JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

DEPARTMENT OF Chemical & Biomolecular ENGINEERING

Undergraduate Advising Manual

Students Entering the Program Fall 2023

(Version: August 2023)

https://engineering.jhu.edu/chembe/

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I – INTRODUCTION

Welcome to the Department of Chemical and Biomolecular Engineering (ChemBE)!

The ChemBE department offers courses and training culminating in a Bachelor of Science degree in Chemical and Biomolecular Engineering. In addition to their B.S. degree, students may choose to pursue an optional track of Molecular and Cellular Bioengineering (MCB) or Interfaces and Nanotechnology (IN).

1. What is Chemical and Biomolecular Engineering?

Chemical and Biomolecular Engineering is dedicated to the study and design of chemical, biological, and physical phenomena, with an ultimate goal of the betterment of society. As a result of the scope and breadth of this rigorous undergraduate program, our students commonly secure employment in industries such as chemical, pharmaceutical, biotechnology, materials, food, energy, and consumer goods. Graduates may embark on a career to design and manufacture technologies such as:

Novel polymers and materials	Biopharmaceuticals
Biofuels	Drugs and Vaccines
Gene Therapy Products	Drug Delivery Devices
Cells and Tissues	Semiconductors
Nanodevices	Food and Beverage
Cosmetics	Petroleum

The demands on the modern engineer are high, and graduates must possess a wide range of skills in order to be competitive in the global market. The ChemBE program successfully satisfies these demands. Students take advanced courses in Chemistry, Physics, Mathematics, and Biology. Additionally, students are trained in Thermodynamics, Transport, Kinetics, and Separations, which are essential to solving real-world engineering problems. Students also hone their professional and communication skills (report writing, oral presentations, and teamwork) in courses involving experimental projects, process design and product design.

Depending on their interests and future career goals, students can choose electives from exciting areas including green engineering, nanotechnology, and bioengineering. These courses, along with undergraduate research opportunities offered by our faculty, are designed to prepare graduates for careers in chemical engineering. The curriculum also offers an outstanding foundation for advanced graduate studies in Chemical and Biomolecular Engineering, Biomedical Engineering, Materials Engineering, or for medical, law, or business school. The BS program in in Chemical and Biomolecular Engineering is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org, under the General Criteria and the Program Criteria for Chemical, Biochemical, Biomolecular, and Similarly Named Engineering Programs.

2. Tracks

Students have the opportunity to develop a more in-depth specialty in two areas within Chemical and Biomolecular engineering. Our two tracks are Molecular and Cellular Bioengineering (MCB) and Interfaces and Nanotechnology (IN). Students completing a track will have this fact designated on their final checklist audit form.

Interfaces and Nanotechnology (IN) Track

Interesting and new physics exist at nanometer length scales, as the surface area of an object begins to approach and exceed its volume. In this track, students are trained in the fundamental sciences used to solve problems in nanotechnology and interfacial science.

Molecular and Cellular Bioengineering (MCB) Track

The fields of biotechnology and medicine often involve processes at the biological, cellular, and molecular levels. Common areas utilizing skills in the MCB track include the genetic manipulation of cells for protein and vaccine production, and the study and treatment of diseases such as arteriosclerosis and cancer.

3. Graduate or Professional Schools

Graduate School

Many of our graduates pursue advanced degrees in Chemical Engineering, Environmental Engineering, Biomedical Engineering or Bioengineering. The ChemBE curriculum offers an excellent foundation for MS and PhD programs. Students can elect to take higher level electives in preparation for graduate school during their junior and senior years. The strength of JHU lies in its ability to offer numerous opportunities for undergraduate research throughout the university. Our students often join research laboratories within the ChemBE or other engineering departments, or at the medical school. More information on graduate school can be found on page 25.

Pre-Medical Option

While the Chemical and Biomolecular Engineering degree provides excellent preparation for medical school, each medical school has its own admissions standards. The pre-medical option requires a few courses not required in the Chemical and Biomolecular Engineering program. As a result, students may need to take additional courses in order to fulfill requirements of a particular medical school. More information on pre-medical requirements can be found on page 26.

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 students' passions for technological innovation, scientific discovery, and leadership in existing and novel fields that cut across traditional boundaries. We aim to develop 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 track 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. 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.

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

(1) succeed in careers in industrial, academic or government organizations in which they apply their chemical and biomolecular engineering skills to solve diverse long-standing or emerging problems

(2) excel in their graduate program, medical school, or other professional education

(3) be recognized as future leaders in their chosen field

(4) perpetuate the JHU legacy of passion for learning, technical excellence, community service and research innovation to foster knowledge creation, lead discovery, and impact society.

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

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Annual Enrollment Data

Academic Year	Freshman Class	Sophomore Class	Junior Class	Senior Class	Graduates
2017-2018	85	78	88	81	80
2018-2019	113	68	69	9287	87
2019-2020	9088	91	71	73	71
2020-2021	98	82	81	70	68
2021-2022	65	76	75	79	73
2022-2023	91	66	69	82	80
2023-2024	84	97	69	72	TBD

Where are our Chemical and Biomolecular Engineering graduates?

Students graduating from the Department of Chemical and Biomolecular Engineering are prepared for a variety of professional career paths or for further education. Some of our recent graduates are now part of:

Accenture
PhD in Chemical Engineering at U of Pennsylvania
PhD in Chemical Eng or Biotechnology at MIT
PhD in Medical Eng & Medical Physics MIT/Harvard
Epic Systems
Genentech
Northwestern Feinberg School of Medicine
W.R. Grace
Deloitte
GlaxoSmithKline
Biogen Idec
PhD in Chem Eng at Georgia Institute of Technology
Medical School University of Pennsylvania
Capitol One
Koch-Glitsch
Sabic Innovative Plastics
Naval Surface Warfare Center
Pepsi
PhD in Chemical Engineering at U of Wisconsin
PhD Stanford University
McCormick & Co, Inc
Merck&Co
PhD in Chemical Engineering at Princeton University
GEA Systems (Columbia MD)
Johns Hopkins Medical Institutions
NIH
Apple
Procter and Gamble
Trane

Required Courses for the ChemBE Undergraduate Degree Fall 2023

Required Mathematics and Science Courses

020.305 Biochemistry **(3)**
030.205 Organic Chemistry I **(4)**
110.108 Calculus I **(4)**
110.109 Calculus II **(4)**
110.202 Calculus III **(4)**
173.111 General Physics Lab I **(1)**

Chemistry (8 credits)
Option 1: no AP credits, take ALL these courses:
030.101 Intro. Chemistry **(3)**
030.102 Intro. Chemistry II **(3)**
030.105 Intro. Chemistry Lab I **(1)**
030.106 Intro. Chemistry Lab II **(1)**
Option 2: 4 AP credits, take
030.103 Applied Chemical Equilibrium and Reactivity **(4)**
Option 3: 8 AP credits,
requirement is fulfilled (continue to Organic Chemistry)
or for those who want a refresher, take
030.103 Applied Chemical Equilibrium and Reactivity **(4)**

Physics (8 credits)
Option 1: no AP credits, take one of the following course series:
171.101 General Physics I **(4)**
171.102 General Physics II **(4)**
or
171.107 General Physics for Physical Science Majors I **(4)**
171.108 General Physics for Physical Science Majors II **(4)**
Option 2: 4 AP credits, take one of these courses
171.102 General Physics II **(4)**
or
171.108 General Physics for Physical Science Majors II **(4)**
Option 3: 8 AP credits,
requirement is fulfilled

Take one of the following courses (1 to 3 credits):
020.315 Biochemistry Project Laboratory **(1)**
030.225 Introduction to Organic Chemistry Laboratory **(3)**
030.305 Physical Chemistry Instrumentation Laboratory 1 **(3)**
250.253 Protein Engineering and Biochemistry Laboratory **(3)**

Take one of the following courses (4 credits):
110.302 Differential Equations with Applications **(4)**
553.291 Linear Algebra and Differential Equations **(4)**

Required Core ChemBE Courses

500.113 Gateway Computing/Python **(3)**
540.202 Intro to Chemical and Biological Process Analysis **(4)**
540.203 Engineering Thermodynamics **(3)**
540.301 Kinetic Processes **(4)**
540.303 Transport Phenomena I **(3)**
540.304 Transport Phenomena II **(4)**
540.306 Chemical and Biological Separations **(4)**
540.315 Process Design with ASPEN **(2)**
540.409 Modeling Dynamics and Control for Chemical and Biological Systems **(4)**
540.490 Chemical and Biomolecular Lab Safety and Ethics **(1)**
Take one of the following courses for Senior Lab:
540.311 Projects in Chemical Engineering Unit Operations **(4)**
540.313 Projects in Chemical and Biomolecular Engineering Unit Operations **(4)**
Chemical Engineering Laboratory at DTU (Technical University of Denmark) **(4)**

