Undergraduate Advising Manual

Students Entering the Program Fall 2008 or later

(version: September 2011)

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 a Bachelor of Science degree in Chemical and Biomolecular Engineering accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

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 final checklist audit form.

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 take a chemistry course on Material and Surface Characterization and electives on interfaces and nanotechnology such as Interfacial Science, Colloids and Nanoparticles, Micro- and Nanotechnology. An example program that includes the I/N concentration is listed on page 12 and the program requirements are specified on page 16.

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 Biochemistry Laboratory 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 11 and the program requirements are specified on page 16.

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 22.

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 of our recent graduates are now part of:

JHU ChemBE BS/MSE Program
Officer in the Navy
MSEM Program at JHU
Medical School
Accenture
MS/PhD Rice University in Applied Physics
Biomedical Engineering PhD at Boston University
Dental School
MedImmune
PhD in Bioengineering at MIT
Merck Gardsasil Manufacturing Plant
Masters in Environmental Engineering
PhD Chemical Engineering University of Delaware
Catalent Pharma Solutions
ChemBE PhD at Princeton
Microbiology PhD Student at Northeastern
Booz Allen Hamilton
Masters in Epidemiology at University of South Florida
JHU BCMB PhD Program
Hydrocarbon Publishing Company
Abbott Labs- LIMS Architect

II – PROGRAM MISSION AND OBJECTIVES

Our mission is to define and educate a new archetype of innovative and fundamentally-grounded engineer at the undergraduate and graduate levels through the fusion of fundamental chemical engineering principles and emerging disciplines. We will nurture our passion for technological innovation, scientific discovery, and leadership in existing and newly created fields that cut across traditional boundaries. We will be known for developing leaders in our increasingly technological society who are unafraid to explore uncharted engineering, scientific, and medical frontiers that will benefit humanity.

The Department of Chemical and Biomolecular Engineering offers courses and training culminating in the Bachelor of Science degree in Chemical and Biomolecular Engineering . The undergraduate program emphasizes the molecular science aspects of chemical engineering and biology, in concert with engineering concepts essential to developing commercial products and processes. By selecting an appropriate concentration or by choice of free electives, students can prepare for a professional career path or for further study in chemical, biomolecular, or a related engineering field as well as medical, law, or business school. Two concentrations are available to students: Interfaces and Nanotechnology (I&N) and Molecular and Cellular Bioengineering (MCB). 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.

Recent graduates of the ChemBE program will attain within a few years of graduation:

(1) careers in industrial, academic, or government organizations related to chemical, physical, and life sciences and engineering, and/or pursue graduate or professional education;

(2) positions in which they apply their chemical and biomolecular engineering skills to solve diverse traditional and emerging problems in the workplace.

Our students attain these objectives by following the curriculum presented in this Undergraduate Manual. At the completion of the program, our graduates demonstrate:

i. the ability to apply the fundamentals of chemistry, biology, mathematics and physics to chemical and biomolecular engineering practice.
ii. the ability to utilize chemical and biomolecular engineering principles to identify, formulate, and solve problems at the interface of engineering, chemistry, and biology.
iii. the proficiency in the application of these principles to the design of products and processes, within realistic societal and engineering constraints.
iv. the ability to design, conduct, and evaluate experiments, including the analysis and interpretation of data.
v. the ability to use the techniques, skills, and tools for modern engineering practice.
vi. a recognition of the importance of, and the ability to engage in life-long learning.
vii. the knowledge of emerging applied science within chemical and biomolecular engineering, attained through electives and/ or research.
viii. the ability to communicate in writing with technical and non-technical audiences.
ix. the ability to give effective oral presentations.

x. the ability to work effectively independently and in multidisciplinary teams.
xi. an awareness of contemporary issues which have an impact on the discipline of chemical and biomolecular engineering.
xii. an understanding of the global societal impact of chemical and biomolecular engineering.
xiii. an appreciation of the professional and ethical responsibilities of chemical and biomolecular engineers.

