BIOE120  Biology for Engineers

Credits: 3  Grading Method: Regular,  
Pass-Fail, Audit

Restriction: Permission of ENGR-Fischell Department of Bioengineering department.

Introduction to the functions and interactions of biological systems from a quantitative perspective. Introduction to the modern experimental techniques and methods of data analysis. Roles for bioengineers in biology, and the role of biology in bioengineering will be elucidated.

Students will be introduced to the functions and interactions of biological systems from a quantitative perspective. They will also be encouraged to solve problems through active inquiry, critical analysis, and creativity. Finally, roles for bioengineers in biology, and the role of biology in bioengineering will be elucidated.

<table>
<thead>
<tr>
<th>Section</th>
<th>Instructor</th>
<th>Seats (Total: 40, Open: 40, Waitlist: 0)</th>
</tr>
</thead>
</table>
| 0101    | Angela Jones | KEB 1110  
TuTh 9:30am - 10:45am  
W 5:00pm - 5:50pm  
EGR 1104  
Discussion |
| 0102    | Angela Jones | KEB 1110  
TuTh 9:30am - 10:45am  
Th 5:00pm - 5:50pm  
CSI 3120  
Discussion |
| 0201    | Instructor: TBA | KEB 1110  
MWF 12:00pm - 12:50pm  
Tu 5:00pm - 5:50pm  
CHM 0128  
Discussion |
| 0202    | Instructor: TBA | KEB 1110  
MWF 12:00pm - 12:50pm  
Th 2:00pm - 2:50pm  
EGR 1108  
Discussion |

BIOE121  Biology for Engineers Laboratory

Credits: 1  Grading Method: Regular,  
Pass-Fail, Audit

Restriction: Must be in Engineering: Bioengineering program.

This course will build on the material covered in BIOE120. Experiments conducted in this laboratory course will cover topics such as biomechanical principles, biochemical methods, genetics and selection, scaling, microcosm interactions, human factors and imaging.
<table>
<thead>
<tr>
<th>Time</th>
<th>Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tu 8:00am - 8:50am</td>
<td>CHE 2108</td>
</tr>
<tr>
<td>W 8:00am - 10:00am</td>
<td>CHE 1145</td>
</tr>
<tr>
<td>Tu 8:00am - 8:50am</td>
<td>CHE 2108</td>
</tr>
<tr>
<td>W 3:00pm - 5:00pm</td>
<td>CHE 1145</td>
</tr>
<tr>
<td>Tu 8:00am - 8:50am</td>
<td>CHE 2108</td>
</tr>
<tr>
<td>F 8:00am - 10:00am</td>
<td>CHE 1145</td>
</tr>
</tbody>
</table>

**BIOE221**  
Introduction to the Bioengineering Major  
Credits: 1  
Grading Method: Regular  

*Prerequisite: BIOE120 and BIOE121. Restriction: Must be in a major within the ENGR-Fischell Department of Bioengineering department.*  

*Introduces students to the bioengineering field through views from faculty, students, and professionals. Guides students through the BIOE major and elective tracks. Helps students with their own academic planning and career preparation.*

<table>
<thead>
<tr>
<th>Time</th>
<th>Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tu 4:00pm - 4:50pm</td>
<td>KEB 1200</td>
</tr>
</tbody>
</table>

**BIOE232**  
Bioengineering Thermodynamics  
Credits: 3  
Grading Method: Regular, Pass-Fail, Audit  

*Prerequisite: PHYS261 and PHYS260; and permission of ENGR-Fischell Department of Bioengineering department. Restriction: Must be in Engineering: Bioengineering program. Credit only granted for: BIOE232, ENES232, ENME232, or ENME320.*

*A quantitative introduction to thermodynamic analysis of bioengineering systems. Bioengineering encompasses a wide range of applications from nanoscale interactions (e.g. reactions between molecules), to cellular interactions (e.g. membrane electrical currents), to overall balances on organisms, all the way to large scale manufacturing. Each of these applications (and many others not mentioned) involve energy interactions which is the domain of thermodynamics. The basic laws of thermodynamics will be introduced and explained through a series of examples related to bioengineering systems.*
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
<th>Grading Method</th>
<th>Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE241</td>
<td>Biocomputational Methods</td>
<td>3</td>
<td>Regular, Pass-Fail, Audit</td>
<td>Permission of ENGR-Fischell Department of Bioengineering department.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Application of computer technology to biological and natural resource systems</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>considering engineering aspects. Designed to help students in the use of</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td>computer technology for problem solving. The course will cover 4-5 software</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>packages important for later use by the student.</td>
</tr>
<tr>
<td>BIOE331</td>
<td>Biofluids</td>
<td>3</td>
<td>Regular, Pass-Fail, Audit</td>
<td>Permission of ENGR-Fischell Department of Bioengineering department.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Credit only granted for: BIOE331, ENCE305, or ENME331.</td>
</tr>
</tbody>
</table>

