

CHEMICAL AND BIOMOLECULAR ENGINEERING, BACHELOR OF SCIENCE

Graduates receive a Bachelor of Science degree in Chemical and Biomolecular Engineering accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>. As permitted under the ABET guidelines, we are continually updating our undergraduate programs to include the latest advances in chemical and biomolecular engineering. Such modifications will enable us to offer the best possible educational experience to our undergraduates. For the latest chemical engineering educational programs, potential applicants are referred to our website at <http://www.jhu.edu/chembe/>

Program Requirements

(See also General Requirements for Departmental Majors (<http://e-catalog.jhu.edu/engineering/full-time-residential-programs/undergraduate-policies/academic-policies/requirements-bachelors-degree/>))

The Bachelor of Science degree requires a minimum of 128 credits. Additional details are given in the *Chemical and Biomolecular Engineering Undergraduate Advising Manual* available from the department or online.

The 128 credits must include:

Code	Title	Credits
Chemical and Biomolecular Engineering Core Courses		
EN.500.113	Gateway Computing: Python	3
EN.540.101	Chemical Engineering Today	1
EN.540.202	Introduction to Chemical & Biological Process Analysis	4
EN.540.203	Engineering Thermodynamics	3
EN.540.301	Kinetic Processes	4
EN.540.303	Transport Phenomena I	3
EN.540.304	Transport Phenomena II	4
EN.540.306	Chemical & Biomolecular Separation	4
EN.540.311	Projects in ChemE Unit Operations with Experiments	4
or EN.540.313	Projects in ChemBE Unit Operations with Experiments	
Select one of the following:		3
EN.500.309	Advanced Multidisciplinary Design	
EN.540.314	ChemBE Product Design	
EN.540.309	Product Design Part 1	
EN.540.310	Product Design Part 2	
EN.540.315	Process Design with Aspen	2
EN.540.409	Dynamic Modeling and Control	4
EN.540.490	Introduction to Chemical Process Safety ¹	1
Engineering Electives		
Select 8 credits of engineering electives		8
<i>Physics Courses and Laboratories</i>		
AS.171.101	General Physics: Physical Science Major I	4

or AS.171.107	General Physics for Physical Sciences Majors (AL)	
AS.173.111	General Physics Laboratory I	1
AS.171.102	General Physics: Physical Science Major II	4
or AS.171.108	General Physics for Physical Science Majors (AL)	
<i>Basic Chemistry Courses and Laboratories</i>		
AS.030.101	Introductory Chemistry I	3
AS.030.105	Introductory Chemistry Laboratory I	1
AS.030.102	Introductory Chemistry II	3
or AS.030.103	Applied Chemical Equilibrium and Reactivity w/lab	
AS.030.106	Introductory Chemistry Laboratory II	1
<i>Advanced Chemistry and Biology Courses</i> ²		
AS.020.305	Biochemistry	4
AS.030.205	Introductory Organic Chemistry I	4
EN.540.307	Cell Biology for Engineers (Optional)	3
Select one of the following:		1-3
AS.020.315	Biochemistry Project lab	
AS.250.253	Protein Engineering and Biochemistry Lab	
AS.030.305	Physical Chemistry Instrumentation Laboratory I	3
AS.030.225	Introductory Organic Chemistry Laboratory	
Mathematics Requirement ³		
AS.110.108	Calculus I (Physical Sciences & Engineering)	4
AS.110.109	Calculus II (For Physical Sciences and Engineering)	4
AS.110.202	Calculus III	4
or AS.110.211	Honors Multivariable Calculus	
AS.110.302	Differential Equations and Applications	4
Humanities and Social Sciences/ Writing Requirements		
EN.661.315	Culture of the Engineering Profession	3
Total Credits		99-101

¹ Students also must have a grade point average of at least 2.00 in the chemical and biomolecular engineering core courses to graduate.

The core courses for GPA calculation comprise all of the above courses except for EN.540.101 Chemical Engineering Today.

