The B.S. in Biological Engineering degree can lead immediately to careers in:  
- Ecological Engineering (water quality and watershed management, water resources and irrigation, low impact development in urban watersheds, stream and habitat restoration, and air quality remediation).
- Food and Bio-Product Process Engineering (food processing, forest products, biotechnology, biofuels, waste treatment and by-product utilization).
- Sustainable Resource Engineering (sustainable agriculture to expand the food supply for a growing population; renewable and bio-energy development; life cycle analysis to assess, design and manage complex biological systems; efficient utilization of organic residues and by-products; conservation of Earth’s finite resources).

Healthy Planet, Healthy People: this is the aspiration for the Biological Engineering program at the University of Arkansas. We improve people’s lives today and help assure a prosperous world for tomorrow by designing sustainable water, food, and energy systems. Where challenges exist, we create solutions by optimizing the living systems of our world (the interactions of human, plant, animal, environment, food, and microbes) using the tools of engineering and biotechnology. Biological engineers contribute significantly to human health and prosperity by ensuring a safe and readily available water supply, a safe and nutritious food supply, and a healthy ecosystem upon which both water and food depend.

The educational objectives of the Biological Engineering program at the University of Arkansas are to produce graduates who:

1. Competently and ethically practice engineering in the design and management of water, food, energy and related systems.
2. Make valuable and life-long contributions that benefit employers, clients and communities in Arkansas and the world.
3. Succeed in continuing professional development, including graduate studies, as needed for professional growth.

The Bachelor of Science in Biological Engineering degree can lead immediately to careers in:

Requirements for B.S. in Biological Engineering

The undergraduate program in biological engineering, leading to a Bachelor of Science degree in Biological Engineering, is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org). The B.S. in Biological Engineering degree is conferred by the College of Engineering and is granted after the successful completion of 128 hours of approved course work.

Diverse applications of biological engineering can be pursued through elective coursework. Each student is required to complete 12 semester hours of biological/engineering/technical electives that are relevant to their career goals. At least 3 hours must be selected from a list of acceptable biological electives. At least 3 hours must be engineering courses within BENG or other engineering programs. The remaining hours can be selected from engineering, math, biology, agriculture, sustainability, and other science/technical areas. A list of suggested electives is maintained by the department. Students may petition their adviser to seek approval of other electives that are not on this list. Courses must provide engineering or technical content that is value-added (i.e. not duplicating or remedial) and meets the career goals of the student.

Biological Engineering B.S.B.E.  
Eight-Semester Degree Program

The Bachelor of Science in Biological Engineering program is eligible for students who want to participate in an Eight Semester Degree Program. See the Eight-Semester Degree Policy (http://catalog.uark.edu/undergraduatecatalog/academicregulations/eightsemesterdegreecompletionpolicy) for more details. The plan below lists a semester-by-semester sequence of courses to finish the degree in eight semesters. University core courses for engineering are listed at the bottom of this page. Students may submit a maximum of four (4) hours of “D” in BENG Courses for their degree.

Some courses are not offered every semester, so students who deviate from the suggested sequence must pay careful attention to course scheduling and course pre-requisites.

<table>
<thead>
<tr>
<th>First Year</th>
<th>Fall</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>GNEG 1111 Introduction to Engineering I</td>
<td>1</td>
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</tr>
<tr>
<td>ENGL 1013 Composition I (ACTS Equivalency = ENGL 1013)</td>
<td>3</td>
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<tr>
<td>CHEM 1103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture)</td>
<td>3</td>
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<tr>
<td>MATH 2554 Calculus I (ACTS Equivalency = MATH 2405)</td>
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<tr>
<td>PHYS 2054 University Physics I (ACTS Equivalency = PHYS 2034)</td>
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<tr>
<td>GNEG 1121 Introduction to Engineering II</td>
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<tr>
<td>ENGL 1033 Technical Composition II or ENGL 1023 Composition II (ACTS Equivalency = ENGL 1023)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Freshman Engineering Science Elective</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>MATH 2564 Calculus II (ACTS Equivalency = MATH 2505)</td>
<td>4</td>
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</tbody>
</table>
HIST 2003 History of the American People to 1877 (ACTS Equivalency = HIST 2113) or HIST 2013 History of the American People, 1877 to Present (ACTS Equivalency = HIST 2123) or PLSC 2003 American National Government (ACTS Equivalency = PLSC 2003)

