	1.5
Cardiac & Coronary Physiology of Exercise	F708	1
Cardiovascular, Renal, & Respiratory Function in Health & Disease	G735	
Cell Physiology of Epithelial Cells	F716 / G765	1
Cellular Structure of the Nervous System	C850	3
Chromosome Instability and Disease	G746	1
Clinical Research Methods	GRAD G660	3
Clinical Trials	GRAD G661	3
Clinical Chemistry I	C700	3
Computational Systems Biology	I646	?
Concepts & Controversies in Cardiovascular Science	G831	2
Concepts in Biotechnology	G828	2
Concepts of Cancer Biology: Signaling Gone Awry	G852	2
Current Topics in Immunology	J807	2
Current Topics in Molecular Genetics of Microorganisms	J829	2
Cytogenetics of Malignancies	Q622	3
Designer Mice - Transgenes and Knockout Animals	F721 / G706	1
Development of the Vascular System	F713 / G714	1
Developmental Biology	566	3
Developmental Genetics	G726	1
Developmental Neurobiology	571	3

List of Potential TSPI Electives (Must be approved by student's Advisory Committee & must NOT be housed in the student's major department)	IUPUI	Credits
Diabetes & Obesity	G805	2
Diagnostic Immunopathology	C803	2
Directed Readings in Biomedical Engineering	BME 69700	1 to 3
Eukaryotic Cell Biology	G 817	3
Experimental Design & Research Biostatistics	F850 / G855	1
Functional Anatomy & Clinical Biomechanics	P513	4
Fundamentals of Human Cytogenetics	Q627	1
Fundamentals of Neuroscience I, II, and / or III	G74X	1 to 3
Fundamentals: Biochemistry & Molecular Genetics	Q626	1
Gene Transfer Approaches To Clinical And Basic Research (Gene Therapy)	G725	1
Hematopoiesis	J854	2
Human Cytogenetics	Q620	3
Human Cytogenetics Laboratory	Q621	3
In vivo Microcirculatory Physiology	F709 / G712	1
Intro to Biomolecular Imaging	F592	3
Introduction into Therapeutic Interventions	P646	4
Introduction to Research	J802	2
Introductory Biochemistry	B500	3
Introductory Biochemistry	533	3
Introductory Virology	530	3
Mammalian DNA Repair in Disease	G 837	3
Mechanisms of Immune Regulation	J840	2
Medical and Psychosocial Aspects of Chronic Illness	I555	3
Medical Genetics Seminar	Q660	1
Methods in Cell Biology	G823	3
Methods In Human Genetics	Q730	3
Methods in Molecular Biology and Pathology	G890	3
Methods in Proteomics	G841	3
Microbial Genetics	641	2
Microbial Pathogenicity	J821	3
Molecular & Cellular Physiology of Ion Transport	F761 / G761	1
Molecular And Biochemical Genetics	Q612	3
Molecular And Biochemical Genetics Laboratory	Q613	2
Molecular Biology	G865	3
Molecular Biology of Cancer	Biol 516	3
Molecular Cancer Genetics	G724	1
Molecular Genetics of Development	564	3
Molecular Immunology	J805	3
Neoplastic Determinants	J842	2
Physiologic Basis of Human Performance	K535	3

