Biochemistry

Degree Offered
Bachelor of Science

Nature of Program
The biochemistry curriculum prepares students for careers requiring a strong background in basic principles of the physical and life sciences. The program is a collaborative effort between the Division of Animal and Nutritional Sciences in the Davis College of Agriculture, Natural Resources and Design, and the Departments of Biology and Chemistry in the Eberly College of Arts and Sciences.

Students completing a biochemistry major are prepared for professional employment in the expanding fields of agricultural and environmental sciences, chemical industry, health-related industries and biotechnology-based industries. The curriculum provides students with the interdisciplinary background in biochemistry, biology, chemistry, mathematics, physics and molecular biology necessary as preparation for professional schools of human and veterinary medicine, dentistry, optometry, and pharmacy. It also provides strong preparation for graduate study in fields such as animal and plant agriculture, biochemistry, biology, molecular biology, genetics, biotechnology, chemistry, food science, nutrition and physiology. The curriculum is modeled after the American Society of Biochemistry and Molecular Biologists guidelines. The degree requirements for a American Chemical Society certified degree can be met within the framework of the program.

Performance Requirements
To maintain biochemistry major status and to graduate, students must maintain at least a 2.0 overall GPA and a 2.0 cumulative GPA in coursework in biology, chemistry, and biochemistry.

Minors
All students have the possibility of earning one or more minors; list of all available minors and their requirements (http://catalog.wvu.edu/undergraduate/minors). Please note that students may not earn a minor in their major field.

Certificate of Global Engagement
Students in the Eberly College, regardless of their major, can earn a Certificate of Global Engagement. Completion of the Certificate demonstrates the student’s knowledge of diverse cultures, as well as the ability to communicate and interact effectively with people of different cultural backgrounds. Students will be required to apply their knowledge of contemporary issues and global social contexts to their course work and their broader citizenship. For details regarding Certificate requirements, please visit the Eberly College page (http://catalog.wvu.edu/undergraduate/eberlycollegeofartsandsciences/#otherdegreeextext).

FACULTY

ANIMAL & NUTRITIONAL SCIENCES DIVISION DIRECTOR
- Robert L. Taylor - Ph.D. (Mississippi State University)
  Professor - Immunology and Disease Resistance

BIOLOGY CHAIR
- Richard B. Thomas - Ph.D. (Clemson University)
  Professor of Physiological plant ecology, Forest ecology, Global climate change

CHEMISTRY CHAIR
- Gregory Dudley - PhD (Massachusetts Institute of Technology)
  Professor and Department Chair

PROFESSORS
- Ashok P. Bidwai - Ph.D. (University of Utah)
  Molecular genetic analysis of protein kinase, CK2 in Drosophila
- Jonathan R. Cumming - Ph.D. (Cornell University)
  Environmental plant physiology, Ecophysiology of root-mycorrhizal-soil interactions, Urban ecology
- Kenneth P. Blemings - Ph.D. (University of Wisconsin)
  Nutritional Biochemistry, Protein and Amino Acid Metabolism
- Robert A. Dailey - Ph.D. (University of Wisconsin)
Reproductive Physiology

- Harry O. Finklea - Ph.D. (California Institute of Technology)
  Analytical/physical chemistry, Electron transfer kinetics, Solid oxide fuel cells, Gas phase sensors
- Terry Gullion - Ph.D. (William and Mary)
  Physical chemistry, Solid State NMR, Biological Materials, Polymers
- Lisa Holland - Ph.D. (University North Carolina-Chapel Hill)
  Micro-separations, High-throughput drug screening
- Glen Jackson - Ph.D. (West Virginia University)
  Mass spectrometry, Forensic science
- Jacek Jaczynski - Ph.D. (Oregon State University)
  Food Science and Technology
- Charles Jaffe - Ph.D. (University of Colorado)
  Theoretical chemistry, Molecular dynamics, Chaotic systems
- P. Brett Kenney - Ph.D. (Kansas State University)
  Animal Science and Meat Science
- Fred L. King - Ph.D. (University of Virginia)
  Analytical chemistry, Mass spectrometry, Trace elements, Gas-phase chemistry
- Hillar Klandorf - Ph.D. (British Council for National Academic Awards)
  Physiology
- Kristen E. Matak - Ph.D. (Virginia Polytechnic Institute and State University)
  Human Nutrition and Foods
- James B. McGraw - Ph.D. (Duke University)
  Plant ecology: Evolutionary ecology of perennial plants, Conservation biology, Demography, Forest remote sensing
- Joseph S. Moritz - Ph.D. (Kansas State University)
  Effect of feed form on animal performance
- John H. Penn - Ph.D. (University of Wisconsin-Madison)
  Chemical education, On-line instruction methods in organic chemistry
- Jeffrey L. Petersen - Ph.D. (University of Wisconsin-Madison)
  Associate Chairperson, Physical inorganic chemistry, Electrophilic transition metal complexes, X-ray crystallography
- Jennifer Robertson-Honecker - Ph.D.
  Adjunct Professor in Chemistry and STEM Specialist, WVU Extension
- Kenneth Showalter - Ph.D. (University of Colorado)
  Bennett Distinguished Professor, physical chemistry, Chemical kinetics, Multi-stability and oscillating chemical systems
- Bjorn Soderberg - Ph.D. (Royal Institute of Technology, Sweden)
  Organic synthesis using transition metals
- Janet C. L. Tou - Ph.D. (University of Toronto)
  Human nutrition and foods
- Matthew E. Wilson - Ph.D. (Iowa State University)
  Reproductive Physiology
- Jianbo Yao - Ph.D. (McGill University)
  Molecular Biology - Genetics