**Second Year**

<table>
<thead>
<tr>
<th>Units</th>
<th>Fall</th>
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</table>

**Fall**

- BENG 2632 Biological Engineering Design Studio 2
- MATH 2574 Calculus III (ACTS Equivalency = MATH 2603) 4
- Sophomore Science Elective 2 4
- BIOL 1543 Principles of Biology (ACTS Equivalency = BIOL 1014 Lecture) 3
- BIOL 1541L Principles of Biology Laboratory (ACTS Equivalency = BIOL 1014 Lab) 1
- MEEG 2003 Statics 3
- BENG 2643 Biological Engineering Methods I 3
- MATH 2584 Elementary Differential Equations 4
- BIOL 2013 General Microbiology (ACTS Equivalency = BIOL 2004 Lecture) 3
- BIOL 2011L General Microbiology Laboratory (ACTS Equivalency = BIOL 2004 Lab) 1
- MEEG 2403 Thermodynamics or CHEG 2313 Thermodynamics of Single-Component Systems 3

**Spring**

- Social Science Elective (from University Core list) 3

Year Total: 17 17

**Third Year**

<table>
<thead>
<tr>
<th>Units</th>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>16</td>
<td>15</td>
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</tbody>
</table>

**Fall**

- BENG 3653 Global Bio-Energy Engineering 3
- BENG 3733 Transport Phenomena in Biological Systems 3
- BENG 3663 Biological Engineering Methods II 3
- Choose one:
  - CHEM 3603 Organic Chemistry I & CHEM 3601L Organic Chemistry I Laboratory 4
  - CHEM 2613 Organic Physiological Chemistry (ACTS Equivalency = CHEM 1224 Lecture) & CHEM 3601L Organic Chemistry I Laboratory
- CVEG 3213 Hydraulics or MEEG 3503 Mechanics of Fluids or CHEG 2133 Fluid Mechanics 3
- BENG 3723 Unit Operations in Biological Engineering 3
- BENG 3113 Measurement and Control for Biological Systems 3
- CVEG 3223 Hydrology 3
- Biological Elective 3
- Technical Elective 3

Year Total: 16 15

**Fourth Year**

<table>
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<tr>
<th>Units</th>
<th>Fall</th>
<th>Spring</th>
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<td>18</td>
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</table>

- BENG 4812 Senior Biological Engineering Design I 2
- BENG 4831 Biological Engineering Professionalism 1
- BENG 4743 Food and Bio-Product Systems Engineering 3
- BENG 4933 Sustainable Watershed Engineering 3
- Humanities Elective (from University Core list) 3
- Social Science Elective (from University Core list) 3
- BENG 4823 Senior Biological Engineering Design II 3
- BENG 4663 Sustainable Biosystems Designs 3
- Technical Elective (Engineering) 3
- Fine Arts Elective (from University Core list) 3
- Social Science Elective (from University Core list) 3
- Technical Elective 3

Year Total: 15 18

Total Units in Sequence: 128

1. The Freshman Engineering Science Elective must be chosen from either CHEM 1123/CHEM 1121L or PHYS 2074.
2. The Sophomore Science Elective must be: PHYS 2074 if CHEM 1123/CHEM 1121L was chosen as the Freshman Engineering Science Elective; or CHEM 1123/CHEM 1121L if PHYS 2074 was chosen as the Freshman Engineering Science Elective. That is, both courses are required for the degree.