List of Potential TSPI Electives (Must be approved by student's Advisory Committee & must NOT be housed in the student's major department)	IUPUI	Credits
Physiological Proteomics	F720 / G704	1
Physiology & Pathophysiology of Lipid Rafts	F782 / G782	1
Physiology I	556	3
Physiology II	557	3
Physiology of Smooth Muscle	F726 / G707	1
Physiology of the Coronary Circulation	F715 /G703	1
Population Genetics	Q630	3
Principles of Biomedical Engineering I	BME 60100	3
Principles of Biomedical Engineering II	BME 60200	3
Principles of Molecular Biology	507	3
Principles of Pharmacology	G747	1
Principles of Toxicology II	G754	?
Principles of Toxicology III	G755	?
Principles of Toxicology: Module 1	G748	1
Psychopharmacology	I545	3
Reaction Mechanisms	657	3
Regenerative Biology and Medicine	568	3
Renal Physiology	F762	1
Select Topics in Biomedical Engineering	BME 59500	3
Seminar in Microbiology	J830	3
Special Topics In Human Genetics	Q640	1
Structural and Chemical Biology	G807	2
Synthetic Organic Chemistry	652	3
Techniques in Biotechnology	548	3
Theory in Statistical Genetics	Q731 (BIOS688)	3
Topics in Biotechnology	540	3
Topics in Translational & Implementation Research	G610	3
Translational Bioinformatics Applications	I656	?
Virology	J828	3

C. Existing Core Courses: Most or all of the courses necessary to deliver the curriculum will be offered on an annual basis.

1. **Tools and Techniques in Translational Research (G667): 3 credits** This course is offered in the fall semester and provides the advanced student with an understanding of the basic technologies and techniques used in translational research today. Key to this training is understanding how and when to use these technologies, and how to interpret their results and pitfalls. The trainees develop an understanding of the

components for protecting human subjects, and how to move a novel concept from the lab to a patient. Finally, the student will understand how to identify and measure target endpoints in patients, and how to assemble a multi-disciplinary team to conduct translational research. The course will uses a case-based approach whereby specific technologies and problems are demonstrated in readings drawn from the textbook. This course is a new offering (initiated spring 2009) and is supported by the Indiana CTSI. Course Director: R. Mark Payne. Offered once in Spring 2009 and is being offered Fall 2010.

2. **Research Ethics (Responsible Conduct of Research - RCR) (G504/G505/P555):** **1 - 3 credits** All students must enroll in coursework related to RCR if they have not completed this coursework during their graduate training.
    a. **Introduction to Research Ethics (G504): 2 - 3 credits** More intensive course than G505. Taught by the Department of Medical and Molecular Genetics and The IU Center for Bioethics. Course Director: Kimberly Quaid de Cordon. Offered 3 times in the past 3 years (every fall).
    b. **Introduction to Research Ethics (G505): 1 credit** Offered in the fall semester. G505 includes lecture and small group discussion formats and covers important issues in biomedical research, such as: 1) Scientific misconduct, 2) Conflict of interest, 3) Animal rights and welfare, 4) Ownership of data, intellectual property, and copyright management, 5) Authorship and scientific manuscripts, and 6) Informed consent and human subjects. Course Director: Michael J. Klemsz. Offered 3 times in the past 3 years (every fall).
    c. **Ethical and Policy Issues in International Research (PHIL P555): 3 credits** If students are contemplating international research, they may opt for this course. This course examines ethical and policy issues in the design and conduct of transnational research involving human participants. Topics discussed include: economic and political factors; study design; the role of ethics review committees; individual and group recruitment/informed consent; end of study responsibilities; national and international guidelines. Course Director: Eric M. Meslin. Offered 3 times in the past 3 years (every fall).
    d. **Responsible Conduct of Research (New): 3 credits** A new course currently being developed by John Baumann, Ph.D. (Executive Director,

Research Ethics, Education and Policy, Office of Vice President for Research, Indiana University) Course Director: John Baumann

3. **Biostatistics I (G651 or approved equivalent): 3 credits** G651 is an introductory level biostatistics course designed for healthcare professionals. It is the first in the G651 and G652 series on biostatistics methodology. The course covers topics such as data description and presentation techniques, probability and probability distributions, sampling distributions, statistical inferences from small and large samples, analysis of categorical data, analysis of variance, correlation and simple linear regression analysis. Upon completion of the course, students will achieve a basic understanding of the concepts and techniques of data description and statistical inferences. Students will also acquire a working knowledge of SPSS, a commonly used statistical computation program. Students will be able to understand and interpret the statistical analyses in research articles published in medical journals. Course Director: B. Katz. Offered 6 times in the past 3 years (spring and fall semesters).