Take one of the following course options for Product Design (3 - 6 Credits)
Option 1: One-semester design (spring)
540.314 ChemBE Product Design (**3)**
Option 2: Two-semester design (two consecutive semesters)
540.309 Product Design Part 1 **(3)**
540.310 Product Design Part 2 **(3)**
Must take both courses to receive credit. 540.309 counts towards core credits; 540.310 counts toward engineering electives
Option 3: WSE two-semester design (two consecutive semesters)
660.345 Multidisciplinary Engineering Design 1 **(3)**
660.346 Multidisciplinary Engineering Design 2 **(3)**
Must take both courses to receive credit. 660.345 counts towards core credits; 660.346 counts toward engineering electives

Required HS Course

661.315 Culture of the Engineering Profession **(3)**

Take Electives to Meet Credit Requirements

128 credits total
48 credits of Engineering (E designation)
16 credits of Mathematics (must be from 110 or 553)
13 credits Advanced Chemistry and Biology
18 H/S credits (must be six courses that are at least 3 credits each)

GPA Requirements

2.0 overall GPA
2.0 GPA in required core ChemBE courses

IV - DEPARTMENTAL ADVISING PROCEDURES

1. Faculty Advisors

Each student in the Chemical and Biomolecular Engineering Department is assigned to a faculty member who acts as their advisor until graduation. Students work with their advisors to plan their programs to reflect individual interests while also ensuring they fulfill program requirements. While advisors are there to provide guidance, it is ultimately the responsibility of the student to complete all of the requirements. Students and advisors agree on courses for each semester by filling out a degree planning checklist together. After both the student and advisor sign off on the checklist, students return the signed version to the Academic Coordinator via email (UGCoordinatorChemBE@jhu.edu). Only then will the Coordinator lift the hold on the student's account in SIS, allowing the student to register on-line. During the semester, lifting the hold will only occur once the student has contacted the advisor and discussed the suggested changes to the course load. See the last page of this manual for faculty contact information. Students can also use the Degree Audit System functionality in SIS to track their requirements and courses as a supplement to their degree planning checklist.

Seniors MUST consult with their advisor before dropping any course at any time during their final year to avoid jeopardizing their chances of graduation. The advisor and the student will make sure that the change will not affect any key requirement in the curriculum nor postpone graduation date in any way.

2. Resources

Manuals and Guides

Students must consult the Johns Hopkins University Undergraduate and Graduate Programs Catalog (ASEN Catalog) for details regarding university requirements, grading options, independent study, etc. 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.

Tracking Program Completion

Students should regularly check their Degree Audit, available in SIS, to ensure that they are fulfilling their degree requirements. The Degree Audit system serves as the method through which seniors are cleared for graduation.

Reference Tools

Two resources are provided in this manual to aid in your course planning. The **sample plans of study** (pages 8 to 11) show *examples* of how program requirements can be fulfilled in four years of study. On these plans, the suggested elective sequence is arranged so that course loads are reasonably balanced but note that they can be adjusted when appropriate. Students might also find the **checklist forms** (see pages 12 - 14) useful as well. They display the same requirements found in the Degree Audit, but in a list format. Some students may find this to be a useful reference tool in addition to the Degree Audit system when meeting with their advisor to monitor their progress towards graduation.

Course Guides and Evaluations

The university manages an online guide in which student evaluations including numerical data and written comments are published for courses offered in the Schools of Engineering and Arts and Science (https://studentaffairs.jhu.edu/registrar/faculty-staff/course-evaluations/). 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.

V EXAMPLE PROGRAMS AND DEGREE CHECKLISTS

Examples of Programs: General Program, MCB Track, I/N Track, General with 12 AP credits

Example Program 1

Chemical and Biomolecular Engineering Degree - General Program

Students entering Fall 2023 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
~~	H/S Elective	3
~~	Optional HEART course or First-Year Seminar	1
	Total	**16-17**

Freshman Year / Spring		
030.102	Intro to Chemistry II	3
030.106	Intro to Chemistry II Lab	1
110.109	Calculus II	4
171.102	General Physics II	4
~~	H/S Elective	3
	Total	**15**

Sophomore Year / Fall		
540.202	Intro to Chemical & Biological Process Analysis	4
~~	Differential Equations with Applications (110.302) or Linear Algebra and Differential Equations (553.291)	4
500.113	Gateway Computing	3
030.205	Organic Chemistry	4
	Total	**15**

Sophomore Year / Spring		
540.203	Engineering Thermodynamics	3
540.303	Transport I	3
110.202	Calculus III	4
~~	H/S Elective	3
	Undesignated Elective	3
	Total	**16**

Junior Year / Fall		
540.304	Transport II	4
~~	Engineering Elective	3
540.490	Introduction to Chemical Process Safety	1
~~	Biochem or Phys Chem or Orgo Laboratory *	1 or 3
020.305	Biochemistry	3
~~	Undesignated Elective	3
	Total	**15-17**

Junior Year / Spring		
540.301	Kinetic Processes	4
540.306	Chemical and Biological Separations	4
661.315	Culture of the Engineering Profession	3
~~	Chem/Bio Elective	3
~~	Undesignated Elective	3
	Total	**17**

Senior Year / Fall		
540.311/313	Projects in ChemBE Unit Operations with Experiments	4
540.409	Dynamic Modeling and Control	4
~~	Engineering Elective	3
~~	H/S Elective	3
~~	Undesignated Electives	3
	Total	**17**

Senior Year / Spring		
540.314	Chemical and Biomolecular Product Design **	3
540.315	ChemBE Process Design Using ASPEN	2
~~	Engineering Elective	3
~~	H/S Elective 300 level	3
~~	Undesignated Electives	6
	Total	**17**

128-131

* Students with no track can choose one of the four labs: 030.225 Introductory Organic Chemistry Lab, 030.305 Physical Chemistry Instrumentation Lab I, 020.315 Biochemistry Project Lab, or 250.253 Protein Engineering and Biochemistry Lab.

** Students may take the 3-credit Product Design course 540.314, the 6-credit Product Design sequence of 540.309 and 540.310, or the 6-credit Multidisciplinary Engineering Design sequence of 660.345 and 660.346.

Example Program 2

Chemical and Biomolecular Engineering Degree - MCB Track

Students entering Fall 2023 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
~~	H/S Elective	3
~~	Optional HEART course or First-Year Seminar	1
	Total	**16-17**

Freshman Year / Spring		
030.102	Intro to Chemistry II	3
030.106	Intro to Chemistry II Lab	1
110.109	Calculus II	4
171.102	General Physics II	4
~~	H/S Elective	3
	Total	**15**

Sophomore Year / Fall		
540.202	Intro to Chemical & Biological Process Analysis	4
~~	Differential Equations with Applications (110.302) or Linear Algebra and Differential Equations (553.291)	4
500.113	Gateway Computing	3
030.205	Organic Chemistry	4
	Total	**15**

Sophomore Year / Spring		
540.203	Engineering Thermodynamics	3
540.303	Transport I	3
110.202	Calculus III	4
~~	H/S Elective	3
	Undesignated Elective	3
	Total	**16**

Junior Year / Fall		
540.304	Transport II	4
~~	Engineering Elective	3
540.490	Introduction to Chemical Process Safety	1
	Biochemistry Laboratory *	1 or 3
020.305	Biochemistry	3
~~	Undesignated Elective	3
	Total	**15-17**

Junior Year / Spring		
540.301	Kinetic Processes	4
540.306	Chemical and Biological Separations	4
661.315	Culture of the Engineering Profession	3
540.307	Cell Biology for Engineers	3
~~	Undesignated Elective	3
	Total	**17**

Senior Year / Fall		
540.313	Projects in ChemBE Unit Operations with Experiments	4
540.409	Dynamic Modeling and Control	4
~~	Bioengineering Elective	3
~~	H/S Elective	3
~~	Undesignated Electives	3
	Total	**17**

Senior Year / Spring		
540.314	Chemical and Biomolecular Product Design **	3
540.315	ChemBE Process Design Using ASPEN	2
~~	Bioengineering Elective	3
~~	H/S Elective 300 level	3
~~	Undesignated Electives	6
	Total	**17**

128-131

* Students with this track can choose one of the two labs: 020.315 Biochemistry Project Lab, or 250.253 Protein Engineering and Biochemistry Lab.