Costello, Thomas A., Ph.D. (Louisiana State University), M.S.Ag.E., B.S.Ag.E. (University of Missouri-Columbia), Associate Professor, 1986.
Haggard, Brian Edward, Ph.D. (Oklahoma State University), M.S. (University of Arkansas), B.S. (Missouri University of Science and Technology), Professor, 2006.
Henry, Christopher Garrett, Ph.D. (University of Nebraska-Lincoln), M.S., B.S. (Kansas State University), Assistant Professor, 2011.
Kim, Jin-Woo, Ph.D. (Texas A&M University), M.S. (University of Wisconsin-La Crosse), B.S. (University of Iowa), Professor, 2001.
Li, Yanbin, Ph.D. (Pennsylvania State University), M.S. (University of Nebraska-Lincoln), B.S. (Shenyang Agricultural University), Distinguished Professor, 1989.
Liang, Yi, Ph.D. (University of Alberta, Canada), M.S., B.S. (China Agricultural University, Beijing, China), Associate Professor, 2007.
Loewer, Otto J., Ph.D. (Purdue University), M.S. (University of Wisconsin-La Crosse), B.S. (University of Iowa), Associate Professor, 1989.
Liang, Yi, Ph.D. (University of Alberta, Canada), M.S., B.S. (China Agricultural University, Beijing, China), Associate Professor, 2007.
Loewer, Otto J., Ph.D. (Purdue University), M.S. (Michigan State University), B.S. (Louisiana State University), Professor, 1996.
Matlock, Marty D., Ph.D., M.S., B.S. (Oklahoma State University), Professor, 2001.
Osborn, G. Scott, Ph.D. (North Carolina State University), M.S., Ag.E., B.S. (University of Kentucky), Associate Professor, 2001.
Runkle, Benjamin R.K., Ph.D., M.S. (University of California–Berkeley), B.S. (Princeton University), Assistant Professor, 2014.
Sadaka, Sammy, Ph.D. (Dalhousie University, Canada, and Alexandria University, Egypt), M.S., B.S. (Alexandria University, Egypt), Assistant Professor, 2007.
Sullivan, Bailey A., Ph.D. (Texas A&M University), M.S., B.S. (Kansas State University), Instructor, 2015.
VanDevender, Karl, Ph.D. (University of Arkansas), M.S., B.S. (Mississippi State University), Professor, 1995.
Verma, Lalit R., Ph.D. (University of Nebraska-Lincoln), M.S. (University of Montana), B. Tech. (J.N. Agricultural University, Jabalpur, India), Professor, 2000.
Zhu, Jun, Ph.D. (University of Illinois at Urbana-Champaign), M.S., B.S. (Zhejiang University, Hangzhou, China), Professor, 2013.

Courses

BENG 2632. Biological Engineering Design Studio. 2 Hours.
Application of the engineering design process to projects involving living systems. Projects are team-based open-ended design with hands-on construction and testing of design prototypes. Emphasis is placed on understanding, quantifying and controlling complex interacting living systems involving humans, plants and microbes with the goal of creating economically and ecologically sustainable systems. 4 hours of design studio per week. Pre- or Corequisite: PHYS 2054 and BIOL 1543 and BIOL 1541L, and (GNEG 1111 or GNEG 1103).

BENG 2643. Biological Engineering Methods I. 3 Hours.

BENG 3113. Measurement and Control for Biological Systems. 3 Hours.
Principles of sensors, instruments, measurements, controls, and data acquisition systems, with emphasis on applications for biological systems; including basic circuit analysis, sensor calibration and hardware selection. Basic process monitoring and control methods, including hardware and software. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: PHYS 2074.

BENG 3113H. Honors Measurement and Control for Biological Systems. 3 Hours.
Principles of sensors, instruments, measurements, controls, and data acquisition systems, with emphasis on applications for biological systems; including basic circuit analysis, sensor calibration and hardware selection. Basic process monitoring and control methods, including hardware and software. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: PHYS 2074 and honors candidacy.
This course is equivalent to BENG 3113.