   OR

4. **Biostatistics II (G652 or approved equivalent): 3 credits** G652 is an advanced applied biostatistics course designed for students with an interest in the health sciences. Students are expected to have completed at least one semester course of basic biostatistics. Knowledge of probability and probability distributions, concepts of estimation and hypothesis testing are assumed. Topics covered in this course include multiple linear regression, multi-factor analysis of variance, analysis of covariance, analysis of repeated measures, logistic regression model, and survival analyses. Upon completion of the course, students are expected to understand the appropriate statistical models for various outcomes and be able to interpret results using statistical techniques covered in this course. Students are also expected to conduct simple analyses using SPSS on personal computers. Course Directors: S. Gao & P. Monahan. Offered 3 times in the past 3 years (every fall).

5. **Electives: (1 - 3 credits)** Electives must be graduate level, be tailored to the student's particular research interests and approved by the Program Director.

D. New Course - Quantitative Aspects of Translational Research, (New - Grad-G668): 3 credits.

Quantitative Aspects of Translational Research is an interdisciplinary weekly seminar series offered in the spring semester. Targeted toward the advanced graduate student and clinical or

research based postdoctoral fellows, it will provide a forum for both Level 1 (bench to bedside) and Level 2 (clinical studies to practice) translational researchers to work together in learning both the key concepts and principles required to develop medically relevant solutions. Through a systematic exploration of diabetes mellitus, students will be exposed to the process of learning about any disease. Lecturers will represent the multiple disciplines with a stake in dealing the various aspects of disease; thus, providing students with a better global understanding. **Course Director:** Robert Bies, Ph.D. and Jamie Dananberg, M.D.

E. **Required Courses Not Offered at IUPUI:** All required courses will be offered at the Indianapolis campus.

III. List the major student outcomes (or set performance based standards) for the proposed minor

A. STRATEGIES for SHORT-TERM OUTCOMES: **The Translational Science Program of Indiana (TSPI) will:**

1. Educate translational researchers who regularly read research literature in both basic and clinical areas, who can state the hypothesis for planned research, who can critically evaluate and choose appropriate research tools, who can explain the fundamental concepts in the discipline, and who can defend methods for analyzing data or scholarly product.
2. Educate translational research students who can apply sophisticated biochemical, molecular and engineering approaches to directly impact the understanding of the mechanisms of human disease.
3. Educate translational scientists and engineers who can move productively between basic and clinical settings as exemplified by collaborative papers.
4. Educate scientists and engineers who can act as teachers or mentors for basic and clinical colleagues.
5. Educate translational scientists and engineers who can develop novel molecular approaches to treat human disease utilizing their understanding of complex clinical problems.
6. Provide a program (involving graduate students, special courses and faculty) that will promote 'translational' research.

B. LONG-TERM OUTCOMES and IMPACT: **The Translational Science Program of Indiana (TSPI) will**:

1. Greater awareness of basic science methodologies and how to apply them to medical problems.
2. Leadership of research teams by Translational Science program graduates.
3. Ongoing partnerships and collaborations between biomedical scientists, engineers and physician scientists.
4. Greater integration of basic, translational, and clinical research.
5. Improved medical practice (i.e., applications for the treatment of disease) using/applying new biological knowledge, tools, and approaches.

IV. Explain how student learning outcomes will be assessed (student portfolios, graduate follow-up, employer survey, standardized tests, etc.) and describe the structure / process for reviewing assessment findings for the purpose of ensuring continuous improvement of the minor.

A. Overview

The minor program will be approved by the student's advisory committee which will take into consideration the student's total didactic experience. The advisory committee may approve additional and/or substitution of appropriate courses to complete the degree requirements.

B. Procedures

Students complete a course evaluation form for each course, providing an overall rating as well as specific comments on what would further improve the course. The results are tabulated, reviewed by the Program Director, and provided to the course director.