** Students may take the 3-credit Product Design course 540.314, the 6-credit Product Design sequence of 540.309 and 540.310, or the 6-credit Multidisciplinary Engineering Design sequence of 660.345 and 660.346.

Example Program 3

Chemical and Biomolecular Engineering Degree - I/N Track

Students entering Fall 2023 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
~~	H/S Elective	3
~~	Optional HEART course or First-Year Seminar	1
	Total	**16-17**

Freshman Year / Spring		
030.102	Intro to Chemistry II	3
030.106	Intro to Chemistry II Lab	1
110.109	Calculus II	4
171.102	General Physics II	4
~~	H/S Elective	3
	Total	**15**

Sophomore Year / Fall		
540.202	Intro to Chemical & Biological Process Analysis	4
~~	Differential Equations with Applications (110.302) or Linear Algebra and Differential Equations (553.291)	4
500.113	Gateway Computing	3
030.205	Organic Chemistry	4
	Total	**15**

Sophomore Year / Spring		
540.203	Engineering Thermodynamics	3
540.303	Transport I	3
110.202	Calculus III	4
~~	H/S Elective	3
	Undesignated Elective	3
	Total	**16**

Junior Year / Fall		
540.304	Transport II	4
~~	Engineering Elective	3
540.490	Introduction to Chemical Process Safety	1
030.452	Materials and Surfaces	3
020.305	Biochemistry	3
~~	Undesignated Elective	3
	Total	**17**

Junior Year / Spring		
540.301	Kinetic Processes	4
540.306	Chemical and Biological Separations	4
661.315	Culture of the Engineering Profession	3
030.305	Physical Chem Instrumentation Lab 1*	3
~~	Undesignated Elective	3
	Total	**17**

Senior Year / Fall		
540.311/313	Projects in ChemBE Unit Operations with Experiments	4
540.409	Dynamic Modeling and Control	4
~~	I/N Engineering Elective	3
~~	H/S Elective	3
~~	Undesignated Electives	1-3
	Total	**15-17**

Senior Year / Spring		
540.314	Chemical and Biomolecular Product Design **	3
540.315	ChemBE Process Design Using ASPEN	2
~~	/N Engineering Elective	3
~~	H/S Elective 300 level	3
~~	Undesignated Electives	6
	Total	**17**

128-131

* Students with this track must take: 030.305 Physical Chemistry Instrumentation Lab I

** Students may take the 3-credit Product Design course 540.314, the 6-credit Product Design sequence of 540.309 and 540.310, or the 6-credit Multidisciplinary Engineering Design sequence of 660.345 and 660.346.

Example Program 4

Chemical and Biomolecular Engineering Degree - General Program

Students entering Fall 2023 or Later with 12-Credits of Advanced Placement in Chemistry and Math

Freshman Year / Fall		
030.103	Applied Chemical Equilibrium and Reactivity	4
~~	Differential Equations with Applications (110.302) or Linear Algebra and Differential Equations (553.291)	4
171.101	General Physics I	4
173.111	General Physics Lab I	1
~~	H/S Elective	3
~~	Optional HEART course or First-Year Seminar	1
	Total	**16-17**

Freshman Year / Spring		
540.202	Intro to Chemical & Biological Process Analysis	4
110.202	Calculus III	4
171.102	General Physics II	4
~~	H/S Elective	3
	Total	**15**

Sophomore Year / Fall		
540.203	Engineering Thermodynamics	3
500.113	Gateway Computing	3
030.205	Organic Chemistry	4
~~	H/S Elective	3
~~	Undesignated Elective	3
	Total	**16**

Sophomore Year / Spring		
540.303	Transport I	3
020.305	Biochemistry	3
~~	H/S Elective	3
~~	Undesignated Elective	3
	Total	**12**

Junior Year / Fall		
540.304	Transport II	4
~~	Engineering Elective	3
540.490	Introduction to Chemical Process Safety	1
~~	Biochem or Phys Chem or Orgo Laboratory *	1 or 3
~~	Undesignated Electives	3
	Total	**12-14**

Junior Year / Spring		
540.301	Kinetic Processes	4
540.306	Chemical and Biological Separations	4
661.315	Culture of the Engineering Profession	3
~~	Chem/Bio Elective	3
	Total	**14**

Senior Year / Fall		
540.311/313	Projects in ChemBE Unit Operations with Experiments	4
540.409	Dynamic Modeling and Control	4
~~	Engineering Elective	3
~~	H/S Elective 300 level	3
~~	Undesignated Electives	3
	Total	**17**

Senior Year / Spring		
540.314	Chemical and Biomolecular Product Design **	3
540.315	ChemBE Process Design Using ASPEN	2
~~	Engineering Elective	3
~~	Undesignated Electives	6
	Total	**14**

116-119

AP credits	
Chemistry	4
Math BC	8

* Students with no track can choose one of the four labs: 030.225 Introductory Organic Chemistry Lab, 030.305 Physical Chemistry Instrumentation Lab I, 020.315 Biochemistry Project Lab, or 250.253 Protein Engineering and Biochemistry Lab.

** Students may take the 3-credit Product Design course 540.314, the 6-credit Product Design sequence of 540.309 and 540.310, or the 6-credit Multidisciplinary Engineering Design sequence of 660.345 and 660.346.

General Checklist

Requirements Sign-Off Sheet for B.S. in Chemical and Biomolecular Engineering

Students Entering Program Fall 2023, General Checklist (no track)

Overall GPA: _____

Basic Science

Course		Crs	Sem
030.101	Intro Chem I (3)		
030.102	Intro Chem II (3)		
030.105	Intro Chem Lab I (1)		
030.106	Intro Chem Lab II (1)		
171.101	General Physics I (4)		
171.102	General Physics II (4)		
173.111	General Physics Lab I (1)		
	Total	*0*	*/17*

Mathematics

Course		Crs	Sem	Grade	
110.108	Calculus I (4)				>C-?
110.109	Calculus II (4)				>C-?
110.202	Calculus III (4)				
110.302	[5]Diff Eqs With Applic. (4)				
553.291	[5]Linear Algebra & Diff. Eq. (4)				
	Total	*0*	*/16 (min)*		

Advanced Chemistry/Biology

Course		Crs	Sem
030.205	Organic Chem I (4)		
020.305	Biochemistry (3)		
020.306	[1]Cell Biology (4)		
540.307	[1]Cell Biology for Engineers (3)		
	[1]Adv. Chem Bio Elective (3)		
030.225	[2]Intro Organic Chem Lab (3)		
030.305	[2]Phys Chem Instrum Lab I (3)		
020.315	[2]Biochemistry Project Lab (1)		
250.253	[2] Protein Eng Biochem Lab (3)		
	Total	*0*	*/13* (min)

Humanities and Social Sciences (6 3-cr courses minimum)

Course		Crs	Sem	Designator (H,S,etc.)
661.315	Culture of Eng. Profession (3)			SW
	Total	*0*	*/18 (min)*	

Advanced H/S Course: _____

Chemical Engineering Core

Course		Crs	Sem	Grade	GPA calc
500.113	Gateway Computing Python (3)				
540.202	Chem & Biol Process Anal. (4)				
540.203	Engineering Thermo (3)				
540.301	Kinetic Processes (4)				
540.303	Transport I (3)				
540.304	Transport II (4)				
540.306	Mass Transfer/Separations (4)				
540.309	[4]ChemBE Product Design Part 1 (3)				
540.311	[3]Projects in Chem Eng Unit Ops (4)				
540.313	[3]Projects in ChemBE Unit Ops (4)				
540.314	[4]ChemBE Product Design (3)				
660.345	[4]Multidisciplinary Engineering Design I (3)				
540.315	Process Design with Aspen (2)				
540.409	Modeling, Dynamics & Control (4)				
540.490	Intro to Chemical Process Safety (1)				
	Total	*0*	*/ 40*		

ChemBE core course GPA

Engineering Elective Courses

Course		Crs	Sem	
540.310	[4]ChemBE Product Design Part 2 (3)			
660.346	[4]Multidisciplinary Engineering Design II (3)			
				Elective 1
				Elective 2
				Elective 3
	Total	*0*	*/8*	
	Total Engineering Credits =	***0***	***/48 (min)***	

