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Integrated Biomedical Science Graduate Program  
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June 15, 2012

Dr. Scott Herness  
The Ohio State University  
Associate Dean, Graduate School  
250 University Hall  
230 North Oval Mall  
Columbus, OH 43210-1366

RE: Response to corrections for IBGP Re-envisioned PhD program request

Dr. Herness:

Please find in the attached file (IBGP Re-envisioned PhD program) modifications that are in response to the comments from you and the Graduate School Curriculum Committee. The issue you had raised was about the student presentation course (IBGP 7972). We had envisioned that that course would be an elective, but your comments made us reconsider, and we now believe that our program would be even stronger if that student presentation course remained required. We have thus modified the request to indicate this course is required. The changes to the document are found on:

1. page 3, item 4 now includes IBGP 7972 among the required courses
2. page 5, line 8: IBGP 7972 is now listed among courses that will not change
3. Appendix C, the comparison of the New/Proposed IBGP curriculum to the old IBGP curriculum
4. Appendices G, H, I: the spelling error is now corrected ("Rational" is now "Rationale").

Sincerely,

A handwritten signature in blue ink, appearing to read 'Joanna Groden'.

Joanna Groden, Ph.D.  
Associate Dean for Graduate Studies  
Professor and Co-Director, IBGP

A handwritten signature in black ink, appearing to read 'Jeffrey Parvin'.

Jeffrey Parvin, M.D., Ph.D.  
Professor and Co-Director, IBGP



# The Integrated Biomedical Science Program

Ph.D. in Biomedical Sciences

Re-envisioned Program Request

June 15, 2012

The Ohio State University  
Integrated Biomedical Science Graduate Program  
Re-envisioned Program Request  
Ph.D. in Biomedical Sciences

## Change in name of the program

The Integrated Biomedical Science Graduate Program (IBGP) Graduate Studies Committee (GSC) voted to change the name of the IBGP to Biomedical Sciences. The motivation of this change in program name is to simplify, to avoid confusing acronyms for recruiting, and to avoid confusion with other Ph.D. programs in the life sciences at OSU (the IGPs). The term “integrated” remains central to our educational philosophy, and it is implicit in the new name.

## Goals of changes to the program

1. To change the curriculum in order to keep pace with the evolving nature of biomedical sciences research.
2. To decrease classroom time and increase research time. The overall approach is best summarized as active learning. We will survey the breadth of biomedical sciences and teach the students how to find things (how to dig deep) on their own. We will not spoon-feed biomedical concepts that will evolve and become outdated.
3. Students interested in certain subdisciplines have not been successfully recruited to IBGP due to the inflexibility of our curriculum. As an example, computational biology students are not interested in the extended classroom time in the core modules learning details of developmental biology or pharmacology. Other subspecialties are similarly losing good applicants to other schools that do not demand this extensive classroom experience. We are shifting from an emphasis on breadth to an emphasis on depth.
4. To give the OSU IBGP a competitive advantage in recruitment – a hardworking student can achieve a PhD in 4 years due to reduced classroom time and increased emphasis on discoveries in research. When choosing among different

schools, we believe that the possibility of a PhD program that takes fewer years could be decisive for an applicant.

### Summary of proposed changes:

The proposed changes will increase the laboratory research experience for our students and streamline the didactic experience while minimizing the loss in breadth. The Biomedical Sciences student under this curriculum will have intensive training in identifying research questions, participating in evaluation of research, and in analytic thinking.

1. The full year module course will now be available as an elective. The 12 modules have been independently assigned course numbers in the semester system.
2. To replace the first year modules, we propose a new survey/concept course (approved course IBGP 7000 Biomedical Sciences Survey). (Description of IBGP 7000 is attached in **Appendix A**.) The overall strategy is for the faculty to summarize broad areas of research and choose specific areas to go into depth. This course goes hand-in-hand with changes in IBGP 7040 (see point 3).
3. The course, IBGP 7040 Research Problem Solving in Biomedical Science, will be changed from 2 semester hours to 4 semester hours. The course description is attached (**Appendix B**). This class will be required for all first year IBGP students and offered in the spring semester. This is a key component of the active learning process. This change in the course has been approved by the OSU Curriculum Committee. This course will analyze the research literature across the breadth of Biomedical Sciences.
4. The Grant Writing course (IBGP 7070 and 7080), Biostatistics (PUBHBIO 607), Research Techniques (IBGP 8050), Research Seminar (IBGP 7972), and Ethics (PHARM 7510) will remain required. All other courses are now electives.
5. A minimum of 10 semester hours in elective courses are required.

### Comparison of old IBGP curriculum with new Biomedical Sciences curriculum

A table is attached (**Appendix C**) that compares the old curriculum to the proposed curriculum.

