Biotechnology Training Program
Summary of Training Program Courses, Other Components & Schedule

The courses in **bold** are those that will be taken by both engineering and life sciences students.

Engineering Students	Life Sciences Students
Year 1	Year 1
Fall	*Fall*
2 Required Eng.	**Foundations of Biomedical Sciences**
Biochemistry for Engineers (if needed)	**Foundations Conferences**
	Laboratory Rotation
Spring	*Spring*
2 Required Eng. Courses	Eucaryotic Molecular Genetics
Molecular Cell Biology and Biophysics I	Biochemistry of Macromolecules
Fundamentals of Biochemical Engineering	**Fundamentals of Biochemical Eng.**
	Laboratory Rotation
Summer	*Summer*
Thesis Research	LaboratoryRotation, statistics
Scientific Ethics	**Scientific Ethics**
Year 2	Year 2
Fall	*Fall*
Foundations of Biomedical Sciences	Gene Expression
Foundations Conferences	Thesis Research
Thesis Research	
Spring	*Spring*
Biomaterials & Biocompatibility*	**Biomaterials& Biocompatibility* *OR***
OR Bioseparation* OR Drug Delivery	**Bioseparation* OR *Drug Delivery****
Thesis Research	Thesis Research
Summer & Beyond	*Summer & Beyond*
Industrial Internship	Industrial Internship

*Students will only have to enroll in one depending on their interest and/or research considerations.

Program Courses

The courses the students will take and why we deem them instrumental to achieving our aims is discussed further below. First the REQUIRED courses are covered and then the Advanced & Specialized courses are discussed.

REQUIRED COURSES

Life Sciences Courses

Preparatory Courses (not required for students with sufficient background)
BioE and ChE 2530. Biochemistry for Engineers (3 credits). Topics covered include DNA structure, protein and enzyme structure and function, general metabolic concepts, energy metabolism, nucleic acid metabolism, and molecular-based control mechanisms.

BIOE 2520 (3 credits. **Molecular Cell Biology and Biophysics I.** Topics covered in this course are bio-macromolecules, protein purification and microscopic techniques, genetics (chromatin organization, DNA replication, recombination, transcription, translation and control of gene expression), molecular perturbation, membrane biophysics and bioenergetics. This course substitute the course that was initially developed for our BTP entitled: *Introduction to Cell and Molecular Biology (3 credits*). While the content of the new version is not very different than the original one, the lectures are more system and quantitative based.

Engineering students who have sufficient background in biochemistry, molecular biology, and cell biology will not be required to take the above introductory courses. However, the Operation Committee will strongly recommend that engineering students take advantage of these courses and build a strong background for the successful completion of the *Foundations of Biomedical Sciences* course. There were several reasons for our decision to develop these courses rather than relying on courses offered by the other units of the University. They include: (1) drastically reduced class size enabling the students to have significant interaction with the faculty and fellow students; (2) ability to count these courses towards the elective courses; and (3) develop the content such that students will be well prepared to enroll in the *Foundation of Biomedical Sciences* course. These courses are described below. These courses are offered every year.

Required Courses
INTB 2000. Foundations of Biomedical Sciences (8 credits). Foundations of Biomedical Sciences is the first course taken by all graduate students entering the Interdisciplinary Biomedical Science Graduate Program. This course is the key course taken by all students in BTP. The conceptual breadth of modern biomedical science is covered through a longitudinally integrated presentation of material principally drawn from disciplines such as biochemistry, cell biology, molecular genetics, and the emerging area of signal transduction. The development of critical thinking skills is emphasized through an evaluation of experimental evidence and reading of the primary literature. The course will provide a broad but integrated presentation of biochemistry, cell biology, and molecular biology, which we feel is ideally suited for the training of biotechnology students. The philosophy behind this course is to convey knowledge of the molecular and cellular mechanisms controlling cell, tissue, and organ function, and to develop an

understanding of the experimental evidence supporting these concepts through an integrated presentation of materials from biochemistry, cell biology, genetics, immunology, microbiology, pathology, pharmacology, and physiology. This course satisfies prerequisites for essentially all advanced or specialized courses in immunology, molecular biology, cell biology, and virology. Apart from the high intellectual value, we envision that this challenging course will bond the students together and thus contribute greatly to the program's cohesiveness and the identification students make with the Training Program.

