Undergraduate Advising Manual

Students Entering the Program Fall 2003 or later

(version: August 2007)

I – INTRODUCTION

Welcome to the Department of Chemical and Biomolecular Engineering!
The ChemBE department offers courses and training culminating in a Bachelor of Science degree in Chemical and Biomolecular Engineering. Additionally, students may choose, if they wish, to pursue a Molecular and Cellular Bioengineering (MCB) Concentration or an Interfaces and Nanotechnology (IN) Concentration.

What is Chemical and Biomolecular Engineering?

Chemical and Biomolecular Engineering is dedicated to chemical, biological and physical transformations starting at the molecular scale. Students find employment in industries such as chemicals, biotechnology, materials, energy, pharmaceutical, biomedical, consumer products, and the environment. Products made by chemical and biomolecular engineers include polymers, chemicals, biopharmaceuticals, drugs, vaccines, gene therapy and drug delivery devices, whole cells and tissues, materials, semiconductors, and nanodevices as well as consumables including beverages, foods, and health care products. Graduates may embark on a career to produce the next biopharmaceutical blockbuster drug for treating cancer or autoimmune disease, design more efficient fuel cells, design a new gene therapy or drug delivery device, create a material for organ therapy and tissue replacement or create an engineered nanodevice for the electronics industry

Students take courses in the foundation sciences of chemistry, physics and biology. This emphasis of biology, chemistry, and engineering at the molecular scale enables graduates to participate in product and process development from the molecular and nano-scales to large-scale processes. In concert, students are educated in the essential chemical and biomolecular engineering paradigms of transport, kinetics, and thermodynamics essential to solving complex engineering problems. Electives can be chosen from areas such as materials science, nanotechnology, and bioengineering. These courses and undergraduate research opportunities can be designed to prepare graduates for a career in the chemical, biotechnology, pharmaceutical or microelectronics industries; for graduate school in Chemical and Biomolecular Engineering, Biomedical Engineering, Materials Engineering or a related major; or for medical, law, or business school. Graduates receive an ABET-accredited Bachelor of Science degree in Chemical and Biomolecular Engineering.

Concentrations

Students pursuing a BS degree in Chemical and Biomolecular Engineering have the opportunity, if they choose, to take some of their courses in a particular area in order to obtain a concentration. The two concentrations that students may choose to complete, Interfaces and Nanotechnology (IN) and Molecular and Cellular Bioengineering (MCB), are described below. Students completing a concentration will have this fact designated on their official university transcript.

Interfaces and Nanotechnology Concentration

Material properties of nanoparticles depend upon their dimensions; by making particles in the nanometer size range, materials with new optical, electrical and magnetic properties can be created. The ability to fabricate these particles and assemble them into ordered structures is central to exploiting these new materials. As such, engineering at the nanoscale will be dominated by surface science, as surface to volume ratios become large. Furthermore, self-assembly techniques, in which molecules can spontaneously assemble in ordered structures with nanometer length scales are ripe for exploitation to create new materials. In this concentration, students are trained in the fundamental scientific underpinnings of this emerging discipline. An example program that includes the IN concentration is listed on page 10 and the program requirements are specified on page 14.

Molecular and Cellular Bioengineering (MCB) Concentration

Many biological transformations of interest in biotechnology and biomedicine involve transformations at molecular and cellular levels. These molecular transformations include the genetic manipulation of cells in order to produce valuable designer protein and vaccines for the biopharmaceutical industry. Alternatively, cellular transformation events can be critical to the onset of diseases such as arteriosclerosis and cancer. Cellular transformations can be critical to the treatment of diseases such as inducing the death of cancer cells or the manipulation of stem cells along desirable pathways.

Students wishing to study molecular and cellular events in biological systems and their applications in more detail can pursue an optional concentration in Molecular and Cellular Bioengineering. Students in this concentration will take lecture and laboratory courses in Cell Biology in order to fulfill advanced science requirements and electives in bioengineering subjects such as Cell Engineering, Tissue Engineering, Drug Delivery, Biological Macromolecules, or Molecular Evolution. In addition, students will take Biomolecular Engineering Laboratory in order to equip students with the hands-on skills needed for future careers involving the application of biological systems at the molecular and cellular level. An example program that includes the MCB concentration is listed on page 9 and the program requirements are specified on page 14.

Pre-Medical Requirements The Chemical and Biomolecular Engineering degree provides excellent preparation for Medical School. Each medical school has its own admissions standards. These requirements may include some courses not included in the Chemical and Biomolecular Engineering program. As a result, students may want to take additional courses in order to fulfill requirements of a particular medical school. More information on premedical requirements is included on page 18.

Where are our Chemical and Biomolecular Engineering graduates?

The Department of Chemical and Biomolecular Engineering graduates students who are prepared for a variety of professional career paths or for further education. Some examples of recent graduates are:

Daniel Abras	Graduate school, University of Wisconsin
Jason Auer	Wyeth Biopharma
Nadia Awad	Medical school, University of Rochester
Ryan Bradley	International MSE, Technical University of Denmark
Anthony Criezis	Kraft Foods
Saira Haider	USPTO
Christopher Hale	Johns Hopkins University PhD program
Hiroki Ito	Mitsubishi
Michael Curtis	Graduate school, Tufts University
Patrick Marti	Cambridge University PhD program
Thomas McCann	ABB Lummus Global
Stephanie Piecewicz	Harvard/MIT PhD program
Raphael Picciotto	Pernod Ricard (wine and spirits industry)
Sudhir Prabhu	Merck
Brian Simpson	MIT PhD program
David Small	GSE Systems
Diana Smirnova	CalTech PhD program
Jeffrey Swanberg	Cornell University PhD program
Daniel Wolgin	MechanixWear

II – Program Mission and Objectives

The Department of Chemical and Biomolecular Engineering offers courses and training culminating in the Bachelor of Science degree in Chemical and Biomolecular Engineering. This discipline is dedicated to solving problems and generating valuable products involving chemical and biological transformations at the molecular scale. The undergraduate program emphasizes the molecular science aspects of biology and chemistry along with the engineering concepts essential to developing commercial products and processes. In the tradition of the Johns Hopkins University, many undergraduates are also involved in research, working closely with faculty and graduate students in research groups.