ASSOCIATE PROFESSORS

- Kimberly M. Barnes - Ph.D. (University of Nebraska)
  Coordinator of the Intercollegiate Biochemistry Program
- Suzanne Bell - Ph.D. (University of New Mexico)
  Analytical chemistry, Forensic science
- Clifton P. Bishop - Ph.D. (University of Virginia)
  Molecular genetics, Developmental biology, Forensic biology
- Jonathan Boyd
- Kevin C. Daly - Ph.D. (University of Arizona)
  Sensory neurobiology, Neural coding, Brain-behavior interactions, Comparative psycho-biology
- Stephen DiFazio - Ph.D. (Oregon State University)
  Plant genomics, Molecular ecology, Plant population genetics, Biotechnology risk assessment
- Sarah M. Farris - Ph.D. (University of Illinois at Urbana-Champaign)
Evolution and development of the insect brain, Neuroanatomy
• Eugene E. Felton - Ph.D. (University of Missouri)
  Ruminant nutrition
• Marlon Knights - Ph.D. (West Virginia University)
  Reproductive Physiology and Animal Production
• K. Marie Krause - Ph.D. (University of Wisconsin)
  Dairy Science Nutrition
• Justin Legleiter - Ph.D. (Carnegie-Mellon University)
  Biophysical Chemistry, Atomic Force Microscopy
• Melissa Olfert - Ph.D., R.D. (Loma Linda University)
  Health and wellness
• William T. Peterjohn
  Ecosystem ecology: Effects of global change on ecosystem dynamics, Nitrogen cycling in natural ecosystems.
• Michelle Richards-Babb - Ph.D. (Lehigh University)
  Chemical education
• Rita V.M. Rio - Ph.D. (Yale University)
  Symbioses
• Alan M. Stolzenberg - Ph.D. (Stanford University)
  Inorganic chemistry, Bio-inorganic chemistry, Organometallic chemistry
• Michelle D. Withers - Ph.D. (University of Arizona)
  Biology education, Neurobiology

ASSISTANT PROFESSORS
• Craig Barrett - Ph.D.
  Plant Evolutionary Biology
• Sadie Bergeron - Ph.D.
  Developmental Neuroscience
• Scott A. Bowdridge - Ph.D. (Virginia Tech)
  Food Animal Production, Parasite Immunology
• Edward Brzostek - Ph.D.
  Forest Ecology and Ecosystem Modeling
• Andrew Dacks - Ph.D. (University of Arizona)
  Neurobiology
• Tim Driscoll - Ph.D.
• Jennifer Gallagher - Ph.D.
• Fabien Goulay - Ph.D. (University of Rennes, France)
  Physical chemistry, Laser spectroscopy
• Jennifer Hawkins - Ph.D. (University of Iowa)
  Plant comparative genomics, Molecular evolution
• Jessica Hoover - Ph.D. (University of Washington)
  Organometallics chemistry, Catalysis
• Peng Li
• Melissa Marra - Ph.D., R.D. (Florida International University)
  Healthy aging and nutritional prevention of chronic disease
• Gary Marsat - Ph.D.
  Neuroscience
• Blake Mertz - Ph.D. (Iowa State University)
  Computational biophysics and chemistry
• Carsten Milsmann - Ph.D. (Max-Planck Institute for Bioinorganic Chemistry)
  Bioinorganic organometallic chemistry
• Brian Popp - Ph.D. (University of Wisconsin-Madison)
  Organic and organometallic chemistry, Catalysis
• Kevin Shaffer - Ph.D.
  Extension Livestock Production Specialist
• Cangliang Shen - Ph.D. (Colorado State University)
  Food Systems and Human Health
• Stephen Valentine - Ph.D. (Indiana University)
  Mass spectrometric analysis of biomolecules

CLINICAL ASSOCIATE PROFESSOR
• Donna Ford-Werntz - Ph.D. (Washington University/Missouri Botanical Garden)
  Plant systematics: Portulacaceae, West Virginia flora

TEACHING ASSOCIATE PROFESSORS
• Megan Govindan - M.P.H., M.S., R.D. (West Virginia University)
  Human nutrition and foods
• Margaret A. Minch - D.V.M. (The Ohio State University)
  Veterinary medicine
• Betsy B. Ratcliff - Ph.D. (Binghamton University)
  Innovative Teaching Methods
• Tabitha Razunguzwa - Ph.D. (West Virginia University)
  Physical Chemistry
• Mingming Xu - Ph.D. (Ohio University)
  General Chemistry

TEACHING ASSISTANT PROFESSORS
• Kevin Barry - Ph.D. (University of Maryland)
  Conservation Ecology
• Erin Battin - Ph.D. (Clemson University)
  Bio-inorganic chemistry
• Adam Burda - R.D.
• Melissa Ely - Ph.D. (West Virginia University)
  General Chemistry
• Amaris Guardiola - Ph.D. (Duke University)
• Dana Huebert-Lima - Ph.D. (University of Wisconsin-Madison)
  Epigenetics
• Kevin Lee - Ph.D. (Temple University)
  Virology, Cell and molecular biology methods
• John Navaratnam - Ph.D. (West Virginia University)
  Wetland ecology
• Joshua Osbourn - Ph.D. (University of Pittsburgh)
  Organic chemistry
• Crystal Smith - Ed.D. (West Virginia University)
• Jennifer Stueckle - Ph.D. (West Virginia University)
  Aquatic toxicology
• Mark R. Tinsley - Ph.D. (Leeds University, England)
  Nonlinear dynamics, chemical oscillators, moving precipitation patterns
• Stephanie T. Young - Ph.D. (West Virginia University)
  Molecular and Forensic Biology