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. Students and advisors agree on courses for the semester, and then both sign an updated degree planning checklist. 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 10-12) show *suggested examples* 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 page 13) 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/chembe/undergraduate-programs/index.html. 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 Student Handbook" should be consulted for details regarding University requirements, grading options, independent study, etc (Undergraduate Student Handbook). In addition, freshmen should refer to " Engineering 101, Program Planning Guide for First-Year Engineering Students" published by the Whiting School of Engineering (WSE). This guide contains additional information about academic policies, advanced placement credits, resources and opportunities for students, etc.

Course Guides and Evaluations

The university maintains online guides in which course evaluations are compiled: the Undergraduate Academic Course Evaluation (ACE) Guide Merlin ((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 2008 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 Engineering Today	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	3
110.302	Differential Equations with Applications	4
020.306	Cell Biology	4
Undesignated Electives		3
	Total	17

Junior Year / Fall

540.204	Applied Physical Chem.	3
540.304	Transport II	4
	Ph Chem or Biochem Laboratory **	3 or 2
540.305	Modeling and Stat Analysis for ChemBE.	3
H/S Elective		3
	Total	15-16

Junior Year / Spring

540.301	Kinetic Processes	3
540.306	Chemical & Biological Separations	3
661.315	The Culture of the Engineering Profession	3
Undesignated Elective		3
Advanced Chemistry Elective		2 or 3
	Total	14 -15

Senior Year / Fall

540.311	Chemical Engineering Lab	6
540.409	Modeling Dynamics & Control for Chemical and Biological Systems	4
H/S Elective		3
Engineering Elective		3
	Total	16

Senior Year / Spring

540.314	Chemical and Biomolecular Process Design	4
Engineering Elective		3
H/S Elective		3
Undesignated Electives		5 or 7
	Total	15-17

*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.

**Students with no concentration have to choose one of the following labs: 030.307 Physical Chemistry Instrumentation Lab III or 020.315 Biochemistry Lab

Example Program: Chemical and Biomolecular Engineering Degree
Molecular and Cellular Bioengineering Concentration
Students entering Fall 2008 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 Engineering Today	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	3
110.302	Differential Equations with Applications	4
020.306	Cell Biology	4
Undesignated Electives		3
	Total	17

*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	Biochem Laboratory	2
540.305	Modeling and Stat Analysis for ChemBE.	3
H/S Elective		3
	Total	15

Junior Year / Spring

540.301	Kinetic Processes	3
540.306	Chemical & Biological Separations	3
661.315	The Culture of the Engineering Profession	3
Undesignated Elective		3
Advanced Chemistry Elective		2 or 3
	Total	14 -15

Senior Year / Fall

540.313	Chemical Engineering Lab	6
540.409	Modeling Dynamics & Control for Chemical and Biological Systems	4
H/S Elective		3
Bioengineering Elective		3
	Total	16

Senior Year / Spring

540.314	Chemical and Biomolecular Process Design	4
Bioengineering Elective		3
H/S Elective		3
Undesignated Electives		6 or 7
	Total	16 -17

Example Program: Chemical and Biomolecular Engineering Degree
Interfaces and Nanotechnology Concentration
Students entering Fall 2008 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 Engineering Today	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	3
110.302	Differential Equations with Applications	4
020.306	Cell Biology	4
Undesignated Electives		3
	Total	17

*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
	Ph Chem or Biochem Laboratory **	3 or 2
540.305	Modeling and Stat Analysis for ChemBE.	3
H/S Elective		3
	Total	15-16

Junior Year / Spring

540.301	Kinetic Processes	3
540.306	Chemical & Biological Separations	3
661.315	The Culture of the Engineering Profession	3
Undesignated Elective		3
H/S Elective		3
	Total	15

Senior Year / Fall

540.311	Chemical Engineering Lab	6
540.409	Modeling Dynamics & Control for Chemical and Biological Systems	4
030.452	Mat.and Surf. Charact.	3
I/N Engineering Elective		3
	Total	16