² Students may need additional courses beyond these courses. Requirements include additional courses in Chemistry and Biology. Students who are pursuing tracks in Molecular and Cellular Bioengineering or Interfaces and Nanotechnology have additional and/or alternate requirements.

³ Calculus is so essential to Chemical Engineering that a grade of C- or better in both Calculus I and Calculus II is required.

- *Humanities and Social Sciences Courses.* Eighteen credits designated as Humanities or Social and Behavioral Sciences are required (6 courses of at least 3 credits each). At least one of these courses must be an advanced course at the 300-level or higher in addition to Culture of Engineering. See the Chemical and Biomolecular Engineering Undergraduate Advising Manual for more details.

- *Writing Courses.* Two writing-intensive courses are required. One of the courses must be EN.661.315 Culture of the Engineering Profession. The courses that are taken to satisfy the university writing requirement must be passed with a grade of C- or better.

- *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, basic science,

advanced chemistry electives, mathematics requirement, and Humanities and Social and Behavioral Sciences courses) students will need to take some undesignated credits.

Tracks

Students pursuing a degree in Chemical and Biomolecular Engineering have the option of concentrating on specific fields including Interfaces and Nanotechnology and Molecular and Cellular Bioengineering. These focus areas have additional and/or alternate requirements, as described.

Interfaces and Nanotechnology (IN) TRACK

Students must fulfill the following requirements:

- The Advanced Chemistry and Biology laboratory requirement is fulfilled with AS.030.305 Physical Chemistry Instrumentation Laboratory I.
- AS.030.452 Materials & Surface is required and satisfies 3 credits of the Advanced Chemistry and Biology electives.
- Six credits of interfaces and nanotechnology electives are required- See department for a list of approved electives.

Molecular and Cellular Bioengineering (MCB) Track

Students must fulfill the following requirements:

- Students take either AS.020.306 Cell Biology or EN.540.307 Cell Biology for Engineers. It Satisfies 3 credits of the Advanced Chemistry and Biology electives.
- The Advanced Chemistry and Biology laboratory requirement is fulfilled with AS.020.315 Biochemistry Project lab or AS.250.253 Protein Engineering and Biochemistry Lab.
- Six credits of bioengineering electives are required. See department for a list of approved electives.
- Students take EN.540.313 Projects in ChemBE Unit Operations with Experiments instead of EN.540.311 Projects in ChemE Unit Operations with Experiments.

Sample Program of Study

First Year

First Semester	Credits	Second Semester	Credits
AS.030.101	3	AS.030.102	3
AS.030.105	1	AS.030.106	1
AS.110.108	4	AS.110.109	4
AS.171.101	4	AS.171.102	4
AS.173.111	1	Humanities/Social and Behavioral Sciences Elective	3
EN.540.101	1		
Humanities/Social and Behavioral Sciences Elective	3		
	17		15

Second Year

First Semester	Credits	Second Semester	Credits
EN.540.202	4	EN.540.203	3
AS.110.202	4	EN.540.303	3
EN.500.113	3	AS.110.302 (H/S Elective)	4
AS.030.205	4	Humanities/ Social and Behavior Sciences Elective	3
		Undesignated Elective	3
	15		16

Third Year

First Semester	Credits	Second Semester	Credits
EN.540.304	4	EN.540.301	4
AS.020.315 or AS.250.253	1-3	EN.540.306	4
Engineering Elective	3	EN.661.315	3
AS.020.305	4	Undesignated Elective	3
EN.540.490 (Undesignated Elective)	1	Advanced Chem/Bio Elective ^{1,2}	3
Undesignated Elective	1		
	14-16		17

Fourth Year

First Semester	Credits	Second Semester	Credits
EN.540.311	4	EN.540.314	3
EN.540.409	4	EN.540.315	2
Humanities/Social and Behavioral Sciences Elective	3	Engineering Elective	3
Engineering Elective	3	Humanities/Social and Behavioral Sciences Elective	3
		Undesignated Electives	5
	14		16

Total Credits 124-126

¹ Cell Biology for Engineers EN.540.307 or any course designated AS.020 and AS.030 at the 200, 300, 400 level.