SENIOR LECTURERS
• Sue Raylman - Ph.D.
  Animal behavior
• Sydha Salihu
  Instructor
• Mark Schraf - M.S. (West Virginia University)
  Analytical chemistry
• Susan Studlar - Ph.D. (University of Tennessee, Knoxville)
  Bryology and botany
• Elizabeth Thomas - M.S. (Clemson University)
  Invertebrate zoology
PROFESSORS EMERITI

- E. Keith Inskeep - Ph.D. (University of Wisconsin)  Reproductive physiology
- Paul Lewis - Ph.D.  Assistant Director of Outreach and Community Affairs for Davis College
- Robert S. Nakon - Ph.D. (Texas A&M University)  Inorganic chemistry
- Ronald B. Smart - Ph.D.
- Anthony Winston - Ph.D. (Duke U.)  Polymer chemistry

Click the appropriate link below to view the corresponding Biochemistry Track Requirements and Suggested Plans of Study.

- American Chemical Society (ACS) (p. 8)
- American Society of Biochemistry and Molecular Biology (ASBMB) (p. 9)

GENERAL EDUCATION FOUNDATIONS

Please use this link to view a list of courses that meet each GEF requirement. (http://registrar.wvu.edu/gef)

NOTE: Some major requirements will fulfill specific GEF requirements. Please see the curriculum requirements listed below for details on which GEFs you will need to select.

General Education Foundations

<table>
<thead>
<tr>
<th>F1 - Composition &amp; Rhetoric</th>
<th>3-6</th>
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<tbody>
<tr>
<td>ENGL 101</td>
<td>Introduction to Composition and Rhetoric</td>
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<tr>
<td>ENGL 102</td>
<td>and Composition, Rhetoric, and Research</td>
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<tr>
<td>or ENGL 103</td>
<td>Accelerated Academic Writing</td>
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<table>
<thead>
<tr>
<th>F2A/F2B - Science &amp; Technology</th>
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<tr>
<td>F3 - Math &amp; Quantitative Skills</td>
<td>3-4</td>
</tr>
<tr>
<td>F4 - Society &amp; Connections</td>
<td>3</td>
</tr>
<tr>
<td>F5 - Human Inquiry &amp; the Past</td>
<td>3</td>
</tr>
<tr>
<td>F6 - The Arts &amp; Creativity</td>
<td>3</td>
</tr>
<tr>
<td>F7 - Global Studies &amp; Diversity</td>
<td>3</td>
</tr>
<tr>
<td>F8 - Focus (may be satisfied by completion of a minor, double major, or dual degree)</td>
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<td>Total Hours</td>
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Please note that not all of the GEF courses are offered at all campuses. Students should consult with their advisor or academic department regarding the GEF course offerings available at their campus.

CURRICULUM REQUIREMENTS

- Writing Requirement; Biochemistry Bachelor of Science students fulfill the Writing and Communication Skills requirement by completing ENGL 101 and ENGL 102 (or ENGL 103), and at least two additional SpeakWrite Certified Courses™ from: BIOL 115, BIOL 117, BIOL 219, BIOL 411, CHEM 403.

University Requirements

<table>
<thead>
<tr>
<th>WVEU 191</th>
<th>First Year Seminar</th>
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<td>GEF Requirements: number of credits will vary depending on overlap</td>
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Program Core Requirements

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<tr>
<th>AGBI 199</th>
<th>Orientation to Biochemistry</th>
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<tbody>
<tr>
<td>AGBI 410</td>
<td>Introductory Biochemistry (Minimum grade of C-)</td>
</tr>
<tr>
<td>AGBI 412</td>
<td>Introduction to Biochemistry Wet Laboratory (Minimum grade of C-)</td>
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Biology Requirement

<table>
<thead>
<tr>
<th>BIOL 115</th>
<th>Principles of Biology (Minimum grade of C-. May substitute BIOL 101-104)</th>
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<tbody>
<tr>
<td>BIOL 117</td>
<td>Introductory Physiology (Minimum grade of C-)</td>
</tr>
<tr>
<td>BIOL 219</td>
<td>The Living Cell (Minimum grade of C-)</td>
</tr>
<tr>
<td>BIOL 310</td>
<td>Advanced Cellular/Molecular Biology</td>
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Chemistry Requirement
Select one set (Minimum grade of C-):

<table>
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<tr>
<th>Course</th>
<th>Description</th>
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<tbody>
<tr>
<td>CHEM 115 &amp; CHEM 116 &amp; CHEM 215</td>
<td>Fundamentals of Chemistry and Introductory Analytical Chemistry</td>
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<td>or:</td>
<td></td>
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<tr>
<td>CHEM 117 &amp; CHEM 118</td>
<td>Principles of Chemistry and Principles of Chemistry</td>
</tr>
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</table>

and all of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>CHEM 233 &amp; CHEM 234 &amp; CHEM 235 &amp; CHEM 236</td>
<td>Organic Chemistry (Minimum grade of C-)</td>
</tr>
<tr>
<td>CHEM 341 &amp; CHEM 342</td>
<td>Physical Chemistry: Brief Course and Experimental Physical Chemistry</td>
</tr>
<tr>
<td>CHEM 462 &amp; CHEM 464</td>
<td>Biochemistry 2 and Biochemistry 2 Laboratory</td>
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**Mathematics and Statistics Requirement**