**IBGP 7000:** The key change is the elimination of the requirement to take IBGP 7010 and 7020 (20 credits total), and replacing this required course with IBGP 7000 (6 credits). IBGP 7010/7020 is a collection of 12 modules that have been at the heart of the “integrated” program since the modules start from DNA, continue through cell biology, and then eventually teach the biology of complex organisms and human disease. The new IBGP 7000 will teach these same integrated curriculum, but redundancies will be reduced compared to the module based courses. The module based courses also spoon-feed facts to the students that are rapidly becoming outdated. In the current internet era, facts are at the students’ fingertips; the new IBGP 7000 will teach concepts and rely on the students to learn the facts out of the classroom. It is a more demanding approach, and we expect our students to mature as scientists more rapidly.

**IBGP 7040:** The Research Problem Solving course is required and is increased from 2 to 4 credit hours. A course description is attached (**Appendix B**). This teaches the research process each week by analyzing current research papers. The subject of the papers will cover the range of topics in IBGP 7000. This course is participatory and demanding, encouraging our students to discuss the scientific literature as mature scientists do.

**IBGP 7930:** Individual Studies in Integrated Biomedical Sciences. These are research rotations. We propose to change the minimum number of research rotations from 3 to 2. This results in a decrease in credit hours from 18 to 12 and which is more than offset by the increase in credits in dissertation research.

**IBGP 8999:** Research in Integrated Biomedical Sciences. This is dissertation research. What will distinguish our students are the discoveries they make as part of their dissertation research. The reductions in classroom time are targeted at rapidly maturing our students as researchers and then providing time in the laboratory to focus on research. We believe that this will result in more research publications per student and a faster time to degree.

**Elective Courses:** Rather than stipulate which senior level seminar courses Biomedical Sciences students must take, the proposed program will require a minimum of 10 credits of electives. The Biomedical Sciences program offers 37 electives (**Appendix D**), and students may choose electives taught by other departments. Students consult with their first-year advisors or with their dissertation supervisors on the most appropriate electives to take for their individualized program. In addition, the Biomedical Sciences program offers Emphasis Areas that can be designated on their transcripts. Each Emphasis Area has a set of electives required to obtain the transcript designation.

**Courses not changing:** The requirements to take IBGP 8050, Pharm 7510, IBGP 7070, IBGP 7080, IBGP 7972, and PUBHBIO 6280 will not change. These courses teach laboratory methods, research ethics, two semesters of grant writing, and biostatistics.

## Content of Program

The content of the Program will not change; the way the content is taught will change. The content in courses IBGP 7010 and 7020 will be offered in IBGP 7000, but it will no longer focus on teaching facts but rather concepts. Much of what is currently taught in 7010/7020 includes facts that rapidly become outdated and that are not relevant to many of our students. Our program proposes to instead focus on the concepts, and selecting opportunities to dig deep into the details and facts as examples of the research process. Further, the 12 modules that comprise IBGP 7010/7020 will be offered as independent electives that have adapted their curriculum to complement the content in IBGP 7000.

Classroom content will not otherwise change.

## Transition Plan

Most of the changes proposed for the program occur in the first year. For students already in the Program, those changes are irrelevant. For the senior level courses and electives, we propose to continue to offer all courses. Which courses are

required depends on which year the student entered. Students entering in the summer of 2012 will have the new elective requirements, and students entering 2011 or earlier will have the old requirements.

## Content of the Electives

As discussed above, the Biomedical Sciences graduate program offers 37 electives (**Appendix D**). Students enroll in electives with the advice of their first year advisor, dissertation supervisor, or emphasis area director.

## Student advising

On the first day of orientation, each student meets with their first year advisor. This advisor is a member of the GSC, and based on the student's application has a common research interest. The first year advisor helps the student select faculty for research rotations and to choose courses. Electives will be taken in the spring semester, and the first year advisor helps in those decisions. It is anticipated that almost all of our students after first year will be advised on courses by their dissertation supervisor and by the relevant emphasis area director. These three individuals provide necessary oversight. In addition, the dissertation committee, which is assembled in the second year, can advise the student about needed elective courses.

## New subplans

Three new emphasis areas are proposed in

- Computational Biology and Bioinformatics;
- Cellular and Molecular Physiology
- Translational Research

Please find attached a letter from the dean of the College of Medicine in support of the subplans (Appendix E) and the detailed subplans (Appendices F, G, and H).

**List of appendices:**

- A. Description of IBGP 7000
- B. Description of IBGP 7040
- C. Table comparing the proposed and current curricula
- D. Elective courses
- E. Request for new subplans from IBGP Directors
- F. Letter of support of subplans from Dr. Charles Lockwood, Dean of the College of Medicine
- G. Subplan in Computational Biology and Bioinformatics
- H. Subplan in Cellular and Molecular Physiology
- I. Subplan in Translational Research



## Appendix A

### IBGP 7000, Biomedical Sciences Graduate Program survey course

This course is not intended as a replacement for the current modules, but as a survey course that includes what the program views as essential for all of its graduates to know before choosing their rotations and/or specializing in an emphasis area. The modules are each on the books as stand-alone courses and can be offered as electives that fill out the gaps left by the survey course.