² Advanced Chemistry or Biology lab: AS.030.225 Introductory Organic Chemistry Lab, AS.030.305 Physical Chemistry Instrumentation Lab I, AS.020.315 Biochemistry Project Lab, or AS.250.253 Protein Engineering and Biochemistry Lab.

Sample Program: Molecular and Cellular Bioengineering Track

First Year

First Semester	Credits	Second Semester	Credits
AS.030.101	3	AS.030.102	3
AS.030.105	1	AS.030.106	1
AS.110.108	4	AS.110.109	4
AS.171.101	4	AS.171.102	4
AS.173.111	1	Humanities/Social and Behavioral Sciences Elective	3
EN.540.101	1		
Humanities/Social and Behavioral Sciences Elective	3		
	17		15

Second Year

First Semester	Credits	Second Semester	Credits
EN.540.202	4	EN.540.203	3
AS.110.202	4	EN.540.303	3
EN.500.113	3	AS.110.302 (H/S Elective)	4
AS.030.205	4	EN.540.307	3
		Undesignated Elective	3
	15		16

Third Year

First Semester	Credits	Second Semester	Credits
EN.540.304	4	EN.540.301	4

AS.020.315 or AS.250.253	1-3 EN.540.306	4
Engineering Elective	3 EN.661.315	3
AS.020.305	4 Undesignated Elective	3
EN.540.490	1 Advanced Chem/Bio Elective ³	3
<hr/>		
13-15		17

Fourth Year

First Semester	Credits	Second Semester	Credits
EN.540.313	4	EN.540.314	3
EN.540.409	4	EN.540.315	2
Humanities/Social and Behavioral Sciences Elective	3	Bioengineering Elective	3
Bioengineering Elective	3	Humanities/Social and Behavioral Sciences Elective	3
		Undesignated Electives	7
<hr/>			
14			18

Total Credits 125-127

³ Advanced Biology lab: 020.315 Biochemistry Project Lab, or 250.253 Protein Engineering and Biochemistry Lab.

Interfaces and Nanotechnology (IN) Focus Area

Students must fulfill the following requirements

- Students take EN.540.204 Practical Applications of Thermodynamics to Complex Phase Equilibria.
- The Advanced Chemistry and Biology laboratory requirement is fulfilled with AS.030.305 Physical Chemistry Instrumentation Laboratory I.
- Sample Program: Interfaces and Nanotechnology Track

First Year

First Semester	Credits	Second Semester	Credits
AS.030.101	3	AS.030.102	3
AS.030.105	1	AS.030.106	1
AS.110.108	4	AS.110.109	4
AS.171.101	4	AS.171.102	4
AS.173.111	1	Humanities/Social and Behavioral Sciences Elective	3
EN.540.101	1		
Humanities/Social and Behavioral Sciences Elective	3		
<hr/>			
17			15

Second Year

First Semester	Credits	Second Semester	Credits
EN.540.202	4	EN.540.203	3
AS.110.202	4	EN.540.303	3
AS.020.305	4	AS.110.302	4
AS.030.205	4	Undesignated Elective	3
		Humanities/Social and Behavioral Sciences Elective	3
<hr/>			
16			16

Third Year

First Semester	Credits	Second Semester	Credits
EN.540.304	4	EN.540.301	4

AS.030.305	3	EN.540.306	4
AS.020.305	4	EN.661.315	3
EN.540.490	1	AS.030.452	3
Undesignated Elective	3	Undesignated Elective	3
Engineering Elective	3		
<hr/>			
18			17

Fourth Year

First Semester	Credits	Second Semester	Credits
EN.540.311	4	EN.540.314	3
EN.540.409	4	EN.540.315	2
Interfaces/Nanotechnology Elective	3	Interfaces/Nanotechnology Elective	3
Humanities/Electives Social	3	Undesignated Electives	5
		Humanities/Social and Behavioral Science Elective	
<hr/>			
14			13

Total Credits 126