The mission of the chemical and biomolecular engineering undergraduate program is to provide students with the knowledge and skills required to pursue a professional career or to continue their studies towards an advanced degree. In order to achieve these goals, the department ensures that students:

1. have a firm grounding in biology, chemistry, mathematics and physics.
2. can utilize engineering principles to identify, formulate, and solve chemical and biomolecular engineering problems.
3. are proficient in the application of these principles in the synthesis, analysis and design of experiments and processes.
4. acquire the techniques, skills, and ability to use tools for modern engineering practice and recognize the importance of lifelong learning.
5. have access to specialized training in biomolecular engineering and chemical engineering through coursework, research and internships.
6. can communicate both orally and in writing with technical and non-technical audiences and work effectively independently and in multidisciplinary teams.
7. understand the impact of chemical and biomolecular engineering on the environment and society, as well as the attendant professional and ethical responsibilities.

The department also offers graduate programs leading to the Master of Science and Ph.D. degrees. These programs emphasize research leading to written thesis.

Undergraduate students strongly involved in research may be interested in our BS/MSE program in Chemical and Biomolecular Engineering that allows students to obtain an Masters in Science in Engineering immediately after the Bachelors of Science by adding an additional year of study (see p. 17).

III - DEPARTMENTAL ADVISING PROCEDURES

Faculty Advisors

Each student enrolled in Chemical and Biomolecular Engineering is assigned to a faculty member who will act as his or her advisor until graduation. Students plan their programs with their advisors to reflect individual interests as well as to fulfill program requirements. The advisor must lift the hold on registration in order for the student to register on-line or add/drop classes after the semester begins. A list of faculty with contact information is included at the end of this manual.

Resources

Forms

Two forms are provided in this manual to aid in your course planning. The **example programs** (pages 8-10) shows a *suggested example* of how the requirements can be fulfilled in four years of study. On this form the suggested elective sequence is arranged so that course loads are reasonably balanced, but note that they can be adjusted when appropriate. The **checklist form** (see p. 29) serves as a checklist to assure that the degree requirements are fulfilled. This is the most useful form to use to monitor your progress toward your degree. This form is available as an Excel spreadsheet at:
http://www.jhu.edu/~cheme/undergraduates/undergraduate.asp.
Students who transfer in from other programs or who enter with significant advanced standing should find this form especially useful.

Manuals and Guides

The Johns Hopkins University "Undergraduate Academic Manual" should be consulted for details regarding University requirements, grading options, independent study, etc. In addition, freshmen should refer to the "Program Planning Guide for First-Year Engineering Students" published by the Whiting School of Engineering. This guide contains additional information about academic policies, advanced placement credits, resources and opportunities for students, etc.

Course Guides and Evaluations

The university maintains two online guides in which course evaluations are compiled: the Undergraduate Academic Course Evaluation (ACE) Guide (http://www.jhu.edu/advanced/ACE_guide) and Merlin, the Students' Academic Manual (http://www.jhu.edu/Merlin/). Student evaluations including numerical data and written comments are published for courses offered in the Schools of Engineering and Arts and Science. These guides are particularly helpful for students in their selection of elective courses. Prior to selecting a course, be sure to review the past years' evaluations to see how students have rated the course and the instructor. Keep in mind that the instructor and course content can change from year to year.

III – EXAMPLE PROGRAMS

Example Program
Chemical and Biomolecular Engineering Degree
Students entering Fall 2003 or later with no advanced placement credits

Freshman Year / Fall

030.101	Intro to Chemistry I	3
030.105	Intro to Chemistry I Lab	1
110.108	Calculus I	4
171.101	General Physics I	4
173.111	General Physics Lab I	1
540.101	Chemical and Biomol. Eng. in Workplace	1
H/S Elective		3
	Total	17

Freshman Year / Spring

030.102	Intro to Chemistry II	3
030.106	Intro to Chemistry II Laboratory	1
110.109	Calculus II	4
171.102	General Physics II	4
H/S Elective		3
	Total	15

Sophomore Year / Fall

540.202	Intro. Chemical & Biological Process Analysis	4
540.490	Chemical and Biomolecular Lab Safety and Ethics*	1
110.202	Calculus III	4
020.305	Biochemistry	4
030.205	Organic Chemistry I	4
	Total	17

Sophomore Year / Spring

540.203	Engineering Thermo	3
540.303	Transport I	4
110.302	Differential Equations with Applications	4
Advanced Chemistry Elective†		4
	Total	15

*This course must be taken no later than the junior year. This course must be passed in order to be allowed to be involved in research in our department.