BENG 3635. Global Bio-Energy Engineering. 3 Hours.
Global energy sources with a focus on renewable energy, solar and biomass derived fuels. Biomass energy production from crops and organic residues or waste products. Conversion of biomass to usable fuels. Utilization of renewable energy in society. Includes detailed systems analyses to examine inputs, efficiencies, usable outputs and by-products. Systems design to select and integrate components which meet client needs while maximizing sustainable global impacts. Three hours of lecture per week. Pre- or Corequisite: MEEG 2403 or CHEG 2313.

BENG 3663. Biological Engineering Methods II. 3 Hours.
Modeling biological processes to predict system behavior as part of the design process. Development and use of spreadsheets and script programming code to represent biological phenomena and processes. Introduction to experimental design as applied to biological processes, including data collection and analysis, and elementary statistics. Use of engineering economics to aid comparisons of alternatives. Analysis of engineering designs and management practices to best meet the needs of society and the client in areas of sustainable water, food and energy systems. Lecture 3 hours per week. Prerequisite: PHYS 2054 and MATH 2564.

BENG 3723. Unit Operations in Biological Engineering. 3 Hours.
Design of basic unit operations typical of biological engineering practice; unit operations include pump-pipe, fan-duct, moist air (psychrometric) processes (cool/heater/humidifier/dryer), air mixing, aeration, and refrigeration; unit operations design will account for unique constraints imposed by biological systems. Lecture 2 hours and lab 3 hours per week. Corequisite: Lab component. Prerequisite: (MEEG 2403 or CHEG 2313) and (CVEG 3213 or CHEG 2313 or MEEG 3503).

BENG 3733. Transport Phenomena in Biological Systems. 3 Hours.
Basic principles governing transport of energy and mass. Estimating transfer of energy (heat) through solid bodies and liquid/gas boundary layers through conduction, convection, and radiation. Modeling the rates at which biological reactions occur (kinetics). Estimating the transfer of diffusing mass (gas or liquid) through solid bodies and liquid/gas boundary layers, including processes such as drying and oxygen diffusion. Three hours lecture per week. Pre- or Corequisite: (CVEG 3213 or MEEG 3503 or CHEG 2133) and (CVEG 3213 or ECEG 3213 or MEEG 3503).

BENG 4123. Biosensors & Bioinstrumentation. 3 Hours.
Principles of biologically based sensing elements and interfacing techniques. Design and analysis methods of biosensing and transducing components in bioinstrumentation. Applications of biosensors and bioinstrumentation in bioprocessing, bioenvironmental, biomechanical and biomedical engineering. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: PHYS 2074 and (CVEG 3213 or MEEG 3503 or CHEG 2133) or (MEEG 2403 or CHEG 2313) and (MATH 2584).

BENG 4132. Special Problems. 1-4 Hour.
Selected problems in biological engineering are pursued in detail. Prerequisite: Senior standing. May be repeated for up to 12 hours of degree credit.

BENG 451VH. Honors Thesis. 1-6 Hour.
Honors thesis. Prerequisite: Honors candidacy.

BENG 452V. Special Topics in Biological Engineering. 1-6 Hour.
Special topics in biological engineering not covered in other courses. Prerequisite: Engineering student. May be repeated for up to 8 hours of degree credit.

BENG 4663. Sustainable Biosystems Designs. 3 Hours.
Process and methodologies associated with measuring, assessing, and designing sustainable systems in water, energy and food. Quantitatively rigorous methodology for life cycle analysis (LCA) for inventory, assessment and impact analyses. Use of other systems analyses and process control theory to evaluate and design sustainable systems. Application of the methods to a project to gain experience in defining, quantifying and utilizing sustainable metrics. Three hours of lecture per week. Prerequisite: BENG 3653.
**BENG 4703. Biotechnology Engineering. 3 Hours.**
Introduction to biotechnology topics ranging from principles of microbial growth, mass balances, bioprocess engineering as well as emerging principles in the design of biologically based microbial and enzymatic production systems. Application areas such as biofuels, and fine and bulk chemical production. Lecture 2 hours, laboratory 3 hours per week. Prerequisite: BENG 2632. Corequisite: Lab component.