Undesignated Electives

Course		Crs	Sem	
	Total	*0*	*/15*	(can be <15)
	Total Credits	***0***	***/128 (min)***	

Writing Intensive Course: _____

Notes:

1. Students must complete at least one of these courses
2. Students must complete at least one of these courses
3. Students must complete only one of these courses
4. Students must complete either the one-semester course (540.314), the yearlong option (540.309-310), or MDE option (660.345-346)
5. Students must complete only one of these courses

Molecular & Cell Biology Track Checklist

Requirements Sign-Off Sheet for B.S. in Chemical and Biomolecular Engineering
Students Entering Program Fall 2023, Molecular and Cellular Bioengineering Track Checklist **Overall GPA:** _____

Basic Science

Course		Crs	Sem
030.101	Intro Chem I (3)		
030.102	Intro Chem II (3)		
030.105	Intro Chem Lab I (1)		
030.106	Intro Chem Lab II (1)		
171.101	General Physics I (4)		
171.102	General Physics II (4)		
173.111	General Physics Lab I (1)		
	Total	*0*	*/17*

Mathematics

Course		Crs	Sem	Grade	
110.108	Calculus I (4)				>C-?
110.109	Calculus II (4)				>C-?
110.202	Calculus III (4)				
110.302	[5]Diff Eqs With Applic. (4)				
553.291	[5]Linear Algebra & Diff. Eq. (4)				
	Total	*0*	*/16 (min)*		

Advanced Chemistry/Biology

Course		Crs	Sem
030.205	Organic Chem I (4)		
020.305	Biochemistry (3)		
020.306	[1]Cell Biology (4)		
540.307	[1]Cell Biology for Engineers (3)		
020.315	[2]Biochemistry Project Lab (1)		
250.253	[2] Protein Eng Biochem Lab (3)		
	Total	*0*	*/13 (min)*

Humanities and Social Sciences (6 3-cr courses minimum)

Course		Crs	Sem	Designator (H,S,etc.)
661.315	Culture of Eng. Profession (3)			SW
	Total	*0*	*/18 (min)*	

Advanced H/S Course: _____

Chemical Engineering Core

Course		Crs	Sem	Grade	GPA calc
500.113	Gateway Computing Python (3)				
540.202	Chem & Biol Process Anal. (4)				
540.203	Engineering Thermo (3)				
540.301	Kinetic Processes (4)				
540.303	Transport I (3)				
540.304	Transport II (4)				
540.306	Mass Transfer/Separations (4)				
540.309	[4]ChemBE Product Design Part 1 (3)				
540.313	[3]Projects in ChemBE Unit Ops (4)				
540.314	[4]ChemBE Product Design (3)				
660.345	[4]Multidisciplinary Engineering Design I (3)				
540.315	Process Design with Aspen (2)				
540.409	Modeling, Dynamics & Control (4)				
540.490	Intro to Chemical Process Safety (1)				
	Total	*0*	*/ 40*		
				ChemBE core course GPA	

Engineering Elective Courses

Course		Crs	Sem	
540.310	[4]ChemBE Product Design Part 2 (3)			
660.346	[4]Multidisciplinary Engineering Design II (3)			
				Bioeng Elective 1
				Bioeng Elective 2
				Elective 3
	Total	*0*	*/8*	
	Total Engineering Credits =	***0***	***/48 (min)***	

Undesignated Electives

Course		Crs	Sem	
	Total	*0*	*/15*	(can be <15)
	Total Credits	***0***	***/128 min***	

Writing Intensive Course: _____

Notes:

1. Students must complete at least one of these courses
2. Students must complete at least one of these course
3. Students must complete 540.313
4. Students must complete either the one-semester course (540.314), the yearlong option (540.309-310), or MDE option (660.345-346)
5. Students must complete only one of these courses

Interfaces & Nanotechnology Track Checklist

Requirements Sign-Off Sheet for B.S. in Chemical and Biomolecular Engineering

Students Entering Program Fall 2023 or later, Interfacial and Nanotechnology Track Checklist **Overall GPA:** _____

Basic Science

Course		Crs	Sem
030.101	Intro Chem I (3)		
030.102	Intro Chem II (3)		
030.105	Intro Chem Lab I (1)		
030.106	Intro Chem Lab II (1)		
171.101	General Physics I (4)		
171.102	General Physics II (4)		
173.111	General Physics Lab I (1)		
	Total	*0*	*/17*

Mathematics

Course		Crs	Sem	Grade	
110.108	Calculus I (4)				>C-?
110.109	Calculus II (4)				>C-?
110.202	Calculus III (4)				
110.302	[5]Diff Eqs With Applic. (4)				
553.291	[5]Linear Algebra & Diff. Eq. (4)				
	Total	*0*	*/16 (min)*		

Advanced Chemistry/Biology

Course		Crs	Sem
030.205	Organic Chem I (4)		
020.305	Biochemistry (3)		
030.305	Phys Chem Instrum Lab I (3)		
030.452	Materials and Surface (3)		
	Total	*0*	*/13 (min)*

Humanities and Social Sciences (6 3-cr courses minimum)

Course		Crs	Sem	Designator (H,S,etc.)
661.315	Culture of Eng. Profession (3)			SW
	Total	*0*	*/18 (min)*	

Advanced H/S Course: _____

Chemical Engineering Core

Course		Crs	Sem	Grade	GPA calc
500.113	Gateway Computing Python (3)				
540.202	Chem & Biol Process Anal. (4)				
540.203	Engineering Thermo (3)				
540.301	Kinetic Processes (4)				
540.303	Transport I (3)				
540.304	Transport II (4)				
540.306	Mass Transfer/Separations (4)				
540.309	[4]ChemBE Product Design Part 1 (3)				
540.311	[3]Projects in Chem Eng Unit Ops (4)				
540.313	[3]Projects in ChemBE Unit Ops (4)				
540.314	[4]ChemBE Product Design (3)				
660.345	[4]Multidisciplinary Engineering Design I (3)				
540.315	Process Design with Aspen (2)				
540.409	Modeling, Dynamics & Control (4)				
540.490	Intro to Chemical Process Safety (1)				
	Total	*0*	*/ 40*		
	ChemBE core course GPA				

Engineering Elective Courses

Course		Crs	Sem	
540.310	[4]ChemBE Product Design Part 2 (3)			
660.346	[4]Multidisciplinary Engineering Design II (3)			
				I/N Elective 1
				I/N Elective 2
				Elective 3
	Total	*0*	*/8*	
	Total Engineering Credits =	***0***	***/48 (min)***	

Undesignated Electives

Course		Crs	Sem	
	Total	*0*	*/15*	(can be <15)
	Total Credits	***0***	***/128 (min)***	

Writing Intensive Course: _____

Notes:

1. Students must complete at least one of those courses
2. Students must complete at least one of those courses
3. Students must complete only one of these courses
4. Students must complete either the one-semester course (540.314), the yearlong option (540.309-310), or MDE option (660.345-346)
5. Students must complete only one of these courses

VI – DESCRIPTION OF CURRICULUM

1. Curriculum

Chemical and Biomolecular Engineering Core Courses

The following ChemBE courses are required:

- 500.113
- 540.202
- 540.203
- 540.301
- 540.303
- 540.304
- 540.306
- 540.311 or 313
- 540.314 (or 540.309/310 or 660.345/346)
- 540.315
- 540.409
- 540.490

See page 6 and page 18 for a list of course names, numbers and pre-requisites.

The total credits of core engineering courses should add up to 39.

Additionally, all students must take a capstone design course. Process Design with Aspen, 540.315 is required for everyone. However, students interested in a more thorough design experience can substitute Chemical Product Design 540.314 with the year-long 6-credit Product Design series (3 credits in 540.309 and 3 credits in 540.310) or the Multidisciplinary Engineering Design series (3 credits in 660.345 and 3 credits in 660.346). Then the first half of the course, 540.309 or 660.345, will count as part of the core requirements and its grade will contribute to the engineering GPA. The 3 credits from 540.310 or 660.346 will count as engineering electives (see below). Note that students will receive credits for 540.309 only once they have finished 540.310.

Online Safety Course

This course is required and is a prerequisite for EN.540.490 Introduction to Chemical Process Safety. It is required for any research course. See page 25 for further information.

- Go to JHU myLearning page. Search for “Laboratory Safety Introduction Course”
- Is delivered through online modules; expect several hours for completion

Engineering Elective Courses

A minimum of 48 engineering credits are required for the degree, which leaves at least 9 engineering credits beyond the ChemBE Core Courses for students to take as electives (usually equivalent to three Engineering Elective courses)..