†Cell Biology is recommended (see undergraduate advising manual)

Junior Year / Fall

540.204	Applied Physical Chem.	3
540.304	Transport II	4
030.307	Physical Chemistry Instrumentation Lab III	3
Undesignated Elective		3
H/S Elective		3
	Total	16

Junior Year / Spring

540.301	Kinetic Processes	4
540.306	Chemical & Biological Separations	4
Advanced Chemistry Elective		3
Undesignated Elective		3
H/S Elective		3
	Total	17

Senior Year / Fall

540.311	Chemical Engineering Lab	6
540.409	Modeling Dynamics & Control for Chemical and Biological Systems	3
H/S Elective		3
Engineering Elective		3
	Total	15

Senior Year / Spring

540.314	Chemical and Biomolecular Process Design	4
Engineering Elective		3
H/S Elective		3
Undesignated Electives		6
	Total	16

Example Program: Chemical and Biomolecular Engineering Degree
Molecular and Cellular Bioengineering Concentration
Students entering Fall 2003 or later with no advanced placement credits

Freshman Year / Fall

030.101	Intro to Chemistry I	3
030.105	Intro to Chemistry I Lab	1
110.108	Calculus I	4
171.101	General Physics I	4
173.111	General Physics Lab I	1
540.101	Chemical and Biomol. Eng. in Workplace	1
H/S Elective		3
	Total	17

Freshman Year / Spring

030.102	Intro to Chemistry II	3
030.106	Intro to Chemistry II Laboratory	1
110.109	Calculus II	4
171.102	General Physics II	4
H/S Elective		3
	Total	15

Sophomore Year / Fall

540.202	Intro. Chemical & Biological Process Analysis	4
540.491	Chemical and Biomolecular Lab Safety and Ethics*	1
110.202	Calculus III	4
020.305	Biochemistry	4
030.205	Organic Chemistry I	4
	Total	17

Sophomore Year / Spring

540.203	Engineering Thermo	3
540.303	Transport I	4
110.302	Differential Equations with Applications	4
020.306	Cell Biology	4
	Total	15

*This course must be taken no later than the junior year. This course must be passed in order to be allowed to be involved in research in our department.

Junior Year / Fall

540.204	Applied Physical Chem.	3
540.304	Transport II	4
020.315	Biochemistry Lab	2
Undesignated Elective		3
H/S Elective		3
	Total	15

Junior Year / Spring

540.301	Kinetic Processes	4
540.306	Chemical & Biological Separations	4
Undesignated Elective		3
020.316	Cell Biology Lab	2
H/S Elective		3
	Total	16

Senior Year / Fall

540.313	Biomolecular Engineering Lab	6
540.409	Modeling Dynamics & Control for Chemical and Biological Systems	3
H/S Elective		3
Bioengineering Elective		3
	Total	15

Senior Year / Spring

540.314	Chemical and Biomolecular Process Design	4
Bioengineering Elective		3
H/S Elective		3
Undesignated Electives		8
	Total	18

Example Program: Chemical and Biomolecular Engineering Degree
Interfaces and Nanotechnology Concentration
Students entering Fall 2003 or later with no advanced placement credits

Freshman Year / Fall

030.101	Intro to Chemistry I	3
030.105	Intro to Chemistry I Lab	1
110.108	Calculus I	4
171.101	General Physics I	4
173.111	General Physics Lab I	1
540.101	Chemical and Biomol. Eng. in Workplace	1
H/S Elective		3
	Total	17

Freshman Year / Spring

030.102	Intro to Chemistry II	3
030.106	Intro to Chemistry II Laboratory	1
110.109	Calculus II	4
171.102	General Physics II	4
H/S Elective		3
	Total	15

Sophomore Year / Fall

540.202	Intro. Chemical & Biological Process Analysis	4
540.315	Chemical and Biomolecular Lab Safety and Ethics*	1
110.202	Calculus III	4
020.305	Biochemistry	4
030.205	Organic Chemistry I	4
	Total	17

Sophomore Year / Spring

540.203	Engineering Thermo	3
540.303	Transport I	4
110.302	Differential Equations with Applications	4
Advanced Chemistry Elective		3
	Total	14

*This course must be taken no later than the junior year. This course must be passed in order to be allowed to be involved in research in our department.

Junior Year / Fall

540.204	Applied Physical Chem.	3
540.304	Transport II	4
030.307	Physical Chemistry Instrumentation Lab III	3
030.452	Mat. & Surf. Charact.	3
H/S Elective		3
	Total	16

Junior Year / Spring

540.301	Kinetic Processes	4
540.306	Chemical & Biological Separations	4
Undesignated Elective		3
Undesignated Elective		3
H/S Elective		3
	Total	17

Senior Year / Fall

540.311	Chemical Engineering Lab	6
540.409	Modeling Dynamics & Control for Chemical and Biological Systems	3
H/S Elective		3
Engineering Elective		3
	Total	15

Senior Year / Spring

540.315	Chemical and Biomolecular Process Design	4
Engineering Elective		3
H/S Elective		3
Undesignated Electives		7
	Total	17

IV – DEGREE REQUIREMENTS

Curriculum

Chemical and Biomolecular Engineering Core Courses

The following ChemBE courses are required 540.101, 540.202, 540.203, 540.204, 540.301, 540.303, 540.304, 540.306, 540.311 (or 540.313), 540.314, 540.409, and 540.490 (see page 20 for a list of course names and numbers). Students that switch majors into ChemBE too late to take 540.101 in their freshman year may have the requirement for 540.101 waived with permission of the student's advisor. However, since the total number of engineering credits ("Chemical Engineering Core Courses" plus "Other Engineering Courses") must be at least 48 credits, the credit requirements for Other Engineering Courses will be raised by one credit.