<table>
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<th>Minimum grade of C-</th>
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<tbody>
<tr>
<td>MATH 155</td>
<td>Calculus 1</td>
</tr>
<tr>
<td>MATH 155 &amp; MATH 154</td>
<td>Calculus 1a with Precalculus and Calculus 1b with Precalculus</td>
</tr>
<tr>
<td>MATH 156</td>
<td>Calculus 2</td>
</tr>
<tr>
<td>STAT 211</td>
<td>Elementary Statistical Inference</td>
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</tbody>
</table>

31

A track is required. Number of credits may vary depending on courses selected

**Biochemistry Electives**

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
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</table>
### Biochemistry

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tr>
<td>BIOL 348</td>
<td>Neuroscience 1</td>
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<tr>
<td>BIOL 350</td>
<td>Plant Physiology</td>
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<tr>
<td>BIOL 386</td>
<td>Undergraduate Research</td>
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<tr>
<td>BIOL 410</td>
<td>Cell and Molecular Biology Methods</td>
</tr>
<tr>
<td>BIOL 411</td>
<td>Introduction to Recombinant DNA</td>
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<tr>
<td>BIOL 413</td>
<td>Molecular Endocrinology</td>
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<tr>
<td>BIOL 414</td>
<td>Molecular Endocrinology-Laboratory</td>
</tr>
<tr>
<td>BIOL 415</td>
<td>Epigenetics</td>
</tr>
<tr>
<td>BIOL 420</td>
<td>Genomics</td>
</tr>
<tr>
<td>BIOL 423</td>
<td>Biochemistry of Nucleic Acids and Proteins</td>
</tr>
<tr>
<td>BIOL 424</td>
<td>Protein Structure and Function</td>
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<tr>
<td>BIOL 425</td>
<td>Developmental Genetics</td>
</tr>
<tr>
<td>BIOL 426</td>
<td>Molecular Biology of Cancer</td>
</tr>
<tr>
<td>BIOL 432</td>
<td>Forensic Biology</td>
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<tr>
<td>BIOL 436</td>
<td>General Animal Physiology</td>
</tr>
<tr>
<td>BIOL 440</td>
<td>Comparative Anatomy</td>
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<tr>
<td>BIOL 441</td>
<td>Vertebrate Microanatomy</td>
</tr>
<tr>
<td>BIOL 453</td>
<td>Molecular Basis of Disease</td>
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<tr>
<td>BIOL 454</td>
<td>Immunology</td>
</tr>
<tr>
<td>BIOL 496</td>
<td>Senior Thesis</td>
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<tr>
<td>BIOL 497</td>
<td>Research</td>
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<tr>
<td>CHEM 310</td>
<td>Instrumental Analysis</td>
</tr>
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<td>CHEM 312</td>
<td>Environmental Chemistry</td>
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<tr>
<td>CHEM 339</td>
<td>Organic Syntheses</td>
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<tr>
<td>CHEM 422</td>
<td>Intermediate Inorganic Chemistry</td>
</tr>
<tr>
<td>CHEM 460</td>
<td>Forensic Chemistry</td>
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<tr>
<td>CHEM 496</td>
<td>Senior Thesis</td>
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<tr>
<td>CHEM 497</td>
<td>Research</td>
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<tr>
<td>CHEM 514</td>
<td>Mass Spectrometry Principles and Practices</td>
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<td>CHEM 516</td>
<td>Bioanalytical Chemistry</td>
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<td>CHEM 552</td>
<td>Biochemical Toxicology</td>
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<tr>
<td>ENTO 404</td>
<td>Principles of Entomology</td>
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<td>Pest Management</td>
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<td>FDST 445</td>
<td>Food Microbiology</td>
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<td>Food Microbiology Lab</td>
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<td>GEN 371</td>
<td>Principles of Genetics</td>
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<tr>
<td>HN&amp;F 460</td>
<td>Advanced Nutrition</td>
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<tr>
<td>HN&amp;F 473</td>
<td>Medical Nutrition Therapy 1</td>
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<tr>
<td>HN&amp;F 474</td>
<td>Medical Nutrition Therapy 2</td>
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<tr>
<td>HORT 330</td>
<td>Plant Propagation</td>
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<td>PPTH 401</td>
<td>General Plant Pathology</td>
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<td>VETS 302</td>
<td>Animal Pathology</td>
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<td>VETS 401</td>
<td>Veterinary Anatomy</td>
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<tr>
<td>VETS 405</td>
<td>Parasitology</td>
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### Capstone Requirement

**ASBMB Track**, select one of the following options:

- AGBI 386 Undergraduate Research Experience 1
- AGBI 486 and Undergraduate Research Experience 2
- A&VS 402 Values and Ethics

**ACS Track**, complete both of the following:

- CHEM 401 Chemical Literature
- CHEM 403 and Undergraduate Seminar
### General Electives

Number of electives may vary depending on course options selected

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<thead>
<tr>
<th>Course</th>
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<th>Hours</th>
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| Total Hours | 120 |