Biomedical Sciences Survey Course: M-W-F, 8:30 – 10:30 AM

Required for IBGP first year students (fall semester), enrollment by other students only with faculty approval.

Block 1: Fundamental molecular biology (5 weeks / 30 h)

- a. Nucleic Acids (6 hours)
- b. Transcription & Translation (8 hours)
- c. Proteins (8 hours)
- d. Genes & Genomes (8 hours)

Block 2: Cell Biology (4 weeks / 24 hours)

- a. Molecular & Cellular Physiology (6 hours)
- b. Cytoskeleton & Extracellular Matrix (4 hours)
- c. Development (6 hours)
- d. Molecular Pharmacology (4 hours)
- e. Neurobiology (4 hours)

Block 3: Systems (5 weeks / 30 hours)

- a. Immunology (8 hours)
- b. Microbial Pathogenesis (6 hours)
- c. Computational Biology (8 hours)
- d. Experimental Therapeutics (8 hours)

Each block will have one take home test for evaluation.

## **Appendix B**

### **Proposed changes to IBGP 7040, Research Problem Solving in Biomedical Science**

This class is required for all first year IBGP students (spring semester). No other students may enroll.

Class meetings: Tuesdays 5:00-7:00 PM, Wednesdays 5:00-7:00 PM

The modified IBGP 7040 is a discussion class, thus active participation in the small groups is required. Students are assigned papers on Wednesday of the preceding week. Students meet in small groups (3 groups of 10 students) on Tuesday afternoons to work out the paper in the absence of faculty. On Wednesday afternoons the students are organized into two groups of 15 students plus two faculty members. Then the same paper is discussed with the faculty groups. Grading is based on participation in the discussion group. Participation does not necessarily reflect quantity so much as quality; valid participation can take the form of questions or other ways of advancing the discussion.

Attendance is required at all classes (both student groups and faculty groups). If a student must miss a class, the student is obligated to notify the faculty member in advance and must write a paper discussing the research article to be handed in on the Monday following the missed class.

Each week, the paper(s) and relevant supplementary material will appear on the course website. Classrooms will require computers with web access and projectors.

For each paper, the student is expected to read background material in order to learn the context for the finding. The goal of each class is to teach a complete understanding of all aspects of a given paper and to evaluate whether the data support the conclusions.

#### Proposed IBGP 7040 schedule

Week 1: Assign groups for Tuesdays (students only) and Wednesdays (different students with faculty). Discuss with students what is expected and how you analyze a biomedical research paper. Assign the paper for week 2.

Week 2-7: Students meet on Tuesdays to analyze the paper (Tuesday 5:00-7:00 PM), and the students+faculty groups meet on Wednesday (5:00-7:00 PM) to discuss the same paper.

Week 8-14: The composition of the student and student+faculty groups are shuffled, and the course continues as previously.

Grading: All grades are based on participation. There are no written exams.

<b>Required Courses- New IBGP Curriculum</b>		<b>Required Courses- Old IBGP Curriculum</b>	
	Credits		Credits
IBGP 8050 Research Techniques and Resources (AU-yr. 1)	4	IBGP 8050 Research Techniques and Resources (AU-yr.1)	4
IBGP 7000 Biomedical Sciences Survey (AU-yr. 1)	6	IBGP 7010, 7020, Biology of Human Disease I and II (AU, SP-yr. 1)	20
IBGP 7040 Research Problem Solving in Biomedical Science (SP- yr.1)	4	IBGP 7040 Research Problem Solving (SP-yr. 1)	2
Pharmacology 7510 Professional and Ethical Issues in Biomedical Science (SP- yr. 1)	2	Pharmacology 7510 Biomedical Research Ethics (SP-yr.1)	2
IBGP 7070 Fundamentals of Grant Writing I (AU-yr. 2)	2	IBGP 7070 Fundamentals of Grant Writing I (AU yr. 2)	2
IBGP 7080 Fundamentals of Grant Writing II (SP-yr. 2)	2	IBGP 7080 Fundamentals of Grant Writing II (SP-yr. 2)	2
PUBHBIO 6280 Practical Biostatistics for Biomedical Laboratory Workers (SU – yr. 2)	3	PUBHBIO 6280 Practical Biostatistics for Biomedical Laboratory Researchers (SU, yr. 2)	3
IBGP 7930 Individual Studies in Integrated Biomedical Science (SU, yr. 1 (optional), AU, SP yr. 1)	12	IBGP 7930 Individual Studies in Integrated Biomedical Science (SU, AU, SP, yr.1)	18
IBGP 8999 Research in Integrated Biomedical Sciences	34	IBGP 8999 Research in Integrated Biomedical Science	19
IBGP 7972 Research Seminar (Student Presentation) (taken the semester before or semester of graduation)	1	IBGP 7060 Faculty Research (SU, yr.1)	1
Elective Courses (may be in IBGP or in other departments such as MVIMG, Neuroscience, Pharmacology, Pathology, MCB courses)	10	IBGP 705 Bioinformatics Applied to Human Disease (SP, yr.1)	1
		IBGP 7971 Research Seminars (AU and SP yr. 1 and yr. 2)	4
		IBGP 7972 Research Seminar (Student Presentation) (taken the semester before or semester of graduation)	1
		IBGP 8510 Advanced Seminars in Integrated Biomedical Science (taken any time beginning the second year)	1
<b>Total Credits</b>	<b>80</b>	<b>Total Credits</b>	<b>80</b>