**BENG 4743. Food and Bio-Product Systems Engineering. 3 Hours.**
Sustainable bio-product engineering through biosystem design, analysis, modeling, control, and optimization. Life cycle phases for bio-products (food, fiber, feed, and fuel). System analysis of inputs and outputs of energy, water and mass for the purpose of producing and processing biomass for human uses. Advanced bioprocess design topics to utilize enzymes, cells, tissues and organisms to create bio-products and methods for deactivating biological agents to preserve the quality and safety of food and other bio-products. Three hours lecture per week. Prerequisite: BENG 3723 and BENG 3733.

**BENG 4753L. Nanotechnology Laboratory. 3 Hours.**
Provides students with hands-on experience in several major areas of nanotechnology, including nanoscale imaging, synthesis of nanomaterials, nanostructure assembly and manipulation, device and system integration, and performance evaluation. Students can earn credit for only one of the following courses: MEEG 4323L, BENG 4753L, BMEG 4103L, CHEM 4153L, PHYS 4793L. Corequisite: Drill component, junior standing and instructor consent. Prerequisite: MATH 2564, PHYS 2074, and CHEM 1123.
This course is cross-listed with MEEG 4323L, CHEM 4153L, PHYS 4793L.

**BENG 4753M. Honors Nanotechnology Laboratory. 3 Hours.**
Provides students with hands-on experience in several major areas of nanotechnology, including nanoscale imaging, synthesis of nanomaterials, nanostructure assembly and manipulation, device and system integration, and performance evaluation. Students can earn credit for only one of the following courses: MEEG 4323L, BENG 4753L, BMEG 4103L, CHEM 4153L, PHYS 4793L. Corequisite: Drill component, junior standing and instructor consent. Prerequisite: MATH 2564, PHYS 2074, and CHEM 1123.
This course is cross-listed with MEEG 4323L, CHEM 4153L, PHYS 4793L.

**BENG 4812. Senior Biological Engineering Design I. 2 Hours.**
Initiation of comprehensive two-semester team-design projects to design processes, devices and systems to meet needs of clients in sustainable water, food and energy. Practice in following the design process, including the definition of design objectives and constraints, establishing functions and performance criteria, generating alternatives and evaluating alternatives through analysis, modeling and prototype testing; exploring relevant design considerations including performance, efficiency, costs, environmental impacts, sustainability and stewardship, safety and ethics. Developing analytic capability; and practicing design optimization to find best alternative for the client. Lecture 1 hour, laboratory 3 hours per week. Prerequisite: Instructor consent. Corequisite: Lab component.

**BENG 4823. Senior Biological Engineering Design II. 3 Hours.**
Completion of comprehensive two-semester team-design projects to design processes, devices and systems to meet needs of clients in sustainable water, food and energy. Focus on building of prototypes or models, system optimization, evaluation and improvement. Final design details packaged to meet the needs of the client. Interaction with appropriate persons from other disciplines. Written and oral reporting. Communications with peers, supervisor, clients and the public. Lecture 1 hour per week, two 2-hour lab periods per week. Prerequisite: BENG 4812. Corequisite: Lab component.

**BENG 4831. Biological Engineering Professionalism. 1 Hour.**
Preparation to be job-ready, employable and successful in transition to a professional career and further study in Biological Engineering. Introduction to job and graduate study searches. Professional and ethical responsibilities; professional registration. Conflict, change and project management. Effective communications and interactions with supervisors, peers, clients, and stakeholders. Two hour discussion section per week. Prerequisite: Senior standing.

**BENG 4933. Sustainable Watershed Engineering. 3 Hours.**
Provides students with expertise in using advanced tools in watershed monitoring, assessment, and design. Builds on core competencies in hydrology and hydraulics to allow student to evaluate water used by sector in water management regions; evaluate and quantify water demands by sector with emphasis on irrigation; develop risk-based simulations of hydrologic processes, including precipitation, evapotranspiration, infiltration, runoff, and stream flow; quantify and simulate constituent loading to watersheds using GIS-based models, and understand the applications of these methods in water resource management policy. Three hours lecture per week. Prerequisite: CVEG 3223.