For a course to be suitable as an “Engineering Elective”, it must be offered by the Whiting School of Engineering, it must be taken for a letter-grade (not S/U), and it must have an area designation of E (for Engineering).

Engineering courses that do not meet the above requirements may also be acceptable as Engineering Electives, but they must be approved by the student’s advisor and the Director of Undergraduate Studies. Courses in the Arts and Sciences school that are not co-listed with ChemBE do not count as engineering electives.

Specific rules apply to the following courses:

- Students who take the year-long design courses will receive 3 of their engineering elective credits from the second of these design courses, 540.310 or 660.346.
- For students who join research groups in the ChemBE department, no more than 4 credits earned of Customized Academic Learning (CAL) courses can be used to fulfill the engineering electives requirements. Any additional CAL credits will serve as undesignated credits (i.e. count towards the total 128-credit minimum).

- Students may take as many credits of - Projects in the Design of a Chemical Car (540.418 and 419) as they wish, but only 4 credits from ChemE Car can count towards engineering electives. Any additional credits will serve as undesignated credits (i.e. count towards the total 128-credit minimum).
- Probability and Statistics courses do not count: courses in Statistics (ex. 553.111), Probability and Statistics (ex. 553.310) or Linear Algebra (ex. 553.291) from the Applied Mathematics and Statistics Departments will not count as engineering electives despite the fact that they carry an E designation.
- All "Bootcamp" Courses are approved as Engineering Electives, regardless of the fact that they are only offered as "S/U".
- AS.250.302 - Modeling the Living Cell is approved as an Engineering Elective even though it is offered by the Arts and Sciences school because it is co-taught by the ChemBE department.

Physics Courses and Laboratories

Students are required to take the following physics courses:

- 171.101 or 171.107 - General Physics for Physical Science Majors I
- 171.102 or 171.108 - General Physics for Physical Science Majors II
- 173.111 - General Physics Laboratory I

Basic Chemistry Courses and Laboratories

The following chemistry courses are required: 030.101, 030.102, 030.105, and 030.106. Students with a score of 4 on their AP exam in chemistry must sign up for 030.103 Applied Chemical Equilibrium and Reactivity with Lab (4 credits). Students with a score of 5 who would like to take one 100-level course in chemistry can take 030.103 as well, or they may skip to Organic Chemistry (see next Section). Make sure to consult the *First Year Academic Guide* and *Engineering 101* from the WSE office for more information on credit counts.

Advanced Chemistry and Biology Courses

Students are required to take 13 credits of Advanced Chemistry and Biology courses. Two lectures, Biochemistry 020.305 and Organic Chemistry I 030.205, and one laboratory course (030.305, 030.225, 250.253 or 020.315) are required (8 to 10 credits). *Students following the Molecular and Cellular Bioengineering track must take one of the biochemistry labs, 020.315 or 250.253, and those following the Interfaces and Nanotechnology track must take Physical Chemistry Instrumentation Laboratory I, 030.305.*

Additionally, students need to take 3 or 5 elective credits beyond the required courses listed above to meet the 13-credit total Advanced Chem/Bio Requirement. Students should discuss with their advisor which elective courses are most appropriate for their educational objectives. These courses must be chosen from the 030 or 020 codes, should be at the 200-level minimum, and must carry a N, Natural Sciences, area designation. Additionally, some courses offered by 250 (Biophysics) may be acceptable. A complete list of approved Advanced Chem/Bio electives can be found on page 19. Courses not on the approved list may also be acceptable as Advanced Chem/Bio elective courses but must be approved by the student's advisor and the Director of Undergraduate Studies. *Students following the Molecular and Cellular Bioengineering track must take Cell Biology for Engineers 540.307 or Cell Biology 020.306, and those following the Interfaces and Nanotechnology track must take Materials and Surfaces 030.452.*

NOTE: 030.312 - Introduction to the Human Brain is not acceptable as an Advanced Chem/Bio elective!

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) or Linear Algebra and Differential Equations (553.291).

Calculus is so essential to Chemical Engineering that a grade of C- or better is required in both Calculus I and II. 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) or Linear Algebra and Differential Equations (553.291) provides this additional mathematical background.

A total of 16 credits of math are required. Some students may be able receive credit for Calculus I through the AP Exam (see the *First Year Academic Guide* from the WSE office for more information). Alternatively, some students who do not receive AP credits may place out of Calculus I by achieving highly on their math department placement exam. In this case, students must take an additional course in mathematics since the placement exam does not earn the student *credits* for Calculus I.

Only courses taught by the KSAS Math Department (110) or the WSE AMS Department (553) will be accepted as Additional Math Courses. If you have taken Diff EQ (110.302) rather than LADE (553.291) we suggest students take Linear Algebra (110.201) or a Probability and Statistics to complete the required 16 credits in mathematics.

Writing Skills

The university requires all students to take two courses with a W, Writing Intensive, area designation and that these courses be completed with a grade of C or better.

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

Humanities and Social Sciences Courses

Students need 6 courses that have a Humanities (H) or Social Science (S) area designation. Each of these courses must be at least 3 credits for a minimum total of 18 (see the ASEN catalog). The only exception to this rule is that students may replace one 3-credit course with a set of courses offered in a 2-credit + 1-credit format (this exception applies to two specific sets of courses, EN.660.400 and 406, or EN.660.400 and 520.404).

For ChemBE students, EN.661.315 Culture of the Engineering Profession will automatically serve as one of their H/S courses, with the remaining 5 courses selected on an elective basis. To encourage depth of knowledge in the humanities and social sciences, at least one of these other 5 courses must be an advanced level course at the 300-level or higher.

Note that most H or S courses taught during the intersession are less than 3 credits and graded pass/fail. They will not count towards the H/S requirement and will instead be counted as undesignated electives.

Acceptable H/S 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, Philosophy, Political Science, Psychology, Religion, and Sociology. Note that many Music courses are not coded as H/S, and that only Music courses with an H/S designation can contribute to the 6 H/S courses.

Foreign language instruction and literature courses are also acceptable as Humanities courses. Note, 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. Beginning language courses will count towards fulfilling the 18 credits of H/S electives even if they lack an H designator. Additionally, be aware that some language departments require that students take an entire year of an introductory language course in order to receive any credit.

Undesignated Electives

A minimum of 128 credits are required for the degree. Therefore, in addition to all the credits taken to fulfill the requirements in the sections above (e.g. ChemBE core courses, engineering electives, H/S courses, etc.) up to 15 additional credits (called undesignated elective credits) are required. There are no restrictions on which courses may count towards undesignated elective credits.

Advanced Placement

The decision as to equivalency between Advance Placement Exams and courses at JHU is decided at the university level and ChemBE adheres to it strictly. This list of equivalencies can be found in on the ASEN Catalogue page.

In addition to the course and credit equivalency that the university provide, there are some additional courses that the ChemBE department ***strongly*** suggests students take. Though not ***required***, these courses are recommended to ensure that students are fully prepared for the more rigorous coursework that comes later in the program.

Exam	**Recommended Course**	**Explanation**
Computer Science A	EN.500.113 -OR- EN.500.133	Some of the later courses require significant proficiency in Python which students might not have from Comp Sci alone. To be successful in these later courses, the department recommends taking Gateway Python or Bootcamp: Python course.
Chemistry	AS.030.103	Students are encouraged to Applied Chemical Equilibrium and Reactivity w/lab in order to complete the introductory chemistry requirements. This will ensure students have a strong enough Chemistry understanding move on to Organic Chemistry in later semesters.

2. Pre-requisites

The ChemBE curriculum is structured such that students learn material in a logical order, starting with fundamental concepts and culminating in senior year's design courses and Senior Lab. The prerequisites for the courses guide the progress of the students through their 4 years of education. With very few exceptions, instructors will enforce these prerequisites to preserve the quality of the program and the educational experience of the students.