### AMERICAN CHEMICAL SOCIETY (ACS) TRACK

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<tr>
<td>CHEM 310</td>
<td>Instrumental Analysis</td>
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<tr>
<td>CHEM 401</td>
<td>Chemical Literature (Minimum grade of C-)</td>
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<tr>
<td>CHEM 403</td>
<td>Undergraduate Seminar</td>
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<tr>
<td>CHEM 422</td>
<td>Intermediate Inorganic Chemistry</td>
<td>3</td>
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<tr>
<td>CHEM 497</td>
<td>Research</td>
<td>3</td>
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<tr>
<td>PHYS 111</td>
<td>General Physics (Minimum grade of C-)</td>
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<tr>
<td>PHYS 112</td>
<td>General Physics (Minimum grade of C-)</td>
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Biochemistry Electives (See list above)

| Total Hours | 12 |

### SUGGESTED PLAN OF STUDY FOR THE AMERICAN CHEMICAL SOCIETY (ACS) TRACK

#### First Year

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<thead>
<tr>
<th>Semester</th>
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<td>ENGL 101 (GEF 1)</td>
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<td>BIOL 117 (GEF 8)</td>
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<td>MATH 156</td>
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#### Second Year

<table>
<thead>
<tr>
<th>Semester</th>
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<td>BIOL 219</td>
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<td>BIOL 310</td>
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#### Third Year

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| Total Hours | 120 |
General Elective 2

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Total credit hours: 120

* Students may substitute CHEM 117 and 118 for CHEM 115, 116, and 215.

**AMERICAN SOCIETY OF BIOCHEMISTRY AND MOLECULAR BIOLOGY (ASBMB) TRACK**

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<tr>
<th>Course Code</th>
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<td>BIOL 313</td>
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<td>or BIOL 410</td>
<td>Cell and Molecular Biology Methods</td>
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<td>AGBI 386</td>
<td>Undergraduate Research Experience 1</td>
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<td>&amp; AGBI 486</td>
<td>Undergraduate Research Experience 2</td>
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<td>&amp; A&amp;S 402</td>
<td>Values and Ethics</td>
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<td>BIOL 423</td>
<td>Biochemistry of Nucleic Acids and Proteins</td>
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<td>Biochemistry Electives (see list above)</td>
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Total Hours 31

**SUGGESTED PLAN OF STUDY FOR THE AMERICAN SOCIETY OF BIOCHEMISTRY AND MOLECULAR BIOLOGY (ASBMB) TRACK**

**First Year**

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<th>Fall Hours</th>
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<tr>
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**Second Year**

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**Third Year**

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<td>CHEM 462 &amp; CHEM 464</td>
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Total credit hours: 120

*Chem 117 and 118 may be substituted for Chem 115, 116, and 215.*

### Major Learning Goals

**BIOCHEMISTRY**

1. Graduates will demonstrate a working knowledge in the following core concepts:
   a. Energy is required by and transformed in biological systems.
   b. Macromolecular structure determines function and regulation.
   c. Information storage and flow are dynamic and interactive.
   d. Discovery requires objective measurement, quantitative analysis, and clear communication.

2. Graduates will demonstrate a working knowledge of the pervasive role evolution and homeostasis play in shaping the form and function of all biological molecules and organisms.

3. Graduates will demonstrate the ability to communicate scientific information using written, electronic, and oral communication practices and skills.

4. Graduates will demonstrate the ability to integrate knowledge and possess problem solving/critical thinking skills necessary for professional and social development and life-long learning and civic engagement.

### AGRICULTURAL BIOCHEMISTRY COURSES

**AGBI 199. Orientation to Biochemistry. 1,2 Hour.**
Orientation to degree programs and requirements, departmental resources, curriculum options, student responsibilities and opportunities.

**AGBI 293. Special Topics. 1-6 Hours.**
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

**AGBI 298. Honors. 1-3 Hours.**
PR: Students in Honors Program and consent by the honors director. Independent reading, study, or research.

**AGBI 386. Undergraduate Research Experience 1. 1,2 Hour.**
PR: At least sophomore standing and faculty permission. Students will write a research proposal, conduct supervised research, and write a progress report. This course is the first of a two-course sequence that leads to a research-based capstone experience. Students must also complete AGBI 486 for this to serve as the Biochemistry Capstone course.

**AGBI 393. Special Topics. 1-6 Hours.**
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

**AGBI 401. Senior Seminar in Biochemistry. 1 Hour.**
PR: Senior standing in biochemistry. Students select a topic at the forefront of biochemistry and gather information on the subject. Students then read, critically evaluate, write about the subject and present the topic in a seminar.

**AGBI 403. Applied Biochemistry Literature. 3 Hours.**
PR: Senior standing. Biochemistry Capstone Experience involving literature review, grant writing, and orally defending a proposal.

**AGBI 410. Introductory Biochemistry. 3 Hours.**
PR: CHEM 231 or (CHEM 233 or CHEM 235). Introduction to chemistry of cellular constituents (proteins, amino acids, carbohydrates, lipids, nucleic acids, enzymes and coenzymes) and their metabolism in animals and plants.

**AGBI 411. Introductory Biochemistry Laboratory. 1 Hour.**
PR or CONC: AGBI 410. Experiments to demonstrate certain principles and properties of animal and plant biochemicals.