Senior Year / Spring

540.314	Chemical and Biomolecular Process Design	4
I/N Engineering Elective		3
H/S Elective		3
Undesignated Electives		5 or 6
	Total	15-16

**Students with I/N concentration have to choose one of the following labs: 030.307 Physical Chemistry Instrumentation Lab III or 020.315 Biochemistry Lab

IV – DEGREE CHECKLISTS

Degree checklists (as Excel spreadsheets) can be found online at:
JOHNS HOPKINS UNIVERSITY - DEPARTMENT OF CHEMICAL AND BIOMOLECULAR ENGINEERING

V - 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, 540.305, 540.306, 540.311 (or 540.313), 540.314, 540.409, and 540.490 (see page 27 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 and a waiver form. 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 28). Students that have had 540.101 waived as a requirement will have additional "other engineering" credit requirements as discussed above. 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 four courses (12 credits) are required, three lectures 020.305, 030.205, 020.306, and one laboratory course (030.307 or 020.315). The required lab course must be either Physical Chemistry Instrumentation Laboratory III, 030.307 or

Biochemistry Laboratory, 020.315. *Students that are concentrating in Molecular and Cellular Bioengineering must take the Biochemistry Lab, 020.315.* Students are required to take at least two additional credits beyond these required courses. Students should meet with their advisor to discuss which courses are most appropriate for their educational objectives. These courses must be chosen from the 030 or 020 codes (280 does not qualify) and should be at the 200 level minimum. 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, and 540.204). A list of approved advanced chemistry and biology electives is found on page 29. 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).

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. For example, a course in Linear Algebra can be used to satisfy this requirement.

Writing Skills

The university requires that two courses designated as a W be taken to graduate and that these two courses be completed with a grade of C or better.

1. One of the two W courses may be any course with a W designation except for 540.311 and 540.313.
2. The second W course must be The Culture of the Engineering Profession (661.315), a requirement for the laboratory and design courses of senior year.

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 courses in at

least two subject areas in addition to writing and communication. At least one of these H/S courses must be an advanced level course at the 300-level or higher. 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. Note that most Music courses do not have an H/S designation. 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:

180.334 Econometrics
200.314 Advanced Statistical Methods
660.203/204 Financial Accounting
660.300 Managerial Finance
660.401 Advanced Corporate Finance

It is not the purpose of this rule to discourage 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.

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 pursuing a degree in Chemical and Biomolecular Engineering have the option of concentrating in two specific fields, Interfaces and Nanotechnology or Molecular and Cellular Bioengineering. Students completing a concentration will have this fact designated

on their final checklist audit form. These concentrations have additional and/or alternate requirements, as described below.

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 page 30 for a list of approved electives.

Molecular and Cellular Bioengineering (MCB) Concentration

Students must fulfill the following requirements:

1. The Advanced Chemistry and Biology laboratory requirement is fulfilled with 020.315 (Biochemistry Lab).
2. Six credits of bioengineering electives are required. See page 29 for a list of approved courses.
3. Students must take 540.313 Chemical and Biomolecular Engineering Lab instead of 540.311 Chemical Engineering Lab.

Pre-Professional Preparation Requirements

Choosing an initial career path and then working toward making it a reality are two very important steps that Chemical & Biomolecular Engineering students will take while at Hopkins. Basic information on preparation for a career and job hunting is available at the Career Center. In addition, the Chemical and Biomolecular Engineering department career network provides regular e-mails on internships and job information. To increase students' chances of success in the future, key elements on how to prepare for career development have been incorporated into the curriculum. The required tasks become a component of 540.101, 540.303, 540.304 and 540.409.

The steps described below are required for successful completion of the pre-professional preparation.

1. Required for 540.101 Chemical & Biomolecular Engineering Today (Freshmen Year Fall):
   Attend the workshop ***"Resumes and Cover Letters: The Basics"*** (presented in class).Write a resume and have it critiqued by the career center.
2. Required for 540.303 Engineering Thermodynamics (Sophomore Year Fall or Spring).
   Log into your Career Center J-Connect account and complete your profile. Highly recommended to attend one event during the Career Center's "Internship Extravaganza" and/or the workshop ***"Starting Your Internship Search"***
3. Required for 540.304 Transport II (Junior Year Fall).