IBGP Electives		
Course Number	Course Title	Descriptions
IBGP 6700	Patient-Centered Research	Lectures and small group discussions will cover an introduction to humanistic aspects of medical research and human experimentation, including historical, socio-political, economic, and ethical aspects.
IBGP 6920	Clinical Biomedical Research	Through lectures, small groups, independent reading, and mentored clinical research projects students learn the nature, goals, importance, basic principles, and administrative requirements of clinical research.
IBGP 7011	Nucleic Acid Structure and Dynamics	First module of the Biology of Human Disease I (7010). Topics include genetic materials and nucleic acid structure and function. The course is offered in the fall semester.
IBGP 7012	Protein Structure and Function	Second module of the Biology of Human Disease I (7010). Topics include various aspects of protein structure. The course is offered in the fall semester.
IBGP 7013	Genes and Genome Organization	Third module of the Biology of Human Disease I (7010). Topics include various aspects of gene regulation and genetics. This course is offered in the fall semester.
IBGP 7014	Transcription and Translation Control Mechanisms	Fourth module of the Biology of Human Disease I (7010). The course will cover transcription and translation.
IBGP 7015	Molecular and Cellular Physiology	Fifth module of the Biology of Human Disease I (7010). This course will cover molecular and cellular physiology. The course is offered in the fall semester.
IBGP 7016	Cytoskeleton and Extracellular Matrix	Sixth module of the Biology of Human Disease I (7010). This course will cover the cytoskeleton and extracellular matrix. The course is offered in the fall semester.
IBGP 7021	Development and Differentiation	First module of the Biology of Human Disease II (7020).
IBGP 7022	Host Defense	Serve as an introduction to the basic principles of host defense and immune response to viruses and bacteria.
IBGP 7023	Cancer Biology	Third module of the Biology of Human Disease II (7020).
IBGP 7024	Integrated Organ Systems	Fourth module of the Biology of Human Disease II (7020).
IBGP 7025	Molecular Pharmacology	Fifth module of the Biology of Human Disease II (7020).
IBGP 7026	Clinical Research	Sixth module of the Biology of Human Disease II (7020).
IBGP 7050	Bioinformatics Applied to Human Disease	Training with computerized bioinformatics packages and electronics sources of genomics information to develop skills for genomics analysis of human diseases.
IBGP 7060	Faculty Research in Biomedical Science	IBGP faculty members will present current research in their laboratories that could provide the basis for student laboratory rotations and dissertation research.
IBGP 7240	Molecular Pathogenesis	In-depth presentation and discussion of the molecular and cellular mechanisms of pathogenesis, emphasizing current research in the field.
IBGP 7300	Biomedical Informatics I	Introduces students to basic topics of bioinformatics including sequence analyses, proteomics, microarrays, regulatory networks, sequence and protein databases.
IBGP 7310	Biomedical Informatics II	Continuation of Biomedical Informatics I.
IBGP 7800	Presentation Skills for Biomedical Researchers	Learn scientific presentation skills through oral and poster presentations of biomedical research in progress given by themselves, faculty, and postdoctoral scientists.
IBGP 7810	Animal Models of Human Disease	Transgenic and knockout mouse technology and examples of models for genetic diseases with each

		pattern of inheritance.
IBGP 7820	Molecular and Cellular Mechanisms of Stress-Associated Diseases in the Human	Through presentations and critical discussions of research and literature students will gain an understanding of the mechanisms underlying stress-associated diseases and methods to study these.
IBGP 7890	Immunological Research of Pediatric Diseases	Trainees will prepare and give presentations on current research on immunological mechanisms of pediatric diseases.
IBGP 7900	Cancer Immunology: Critical Journal Readings	Faculty, students and postdoctoral fellows will give critical interpretations of research and journal readings on cancer immunology.
IBGP 7910	Current Research in Human Viral Diseases	Faculty, students and postdoctoral trainees will give critical interpretations of research and journal readings on human viral diseases.
IBGP 7920	Translational Biomedical Research	Through lectures, small group discussions and independent reading, students will learn the nature, goals, importance, basic principles and administrative requirements of translational research.
IBGP 7950	Host-Pathogen Interactions: Research Seminar	Faculty, students and outside speakers will give research presentations on microbial-host interactions.
IBGP 7960	Research Seminars in Heart and Lung Disease	Faculty and outside speakers will give basic and clinical science research seminars on mechanisms of heart and lung disease.
IBGP 7971	Integrated Biomedical Science Graduate Seminar	Junior graduate students will present research work in progress under the supervision of a faculty mentor.
IBGP 7972	Integrated Biomedical Science Senior Seminar	Senior IBGP graduate students will present research work and be advised and critiqued by other senior students and a faculty advisor.
IBGP 7980	Seminar in Pediatric Research	Faculty and outside speakers will give presentations on research in biological mechanisms of pediatric disease.
IBGP 7991	Cancer Immunology: Research Seminar	Students attend research presentations on cancer immunology given by faculty, students and postdoctoral fellows.
IBGP 7992	Cancer Immunology: Research Seminar Presentation	Faculty, students and postdoctoral fellows will give research presentations on cancer immunology.
IBGP 8510	Advanced Seminar in Integrated Biomedical Science	Interdisciplinary biomedical topics will be reviewed in depth with student participation in analyzing literature, and faculty and outside experts presenting their own original research.
IBGP 8520	Career Discovery in the Biomedical Sciences	Seminar topics related to career opportunities available in the biomedical sciences, as well as topics on career development tools such as CV preparation, interview strategies, networking and prioritizing commitments.
IBGP 8910	Interdisciplinary Seminar	Graduate seminar for interdisciplinary studies.
IBGP 8911	Interdisciplinary Seminar on Biomedical Images	Graduate seminar for Graduate Interdisciplinary Specialization in Comprehensive Engineering and Science of Medical Images.