**AGBI 412. Introduction to Biochemistry Wet Laboratory. 1 Hour.**
PR or CONC: AGBI 410 or Consent. Classic and modern techniques in biochemistry.
AGBI 480.Assigned Topics. 1-4 Hours.

AGBI 486. Undergraduate Research Experience 2. 2-4 Hours.
PR: AGBI 386 and faculty permission. Continuation of a research-based Capstone Experience where students will conduct supervised research, present their research, and prepare a final report. This course is the second of a two-course research-based sequence and must be completed after AGBI 386 to count as the capstone experience.

AGBI 490. Teaching Practicum. 1-3 Hours.
PR: Consent. Teaching practice as a tutor or assistant.

AGBI 491. Professional Field Experience. 1-18 Hours.
PR: Consent. (May be repeated up to a maximum of 18 hours.) Prearranged experiential learning program, to be planned, supervised, and evaluated for credit by faculty and field supervisors. Involves temporary placement with public or private enterprise for professional competence development.

AGBI 492. Directed Study. 1-3 Hours.
Directed study, reading, and or research.

AGBI 493. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

AGBI 494. Seminar. 1-3 Hours.
PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

AGBI 495. Independent Study. 1-6 Hours.
Faculty-supervised study of topics not available through regular course offerings.

AGBI 496. Senior Thesis. 1-3 Hours.
PR: Consent.

AGBI 497. Research. 1-6 Hours.
Independent research projects.

BIOLOGY COURSES

BIOL 101. General Biology. 3 Hours.
PR or CONC: BIOL 103. Introductory course in biology: cellular, organismal, and population genetics, including reproduction, growth and development, and evolution.

BIOL 102. General Biology. 3 Hours.
PR or CONC: BIOL 104. Introductory biology: energetics and physiology of cells, organisms, and populations, including regulation and control of multicellular organisms.

BIOL 103. General Biology Laboratory. 1 Hour.
PR or CONC: BIOL 101. Experiments in biology: genetics and evolution; reproduction, growth, and development of cells, organisms, and populations.

BIOL 104. General Biology Laboratory. 1 Hour.

BIOL 105. Environmental Biology. 3 Hours.
(Designed for non-biology majors.) Population growth and human impacts on the environment, including ecosystem destruction, biological diversity, pollution, and global climate change are explored to obtain the concepts necessary to understand complex environmental issues of our time.

BIOL 106. Environmental Biology Laboratory. 1 Hour.
CoReq: BIOL 105. Field and laboratory exercises explore fundamental ecological concepts and environmental problems, such as biodiversity, pollution, and natural resource utilization.

BIOL 107. Biotechnology and Society. 3 Hours.
An overview of the use of biotechnology to solve agricultural, medical, and environmental problems. Bioethical concerns and societal impacts of the use of the technologies will be discussed.

BIOL 115. Principles of Biology. 4 Hours.
An introductory course presenting basic principles of modern biology. This course represents the first in a four-course, integrated sequence required of biology majors. Topics include ecology and evolution, organismal biology, and cellular/molecular biology.

BIOL 117. Introductory Physiology. 4 Hours.
PR: BIOL 115 or BIOL 101 and BIOL 102 AND BIOL 103 AND BIOL 104. Continuation of BIOL 115. The diversity of reproductive, developmental, functional, and integrative mechanisms in plants and animals.

BIOL 122. Human Sexuality. 3 Hours.
A study of biological, behavioral and societal aspects of sexuality. Issues considered include changing fecundity, social-legal implications, sex roles, sexually transmitted diseases, populations, erotica, aging, dysfunctions, and decision-making skills for sex related issues.
BIOL 124. The Human Environment. 3 Hours.
An examination of several aspects of current worldwide environmental deterioration caused by the actions of humans. Public policies and alternative mitigative strategies are also presented.

BIOL 215. Cell Biology for Pre-Pharmacy. 3 Hours.
PR: BIOL 115 and BIOL 117 and (CHEM 115 or CHEM 117). Structure, function and diversity of cells with an emphasis on gene expression and cellular phenotype including cell chemistry, energetics, and regulation of cell activities. This course is offered only to Pre-Pharmacy majors.

BIOL 219. The Living Cell. 4 Hours.
PR: (CHEM 115 or CHEM 117) and (BIOL 117 or BIOL 240). Continuation of BIOL 117. Structure, function and diversity of cells with an emphasis on gene expression and cellular phenotype including cell chemistry, energetics, and regulation of cell activities.

BIOL 221. Ecology and Evolution. 3 Hours.

BIOL 235. Human Physiology. 3 Hours.
PR: (BIOL 101 and BIOL 102 and BIOL 103 and BIOL 104) or BIOL 115. (Intended for non-biology majors.) An introductory course in the function of the human.

BIOL 236. Human Physiology: Quantitative Laboratory. 1 Hour.
PR: MATH 156 and CHEM 116 and (BIOL 115 or (BIOL 101 and BIOL 102 and BIOL 103 and BIOL 104)) and PR or CONC: BIOL 235. Optional lab for BIOL 235 incorporating engineering concepts, such as mass and energy balances, circuit theory, and chemical kinetics to quantify and help understand many aspects of human physiology.

BIOL 293. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 298. Honors. 1-3 Hours.
PR: Students in the Honors Program and consent by the honors director. Independent reading, study, or research.

BIOL 301. History of Biology. 3 Hours.
PR: (BIOL 101 and BIOL 103 and BIOL 102 and BIOL 104) or BIOL 115. History of development of biological knowledge with philosophical and social backgrounds.