Prerequisites of ChemBE Core Courses

Course	Credits	Semester	Prerequisites
540.202 Introduction to Chemical & Biological Process Analysis	4	Fall/Spring	AS.030.101 Intro Chem I AS.171.101 or 107 General Physics I and ONE of the following courses: AS.030.102 Intro Chem II AS.030.103 Applied Chemical Equilibrium and Reactivity w/ Lab AS.110.109 Calculus II AS.171.102 or 108 General Physics II
540.203 Engineering Thermodynamics	3	Fall/Spring	EN 540.202 Process Analysis AS.110.202 Calculus III (allowed concurrent)
540.303 Transport Phenomena 1	3	Fall/Spring	AS.110.302 Differential Equations or EN.553.291 Linear Algebra and Differential Equations
540.304 Transport Phenomena 2	4	Fall	EN.540.303 Transport Phenomena 1 EN.500 113 Gateway to Computing - Python
540.301 Kinetic Processes	4	Spring	EN.540.203 Engineering Thermodynamics EN.540.303 Transport Phenomena 1
540.306 Separations	4	Spring	EN.540.203 Engineering Thermodynamics EN.540.303 Transport Phenomena 1
540.307 Cell Biology for Engineers	3	Spring	AS.020.305 Biochemistry
540.309 Product Design Part 1	3	Fall	EN.540.301 Kinetic Processes EN.540.303 Transport Phenomena 1 EN.540.306 Separations EN.540.490 Process Safety
540.310 Product Design Part 2	3	Spring	EN540.309 Product Design Part 1
540.311 Projects in Chemical Engineering Unit Operations with Experiments	4	Fall	EN.540.301 Kinetic Processes EN.540.304 Transport Phenomena 2 EN.540.306 Separations EN.540.490 Process Safety EN.661.315 Culture of the Engineering Profession
540.313 Projects in ChemBE Unit Operations with Experiments	4	Fall	EN.540.301 Kinetic Processes EN.540.304 Transport Phenomena 2 EN.540.306 Separations EN.540.490 Process Safety EN.661.315 Culture of the Engineering Profession
540.314 Product Design	3	Spring	EN.540.301 Kinetic Processes EN.540.303 Transport Phenomena 1 EN.540.306 Separations
540.315 Process Design with Aspen	2	Spring	EN.540.301 Kinetic Processes EN.540.303 Transport Phenomena 1 EN.540.306 Separations EN.540.311/313 Senior Lab EN.540.490 Process Safety
540.409 Dynamic Modeling/Control	4	Fall	EN.540.301 Kinetic Processes EN.540.306 Separations
540.490 Introduction to Process Safety	1	Spring	EN.540.203 Engineering Thermodynamics EN.540.303 Transport Phenomena 1 Online Lab Safety

3. Tracks

Students have the opportunity to develop a more in-depth specialty in two areas within Chemical and Biomolecular engineering. Our two tracks are Molecular and Cellular Bioengineering (MCB) and Interfaces and Nanotechnology (IN). Students completing a track will have this fact designated on their final checklist audit form. These tracks have additional and/or alternate requirements, as described below.

Molecular and Cellular Bioengineering (MCB) Track

Completion of this track has the following requirements:

- Students must take Cell Biology for Engineers EN.540.307 or Cell Biology AS.020.306.
- Students must fulfill the Advanced Chemistry and Biology laboratory requirement with AS.020.315 (Biochemistry Lab) or AS.250.253 (Protein Engineering and Biochemistry Lab).
- 6 credits of bioengineering electives are required; see page 21 for list of approved courses. One of these courses can be research in the bio area; see page 25 for how this is approved.
- Students must take EN.540.313 Chemical and Biomolecular Engineering Lab instead of EN.540.311 Chemical Engineering Lab.

Interfaces and Nanotechnology (IN) Track

Completion of this track has the following requirements:

- Students must fulfill the Advanced Chemistry and Biology laboratory requirement with AS.030.305 (Physical Chemistry Instrumentation Lab I).
- Students take Materials and Surface (AS.030.452)
- Both courses above provide six credits for the advanced chemistry electives.
- 6 credits of interfacial/nano engineering electives are required; see page 22 for list of approved electives. One of these courses can be research in the interfacial/nano area; see page 25 for how this is approved.

4. Electives

Approved Advanced Chemistry and Biology Electives

Advanced Chem/Bio Electives should be offered from either the Biology (020) or Chemistry (030) departments, be at least a 200-level course, and have an N designation.

You can find a complete list of the courses to be offered by the Biology (020) and Chemistry (030) departments for the upcoming semester at the following link: https://studentaffairs.jhu.edu/registrar/students/course-schedule

In addition to the courses offered by the Biology (020) and Chemistry (030) departments that are N designated and 200-level and above, the following courses are also approved Advanced Chem/Bio Electives:

171.310	Biological Physics
250.253	Protein Engineering and Biochemistry Lab
250.302	Modeling the Living Cell
250.351	Reproductive Physiology
250.353	Computational Biology
270.317	Conservation Biology
360.339	Planets, Life and Universe
510.403	Materials Characterization
540.307	Cell Biology for Engineers

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 Chem/Bio-related electives.

NOTE: 030.312 - Introduction to the Human Brain is not acceptable as an Advanced Chem/Bio elective!

Approved Engineering Electives

All courses offered by the Whiting School of Engineering that hold an Area Designation of E (for Engineering), and are taken for a letter-grade (not S/U) are approved as Engineering Electives EXCEPT:

- Courses in which there is significant overlap of content with required ChemBE courses
- Probability, Statistics, and Prob/Stat courses offered by the AMS Department, as these are *math* courses: (EN.553.111, EN.553.113, EN.553.291, EN.553.310, EN.553.311, EN.553.420, EN.553.430)

The only courses that do not meet the above requirements but are still approved electives are:

- All Bootcamp Courses (EN.500.132, EN.500.133, EN.500.134)
- Modeling the Living Cell (AS.250.302)
- All WSE Research Courses (EN.XXX.5XX)

Other courses with significant engineering content may also be acceptable but must be approved by your advisor and the Director of Undergraduate Studies.

Approved Bioengineering Electives

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 that have a significant overlap of content with required courses are not acceptable as bioengineering electives.

Be aware, some elective courses are not offered every year or may not be offered for several years.

250.302	Modeling the Living Cell
510.316	Biomaterials I
510.407	Biomaterials II
510.430	Biomaterials Lab
520.315	Intro. to Bio-Inspired Processing of Audio-Visual Signals
530.410	Biomechanics of the Cell and Organisms
540.426	Fundamentals of Cell Bioengineering
530.436	Bioinspired Science and Technology
530.445	Introductory Biomechanics
530.446	Experimental Biomechanics
540.402	Metabolic Systems Biotechnology
540.414	Computational Protein Structure Prediction and Design
540.421	Projects in Design: Pharmacodynamics
540.428	Supramolecular Materials and Nanomedicine
540.432	Projects in Design: Pharmacokinetics
540.437/637	Application of Molecular Evolution to Biotechnology
540.452	Eukaryotic Cell Biotechnology
540.462	Polymer Design and Bioconjugation
540.465	Engineering Principles of Drug Delivery
570.411	Environmental Microbiology
570.446	Biological Processes of Wastewater Treatment
580.242	Biological Models and Simulations
580.311/312	BME Design Group
580.411/412	BME Design Group – Senior
580.441	Cellular Engineering
580.442	Tissue Engineering
580.444	Biomedical Applications of Glycoengineering
580.447	Computational Stem Cell Biology
580.480	Precision Care Medicine I
580.481	Precision Care Medicine II
580.485/487	Computational Medicine: Cardiology (and Lab)
601.350	Genomic Data Science

Approved Interfaces and Nanotechnology Electives

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 that have a significant overlap of content with required courses are not acceptable as interfaces and nanotechnology electives.

Be aware, some elective courses are not offered every year or may not be offered for several years.

510.311	Structures of Materials
510.422	Micro and Nano Structured Materials & Devices
530.495	Microfabrication Laboratory
540.403	Colloids and Nanoparticles
540.415	Interfacial Science with Applications to Nanoscale Systems
540.428	Supramolecular Materials and Nanomedicine
540.440	Micro/Nanotechnology: The Science and Engineering of Small Structures

5. Rules and Limitations

Grade Requirements and Department Honors

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: 500.113, 540.202, 540.203, 540.301, 540.303, 540.304, 540.306, 540.311 (or 540.313), 540.314, 540.315, 540.409 and 540.490. Students with a ChemBE GPA of 3.6 and above 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, other Thermodynamics courses (for example 510.312) cannot be counted for this reason. You should carefully discuss the content of all elective courses with your advisor. Your advisor's approval, and in escalated cases, that of the Director of Undergraduate Studies, is critical to avoid problems in fulfilling course requirements.

Undergraduate Research and/or Independent Study to Fulfill Engineering Elective Requirement

No more than 4 credits earned of Undergraduate Research and/or Independent Study courses can be used to fulfill the engineering electives requirements. Any additional credits in these courses will serve as undesignated credits (i.e. count towards the total 128 credit minimum).