Update your resume and have it critiqued by the career center. Attend the workshop ***"Interviews: Practical Tips to Market Your Skills."***
Also this year, consider getting a head-start on senior-year preparation by taking a Mock Interview.

4. Required for 540.409 Modeling, Dynamics and Control for Chemical and Biological Systems (Senior Year Fall).
   Update your resume and cover letter and have them critiqued by the Career Center.
   Take a Mock Interview at the Career Center (if not completed during Junior Year).

The faculty strongly recommends that all students also do the following:

a) Join the Hopkins ChemBE Professional Networking Group at http://www.linkedin.com/groups?gid=46097.

b) Attend the AIChE/SBE and ChemBE Career Network pre-professional events.

c) Take full advantage of the Career Center at Johns Hopkins, including attending the ***"Starting Your Job Search"*** Workshop

d) Read emails sent by the Hopkins ChemBE Career Network (HCCN), and visit the HCCN blog for more internship and job information.

Rules and Limitations

Grade Requirements

Students 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, 540.305, 540.306, 540.311 (or 540.313), 540.314, 540.409. Students with a ChemBE GPA of 3.6 will automatically receive Department Honors on their Official Transcript at graduation (no application required).

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 Director of Undergraduate Studies, 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 will serve as undesignated credit (i.e. towards the total 128 credit minimum).

Students who wish to use research credits to fulfill their engineering elective or concentration elective requirements must complete the Research Credit Elective Request form on the ChemBE undergraduate website and submit it to the Academic Program Coordinator.
(http://www.jhu.edu/chembe/undergraduate-programs/docs/Research_Credit_Elective_Request.pdf). Once the request is evaluated, the student and faculty advisor will be notified of the final decision.

Students doing research in the ChemBE department can earn their four credits of research two ways. They can sign up for Undergraduate Research or they have the opportunity to sign up for a Special Topics course offered by their Research Professor. Students who signs up for a Special topics course for one semester cannot receive any other research credits that semester. They will receive three credits for attending the Special Topics class and simultaneously continuing their research work. For that semester, the Special topics course credits will count as research credits automatically.

Thus the four credits allowed to fulfill the engineering elective requirements can consist of four credits of Undergraduate Research over a few semesters or, of three credits from the appropriate Special Topic course plus one credit of Undergraduate Research from another semester.

For further information about participating in Undergraduate Research, see page 24.

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 cannot 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 studies, can allow up to four credits of technical electives and up to two courses of H/S courses to be taken pass/fail. The student and his/her advisor fill out the Waiver and Substitution Form on the ChemBE Undergraduate Website (http://www.jhu.edu/chembe/undergraduate-programs/docs/ReqWaiver.pdf). The form must be delivered to the Academic Program Coordinator for approval.

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 Director of Undergraduate Studies. Student and advisor fill out the Waiver and Substitution Form on the ChemBE Undergraduate Website (http://www.jhu.edu/chembe/undergraduate-programs/docs/ReqWaiver.pdf). The form must be delivered to the Academic Program

Coordinator for approval. The approved waiver form will be placed in the student's departmental file, the student will receive an e-mail notice of the approval.

VI – OPTIONS AVAILABLE IN CHEMICAL AND BIOMOLECULAR ENGINEERING

Minors

Minors are available in various departments.

For example, one 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 dogeeundergradminor@jhu.edu.

A minor in Entrepreneurship and Management is offered by the Center for Leadership Education. (http://web.jhu.edu/Leadership/html/entrepreneurship_program.html). Or contact:

Pam Arrington
104 Whitehead Hall
410-516-6741
Parring2@jhu.edu

Cooperative Program

Department of Chemical and Biomolecular Engineering allows students to join 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. The department helps to identify potential employers with internship opportunities through the Hopkins ChemBE Career Network, however, students are responsible for obtaining an offer from a suitable employer. Students successfully completing a cooperative program receive a notation on their transcript. Interested students should contact their academic advisor and Prof. Gray, Director of the ChemBE Career Network.