INTB 2005. Foundations Conferences (4 credits). Contemporary approaches to problem-solving in biology, as well as principles underlying modern methods of biomedical research will be integrated with the lecture component of the course through an analysis of mechanisms underlying biological phenomena. Students will present papers, critically analyze data and devise experimental approaches to biomedical problems considered in lecture.

Engineering Courses

Required for both Engineering and Life Sciences Students

Fundamentals of Biochemical Engineering (3 credits). Students will be exposed to cultivation methods (batch, fed-batch, continuous) and their quantitative analysis, metabolic engineering, cell culture bioengineering including oxygen transfer in immobilized bioreactors and various bioreactor designs that provide adequate mass transfer ensuring cellular viability and device functionality. Case studies include hepatocyte culture, production of natural and recombinant proteins including antibodies, and DNA and viral vectors and vaccines.

One of the Following Three Courses is required for all students

Bioseparation* (*BioE & ChE 2532). This course will focus on purification of recombinant and natural proteins, DNA, and viral vectors for gene therapy applications. Ultrafiltration, tangential or cross-flow systems, precipitation, and chromatography processes including size exclusion, hydrophobic, ion exchange, and affinity-based chromatography will be discussed in detail. Quantitative analysis of the interactions of biomolecules with immobilized ligand and modeling of chromatography will be emphasized. Application of genomic manipulation and proteomics for improving bioseparation processes will also be covered. Plasma fractionation and new plasma products will be used to demonstrate the overall separation and purification schemes.

Biomaterials and Biocompatibility (BioE 2810 3 credits). This course will focus on chemical and physical properties of orthopaedic and cardiovascular biomaterials. Wear and corrosion of implant materials; fracture healing; inflammatory response; fixation and loosening of permanent implants; protein adsorption; coagulation cascade; and bacterial adhesion will be discussed.

Controlled Drug Delivery (BioE & ChE 3533, 3 credits). This course will focus on providing students with a basic understanding of the rationale behind the engineering of controlled drug delivery systems. To this end, we will focus on topics at the interface between chemical engineering and medicine such as polymer chemistry, biomaterials, pharmacokinetics, and transport phenomena. Pertinent pharmaceutical examples that will be discussed include: transdermal, aerosol, oral, bioMEMS, gene, and targeted cellular delivery, with emphasis being placed on fabrication considerations and the relevant physiological milieu.

Inter-Campus Course Credits Fulfillment & Registration

- All the forms required for intercampus registration have been centralized Please contact. Mr. Rob Toplak (Tel: 4-9398; Email: **Toplak@engr.pitt.edu**, Chemical Engineering Dept., University of Pittsburgh).

- CMU students registering for courses taught on the University of Pittsburgh campus will receive letter grades for the course and the courses will be viewed and credited towards their graduation as if the courses were taken on the CMU campus.

- The same will hold for University of Pittsburgh students taking courses on the CMU campus; graduation requirements will be met and indicated as such in that student's transcript from the University of Pittsburgh.

Seminars, Journal Club, Industrial Internship

Seminars

You must attend two seminars (outside your own department) each term. Below are links to several seminar series offered in programs at Pitt and CMU.

Pitt-ChE
http://www.engr.pitt.edu/chemical/graduate/seminars/index.html

McGowan Institute
http://www.mirm.pitt.edu/events/seminarseries.htm

Pitt-Biological Sciences
http://www.pitt.edu/~biohome/Dept/Frame/mondayseminarseries.htm

Pitt- Molecular Genetics and Biochemistry
http://www.mgb.pitt.edu/news/new_seminars.asp

CMU – Chemical Engineering
http://www.cheme.cmu.edu/newsevents/index.htm

Journal Club

You must attend Journal Club meetings and other activities that will be planned by the program.

Industrial Internship

All the students in the training program are required to participate in industrial internships of about three months in duration. The internship can begin as soon as the Summer of the student's second year in residence. The duration of the industrial internship will be about 3-4 months. Thus, industrial internships can be arranged readily.

Students completing industrial internships will be required to present a short seminar sharing their research and working experience with the program faculty and students at the Annual Graduate Symposium.