Current Topics courses are included in research credits thus students can automatically count one Current Topics course as an engineering elective. Current Topics Courses from the bio labs count automatically towards the MCB track and those from the I/N labs towards the I/N track. Then only one or two more credits from Undergraduate Research can count towards the engineering electives. Other research credits or credits from a second Current Topics course will count as undesignated electives.

Students who do not receive any Current Topics credits can use 4 credits of Undergraduate Research to fulfill their engineering electives or track electives. If students belong to a research group in ChemBE, they will register for 540.511 and their research credits can automatically count towards engineering electives and track electives. For students who have completed research in a different department and would like that research to count towards their engineering electives, they must complete the Research as Engineering Elective Form on the ChemBE undergraduate website upon completion of that semester's research. It will be submitted to the Director of Undergraduate Studies who will evaluate the request and notify the student if approved or not.

For further information about participating in Undergraduate Research, see pages 25 & 26.

Courses Taken Satisfactory/Unsatisfactory (S/U)

All required courses, all courses fulfilling technical electives, and all H/S requirements cannot be taken Satisfactory/Unsatisfactory (S/U), sometimes referred to as "pass/fail", except under extreme extenuating circumstances.

In these very rare cases, the student's advisor, with the approval of the Director of Undergraduate Studies, can approve up to 4 credits of technical electives, and up to 2 H/S courses to be taken S/U (See "Exemptions" below).

There is no limit on the total number of undesignated credits that may be taken S/U. However, the university only authorizes students to take one S/U course each semester (see Grading Policies in the catalog).

Course Retakes

The university allows students to retake a course to obtain a better grade if the first grade is C+ or lower. The grade from the second attempt is the only grade recorded on the transcript and included in the GPA calculation, even if the second grade is lower than the first. The grade from the first attempt disappears. See the ASEN Catalog's section on Retaking a Course for details.

Exceptions

For exception to any **Curriculum Requirements** or any **Rules and Limitations** discussed in the sections above:

First, the student must meet with their faculty advisor to discuss the circumstances leading to the exception request. If your advisor agrees that an exception may be warranted, the student and advisor will fill out a WSE Undergraduate Substitution-Exception-Waiver (SEW) Form and email it to the Director of Undergraduate Studies with their faculty advisor and the Academic Program Coordinator CC'd. The Director of Undergraduate Studies will then evaluate the request and reply to the student's email to either approve the request or explain why the request cannot be approved. If approved, the Academic Program Coordinator will update the student's file in the Degree Audit System to reflect this exception and respond via email to verify this change has been processed.

6. Ethics

Cheating and other forms of academic dishonesty are corrosive and harmful to our university. The strength of the university depends on academic and personal integrity. You must be honest and truthful in your courses and your coursework. Violations of the university's policy surrounding Ethics include cheating on exams, plagiarism, reuse of assignments, improper use of the internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Any violations of the ethical standards that you witness should be reported to the instructor. You may also consult the Associate Dean of Student Affairs and/or the Chair of the Ethics Board beforehand. For undergraduate students, the procedures can be found online at https://studentaffairs.jhu.edu/policies-guidelines/undergrad-ethics/.

VII – OPTIONS AVAILABLE IN CHEMICAL AND BIOMOLECULAR ENGINEERING

1. Study Abroad

ChemBE students have the option to spend a semester studying abroad in a variety of countries. This is best during sophomore and junior year and requires a good deal of planning. Interested students should work with the Study Abroad Office to discuss their various options. They must then meet with their advisor and the Director of Undergraduate Studies to review their plan and sign off on the Study Abroad form.

2. Projects in Chemical Engineering Unit Operations with Experiments at DTU in Copenhagen in the Summer

ChemBE Students have the option to take a Laboratory Course at the Technical University of Denmark (DTU) in Copenhagen during the summer before their senior year. This course substitutes for EN.540.311/313 in the ChemBE curriculum. Contact the Academic Coordinator or Director of Undergraduate Studies for more information.

3. Undergraduate Research

Many undergraduate students choose to be involved in research. They can find opportunities to work in research laboratories in the ChemBE department or in other programs at Hopkins. Students can start research as early as freshman year. The university limits the total number of research credits to 6 per academic year (starting in June). For more information about Research policies, see ASEN Catalog Special Situations.

Joining a Research Group in the Engineering School

If you are interested in joining a research group in the engineering school, the first step is to meet with your faculty advisor. Your advisor 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 different faculty members by reading their departmental webpages and publications and (ii) make appointments to talk to faculty members whose research interests you. Contact the faculty member by email to find out if there is an opening in their lab and if they are willing to serve as your **Principal Investigator (PI)**. Include a resume, a transcript, and any useful information in your application. You may also speak to graduate students in the research group for more information.

To register for research credits, the student should begin by meeting with their intended research professor to discuss the expectations for the research project and agree on the nature of the final deliverables (experiments, report, presentation, etc.). They should also clarify how much work (time) is expected per credit of research. Once the student and research professor set these expectations, the student will use the Independent Academic Work form in SIS (Under “Online Forms” on the “Registration” tab) to register for their PI’s research course and section.

The course number to register for in order to conduct research in a ChemBE faculty member’s lab is **EN.540.511**.

To register to conduct research with a PI in another WSE department, **you will have to register for that department’s research course number**. Each WSE department has their own specific research course number, so make sure you are registering for the correct course number and section based on you PI’s department in WSE and your PI’s section of that course.

At the end of the semester, the student’s PI will review the deliverables of that student, verify that the student invested enough time to earn the pre-agreed upon credits, and assign them a grade. Up to 4 credits from this type of research may count as Engineering Elective credits.

Joining a Research Group outside the Engineering School

If students wish to join research laboratories in another school in JHU (ex. the Medical School), they must consult with their academic advisor to transfer the final research grade from the other school into WSE. After receiving approval from their advisor, students use the Independent Academic Work form in SIS (Under “Online Forms” on

the “Registration” tab) to register for their ChemBE faculty advisor’s section of 540.501 - Interdepartmental Undergraduate Research”. They must establish a set of deliverables and expectations the faculty member serving as their PI and convey these deliverables to their ChemBE faculty advisor. At the end of the semester, students must send an e-mail to their ChemBE faculty explaining the nature of their project and how they met the requirements set by their PI. It is also the students’ responsibility to remind their PI to send a final grade and number of credits to the ChemBE faculty advisor. The ChemBE faculty advisor will then enter this grade in SIS. To count credits from 540.501 as engineering electives, students must fill out the Research as Engineering Elective Form, which should only be submitted upon completion of the research.

Credits received for unpaid research from another university might be eligible to transfer to Hopkins. Follow the WSE procedure for any credit transfer. If research takes place in a university outside the United States, the transfer of credits follows the procedures of the Study Abroad office. They will count as undesignated credits.

Using Research as MCB or IN Elective Credit

Up to 3 credits of research may be used for MCB or IN Elective credit but this must be approved by the DUS. Credits earned from either 540.511 or 540.501 can be used in this way. In either case, upon completion of the research, you will submit a Research as Engineering Elective Form, and indicate that you would like the credits to count towards either your MCB or your INT track. To be approved, you must be able to explain in detail how your work in the lab was directly related to your track’s content area. Final deliverables from the research itself can be used as evidence that the research was track-relevant.

Safety Course for Research

Students who join a research group must take the online laboratory safety course through myLearning. Most students meet this requirement since they must take the online safety course before joining any lab course. It does not replace 540.490 but allows students to start research.

4. BS/MSE or MSE programs in Chemical and Biomolecular Engineering

In addition to the Bachelor of Science degree, the ChemBE department also offers a Master of Science in Engineering program as well. Students have two options in pursuing an M.S.E. in Chemical and Biomolecular Engineering: a 10-course coursework-only Masters or a 6-course essay-based Masters that entails working under the guidance of a ChemBE faculty advisor to create and document original research to be submitted in an essay.

Double Counting Policy

Students pursuing both their undergraduate and master’s degrees in ChemBE at JHU should be aware that the ChemBE Graduate program’s policy on double counting courses is stricter than WSE’s policy on this topic. Only 2 courses maximum 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 master’s degree.

Application Process

The BS/MSE program in Chemical and Biomolecular Engineering allows students to obtain a Master of Science in Engineering concurrently with the Bachelor of Science. Students apply to this program during their junior year. They benefit from having an undergraduate and graduate student status, thus avoiding the need for approval to sign up for graduate level courses.