Other Engineering Courses

A minimum of 48 engineering credits are required for the degree; therefore, students are required to take at least 6 engineering elective credits (a list of suggested engineering electives is on page 26). Students that have had 540.101 waived as a requirement will have additional "other engineering" credit requirements as discussed above. Students who have completed 540.102 Intro to ChemBE Problems can count the course as an engineering elective. A list of approved engineering electives is found near the end of this manual. Other engineering courses not on the approved list may also be acceptable as engineering elective courses but must be approved by the advisor and the director of undergraduate studies.

Physics Courses and Laboratories

The following physics courses are required: 171.101, 171.102 and 173.111.

Basic Chemistry Courses and Laboratories

The following chemistry courses are required: 030.101, 030.102, 030.105, and 030.106.

Advanced Chemistry and Biology Courses

Students are required to take 16 credits of Advanced Chemistry and Biology courses. The following three courses (11 credits) are required 020.305, 030.205, and 030.307. Students are required to take five additional credits (usually two courses) beyond these two required courses. *Students that are concentrating in Molecular and Cellular Bioengineering or Interfaces and Nanotechnology have additional and/or alternate requirements (see page 14)*. Students should meet with their advisor to discuss which courses are most appropriate for their educational objectives. Cell Biology (020.306) should be seriously considered as one of the two additional advanced chemistry courses. However, for some students, taking two of the other approved courses listed on page 25, is more appropriate. Note that Physical Chemistry I (030.301) is not an approved course because most of its content is covered in our required courses (540.202, 540.203, 540.204). A list of approved advanced chemistry and biology electives is found near the end of this manual. Other courses not on the approved list may also be acceptable as advanced chemistry and biology elective courses but must be approved by the advisor and the director of undergraduate studies.

Mathematics Requirement

The following mathematics courses are required: Calculus I, II and III (110.108, 110.109 and 110.202) and Differential Equations with Applications (110.302). Differential Equations (EN.550.303) may be substituted for 110.302.

Calculus is so essential to Chemical Engineering that a grade of C- or better in both Calculus I and Calculus II is required. In addition to knowledge of the material covered in Calculus I, II and III, Chemical Engineers need to be able to solve linear differential equations, some simple partial differential equations and systems of differential equations often by numerical methods. Differential Equations with Applications (110.302) provides this additional mathematical background.

Sixteen credits of math are required. Successful completion of the Advance Placement examinations will count toward these credits (see the Undergraduate Academic Manual for scores needed). Students who do not receive advance placement credits but who place out of Calculus I by their score on the math department placement exam are required to take an additional course in mathematics since they do not receive *credit* for Calculus I and students must have a total of at least 16 credits in mathematics. Note that a course in probability and/or statistics can be used to satisfy this requirement.

Writing Skills

The university requires that two courses designated as a W must be taken to graduate and that these two courses must be completed with a grade of C or better. In addition, the ChemBE major requires the following:

1) One of the two W courses must be a course from the following list:

060.113/114 Expository Writing
060.215 Advanced Expository Writing
220.146 Undergraduate Workshop in Science Writing
661.110 Technical Communication
661.310 Scientific Writing
661.330 Writing for Health Professions
661.411 Grant Proposal Writing

2) The second W course may be any course with a W designation (including those listed in (1) above) except for 540.311 and 540.313.

Students entering the major prior to Fall 2006 are exempted from the above requirements that are specific to ChemBE majors (i.e. rules (1) and (2) above) but are NOT exempted from the university W requirement. However, it is most strongly recommended that all ChemBE majors follow the above two rules in fulfilling the W requirements.

Humanities and Social Sciences Courses

Eighteen credits designated as humanities (H) or social science (S) are required. The goal of this requirement is for students to acquire both *breadth* and *depth* in the humanities and social sciences. Therefore, students are required to take the courses in at least three subject areas. In addition students are required to have a concentration consisting of two or more courses in at least one of the three (or more) subject areas. This concentration may be fulfilled either by completing (a) an introductory course and one or more advanced level courses that have this introductory course as a prerequisite or (b) two advanced level courses.

An advanced course generally means a 300-level course or higher. However, a 200-level course that has a 100-level course as a prerequisite can also be considered advanced.

Acceptable H/S concentration subjects include, but are not limited to: Anthropology, Archaeology, Arts (Visual or Performing), Classics, Communications, Economics, Ethics, Geography, History, Film, Foreign Languages and Cultures, Jurisprudence (Law), Linguistics, Literature, Music, Philosophy, Political Science, Psychology, Religion, and Sociology. Courses used to fulfill the H/S concentration requirement do not have to be taken within a single department. Please note that "Entrepreneurship and Management" is not an acceptable H/S concentration because it is not a humanities or social science subject per se. However many of the classes offered by Entrepreneurship and Management have humanities and social science aspects such that combinations of courses within Entrepreneurship and Management or between Entrepreneurship and Management and other departments can be used to fulfill the H/S concentration in one of the above approved H/S concentration subjects (e.g. Economics, Ethics, Law, etc.).

It is necessary but not sufficient for the course to have an H or an S designator for it to count as an H/S elective for our major. The following courses are NOT acceptable as H/S electives even though they are designated as an H or an S since they lack significant humanities or social science content:

180.314 Mathematical Economics
180.334 Econometrics
200.314 Advanced Statistical Methods
660.203/204 Financial Accounting
660.302 Corporate Finance
660.102 Personal Finance

It is not the purpose of this rule to discouraged students from taking these classes. Students who wish to take these courses can count them as undesignated elective credits.

No more than 6 credits designated as H or S that are also designated with an N (natural science), an E (engineering) or a Q (quantitative) may count towards fulfilling the 18 credits of H/S/ electives.