**BIOE241 Biocomputational Methods**

<table>
<thead>
<tr>
<th>Section</th>
<th>Instructor</th>
<th>Seats (Total: 30, Open: 30, Waitlist: 0)</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>0101</td>
<td>Gregory Payne</td>
<td></td>
<td>TuTh 11:00am - 12:15pm</td>
<td>KEB 1110</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F 1:00pm - 1:50pm</td>
<td>EGR 0135</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Discussion</td>
<td></td>
</tr>
<tr>
<td>0102</td>
<td>Gregory Payne</td>
<td></td>
<td>TuTh 11:00am - 12:15pm</td>
<td>KEB 1110</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F 2:00pm - 2:50pm</td>
<td>EGR 0135</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Discussion</td>
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</table>

**BIOE331 Biofluids**

<table>
<thead>
<tr>
<th>Section</th>
<th>Instructor</th>
<th>Seats (Total: 30, Open: 30, Waitlist: 0)</th>
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<th>Location</th>
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</thead>
<tbody>
<tr>
<td>0101</td>
<td>Hubert Montas</td>
<td></td>
<td>MWF 4:00pm - 4:50pm</td>
<td>KEB 2107</td>
</tr>
<tr>
<td>0201</td>
<td>Hubert Montas</td>
<td></td>
<td>MWF 5:00pm - 5:50pm</td>
<td>KEB 2107</td>
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</table>

**BIOE331 Biofluids**

<table>
<thead>
<tr>
<th>Section</th>
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<th>Seats (Total: 30, Open: 30, Waitlist: 0)</th>
<th>Time</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>0101</td>
<td>Christopher Jewell</td>
<td></td>
<td>MW 12:30pm - 1:45pm</td>
<td>MCB 1207</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F 1:00pm - 2:50pm</td>
<td>CHM 0119</td>
</tr>
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<td></td>
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<td></td>
<td>Discussion</td>
<td></td>
</tr>
</tbody>
</table>
### BIOE340

**Modeling Physiological Systems and Lab**

| Credits: 4 | Grading Method: Regular, Pass-Fail, Audit |

Prerequisite: BSCI330, MATH246, BIOE120, BIOE121, and BIOE241; and permission of ENGR-Fischell Department of Bioengineering department. Credit only granted for: BIOE340 or (BSCI440 and BSCI441).

Topics covered will include cell and general physiology, membrane physiology, blood cells and clotting, circulation, metabolism, respiration, and the nervous system. A lab component will also be included.

### BIOE372

**Biostatistics for Experimental Design and Data Analysis**

| Credits: 3 | Grading Method: Regular |

Prerequisite: BIOE120, BIOE121, and BIOE241. Recommended: MATH246. Restriction: Must be in a major within the ENGR-Fischell Department of Bioengineering department. Credit only granted for: BIOE372 or STAT464.

This course will instruct students in the fundamentals of probability and statistics through examples in biological phenomenon, the design of bioengineering experiments, and clinical data analysis. Fundamentals covered in the course include probability distributions, hypothesis testing, power analysis, regression analysis, and correlation analysis.
BIOE399

Independent Study in Bioengineering

Credits: 1-3
Grading Method: Regular, Pass-Fail, Audit

Independent study.

Prerequisite: permission of department.

Contact department for information to register for this course.

BIOE399H

Independent Study in Bioengineering

Credits: 1-3
Grading Method: Regular, Pass-Fail, Audit

Independent study.

Contact department for information to register for this course.

BIOE404

Biomechanics

Credits: 3
Grading Method: Regular, Pass-Fail, Audit

Prerequisite: MATH246, BIOE120, ENES102, BIOE121, and BIOE241; and permission of ENGR-Fischell Department of Bioengineering department. Restriction: Must be in Engineering: Bioengineering program.

Introduction to the fundamentals of biomechanics including force analysis, mechanics of deformable bodies, stress and strain, multiaxial deformations, stress analysis, and viscoelasticity. Biomechanics of soft and hard tissues.
BIOE453

Biomaterials

Credits: 3
Grading Method: Regular, Pass-Fail, Audit

Prerequisite: CHEM231, MATH246, CHEM232, BIOE120, BIOE121, and BIOE241. Corequisite: BIOE454. Restriction: Permission of ENGR-Fischell Department of Bioengineering department. Also offered as: ENMA425. Credit only granted for: ENBE453, BIOE453, or ENMA4425. Formerly: ENBE453.