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 fifty percent waiver after the completion of 8 semesters or having received the Bachelor of Science for Students who qualify academically.

Admission decisions to the ChemBE BS/MSE program are made on a variety of criteria including undergraduate GPA. Students are expected to have an undergraduate GPA of at least 2.8 (and preferably higher) in order to be admitted to the BS/MSE program.

Applicants for the BS/MSE Concurrent program must:

1. Visit http://www.grad.jhu.edu/bachelors-masters/requirements.php for full information regarding the application process and financial aid/Dean's Masters Fellowship.

2. Consult with their advisor to see if/when they should apply. If applying to the 10-course MSE they should consult their Academic Advisor. If applying to the 6-course program with essay they should consult their Lab Advisor or proposed MS Research Advisor. Students should apply BEFORE their final semester as a senior and can apply as early as before the start of their senior year (as final semester juniors). The concurrent status MUST be in place before the start of the 8th /final semester of undergraduate study.

3. Inform the ChemBE Academic Program Coordinator that they will be applying for the concurrent program. The Program Coordinator will then supply you with detailed instructions.

4. Apply online through "Apply Yourself" www.grad.jhu.edu , following all instructions from the Program Coordinator.

5. There are no GRE requirements

6. The TOEFL is waived for international students

7. BS/MSE Concurrent applicants are not subject to the official January 5th deadline but applicants are encouraged to apply as early as possible. Students should apply BEFORE their final semester as a senior and can apply as early as before the start of their senior year (as juniors). The concurrent status MUST be in place before the start of the 8th /final semester of undergraduate study. No application will be accepted after May 1, as a student cannot graduate with their BSE and apply to the BS/MSE Concurrent program simultaneously. At that point, a student would be simply applying to the MSE program.

8. Once a student is successfully enrolled in the BS/MSE Concurrent program, they will have to consult with their advisor and inform the Academic Program Coordinator when they are ready to switch to graduate status. Please see the instruction sheet as supplied by the academic program coordinator for full details.

Contact the Academic Program Coordinator for more information:

Caroline Qualls
Academic Program Coordinator
Johns Hopkins University
Department of Chemical and Biomolecular Engineering
Whiting School of Engineering
3400 N. Charles Street
Baltimore, MD 21218
Maryland Hall 223
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Double Counting Policy

The Whiting School of Engineering 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. http://engineering.jhu.edu/graduate-double-counting/"

Students pursing both their undergraduate and masters degrees in ChemBE at JHU should be aware of the departments rules on double counting courses. Up to two courses can be counted for both degrees. For classes offered at both the 400- and 600-level, students MUST take the course at the 600-level to apply the course to their masters degree. Thus, the ChemBE graduate program's policy on double-counting courses is stricter than the WSE policy found above.

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)

Most 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) (d) cell biology lab (030.316) and (e) 6 credits of humanities, social sciences or behavioral science. 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).

VII - OTHER RESOURCES AND OPPORTUNITIES FOR STUDENTS:

Undergraduate Research

Many undergraduate students are involved in research. They can find opportunities to work in research laboratories in the ChemBE department or in other programs at Hopkins. Students often begin research in the sophomore year. By this time, they have completed a few 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 webpage's and publications and (ii) make appointments to talk to faculty members whose research interests you. Contact the faculty member in order to learn more about their research and to find out if there is an opening in their lab. Include a resume and any useful information in your application. 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 Dahuron or Professor Prakash for this impartial discussion.

To register for research credits, the student must fill out the (yellow) Research Form from the registrar's office. The student and the research professor discuss the expectations of the research project and agree on the nature of the final deliverables (see list on research registration form). They should also clarify how much work (time) is expected for one credit of research.