Foreign language instruction and literature courses are acceptable as Humanities credits. Note that beginning language courses often do not have an H designation because they are not allowed as an H course for Arts & Science majors. However, University rules state that beginning language courses do have an H designation for engineering students. Thus, beginning language courses count towards fulfilling the 18 credits of H/S electives even if they lack an H designator. Be aware that some language departments require that the entire year of an introductory language course must be taken in order to receive credit. Students who wish to complete their concentration in a foreign language must do so by completing two semesters at the intermediate level or higher.

Undesignated Electives

A minimum of 128 credits is required for the degree. Therefore, in addition to all the credits taken to fulfill the requirements mentioned in the various sections above (e.g. chemical engineering core courses, engineering electives, advanced chemistry electives, computing requirement, mathematics requirement, and H & S courses) up to 13 additional credits (called undesignated credits) are required. There are no restrictions on the courses that can be used as undesignated electives.

Concentrations

Students pursing a degree in Chemical and Biomolecular Engineering have the option of concentrating in specific fields including Interfaces and Nanotechnology and Molecular and Cellular Bioengineering. Students completing a concentration will have this fact designated on their official university transcript. These concentrations have additional and/or alternate requirements, as described below.

1. Interfaces and Nanotechnology (IN) Concentration

Students must fulfill the following requirements:

1. Materials and Surface Characterization (030.452) is required and satisfies three credits of the advanced chemistry electives.

2. Six credits of interfaces and nanotechnology electives are required. See p. 27 for a list of approved electives.

2. Molecular and Cellular Bioengineering (MCB) Concentration

Students must fulfill the following requirements:

1. Cell Biology (020.306) is required and satisfies four credits of the advanced chemistry and biology electives.
2. The requirement for 030.307 (Physical Chemistry Instrumentation Lab III) is replaced with a requirement for ***both*** 020.315 (Biochemistry Lab) ***and*** 020.316 (Cell Biology Lab).
3. Six credits of bioengineering electives are required. See p. 25 for a list of approved courses.
4. Students must take 540.313 Chemical and Biomolecular Engineering Lab instead of 540.311 Chemical Engineering Lab.

Note that the four credits from Cell Biology and the one extra credit arising from taking 020.315 and 020.316 instead of 030.307 satisfy the 5 credits of advanced chemistry and biology electives.

Rules and Limitations

Grade Requirements

Students also must have a grade point average of at least 2.00 in the Chemical and Biomolecular Engineering Core courses to graduate. These core courses are: 540.202, 540.203, 540.204, 540.301, 540.303, 540.304, 540.306, 540.311 (or 540.313), 540.314, 540.409.

Repetition of Course Content

Courses taken to fulfill any requirement, including the requirement of 128 total credits, must not overlap in content to a substantial extent. For example, students cannot count Physical Chemistry I (030.301) because its content is covered in 540.203. At present, the Material Science course, Thermodynamics (510.312) so extensively duplicates our courses that this course also cannot be counted. You should discuss carefully the content of all elective courses with your advisor. His/her approval, and in questionable cases, that of the undergraduate advising coordinator, is required to avoid problems in fulfilling course requirements.

Undergraduate Research and/or Independent Study to Fulfill "Other Engineering" Requirement

No more than four credits earned in Undergraduate Research and/or Independent Study can be used to fulfill this requirement. Any additional credits in these courses can serve only as undesignated credit (i.e. towards the total 128 credit minimum). For further information about participating in Undergraduate Research, see page 20.

Courses Taken Pass/Fail

There is no limit on the number of undesignated credits that may be taken pass/fail. However, all required courses and all courses fulfilling technical elective and H & S elective requirements can not be taken pass/fail without special permission. To allow for situations where it may be *educationally* appropriate for the student to take a course for which he/she has significantly less than the normal preparation, the advisor, with the approval of the director of undergraduate advising, can allow up to four credits of technical electives and up to two courses of H & S courses to be taken pass/fail.

Exceptions

The procedure for obtaining an exception to any of the above requirements is a recommendation in writing by the advisor, and approval by the Undergraduate Advising Coordinator. A copy of this exception request, with approvals, will be provided to the student and to the advisor; the original will be retained in the departmental file.

V – OPTIONS AVAILABLE IN CHEMICAL AND BIOMOLECULAR ENGINEERING

Minors

An official minor is available in environmental engineering. Detailed information regarding this program can be found at: http://engineering.jhu.edu/~dogee/undergraduate-programs/ or by contacting:

Dr. William P. Ball, Coordinator
308 Ames Hall (DoGEE)
410-516-5434
bball@jhu.edu

Cooperative Program

The Department of Chemical and Biomolecular Engineering has begun a cooperative program in which students spend up to one year in industry after completing their sophomore or junior year. Students do not pay tuition during the work periods and are paid a salary by their employer. Although the department arranges employment contracts, final negotiations are made between the student and the employer. Students successfully completing a cooperative program receive a notation on their transcript. Interested students should contact their academic advisor.

Examples of recent participants:

Michael Parham participated in the program during the 2001-2002 academic year. Michael took one year in-between his junior and senior years to co-op at FMC Baltimore as a process engineer. At FMC he focused on reliability and process control engineering. He designed and implemented several cost saving, safety and environmental process improvements and took part in configuring FMC Baltimore's data historian system to process batch data. He identified process sample points for use in and started a pilot statistical process control charting system for FMC Baltimore's engineers.