Examination of the structure and function of natural biomaterials, and cell-extracellular matrix interactions. Study physical properties of synthetic biomaterials for biomedical applications. Understanding molecular level interactions between biomolecules and biomaterials to design novel biomaterials with desirable characteristics. Application of biomaterials as implants, drug delivery systems, biosensors, engineered materials such as artificial skin and bone growth scaffolds will be covered.

0101
Instructor: TBA
Seats (Total: 30, Open: 30, Waitlist: 0)
MWF 11:00am - 11:50am
F 12:00pm - 12:50pm
KEB 1200
EGR 2154
Discussion

BIOE457

Biomedical Electronics & Instrumentation

Credits: 4
Grading Method: Regular, Pass-Fail, Audit

Prerequisite: BIOE120, BIOE121, BIOE241, and PHYS261. Restriction: Permission of ENGR-Fischell Department of Bioengineering department.

Students learn fundamental concepts of electronics, assembly of electronic components into functional circuits, and integration of functional electronic devices and circuits into a system. In the lab component, students will learn to assemble and evaluate circuits and systems.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Grading Method</th>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE485</td>
<td><strong>Capstone Design I: Entrepreneurship, Regulatory Issues, and Ethics</strong></td>
<td>3</td>
<td>Regular, Pass-Fail, Audit</td>
<td>21 credits in BIOE courses. Restriction: Permission of ENGR-Fischell Department of Bioengineering department; and senior standing; and must be in Engineering: Bioengineering program. Credit only granted for: BIOE485 or ENBE485. Formerly: ENBE485. This is the first part of a two-semester senior capstone design course which covers principles involved in engineering design, design approaches, economics of design, ethics in engineering, and patent regulations. It also helps students learn team work and write design project proposals under the mentorship of a faculty advisor. A Fearless Ideas Course from the Academy for Innovation &amp; Entrepreneurship (AIE): <a href="http://ter.ps/iamFEARLESS">http://ter.ps/iamFEARLESS</a> Click here for more information on the Fearless Ideas Courses.</td>
</tr>
<tr>
<td>BIOE489B</td>
<td><strong>Special Topics in Bioengineering; Numerical Methods in Bioengineering</strong></td>
<td>3</td>
<td>Regular, Pass-Fail, Audit</td>
<td>Exploring a variety of topics with Bioengineering.</td>
</tr>
<tr>
<td>BIOE489D</td>
<td><strong>Special Topics in Bioengineering; Bioinformatics and Biological Datamining</strong></td>
<td>3</td>
<td>Regular, Pass-Fail, Audit</td>
<td>Exploring a variety of topics with Bioengineering.</td>
</tr>
</tbody>
</table>
BIOE489H  
Special Topics in Bioengineering; Bioengineering Honors Seminar  
Grading Method: Regular, Pass-Fail, Audit  
Credits: 1  
Exploring a variety of topics with Bioengineering.

0101  
Jose Aranda-Espinoza  
Seats (Total: 40, Open: 40, Waitlist: 0)  
M 3:15pm - 4:15pm  
KEB 1200

BIOE489L  
Special Topics in Bioengineering; Metabolic Pathway Engineering  
Grading Method: Regular, Pass-Fail, Audit  
Credits: 3  
Exploring a variety of topics with Bioengineering.

Also offered as BIOE689L, ENCH468M, and ENCH648M. Credit will be granted for one of the following: BIOE489L, BIOE689L, ENCH468M, or ENCH648M.

0101  
Ganesh Sriram  
Seats (Total: 30, Open: 30, Waitlist: 0)  
MW 5:00pm - 6:15pm  
CHE 2136

BIOE601  
Biomolecular and Cellular Rate Processes  
Grading Method: Regular, Audit  
Credits: 3  
Credit only granted for: BIOE601 or ENCH859B.

Presentation of techniques for characterizing and manipulating non-linear biochemical reaction networks. Advanced topics to include mathematical modeling of the dynamics of biological systems; separation techniques for heat sensitive biologically active materials; and rate processes in cellular and biomolecular systems. Methods are applied to current biotechnological systems, some include: recombinant bacteria; plant insect and mammalian cells; and transformed cell lines.