Students may also take classes in other departments such as MVIMG, Neuroscience, Pharmacology, Pathology, MCB. Students that wish to designate an area of research emphasis will have to take additional required courses in order to earn an official designation of that area on their transcript. These required courses are determined by the area of research emphasis leader and listed on the IBGP website. ([www.ibgp.org](http://www.ibgp.org))



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May 15, 2012

Dr. Scott Herness  
Associate Dean, Graduate School  
The Ohio State University  
250 University Hall, 230 North Oval Mall  
Columbus, OH 43210-1366

Dear Dr. Herness:

It has come to our attention that three of our Areas of Research Emphasis (Subplans) which have been advertised on our web site, have not been officially approved through the Graduate School. We have a number of students who are currently taking the coursework in pursuit of transcript designation in these areas. These subplans include: 1) Computational Biology and Informatics, 2) Cellular and Molecular Physiology, and 3) Translational Research.

Please find attached detailed information about each Subplan including the learning goals, course requirements, and program rationale statement. We have also provided a letter of support from the Dean of the College of Medicine, Charles Lockwood.

We have one student who has applied to graduate in Spring 2012 who has also applied for transcript designation (Levy Reyes in Translational Research). We understand that these Subplans may not be approved to add the designation to his Spring Quarter 2012 academic record at graduation, but respectfully request that the Translational Research designation be added to his transcript retroactively, once these areas are officially approved.

Please contact Jeff Parvin at [parvin.4@osu.edu](mailto:parvin.4@osu.edu) or 292-0523 with any questions or if you need additional information. Thank you.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Joanna Groden'.

Joanna Groden, Ph.D.  
Associate Dean for Graduate Studies  
Professor and Co-Director, IBGP

A handwritten signature in black ink, appearing to read 'Jeffrey Parvin'.

Jeffrey Parvin, M.D., Ph.D.  
Professor and Co-Director, IBGP



Charles J. Lockwood, MD, MHCM  
Dean, College of Medicine  
Vice President for Health Sciences  
Professor, Obstetrics and Gynecology

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370 West 9th Avenue  
Columbus, OH 43210  
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May 15, 2012

Dr. Scott Herness  
Associate Dean, Graduate School  
The Ohio State University  
250 University Hall, 230 North Oval Mall  
Columbus, OH 43210-1366

**RE: IBGP-PH Areas of Research Emphasis (Subplans) for Transcript Designation**

Dear Dr. Herness:

We wish to create subplans for transcript designation for IBGP-PH students in the following Areas of Research Emphasis: 1) Computational Biology and Bioinformatics, 2) Cellular and Molecular Physiology, and 3) Translational Research. This request has the full support of the College of Medicine. As the accompanying material will detail, these Subplans allow students to obtain specialized training in these content areas and will add value in terms of making students more marketable for employment in research support positions in biotech industry and in consulting.

Thank you for your attention to this matter.

Sincerely,

A handwritten signature in black ink, appearing to read 'Charles J. Lockwood'.

Charles J. Lockwood, MD  
Dean, College of Medicine  
Vice President for Health Sciences  
Professor, Obstetrics and Gynecology  
Professor, Leslie H. and Abigail S. Wexner Chair in Medicine

# Computational Biology and Bioinformatics

## 1. Learning Goals

An overarching goal of the Computational Biology and Bioinformatics Area of Research Emphasis is to develop the insights and the technology needed to gather the information needed to quantify biological function and to develop detailed predictive biomedical models. These will be used to accurately describe normal physiological function, to understand mechanisms that underlie pathological processes, to discover new biomarkers and therapeutical targets for diseases, and to evaluate medical and surgical interventions.