David Neuberger participated in the program during the 2000-2001 academic year. He worked at Grace Davison in Columbia, Maryland on the scale-up of a new Polyolefin catalyst. His Co-Op started with making this catalyst on a benchtop scale (100g) which then progressed to the final 300 lb prep to meet customer specifications. During the scale-up process David performed a Process Hazard Analysis (PHA) which included such things as how the process would be carried out, potential safety hazards, etc. During the final 300 lb run he monitored the catalyst as it went downstream to check for the necessary qualities. David is now performing experiments on these catalysts to determine better preparation methods and to investigate the catalytic mechanism of the catalyst itself.

BS/MSE Program in Chemical and Biomolecular Engineering

The BS/MSE program in Chemical and Biomolecular Engineering allows students to obtain a Masters in Science in Engineering immediately after the Bachelors of Science by adding an additional year of study. The Whiting School of Engineering allows a twenty-five percent waiver after the completion of 8 semesters or having received the Bachelor of Science for students who qualify academically. The waiver is available for three semesters.

Applicants for the BS/MSE program must submit:

- Completed application form
- Three letters of recommendation, including at least one from a faculty member in the student's baccalaureate department (the latter not only making the recommendation, but acknowledging that the student can fulfill both BS and MSE requirements on schedule.
- Official JHU transcript
- Statement of purpose.

For more information, contact:

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Double Counting Policy

http://engineering.jhu.edu/academicaffairs/g-double-count-policy/

The Whiting School of Engineering (WSE) has established policies on double-counting coursework for all students in the full-time (Homewood) programs and the part-time Engineering and Applied Science Programs for Professionals. If an individual program adopts double-counting policies more strict than these, the program's policies override the School-wide policies. Students are encouraged to refer to individual program policies.

Information about Premedical Requirements

The Chemical and Biomolecular Engineering degree is an excellent curriculum for preparing students for medical school. Students who intend to go to medical school must plan their program carefully to satisfy all medical school requirements. Medical schools vary in their admission standards, but the present course requirements of the Johns Hopkins Medical School, listed below, will serve as a general guide.

Current Admissions Requirements for The Johns Hopkins University School of Medicine
http://www.hopkinsmedicine.org/admissions/apps.html
(Johns Hopkins University course that meet these requirements in parenthesis)

1. College Biology with Lab, one year (8 semester hours) Advanced Placement credit may not be used to satisfy the biology requirement.
(020.305/306/315/316)

2. General College Chemistry with Lab, one year (8 semester hours) Applicants with acceptable Advanced Placement credit for general chemistry must take one additional semester of advanced college chemistry with lab.
(030.101/102/105/106)

3. Organic Chemistry with Lab, one year (8 semester hours) A semester of biochemistry with lab may be substituted for the second semester of organic chemistry, but one must then use another biology course to fulfill the 'college biology with lab' requirement listed above.
(030.205/206/225)

4. Humanities, Social and Behavioral Sciences Applicants are required to complete at least 24 semester hours in these disciplines.

5. Mathematics-Calculus or Statistics, one year (6 to 8 semester hours) Advanced Placement credit for calculus, acceptable to the student's undergraduate college, may be used in fulfillment of one semester of the Hopkins' math requirement.
(110.108/109)

6. College Physics with Lab, one year (8 semester hours) Advanced Placement credit for physics, acceptable to the student's undergraduate college, may be used in fulfillment of the Hopkins' physics requirement.
(171.101/102/111/112)

All of these courses are contained in the Molecular and Cellular Bioengineering Concentration (MCB) requirements with the exception of (a) second semester organic chemistry (030.206), (b) organic chemistry lab (030.225), (c) the second semester of physics lab (173.112) and (d) 6 credits of humanities, social sciences or behavioral science. Students can count these additional courses as "undesignated electives." Premedical students should be aware that traditionally both organic chemistry II (030.206) and organic chemistry lab (030.225) also have been offered in the summer and it may be convenient to take these courses during the summer session.

Please be aware that the admissions requirements listed above are *only* for Johns Hopkins University School of Medicine. Most medical schools will require a year of English

(literature and/or writing seminars). Also, not all schools will allow the second semester of organic chemistry to be fulfilled by biochemistry and some schools will have restrictions as to the number and kind of AP credits they will accept. Students should take care to review and meet the admissions requirements for their state medical schools as well.

An important resource for pre-medical students is the Office of Pre-Professional Advising, 300 Garland Hall (http://www.jhu.edu/preprof/). For more information on medical school requirements, see Medical School Admission Requirements: United States and Canada, a book published annually by the Association of American Medical Colleges (www.aamc.org).

VI - OTHER RESOURCES AND OPPORTUNITIES FOR STUDENTS:

Undergraduate Research

Many undergraduate students are involved in research within the department. Students often begin research in the sophomore year. By this time, they have completed some courses and are able to understand and contribute to a laboratory research project. However, some professors may have projects that are suitable for less advanced students.

If you are interested in beginning research within the department, the first step is to meet with your faculty advisor. He/she will go over your academic record with you to determine if you are prepared for a research project. Next, you should (i) investigate the research interests of the faculty by reading their departmental webpages and publications and (ii) make appointments to talk to faculty members whose research interests you in order to learn more about their research and to find out if there is an opening in that faculty member's lab. You may also speak to graduate students in the research group for more information. Finally, students should return to their faculty advisor for an impartial discussion of the proposed research. If you are hoping to do research in *your* advisor's lab, you may request an appointment with either Professor Kermis or Professor Ostermeier for this impartial discussion.