BIOL 302. Biometry. 3 Hours.
PR: STAT 211. Application of quantitative methods and statistics to biological data with emphasis on hands-on hypothesis construction, experimental design, data analysis and biological interpretation of statistical results.

BIOL 310. Advanced Cellular/Molecular Biology. 3 Hours.

BIOL 311. Advanced Cellular/Molecular Biology-Laboratory. 2 Hours.
PR or Conc: BIOL 310. Experimental approaches to the study of cellular systems.

BIOL 312. Introduction to Virology. 3 Hours.

BIOL 313. Molecular Basis of Cellular Growth. 3 Hours.
PR: BIOL 219. Study of the integration of internal and external influences as they regulate the division, growth, and differentiation of cells. Topics include hormones as cell effectors, cancer, and stem cells.

BIOL 315. Communicating Natural Science. 3 Hours.
PR: BIOL 219 or BIOL 221. Teaches students to effectively communicate about scientific discoveries and scientific issues in both written and oral forms to professional scientists, the public, the media and politicians. Students will learn to consider the knowledge, biases and goals of their intended audience to communicate thoughtfully and effectively.

BIOL 316. Developmental Biology. 3 Hours.
PR: BIOL 219. A molecular genetic analysis of the mechanisms by which multicellular organisms develop from single cells.

BIOL 317. Developmental Biology Laboratory. 1 Hour.
PR: BIOL 219. CoReq: BIOL 316. Experimental approaches to the genetic analysis of the mechanisms by which multicellular organisms develop from single cells.

BIOL 318. Writing Appalachian Ecology. 3 Hours.
This course encourages students to think about the long-term future of our planet. What could our world be like in 200 years? How will current environmental problems change the future? How will relationships with the natural world change? Students address questions like these in creative nonfiction essays they write about research being conducted at the Fernow Experimental Forest in WV.

BIOL 320. The Total Science Experience: Genomics. 2 Hours.
PR: BIOL 219. Biological research experience incorporating critical skills of being a research scientist, including writing grant proposals, manuscripts, and materials for presentation of results in a public forum. Students conceive, design, propose, execute, analyze, and report an experiment with a genomics focus. Fulfills the capstone requirement in Biology and provides a realistic exposure to joys and challenges of performing scientific research.
BIOLOGY 321. Total Science Experience Lab. 2 Hours.
PR or Conc: BIOL 221. Biological research experience incorporating diverse learning experiences that take place in the process of being a research scientist; including writing grant proposals, manuscripts, and presentation of results in a public forum.

BIOLOGY 324. Molecular Genetics. 3 Hours.
PR: BIOL 219. Theoretical and practical knowledge in genetics as a field of study and as an approach for investigating biological problems.

BIOLOGY 325. Molecular Genetics Laboratory. 1 Hour.
PR: BIOL 219. CoReq: BIOL 324. The laboratory is a logical sequence of experiments providing actual research experience in molecular genetics. Must be taken at the same time as BIOL 324.

BIOLOGY 327. Professional Development. 1 Hour.
PR: BIOL 219. This course provides an overview of opportunities for students graduating with degrees in the biological sciences. An assessment test will help identify strengths and weaknesses within the field.

BIOLOGY 335. Cell Physiology. 3 Hours.
PR: BIOL 219. Emphasis on the unity and diversity of cells; membrane structure and function; and the role that intracellular compartments, cytoskeleton, and extracellular matrix play in cell physiology.

BIOLOGY 336. Vertebrate Embryology. 4 Hours.
PR: BIOL 112 or BIOL 219. An experimental and descriptive analysis of vertebrate development. Students on the Morgantown campus will be required to complete BIOL 219.

BIOLOGY 337. Physiological Psychology. 3 Hours.
PR: PSYC 301 and junior or senior standing. Advanced study of the physiological mechanisms of behavior. Topics include neural and endocrine mechanisms of behavior and issues, methods, and findings in behavioral neuroscience. (Also listed as PSYC 426.).

BIOLOGY 338. Behavioral Ecology. 3 Hours.
PR: BIOL 112 or BIOL 221. Consideration of the influences of environmental factors on short-and long-term regulation, control, and evolution of the behavior of animals. Students on the Morgantown campus will be required to complete BIOL 221.

BIOLOGY 339. Animal Communication. 3 Hours.
PR: BIOL 221 or consent. Communication mediates most interactions between individuals and the brain dedicates much of its resources to generating and processing these signals. This course examines why and how animals communicate, the physiological mechanisms involved in generating / sensing communication signals, how evolution shapes communication, and how communication signals can influence decision making.

BIOLOGY 340. Invertebrate Zoology. 3 Hours.
PR: BIOL 221. The evolution of animals without vertebral columns.

BIOLOGY 341. Ichthyology. 4 Hours.
Study of the internal and external structure of fishes, their systematic and ecological relationships, and their distribution in time and space. (Dissection kit required.).

BIOLOGY 348. Neuroscience 1. 3 Hours.
PR: BIOL 219. An introduction to neuroscience, including basic neuroanatomical neurophysiology, and the relationship between the central nervous system, physiology, and behavior.

BIOLOGY 349. Neuroscience 2. 3 Hours.
PR: BIOL 348. An introductory systems level course on organization of the nervous system, from an evolutionary to a clinical perspective. Topics include development and functional organization of sensory, motor, autonomic and cognitive systems. The evolutionary history and human health concerns associated with these systems will be addressed, through lecture, discussion, and readings in the primary literature.