Transcript designation in Computational Biology and Bioinformatics can include any of the following: 1) Training in the processing, analysis, mining, and integration of data from multiple sources such as genomic sequencing, epigenetics studies, gene and protein expression profiling, radiological studies, microscopy imagery, electrophysiological experiments, and numerical simulation studies, 2) Development of models to explain physiological and pathological processes, and 3) Development of database technology, data analysis techniques, high performance computing infrastructure, and systems software/middleware needed to carry out tasks associated with the aggregation and analysis of biomedical data, and needed to carry out biomedical simulations.

This Area of Research Emphasis will involve the integration of large-scale data analysis, management, processing, and visualization with biomedical informatics. We will engage trainees in a highly collaborative interdisciplinary research program on high throughput data analysis and integration for biomedical applications in high end computing environment. We will also provide access to a customized program of course work in biomedical informatics, computer science and in basic and translational biomedical sciences.

Faculty members have diverse research interests which span analysis of gene sequence and gene and protein expression data, epigenetics, analysis and modeling of therapeutic and toxic drug effects, computational modeling of physiological systems, biomedical image processing and feature detection, visualization and development of database, data mining and data exploration algorithms and middleware.

## 2. Course Requirements

### **Requirements for Students to receive transcript designation in**

**Computational Biology and Bioinformatics:** Students will ordinarily be expected to have strong backgrounds in Computer Science and/or undergraduate majors in Computer Science, Engineering, Physics, Chemistry or Biomedical Engineering. However, candidates with weaker preparation in computer science and related fields may pursue this, but if warranted may be required by their dissertation advisory committee to take an additional customized program of coursework.

### **1. Required Courses**

In addition to the **IBGP core curriculum**, students must complete the following courses:



- **IBGP 7300** (2 credits-letter graded)  
Biomedical Informatics I: Introduces students to basic topics of bioinformatics including sequence analyses, proteomics, microarrays, regulatory networks, sequence and protein databases.
- **IBGP 7310** (2 credits-letter graded).  
Biomedical Informatics II: Continuation of Bioinformatics I.

Students will also complete at least one of the following or its equivalent:

- **BMI 5710** – Introduction to Clinical Informatics
- **BMI 5720** – Introduction to Imaging Informatics
- **BMI 5740** - Introduction to Translational Informatics
- **BMI 7830** – Systems Biology
- **CSE 5441** - Introduction to Parallel Computing  
(Converted from quarter course: **CIS 621** Introduction to High Performance Computing)
- **CSE 5431** - Systems III: Introduction to Operating Systems  
(Converted from quarter course: **CIS 660** Introduction to Operating Systems)
- **CSE 5433** Operating System Laboratory
- **CSE 5421** Introduction to Database Systems
- **CSE 5461** - Computer Networking and Internet Technologies\*
- **CSE 5331** - Foundations II: Data Structures and Algorithms\*\*
- **CIS 6441** Parallel Computing
- **CSE 5242** - Advanced Database Management Systems
- **CSE 5542** - Real-Time Rendering  
(Converted from quarter course: **CIS 781** Introduction to 3D Image Generation)
- **CSE 5545** - Advanced Computer Graphics  
(Converted from quarter course: **CIS 782** Advanced 3D Image Generation)
- **CSE 6331** – Algorithms
- **CSE 5243** – Introduction to Data Mining
- **ECE 7868** – Pattern Recognition and Machine Learning
- **ECE 7005** – Information Theory
- **ECE 7866** – Computer Vision
- **STAT 6410** – Design and Analysis of Experiments
- **STAT 6450** – Applied Regression Analysis
- **STAT 6560** – Applied Multivariate Analysis
- **STAT 6570** – Applied Bayesian Analysis
- **STAT 6625** – Statistical Analysis of Genetic Data
- **STAT 7620** – Elements of Statistical Learning

## 2. Seminars

Due to the interdisciplinary nature of Bioinformatics; relevant seminars are given through Biomedical Informatics, CIS, Biomedical Engineering, and IBGP. To receive the designation of Graduate Specialization in Biomedical Informatics students will be required to register for a total of at least 4 credit hours (i.e., 4 semesters) in these relevant seminars approved by the student's advisor.

## 3. Dissertation Research

After selection of an advisor, students must register each semester for dissertation research by registering for IBGP 8999.

### **3. Program Rationale Statement**

The achievement of an integrated understanding of biological function and interactions between multiple components of a biological system across hierarchical levels of analysis ranging from that of the gene to that of cell, tissue and organ is the next major frontier of biomedical science. Because of the inherent complexity of real biological systems, the development and analysis of computational models based directly on experimental data is necessary to achieve this understanding and translation to clinical practices.

# Cellular and Molecular Physiology

## 1. Learning Goals

Students receiving the special designation of Cellular and Molecular Physiology will focus their training on advanced methods necessary to examine physiological and pathophysiological processes. This training will provide students with an understanding of integrative biological approaches to the analysis of the disease process.