V. Describe the student population to be served

The proposed Ph.D. Minor is designed for students who are in the process of completing their basic science doctoral degree. Students, who meet these criteria, will be actively recruited by announcement via the department chairs and program directors, by advertising the program over campus electronic newsletters, and by faculty recommendation of students.

All entering students will be provided with a brochure through the graduate school describing the program at the time of their matriculation. All students expressing interest will be encouraged to speak with the program director (Payne) or one of the Executive Committee members (Rhodes, Kroenke, Moe, Fife, Hetrick, or Heath) for further details. We will also provide the brochure for undergraduates visiting the school as part of our general recruiting programs, for distribution to minority-based colleges and universities during recruiting visits (to help develop a pipeline of trainees), and through our web sites.

VI. List and indicate the resources required to implement the proposed program. Indicate sources (e.g., reallocations or any new resources such as personnel, library holdings, equipment, etc.)

A. **Existing Learning Resources**: This minor program will be administered by the same faculty and staff established for the Master's Degree Program in Translational Science (currently submitted for approval).

(Core Leadership Team)

Program Director	**R. Mark Payne, M.D.** (Professor in Indiana University School of Medicine)
Program Coordinator	**Carrie Hansel**
Executive Committee	**Simon J. Rhodes, Ph.D.** (Professor and Associate Dean in Indiana University School of Medicine)
	Kurt Kroenke, M.D. (Chancellor's Professor of Medicine, Director of Clinical Investigation and Translational Education (CITE) Program, Senior Scientist in Regenstrief Institute, Director of Indiana Clinical and Translational Sciences Institute (CTSI) Education Programs, and Associate Director of Education in the General Clinical Research Center)
	Hunter Heath, III, M.D. (Adjunct Professor of Medicine, Division of Endocrinology and Metabolism, Indiana University School of Medicine)
	Sharon M. Moe, M.D. (Professor of Medicine and Vice-Chair for Research in Indiana University School of Medicine)
	Rose Fife, M.D., M.P.H. (Associate Dean for Research, Associate Director of the Indiana CTSI, Co-Director of the IU Family Violence Institute, Barbara F. Kampen Professor of Women's Health, Professor of Medicine and Biochemistry and Molecular Biology, Indiana University School of Medicine)
	William P. Hetrick, Ph.D. (Professor of Psychological and Brain Sciences and of Neuroscience at Indiana University, Bloomington, Adjunct Professor of Clinical Psychology in the Department of Psychiatry, IU School of Medicine)
Additional Faculty Involved in the Program	**Jon A. Story, Ph.D.** (Associate Dean of Purdue University Graduate School)
	Stephen R. Dlouhy, Ph.D. (Associate Scientist in Medical & Molecular Genetics; Associate Director of the Medical & Molecular Genetics DNA Services Laboratory; Director of the Cell Repository)
	Edward Srour, Ph.D. (Robert J. and Annie S. Rohn Professor of Leukemia Research; Professor of Medicine; Professor of Pediatrics; Professor of Microbiology & Immunology; Director of Flow Cytometry Resource Facility)
	Tatiana Foroud, Ph.D. (Michael Conneally Professor of Medical and Molecular Genetics; Director of Hereditary Genomics Division)

David A. Flockhart, M.D. / Ph.D. (Harry and Edith Gladstein Chair in Cancer Genomics; Professor of Medicine, Medical Genetics and Pharmacology; Indiana University School of Medicine & Division of Clinical Pharmacology)

Yunlong Liu, Ph.D. (Adjunct Assistant Professor of Informatics; Assistant Professor of Medical & Molecular Genetics; Adjunct Assistant Professor of Medicine - Biostatistics)

Narayanan Perumal, Ph.D. (Assistant Professor, Bioinformatics)

Ken Cornetta, M.D. (Joe C. Christian Professor & Chairman of Medical & Molecular Genetics; Professor of Medicine & Microbiology/Immunology)

Carl Garner, Ph.D. (Senior Director, Pharmaceutical Projects Management Eli Lilly and Company)