Students can also elect to finish their BS before starting an MSE program in ChemBE. In this case, the application process takes place in December of senior year, on the same schedule as all other graduate school applicants.

The Whiting School of Engineering offers a fifty percent tuition waiver for (a) having completed eight full-time semesters of study at Johns Hopkins, or (b) having completed a Bachelors degree at JHU *and* having not been enrolled at Johns Hopkins for at least one year (Dean's Master's Fellowship).

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

If a student is interested in applying for the MSE program, they should:

- Consult with their faculty advisor to see if/when they should apply.
- If applying to the coursework-only MSE they should consult their Academic Advisor. If applying to the essay-based they should consult their Research Professor or proposed MS Research Advisor.
- Apply through https://engineering.jhu.edu/graduate-admissions/, Check BS/MSE website for deadlines
- Request only one letter of recommendation for the application file (the department waives the other two). The letter should come from your MS research advisor for students applying to the essay-based program and from your BS academic advisor if applying to the coursework-only program.
- There are no GRE requirements.
- The TOEFL is waived for international students

Contacts for more information:

Sonya Brown
MSE Academic Program Coordinator
Maryland Hall 230F
Sbrow280@jh.edu

Dr. Sakul Ratanalert
Director of Master's Studies
Maryland Hall 124
sratana4@jhu.edu

5. Planning for Graduate School

Many ChemBE students, upon completion of their Bachelors degree, opt to go on to graduate school. Half of our graduating class continues on to join a MS or PhD program directly after their senior year or within a few years of graduation. Students who plan to get a graduate degree, especially a PhD, must demonstrate a dedication to their undergraduate course of studies and an ability to work independently.
Students who plan to get a graduate degree should consider the following:

- Join a research laboratory and focus on making serious contributions to the projects of the group
- Maintain a very high GPA
- Take additional courses in math or computer science
- Take Physical Chemistry I (030.301) and Linear Algebra (110.201)
- Take Cell Biology (540.307 or 020.306) if you wish to join a Bio-related program
- Sign up for graduate level courses (600 level) during senior year. Note that graduate level courses do not show any credits. For undergraduate students, they will count as three-credit courses on their transcripts after completion of the course.
- Prepare for the GRE
- Attend AIChE/SBE panels on graduate school and research
- Present a poster at a technical meeting
- Become familiar with technical writing
- Publish technical papers

Application due dates vary between universities, but most are due in December or January of your senior year.

6. Pre-medical Requirements

The Chemical and Biomolecular Engineering curriculum functions as excellent preparation for students interested in going on to medical school. Students who intend to apply to medical school must plan their program very carefully. In addition to the courses required for your ChemBE and university requirements, we advise that you also take the courses necessary to prepare you for the MCAT, as well as courses that are admission requirements for the majority of medical/dental schools you may be interested in. Do realize however that the requirements of each individual medical program do vary somewhat and it may not be possible to take *every* prereq for *every* medical school.

An important resource for pre-medical students is the Office of Pre-Professional Programs and Advising. All freshmen interested in the healthcare profession are required to attend a Pre-Health 101 workshop prior to making their first individual appointment with a pre-med/pre-health advisor. For more information about Pre-Health 101 and appointments, please visit the Pre-Professional Advising website. In addition, all freshmen who indicate an interest in pre-med/pre-health careers are automatically added to the Office's listserv to receive important program announcements, newsletters, and general information. If you are not already on the listserv, you can subscribe here.

A strong medical school application must reflect the personal qualities of the applicant as well as their academic achievements. While applicants should build med program prerequisite courses into their undergraduate curriculum and maintain a good GPA, good grades alone are not sufficient. It is as important to demonstrate interest in service to the community, experience in patient care, aptitude for leadership, evidence of collaboration, and dedication to projects that benefit society. Students are encouraged to volunteer at school, at home or even abroad, to join a research group, to get experience in the medical world, etc.

Pre-med required courses included in the ChemBE curriculum:

- General Chemistry I and II with Lab (8 credits) (030.101/102/105/106)
- Organic Chemistry I (4 credits) (030.205)
- Biochemistry with Lab and Cell Biology (8 to 11 credits) (020.305, 020.315 or 250.253, and 020.306 or 540.307)
- General Physics I with Lab and General Physics II (9 credits) (171.101/102/111)
- Calculus I and II (8 credits) (110.108/109)
- Two courses that emphasize English and/or writing intensive coursework
- Introductory Psychology and Introductory Sociology are recommended to assist with MCAT prep. Other H/S coursework is recommended to demonstrate academic diversity.
- Some bioengineering electives can enhance the biology component of the pre-med requirements

Additional courses required for pre-meds:

- Organic Chemistry II and Organic Chemistry Lab (7 credits) (030.206/225)
- A Probability and Statistics course
- Cell Biology Lab (020.316)
- Physics Lab II (171.112)
- Note that there is no requirement to take General Biology (020.151 and 020.152)

Some medical schools might have different specifications on course selection and use of AP credits. Please consult with the Pre-Professional Advising Office.

7. Minors

Minors are available in various departments (Classics, Economics, Music, Russian, Spanish, etc.). Students are responsible for learning the requirements for their minor and receiving clearance from that department for graduation. They must bring this information to their ChemBE advisor in order to design a suitable course plan.

A popular minor for ChemBE students is Entrepreneurship and Management and is offered by the Center for Leadership Education (105 Whitehead Hall). For information about it, send an email to cle@jhu.edu

8. Student Organizations (AIChE/SBE)

The student chapter of the American Institute of Chemical Engineers (AIChE) and Society for Biological Engineering (SBE) is a organization that eases the transition from undergraduate learning to the actual practice of chemical and biomolecular engineering. It promotes the professional development of the students through association with practicing engineers. Social activities include picnics, a formal dance, and a holiday party. AIChE also organizes tours of local plants and hosts speakers on various topics such as what to expect from graduate school or the role of chemical/biomolecular engineers in industry. For more information, please see the JHU AIChE Chapter website or email chembe_aiche@jhu.edu.

9. Cooperative Program

The 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. Students are responsible for obtaining an offer from a suitable employer and discuss with their faculty advisor and DUS about the impact on their curriculum progress. Students successfully completing a cooperative program receive a notation on their transcript.

10. How to get an internship

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

- 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.
- Start Early – Start browsing the internet in September/October to figure out what sort of companies and positions are available and interest you. Don't limit yourself to any one particular company and regularly visit their websites, specifically their career pages, to review and apply to positions.
- **Pay careful attention to emails you receive from ChemBE CEO (Communications, Events, and Opportunities) as they frequently share internship opportunities.**
- Interviews – The Career Center offers interviews with companies in the fall semester. They recruit BS and graduate students on campus and often include interviews for internships. 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 the opportunity doesn't perfectly align with your interests because interview practice is always good. Don't forget to send thank you emails!
- Work Your Connections – Talk to professors, deans, parents, relatives, friends, etc. Use LinkedIn, Handshake, the Career Center and even the JHU alumni network
- Go to EVERYTHING – Go to any and every employer showcase, informational session, job fair, alumni panel, etc. that you can. You never know where you might learn the right thing or meet the right person.
- 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 intersession . You get paid, and often free housing!
- Don't panic – Most companies don't start offering summer positions until mid-March and continue to post them through the end of April and sometimes even into May.

VIII – OTHER RESOURCES

Resource	URL
ChemBE Department Website	http://engineering.jhu.edu/chembe/
Student Enrollment and Account Management (SEAM)	https://support.sis.jhu.edu/case-home
Whiting School of Engineering – Academic Policies and Procedures	https://e-catalogue.jhu.edu/engineering/full-time-residential-programs/undergraduate-policies/academic-policies/
Whiting School of Engineering Office of Undergraduate Advising	https://engineering.jhu.edu/advising/
Office of Pre-Professional Advising	http://studentaffairs.jhu.edu/preprofadvising/
Learning Den Tutoring	https://academicsupport.jhu.edu/learning-den/
Life Design Lab (Kara Hunter, ChemBE educator)	https://studentaffairs.jhu.edu/life-design/ https://jhu.joinhandshake.com/login
Homewood Student Affairs	https://studentaffairs.jhu.edu/
Student Health and Wellness Center	https://studentaffairs.jhu.edu/student-health
Global Education Office (Study Abroad)	https://studyabroad.jhu.edu/
ASEN Catalog	https://e-catalogue.jhu.edu/

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