## 2. Course Requirements

In addition to the **IBGP core requirements**, for a student to receive on their transcript the special designation of Cellular and Molecular Physiology, he/she must complete a minimum of 4 additional hours of specialized elective course work, at least 2 of which must be from the list of approved elective courses listed below. Up to 2 hours of other elective courses may substitute for the approved courses upon approval of the student's dissertation advisory committee.

### 1. Approved Courses

- **Neuroscience 7001**- Foundations of Neuroscience (6 Credit hours)
- **Physiology 6080** –Physiology I (3 credit hours). First of a two-course sequence presenting the application of physiology to the practice of pharmacy.
- **Physiology 6101** – Advanced Physiology I (3 credit hours). First in two semester graduate course sequence covering Cell, Neuro, Muscle, Cardiovascular, GI, Respiratory, Renal & Endocrine Physiology.
- **Pharmacology 5600** – Introduction to General Pharmacology (2 credit hours). Introduction to the general principles of pharmacology, drug classification, and the sites and mechanisms of drug action.
- **Pharmacy 8020** – Advanced Pharmacokinetics (3 credit hours). Coverage of multiple general areas of pre-clinical, clinical, and population pharmacokinetic data analysis, modeling and PK study design.
- **PhysioCB 8101** – Advanced Cardiac Physiology (3 credit hours). Faculty give lectures in the field of basic cardiac physiology

### 2. Seminars

Due to the interdisciplinary nature of Cellular and Molecular Physiology, relevant seminars are given through a variety of departments, centers, and programs (HLRI, IBGP, MCDB, OSBP, and various departmental seminar series), which are relevant. To receive this special graduate designation, students will be required to register for a total of 6 credit hours (i.e. 6 semesters).

### 3. Dissertation Research

After selection of an advisor, students must register each semester for dissertation research by registering for IBGP 8999.

## 3. Program Rationale Statement

Research in Cellular and Molecular Physiology and Cell Biology is geared towards understanding the mechanisms that contribute to cardiovascular, gastrointestinal, neurological and other organ and systems related diseases. The mechanisms that control physiology can be studied at many levels of complexity ranging from single molecule interactions to social and environmental pressures. As a highly integrated science, physiology uses techniques and ideas from chemistry, mathematics, physics and biology to synthesize, describe and elucidate the fundamental workings of the body. Animal and cellular models are commonly used to investigate human diseases and their progression. In discovering how the cell, organ and body functions, we can identify specific molecular targets required for the development of therapies to treat different human diseases. The cellular and molecular physiology faculty and students participate in research programs conducted in the Spinal Cord Injury Research Center, the Aging Research Center, the Neuroscience Research Center, the Reye's Syndrome Research Center, the Comprehensive Cancer Center, and the Davis Heart and Lung Research Institute.

# Translational Research

## 1. Learning Goals

The IBGP has designed the curriculum described below for students interested in translational research that will extend their time to degree by approximately two semesters. In addition to the IBGP core curriculum, students wishing to obtain a Graduate Specialization Transcript Designation in Translational Research must take the curriculum outlined below, because those wishing to conduct cutting edge translational research must go beyond the material in the core courses and master additional information that is more clinically related. The OSU College of Medicine has all the resources necessary to provide this specialized training. First, there are many excellent faculty members at OSU with expertise in clinically related areas that can provide several highly specialized courses and seminars in which students can obtain this advanced level of training. Second, the independent study courses in Human Medical Science (IBGP-7601) and Human Pathobiology (IBGP-7631) provide a unique resource that covers clinically related materials for all the major organ systems. However, students will take only those that relate most closely to their dissertation research. They will be guided in the most appropriate choices of these courses, independent studies, and seminars by their dissertation advisors, dissertation advisory committees and the Translational Research Liaison.

## 2. Course Requirements

Students are required to satisfy all of the **IBGP course requirements**. Most of the core curriculum courses are taken by IBGP students during the first two years. These provide an excellent basis for investigating human disease. In addition to the IBGP core curriculum, for a student to receive the transcript designation in "Translational Research," he/she must complete the following:

### 1. Required Courses

- **PH-795 (TBD in semesters- course not yet converted to semesters)** Seminar addressing varying topics in clinical and translational research; literature reviews, guest speakers, discussion of issues, student research presentations. This course is graded S/U.
- **IBGP-7602** Independent Studies in Human Histology (2 credits)
- **IBGP-7603** Independent Studies in Human Pathologic Mechanisms (2 credits)
- **IBGP-7700** Introduction to Clinical Aspects of Translational Research (1 credit)  
Through lectures and small group sessions, this course will provide the basic information needed to begin work on hospital wards and in the ambulatory environment for graduate students with an interest in translational research.
- **One Clinical Experiences course of IBGP- 7701-7773** Clinical Experiences for Students in Translational Research  
This course will provide graduate students a clinical experience on hospital wards and in the ambulatory environment in a clinical area related to his/her dissertation research. The student will learn about the clinical presentations of diseases, diagnostic and therapeutic procedures, and social interactions in the clinical environment. Understanding these issues will assist the student to function as a translational researcher by performing experiments to generate information at the interface between basic and clinical research, and to

facilitating the transfer of information in a bidirectional manner between the clinical and basic research environments.