Brad Ackermann, Ph.D. (Research Fellow - Laboratory for Experimental Medicine; Translational Medicine Eli Lilly and Company)

Deborah W. Knapp, D.V.M., M.S. (Dolores L. McCall Professor of Comparative Oncology; Director of Purdue Comparative Oncology Program)

Marie Kerbesian, Ph.D. (Vice President for Technology Commercialization)

Jeremy Schieler, Ph.D. (Senior Technology Manager)

Jamie Dananberg, M.D. (Executive Director, Exploratory and Program Medical - Eli Lilly and Company)

Robert Bies, Pharm.D., Ph.D. (Associate Professor of Clinical Pharmacology; Director, Disease Modeling Program, CTSI Member; Center for Computational Biology and Bioinformatics)

B. Resource Materials

Indiana University has an extensive array of learning resources and facilities that will be available to the proposed Ph.D. Minor in Translational Science Program in support of its educational and research mission. These include system, campus and participating school resources. State-of-the-art data, video and voice technologies are present to create a sophisticated learning environment.

Students in the Ph.D. Minor Program of Translational Science will need access to the libraries, journals and databases on the IUPUI and IU Bloomington campuses. Additionally, students will need access to various opportunities on campus, including but not limited to: seminars, study groups, lectures, and research experiences.

C. New Learning Resources Needed

The program requires the above-mentioned faculty, an administrative support position, additional funds for supplies and expenses, office space, secure location for filing confidential student information and funds for additional financial assistance. (This Ph.D. minor program will use the same resources and be administered by the same faculty and staff established for the Master's Degree Program in Translational Science - currently submitted for approval.)

VII. Describe any innovative features of the program (e.g., involvement with local or regional agencies or offices, cooperative efforts with other institutions, etc.)

A. Distinctive Features & Strengths of the Program: Currently, training in human disease at both a basic and clinical level is not well-addressed by current training programs, which leaves a nationally unmet need for translational scientists. The proposed program will fill this unmet need by offering basic science students a Ph.D. Minor in Translational Science that is specifically designed for them.

In addition to the direct opportunities and objectives of the Translational Science Program of Indiana, several indirect benefits are expected. This program will facilitate the interaction of scientists and engineers interested in common problems and increase the cross-pollination of ideas between scientists and engineers in basic and clinical departments. A program which achieves both the specific goals and the indirect benefits outlined above will prepare these translational scientists with a better understanding of basic and clinical science and the implications on their research in the area of human disease and facilitate desperately-needed translational research in all areas of medicine and science. We believe that these innovations are critically important at a time when advances in basic science can rapidly impact the diagnosis and treatment of human disease.

Fundamental changes in academic and pharmaceutical biomedical operations have dictated the need for the training of more 'translational' researchers. For example, managed care has put more pressure on those with clinical training to participate in patient care. As a result, those scientists with the most clinical insight are spending much less time carrying out basic research as it relates to clinical problems. At the same time, there has been a major emphasis by national, private and industrial granting organizations to fund basic research that has the potential to immediately impact human disease. The NIH, for example, has recognized this need and responded with several RFAs. Additionally, in the pharmaceutical and biotechnology industries, most traditional departments have now been restructured with major foci on disease areas. Thus, it is becoming

increasingly important for scientists who move into these industries to be well versed in basic science methodologies as well as to have an intimate understanding of human disease. The Translational Science Program of Indiana (TSPI) has been designed to train researchers, who will fill the critical niches described above in major medical centers and industry.