Student Organizations (AIChE)

The American Institute of Chemical Engineers (AIChE) student chapter is an organization that eases the transition from the undergraduate learning stage to the actual practice of chemical and biomolecular engineering and promotes the professional development of the students through association with practicing engineers. Social activities include two picnics, one in the fall and one in the spring, a holiday party, and a graduation reception. AIChE also organizes tours of local plants and arranges for speakers to discuss topics such as what to expect at graduate school, and the role of the chemical/biomolecular engineer in industry. For more information, please see the AIChE chapter webpage (www.jhu.edu/chbe/aiche) or email at aiche@jhu.edu.

How to get an internship

The AIChE student group has written the following tips, to assist students in securing an internship:

1. Resume – Spend some time working on your resume. Have it critiqued, numerous times. The career center, professors, and parents are good resources. Get lots of opinions and then decide what will work best for you.
2. Start Early – Start surfing the net in October/November to figure out what sort of companies and positions are out there and interest you. Don't limit yourself to any one particular company. Post your resume on companies' web pages, the more, the better. Also, post your resume on Monstertrak and other Job Search web pages. SWE has one.
3. Practice Interviews – The career center offers these in the fall semester. Take advantage of them. They are real companies that recruit on campus and will give you great feedback on how to improve your interviewing style. Send thank you emails.
4. Work your Connections – Talk to professors, deans, parents, relatives, friends, etc. Hopkins has a great alumni network (check out the career center web page).

5. Go to EVERYTHING – Go to any and every employer showcase, informational session, job fair, alumni panel, etc. that you can. You never know when you might learn something or meet someone.
6. Use Hopkins Resources – The career center has a job/internship database, but the best database is through the Whiting School of Engineering. http://www.wse.jhu.edu/student_opportunities/ Email kuria@jhu.edu to obtain the password. There are TONS of industry and academia listings. Email them, call them, do whatever you have to. Show interest. Follow up. Be annoying in a very nice, polite kind of way.
7. Visit Monstertrak Regularly – Some companies recruit on campus. This is your best bet for an internship because they are seeking Hopkins students specifically. Submit your resume to as many as you can…even if you're not all that interested because the interview practice is always good. This web page gets updated a lot so check often for new companies, etc. Companies usually don't start interviewing for internships until after January. Don't forget to send thank you emails!
8. Don't Forget REU Programs! – Almost every large college/university has some sort of REU – Research Experience for Undergrads – Apply! The deadlines are usually Feb/March/April so start writing essays over Intercession. You do get paid, and usually free housing!
9. Don't panic – Most companies don't start offering summer positions until mid-March through the end of April and even into May sometimes.

VII - DEPARTMENT CONTACT LIST

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VIII - COURSE LISTING

Required Courses

020.305	Biochemistry
030.101	Intro. Chemistry
030.102	Intro. to Chemistry II
030.105-106	Intro. Chemistry Lab I and II
030.205	Organic Chemistry I
030.307	Physical Chemistry Lab III
110.108-109	Calculus I and II
110.202	Calculus III
110.302	Differential Equations with Applications (or 550.303)
171.101-102	General Physics I, II
173.111	General Physics Lab I
540.101	Chemical and Biomolecular Engineering in the Workplace: Biotechnology, Nanotechnology and Beyond
540.202	Intro to Chemical and Biological Process Analysis
540.203	Engineering Thermodynamics
540.204	Applied Physical Chemistry
540.301	Kinetic Processes
540.303	Transport Phenomena I
540.304	Transport Phenomena II
540.306	Chemical and Biological Separations
540.311	Chemical Engineering Lab
540.314	Chemical and Biomolecular Product and Process Design
540.409	Modeling Dynamics and Control for Chemical and Biological Systems
540.490	Chemical and Biomolecular Lab Safety and Ethics

Additional / Alternate Required Courses of the Molecular and Cellular Bioengineering Concentration

020.306	Cell Biology
020.315*	Biochemistry Lab
020.316*	Cell Biology Lab
540.313†	Chemical and Biomolecular Engineering Lab

*these two course are required in place of 030.307 Physical Chem. Lab III
† this course is required in place of 540.311 Chemical Engineering Lab

Additional Required Courses of the Interfaces and Nanotechnology Concentration

030.452	Materials and Surface Characterization

Approved Advanced Chemistry and Biology Electives*

030.206	Intermediate Organic Chemistry
030.225	Intro. Organic Chem Lab
030.228	Intermediate Organic Lab
030.302	Physical Chemistry II
030.356	Advanced Inorganic Lab
030.425	Advanced Mechanistic Organic Chemistry I
030.449	Chemistry of Inorganic Compounds
030.451	Spectroscopy
030.452	Materials and Surface Characterization
020.315	Biochemistry Lab
020.306	Cell Biology
570.443	Aquatic Chemistry
270.341	Crystallography
540.427	Intro. to Polymer Science
580.423-424	Phys. Found Lab (both semesters=1course)
020.316	Cell Biology Lab

*Other courses with significant advanced chemistry content may also be acceptable, but must be approved by your advisor and the director of undergraduate studies. Note that courses in which there is significant overlap of content with required courses are not acceptable advanced chemistry or chemistry-related electives.

Approved Engineering Electives

Approved engineering electives include the courses listed directly below as well as those approved as Bioengineering or Interfaces and Nanotechnology electives that are listed further below.

Other courses with significant engineering content may also be acceptable, but must be approved by your advisor and the director of undergraduate studies. Note that courses in which there is significant overlap of content with required courses are not acceptable engineering electives.

Students should be aware that some elective courses are not offered every year or may not be offered for several years.