0101  
William Bentley  
Seats (Total: 30, Open: 30, Waitlist: 0)  
TuTh 9:30am - 10:45am  
JMP 1202
### BIOE602
**Cellular and Tissue Biomechanics**

Grading Method: Regular, Audit

*Introduction to the fundamentals of biomechanics including force analysis, mechanics of deformable bodies, stress and strain, multiaxial deformations, stress analysis, and viscoelasticity. Biomechanics of soft and hard tissues.*

For BIOE majors only.

<table>
<thead>
<tr>
<th>0101</th>
<th>Kimberly Stroka</th>
<th>Seats (Total: 30, <strong>Open</strong>: 30, Waitlist: 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>TuTh 11:00am - 12:15pm</strong></td>
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<tr>
<td></td>
<td></td>
<td><strong>BPS 1236</strong></td>
</tr>
</tbody>
</table>

### BIOE604
**Cellular and Physiological Transport Phenomena**

Grading Method: Regular

*A study of transport processes, including momentum, energy and mass transport, relevant to biosystems at various scales from physiological to cellular systems. Transport leads to sets of partial differential equations and the course revolves around approaches to solving these equations to arrive at fundamental understanding of the physics of transport in biosystems.*

<table>
<thead>
<tr>
<th>0101</th>
<th>Jose Aranda-Espinoza</th>
<th>Seats (Total: 30, <strong>Open</strong>: 30, Waitlist: 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>TuTh 8:00am - 9:15am</strong></td>
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<tr>
<td></td>
<td></td>
<td><strong>EGR 2116</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BI01</th>
<th>Keith Herold</th>
<th>Seats (Total: 30, <strong>Open</strong>: 30, Waitlist: 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Class time/details on ELMs</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>ONLINE</strong></td>
</tr>
</tbody>
</table>

*This section is restricted to ENPM students only.*

### BIOE605
**BIOE Graduate Studies I**

Grading Method: Regular

*Restriction: Must be in ENGR: PhD Only-Bioengineering (Doctoral) program.*

*Introduction to the bioengineering graduate program. Students gain exposure to departmental research through lab rotation and to current research in the field through seminar. Students will also gain preparation and guidance on other first-year academic requirements.*
BIOE608  
**Bioengineering Seminar Series**

Credits: 1  
Grading Method: Regular, Audit

*A variety of topics related to Bioengineering will be presented in weekly seminars.*

For BIOE majors only.

<table>
<thead>
<tr>
<th>Course</th>
<th>Instructor</th>
<th>Credits</th>
<th>Grading Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE608</td>
<td>TBA</td>
<td>1</td>
<td>Regular, Audit</td>
<td>A variety of topics related to Bioengineering will be presented in weekly seminars. For BIOE majors only.</td>
</tr>
</tbody>
</table>

BIOE632  
**(Perm req)**

**Biphotonic Imaging and Microscopy**

Credits: 3  
Grading Method: Regular, Audit

*Prerequisite: PHYS270 and BIOE420; and permission of ENGR-Fischell Department of Bioengineering department. Credit only granted for: BIOE432, BIOE632, or BIOE689C.*

*Principles and instrumentation of various biomedical optical techniques including fluorescent and Raman spectroscopy, confocal and multi-photon microscopy, optical coherence tomography, and diffuse optical tomography. Biomedical applications will also be discussed.*

<table>
<thead>
<tr>
<th>Course</th>
<th>Instructor</th>
<th>Credits</th>
<th>Grading Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE632</td>
<td>Yu Chen</td>
<td>3</td>
<td>Regular</td>
<td>Principles and instrumentation of various biomedical optical techniques including fluorescent and Raman spectroscopy, confocal and multi-photon microscopy, optical coherence tomography, and diffuse optical tomography. Biomedical applications will also be discussed.</td>
</tr>
</tbody>
</table>

BIOE689  
**Special Topics in Bioengineering**

Credits: 1-3  
Grading Method: Regular

*Research Oriented Individual Instruction course.*

*Contact department for information to register for this course.*

BIOE689V  
**(Perm req)**

**Special Topics in Bioengineering; Computer-Aided Design in Bioengineering**

Credits: 3  
Grading Method: Regular

*Research Oriented Individual Instruction course.*
BIOE799  Master's Thesis Research
Credits: 1-6  Grading Method: Regular, Sat-Fail
Contact department for information to register for this course.

BIOE898  Pre-Candidacy Research
Credits: 1-8  Grading Method: Regular, Sat-Fail
Contact department for information to register for this course.

BIOE899  Doctoral Dissertation Research
(Perm req) Credits: 6  Grading Method: Regular, Sat-Fail
Contact department for information to register for this course.