## 2. Elective Courses

For a student to obtain a Graduate Specialization Transcript Designation in Translational Research, (s)he must take **at least one course** from the list below that are relevant to the organ system or biological process most closely related to his/her dissertation research. These are in addition to those listed above that are required for all students in Translational Research. A student will choose courses to design a customized curriculum in consultation with the dissertation advisor, dissertation advisory committee, and the Liaison for the Translational Research area of research emphasis.

- **IBGP-7601** Independent Studies in Human Medical Science (2 credits)
- **IBGP-7602** Independent Studies in Medical Biochemistry (2 credits)
- **IBGP-7603** Independent Studies in Human Neuroanatomy (2 credits)
- **IBGP-7604** Independent Studies in Human Neurophysiology (3 credits)
- **IBGP-7605** Independent Studies in the Human Cardiovascular System (2 credits)
- **IBGP-7606** Independent Studies in the Human Respiratory System (2 credits)
- **IBGP-7607** Independent Studies in the Human Urinary System and Body Fluids (2 credits)
- **IBGP-7608** Independent Studies in the Human Gastrointestinal System (2 credits)
- **IBGP-7610** Independent Studies in Human Blood and Lymphatic Tissues (1 credit)
- **IBGP-7611** Independent Studies in Human Immunological Mechanisms (2 credits)
- **IBGP-7612** Independent Studies in Human Medical Nutrition (2 credits)
- **IBGP-7613** Independent Studies in Human Endocrine and Metabolic Systems (2 credits)
- **IBGP-7614** Independent Studies in the Human Reproductive System (2 credits)
- **IBGP-7631** Independent Studies in Human Pathobiology (2 credits)
- **IBGP-7632** Independent Studies in Human Microbial Mechanisms (3 credits)
- **IBGP-7633** Independent Studies in Human Drug Mechanisms (4 credits)
- **IBGP-7634** Independent Studies in Human Infectious Diseases (3 credits)
- **IBGP-7635** Independent Studies in Cardiovascular Pathobiology (4 credits)
- **IBGP-7636** Independent Studies in Respiratory Pathobiology (2 credits)
- **IBGP-7637** Independent Studies in Renal Pathobiology (2 credits)
- **IBGP-7638** Independent Studies in Endocrine Pathobiology (2 credits)
- **IBGP-7639** Independent Studies in Gastrointestinal Pathobiology (2 credits)
- **IBGP-7640** Independent Studies in Reproductive Pathobiology (2 credits)
- **IBGP-7641** Independent Studies in Human Neuro-Pathobiology (2 credits)
- **IBGP-7642** Independent Studies in Psychiatry (1 credit)
- **IBGP-7643** Independent Studies in Hematology Pathobiology (2 credit)
- **IBGP-7644** Independent Studies in Rheumatic and Musculoskeletal Pathobiology (1 credit)
- **IBGP-7645** Independent Studies in Ophthalmo-Pathobiology (1 credit)

## 3. Optional Courses:

- **Anatomy-6193** Individual Studies in Anatomy (1-5 credits)  
The goal is to provide a fundamental understanding of the structure of the human body using a systems-based approach and a lecture-laboratory format to build a conceptual framework of the body that will serve as the foundation for subsequent study of pathobiology. A key component of the laboratory exercises will be a comparison of anatomical structures seen in the laboratory with the appearance of those structures in images obtained using conventional radiography, computed tomography, and magnetic resonance. This will provide an anatomical context of the body for understanding microscopic and molecular levels of normal anatomy and of disease processes.
- **Pathology-7793.11** Individual Studies in Pathologic Anatomy (3-18 credits)  
The student will participate in one autopsy, including the prosection, preparation of tissues for microscopy, review of histological slides, completion of autopsy report, and presentation at the gross autopsy conference.
- **Radiology-7193.01** Individual Studies in Radiology (1-6 credits)  
The student will be assigned to an OSU faculty clinical radiologist who is a subspecialist in an area closely related to the student's dissertation topic (e.g. neuroradiology, musculoskeletal radiology). The student will attend 10 sessions at which the radiologist interprets images (MRI, CT, X-ray, and other special techniques) on current clinical patients. Appropriate reading materials will be provided.

#### **4. Dissertation Research**

To be eligible for this graduate specialization transcript designation in Translational Research, the student must have selected an advisor and have defined a dissertation research project that has a translational component to it. Students must register each semester for dissertation research by registering for IBGP 8999.

#### **3. Program Rationale Statement**

The fundamental mission of academic medicine is the acquisition and application of scientific knowledge to improve health care, and the translation of information derived from basic biomedical research into clinical applications is essential for this mission to be accomplished. The importance of this is highlighted by the NIH declaring translational research to be a very high priority in its Roadmap for future funding of research (<http://nihroadmap.nih.gov/>).