Students can follow the same process to pursue research projects in other departments. If the laboratory belongs to the WSE, the student can receive research credits and a grade by signing up under the ISIS course number for the Professor or Principal Investigator of the research lab. If the laboratory is part of another school (for example the Medical School), the student must consult with his/her faculty advisor to receive research credits and a grade for their research. The advisor must be able to transfer the final research grade from the other school into the WSE. After receiving approval from their advisor, students use the (yellow) Research Form from the registrar's office to sign up under the ISIS course number for their ChemBE advisor. They must inform their advisor of the deliverables and expectations discussed with the research professor. At the end of the semester, students must send an e-mail to their advisor explaining how they met the requirements set by their research professor. It is also the student's responsibility to remind the research professor to send a final grade and number of credits to the advisor. The advisor will then enter this grade in ISIS.

Student Organizations (AIChE/SBE)

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 (http://jhuaiche.org/) or email at jhu.aiche.sbe@gmail.com.

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 September/October to figure out what sort of companies and positions are out there and interest you. Don't limit yourself to any one particular company. Visit their web sites regularly, specifically their career pages, to review and apply to positions. Go to J-connect to find out what is available.
3. Practice Interviews – The career center offers these in the fall semester. Take advantage of them. There 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 and the HCCN web pages).
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. Email them, call them, do whatever you have to. Show interest. Follow up. Be annoying in a very nice, polite kind of way.
7. 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. 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
020.306	Cell Biology
020.315	Biochemistry Laboratory*
030.101	Intro. Chemistry
030.102	Intro. to Chemistry II
030.105-106	Intro. Chemistry Lab I and II
030.205	Organic Chemistry I
020.315	Biochemistry Lab
030.307	Physical Chemistry Lab III*
110.108-109	Calculus I and II
110.202	Calculus III
110.302	Differential Equations with Applications
171.101-102	General Physics I, II
173.111	General Physics Lab I
540.101	Chemical and Biomolecular Engineering Today
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
540.305	Modeling and Statistical Analysis of Data for ChemBE
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
661.315	Culture of the Engineering Profession

(*students must choose one of these two laboratory courses)

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

020.315	Biochemistry Lab
540.313†	Chemical and Biomolecular Engineering Lab

† 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
020.316* Cell Biology Lab
020.312 Introduction to the Human Brain

*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
540.447	Advanced Problems in Fluid Mechanics
545.475	Spectroscopic and Analytical Methods
550.310	Probability and Statistics for the Physical Sciences and Engineering
550.311	Probability and Statistics for the Biological Sciences and Engineering
560.206	Solid Mechanics and Theory of Structures
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

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.

500.410	Surgery for Engineers
510.316	Biomaterials I
510.407	Biomaterials II
510.430	Biomaterials Lab
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
540.402	Cellular and Molecular Biotechnology
540.414	Computational Protein Structure
540.426	Biomacromolecules at the Nanoscale

540.428	Supramolecular Materials and Nanomedicine
540.437	Application of Molecular Evolution to Biotechnology
540.449	Logic and Decision-making in Biomolecular Systems
540.459	Bioengineering in Regenerative Medicine
570.411	Environmental Microbiology
570.446	Biological Processes for Water and Wastewater Treatment
580.311/312	Design Team – Junior
580.411/412	Design Team – Senior
580.421	Physiological Foundations I
580.425	Ionic Channels in Excitable Membranes
580.435	Bioelectromagnetic Phenomena
580.439	Models of Physiological Processes in the Neuron
580.441	Cellular Engineering
580.448	Biomechanics of Cells and Organisms
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	Fundamentals 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.

510.311	Structures of Materials
510.404	Micro- and Nano-Structured Materials and Devices
510.421	Nanoparticles
530.495	Microfabrication Laboratory
540.403	Colloids and Nanoparticles
540.415	Interfacial Science with Applications to Nanoscale Systems
540.426	Biomacromolecules at the Nanoscale
540.428	Supramolecular Materials and Nanomedicine

540.438	Interfacial Phenomena in Nanotechnology
540.440	Micro to Nanotechnology