The Ph.D. Minor Program in Translational Science at IUSM is a natural outgrowth of the planning and implementation of the Indiana Clinical Translational Science Institute (CTSI) that was awarded in 2008 by the NIH. It was jointly designed by several basic and physician scientists, who have worked together on models of human disease and on training in translational research in the Departments of Internal Medicine, Pediatrics, Biochemistry and Molecular Biology, and Physiology/Pharmacology. This group realized that historically in the best major medical centers in this country, there has been a very valued group of scientists, who has worked at the interface of basic science and human health. This program has been designed to enhance the basic science training of doctoral students with translational science approaches to focus on the application of these approaches to human disease. This program differs from other graduate programs by offering a new pathway for basic scientists to incorporate a comprehensive knowledge of translational science methodologies, as well as, learn how to collaborate with other scientists in a translational research environment, regardless of their specialty. An overall goal of TSPI is to produce exceptional 'translational' researchers in a fashion that saves both time and expense when compared to more conventional translational' training routes.

B. Collaborative Arrangements

The multi-disciplinary program will offer training to the partnering institutions: Indiana University-Purdue University Indianapolis, Purdue University West Lafayette, University of Notre Dame, as well as the IUSM biomedical programs in Indianapolis and Bloomington. As the program grows, collaborative agreements will be established between partnering universities to allow students to readily assimilate components into their programs. The long term goal is to establish a training program that addresses the critical need for generating talented research scientists, who can pursue a career that lies at the interface between basic and clinical investigative medicine.

Comparison of Minor in Translational Research and Minor in Life Sciences

Curriculum

Course Title	*Course #*	*Credits*	Graduate Minor in Life Sciences	Ph.D. Minor in Translational Science
Tools & Techniques in Translational Research	GRAD G667	3		X
Quantitative Aspects of Translational Research	GRAD G668 (New)	3		X
Introduction to Research Ethics **or** Ethical and Policy Issues in International Research	GRAD G504 **or** PHIL P555	2 to 3		X
Biostatistics I or II (or approved equivalent)	GRAD G651 or G652	3		X
Electives (must be approved by the Program Director)	GRAD XXX	Up to 12	X (3 if Ph.D. program doesn't require G715, G716, & G717; 12 if Ph.D. program requires them)	Up to 3
Biomedical Science I – Biochemical Basis of Biological Processes	GRAD G715	3	X	
Biomedical Science II – Molecular Biology & Genetics	GRAD G716	3	X	
Biomedical Science III - Cellular Basis of Systems Biology	GRAD G717	3	X	
Total Required Credits			12	12

Comparison of Minor in Translational Research and Minor in Life Sciences

Course Descriptions

Requirements for both Minors

Electives (Up to 12 credits)
Example electives include graduate level courses in more advanced biostatistics, epidemiology, clinical pharmacology, genetics, molecular biology, and computer sciences. However, enrollees may select electives from the entire offering of graduate courses at both Indiana University and Purdue University at Indianapolis as well as IU at Bloomington. Must be approved by Program Director.

Requirements for Ph.D. Minor in Translational Science

Tools and Techniques in Translational Research (G667): 3 credits. This course is offered in the spring semester and provides the advanced student with an understanding of the basic technologies and techniques used in translational research today. Key to this training is understanding how and when to use these technologies, and how to interpret their results and pitfalls. The trainees develop an understanding of the components for protecting human subjects, and how to move a novel concept from the lab to a patient. Finally, the student will understand how to identify and measure target endpoints in patients, and how to assemble a multi-disciplinary team to conduct translational research. The course will uses a case-based approach whereby specific technologies and problems are demonstrated in readings drawn from the textbook. This course is a new offering (initiated spring 2009) and is supported by the Indiana CTSI. **Course Director:** R. Mark Payne. Offered once in Spring 2009 and is being offered Fall 2010.

Quantitative Aspects of Translational Research, (New - Grad-G668): 3 credits. Quantitative Aspects of Translational Research is an interdisciplinary weekly seminar series offered in the spring semester. Targeted toward the advanced graduate student and clinical or research based postdoctoral fellows, it will provide a forum for both Level 1 (bench to bedside) and Level 2 (clinical studies to practice) translational researchers to work together in learning both the key concepts and principles required to develop medically relevant solutions. Through a systematic exploration of diabetes mellitus, students will be exposed to the process of learning about any disease. Lecturers will represent the multiple disciplines with a stake in dealing the various aspects of disease; thus, providing students with a better global understanding. **Course Director:** Robert Bies, Ph.D. and Jamie Dananberg, M.D.