510.311	Structures of Materials
510.313	Mechanical Properties of Materials
510.314	Electronic Properties of Materials
510.401	Materials in Service
510.402	Structural Materials Engineering
510.403	Materials Characterization
510.405	Materials Physics
520.142	Digital System Fundamentals
520.219-220	Fields, Matter, and Waves
530.352	Materials Selection

530.405	Mechanics of Solids and Structures
540.427	Introduction to Polymer Science
545.475	Spectroscopic and Analytical Methods
560.206	Engineering Mechanics of Solids
570.301	Environmental Engineering I: Fundamentals
570.302	Environmental Engineering II: Water and Wastewater Treatment
570.304	Environmental Engineering and Science
570.305	Environmental Engineering Systems Design
570.411	Engineering Microbiology
570.443	Aquatic Chemistry
570.491	Hazardous Waste Management

With instructor's permission, students with a good academic record also can take the following graduate courses as engineering electives:

540.621/622	Advanced Thermodynamics I, II
540.623	Phase Equilibria
540.624	Applied Statistical Thermodynamics
540.642	Advanced Chemical Kinetics and Reactor Design
540.651	Advanced Transport Phenomena

Approved Bioengineering Electives

Students should be aware that some bioengineering elective courses are not offered every year or may not be offered for several years.

Other courses with significant bioengineering content may also be acceptable, but must be approved by your advisor and the director of undergraduate studies. Note that courses in which there is significant overlap of content with required courses are not acceptable as bioengineering electives.

510.316	Biomaterials I
510.407	Biomaterials II
510.420	Topics in Biomaterial Science
540.426	Biomolecular Materials
510.431	Biocompatibility of Materials
530.410	Biomechanics of the Cell and Organisms
530.440	Computational Mechanics of Biological Macromolecules
530.445	Introductory Biomechanics
530.446	Experimental Biomechanics
530.496	Micro/Nanoscience and Biotechnology
540.402	Cellular and Molecular Biotech. of Mammalian Systems
540.404	Therapeutic and Diagnostic Colloids in Biological Fluids
540.441	Cellular Engineering
540.442	Advanced Topics in Biochemical Kinetics
540.426	Introduction to Biomacromolecules
540.431	Biochemical Engineering/Biotechnology
540.433	Engineering Aspects of Controlled Drug Delivery
540.436	Metabolic Engineering

540.437	Application of Molecular Evolution to Biotechnology
540.451	Cell and Tissue Engineering Laboratory
540.458	Biochemical Engineering of Medicinal Plants
540.460	Design of Biological Molecules and Systems
540.462	Polymer Synthesis and Biomaterial Applications
570.411	Environmental Microbiology
570.446	Biological Processes for Water and Wastewater Treatment
580.420	Build a Genome
580.421	Systems Bioengineering
580.425	Ionic Channels in Excitable Membranes
580.426	Calcium Signals in Biological Systems
580.430	Cardiovascular Systems Mechanics
580.435	Bioelectromagnetic Phenomena
580.439	Models of the Neuron
580.440	Cellular and Tissue Engineering
580.438	Cell Mechanics and Motility
580.439	Models of Physiological Processes in the Neuron
580.440	Biomedical Polymers
580.444	Biocompatibility of Materials
580.450	Mechanics of Living Tissues
580.455	Introduction to Orthopaedic Biomechanics
580.460	Physiological Fluid Mechanics

With instructor's permission, students with a good academic record also can take the following courses as bioengineering electives:

540.630	Thermodynamics and Statistical Mechanics for Chemical and Biomolecular Systems
540.652	Fundamental of Biotransport Phenomena

Approved Interfaces and Nanotechnology Electives

Students should be aware that some interfaces and nanotechnology elective courses are not offered every year or may not be offered for several years.

Other courses with significant content related to interfaces and nanotechnology may also be acceptable, but must be approved by your advisor and the director of undergraduate studies. Note that courses in which there is significant overlap of content with required courses are not acceptable as interfaces and nanotechnology electives.

360.404	Interfacial Phenomena in Nanostructure Materials
510.311	Structures of Materials
510.404	Micro- and Nano-Structured Materials and Devices
530.495	Microfabrication Laboratory
530.496	Micro/Nanoscience and Biotechnology
540.424	Novel Methods in Micro and Nanofabrication
540.434	Engineering Aspects of Controlled Drug Delivery
540.438	Interfacial Phenomena in Nanotechnology
540.440	Micro to Nanotechnology
540.473	Interfacial Phenomena

IX - 2007-2008 ACADEMIC CALENDAR

2007–2008 Academic Calendar for the Krieger School of Arts & Sciences and the G.W.C. Whiting School of Engineering

2007	
August 31 - September 4	Orientation for all new undergraduates
September 3	Labor Day—classes suspended
September 4–5	In-person registration for graduate students
September 6	**First day of classes**
October 15	Fall Break Day—classes suspended
November 12–21	Undergraduate registration for spring term
November 22–25	Thanksgiving Vacation
December 10	Last day of classes
December 11–12	Reading period
December 13–20	Final examination period
December 21–January 6	Mid-year Vacation
2008	
January 7 –25	Intersession
January 21	Observance of Martin Luther King's birthday; No Intersession classes
January 24–25	In-person registration for graduate students
January 28	**First day of classes**
March 17–23	Spring vacation
April 14–25	Undergraduate registration for fall term
May 2	Last day of classes
May 5–7	Reading period
May 8–15	Final examination period
May 22	University Commencement

X – DEGREE CHECKLISTS

Degree checklists (as Excel spreadsheets) can be found online at:

http://www.jhu.edu/~cheme/undergraduates/undergraduate.asp

Be sure and use the checklist appropriate for when you matriculated to Hopkins and for the concentration you are fulfilling (if you are fulfilling a concentration).