Biostatistics I (G651 or approved equivalent): 3 credits. G651 is an introductory level biostatistics course designed for healthcare professionals. It is the first in the G651 and G652 series on biostatistics methodology. The course covers topics such as data description and presentation techniques, probability and probability distributions, sampling distributions, statistical inferences from small and large samples, analysis of categorical data, analysis of variance, correlation and simple linear regression analysis. Upon completion of the course, students will achieve a basic understanding of the concepts and techniques of data description and statistical inferences. Students will also acquire a working knowledge of SPSS, a commonly used statistical computation program. Students will be able to understand and interpret the statistical analyses in research articles published in medical journals. Course Director: B. Katz. Offered 6 times in the past 3 years (spring and fall semesters).

OR

Biostatistics II (G652 or approved equivalent): 3 credits. G652 is an advanced applied biostatistics course designed for students with an interest in the health sciences. Students are expected to have completed at least one semester course of basic biostatistics. Knowledge of probability and probability distributions, concepts of estimation and hypothesis testing are assumed. Topics covered in this course include multiple linear regression, multi-factor analysis of variance, analysis

of covariance, analysis of repeated measures, logistic regression model, and survival analyses. Upon completion of the course, students are expected to understand the appropriate statistical models for various outcomes and be able to interpret results using statistical techniques covered in this course. Course Directors: S. Gao & P. Monahan. Offered 3 times in the past 3 years (every fall).

Research Ethics (Responsible Conduct of Research - RCR) (G504/ P555): 2 - 3 credits. All M.S. students must enroll in coursework related to RCR if they have not already done so.

1. Introduction to Research Ethics (G504): 2 - 3 credits. More intensive course than G505. Taught by the Department of Medical and Molecular Genetics and The IU Center for Bioethics. Course Director: Kimberly Quaid de Cordon. Offered 3 times in the past 3 years (every fall).
2. Ethical and Policy Issues in International Research (PHIL P555): 3 credits. If students are contemplating international research, they may opt for this course. This course examines ethical and policy issues in the design and conduct of transnational research involving human participants. Topics discussed include: economic and political factors; study design; the role of ethics review committees; individual and group recruitment/informed consent; end of study responsibilities; national and international guidelines. Course Director: Eric M. Meslin. Offered 3 times in the past 3 years (every fall).

Requirements for Graduate Minor in Life Sciences

Biomedical Science I – Biochemical Basis of Biological Processes (IBMG - GRAD G715): 3 credits
Textbook: Biochemistry 6th edition, by Berg, Tymoczko and Stryer. One of three biomedical science courses intended for incoming doctoral graduate students in the School of Medicine or other graduate students. Covers molecular and metabolic aspects of cellular function. The course will explore topics in the biochemical basis of biological systems, including biological macromolecules, protein ligand interactions, cell-signaling, and metabolic processes. Course Director: T. Hurley.

Biomedical Science II - Molecular Biology and Genetics (IBMG - GRAD G716): 3 credits Second of three biomedical science courses intended for incoming doctoral graduate students in the School of Medicine or other graduate students. Topics covered include DNA structure and replication, recombination and repair, genomics and processes of inheritance, gene expression, eukaryotic systems, and molecular genetics and disease. Course Directors: D. Gilley & R. Wek.

Biomedical Science III - Cellular Basis of Systems Biology (IBMG - GRAD G716): 3 credits Third of a group of three biomedical science core courses intended for incoming doctoral graduate students in the School of Medicine or other graduate students. Organization and function of cells, tissues and physiologic systems using disease examples. Topics include neurophysiology, musculoskeletal, renal, cardiovascular, gastrointestinal, endocrine and pulmonary systems, and cancer. Course Director: J. Bidwell & F. Pavalko.