BIOLOGY 350. Plant Physiology. 4 Hours.
PR: (BIOL 117 and CHEM 116) or (CHEM 112 and PLSC 206). Physiochemical processes of plants.

BIOLOGY 351. Plant Diversity. 4 Hours.
PR: (BIOL 101 and BIOL 102 and BIOL 103 and BIOL 104) or BIOL 115. Evolution, morphology, life cycles, ecology, and uses of cyanobacteria, lichens, algae, bryophytes, ferns, gymnosperms, and angiosperms. Laboratory emphasizes comparing living specimens with local field trips.

BIOLOGY 352. Plant Anatomy and Development. 4 Hours.
PR: BIOL 117 or PLSC 206. How plants (especially angiosperms) develop, stand up, defend themselves, transport food and water, and reproduce; also evolution and uses of wood and bark. Students observe development from spores, seeds, and cuttings. (Two local field trips.).

BIOLOGY 353. Flora of West Virginia. 3 Hours.
PR: (BIOL 101 and BIOL 103 and BIOL 102 and BIOL 104) or BIOL 115. Identification of local woody and herbaceous seed plants, with emphasis on common native and introduced species. Conducted primarily through field trips to nearby areas with the use of dichotomous keys to determine the scientific names of observed specimens.

BIOLOGY 356. Plant Ecology. 4 Hours.
PR: BIOL 221. Introduction to the four divisions of plant ecology, including physiological ecology, population ecology, community ecology and ecosystem ecology.
BIOL 363. Plant Geography. 3 Hours.
PR: BIOL 221. World-wide distribution patterns of plants and factors related to these distributions, including dispersal. Limiting factors, climate, isolation, evolutionary history, plate tectonics, pleistocene glaciations, and human activities. Plant communities and soils of polar, temperate, and tropical biomes are discussed.

BIOL 376. Research Methods. 3 Hours.
PR or CONC: BIOL 221 (may be taken as a corequisite). An introduction to the tools and mathematics that scientists use to solve scientific problems. Mathematical modeling, experimental design, hypothesis formulation, data collection, use of statistics, reading and evaluating the scientific literature, writing and reviewing scientific papers, and oral presentation of scientific research.

BIOL 384. Marine EcoSystem Topics. 3 Hours.
Three-week field-based courses offered at the Marine Science Consortium in Virginia. Courses vary by year including marine ichthyology, marine mammals, and coral reef ecology. A maximum of six-hours counts toward the biology major.

BIOL 386. Undergraduate Research. 1-4 Hours.
PR: Written consent of chair and a 2.7 grade point average in biology. (May be repeated for a maximum of 6 credit hours.) Individual laboratory or field experiments supervised by a faculty member.

BIOL 393. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 409. Biochemical Basis of Therapeutics. 3 Hours.
PR: BIOL 219. This course explores the process of drug discovery and development. The topics emphasized include the biological factors that determine success, failure, or limitation of therapeutics. Other topics include, specific therapeutic areas and regulation.

BIOL 410. Cell and Molecular Biology Methods. 3 Hours.
PR: BIOL 219. Introduction to the theory, application, ethic and economics of biotechnologies.

BIOL 411. Introduction to Recombinant DNA. 4 Hours.
PR: BIOL 219. An introductory course covering the basic principles and techniques of recombinant DNA technology, includes molecular cloning, isolation of plasmid DNA, agarose/acrylamide gel electrophoresis, restriction enzyme mapping, nucleic acid hybridization, and DNA sequencing.

BIOL 413. Molecular Endocrinology. 3 Hours.
PR: BIOL 219. Hormonal action is discussed at the cellular and molecular levels. Topics include hormone production and regulation, receptor kinetics and activation, and receptor output.

BIOL 414. Molecular Endocrinology-Laboratory. 1 Hour.
CoReq: BIOL 413. Experimental techniques used to study hormones and receptors.

BIOL 415. Epigenetics. 3 Hours.
PR: BIOL 219 or consent. Explores the molecular mechanisms, phenotypic phenomena and current applications of epigenetics and the study of how genetic information is used and maintained.

BIOL 418. Medical Genetics. 3 Hours.

BIOL 420. Genomics. 3 Hours.
PR: BIOL 219. Advanced elective examining biology and evolution on a genome-wide scale. Topics include fields of study and methods of DNA sequence acquisition and annotation, including exploration of the human genome and its contribution to disease discovery.

BIOL 421. Experimental Biochemistry. 2 Hours.
PR: AGBI 410 and PR or CONC: BIOL 423. Advanced biochemistry laboratory. Research and hypothesis design, manipulation of DNA and proteins, use of biochemical techniques to express protein and analyze function.

BIOL 422. Current Topics in Genome Biology. 1 Hour.
PR: BIOL 219. Exploration of modern topics in genomics research through interactive discussion of current literature. Students learn approaches to critical evaluation of manuscripts while exploring current research in this rapidly growing field. The course is organized around student-led discussions of manuscripts selected by the class. Undergraduate students are paired with graduate students to facilitate interpretation of complex material.

BIOL 423. Biochemistry of Nucleic Acids and Proteins. 3 Hours.
PR: AGBI 410 or equivalent. Focuses on the biochemistry of proteins and nucleic acids, with an emphasis on application of advanced knowledge to contemporary problems in cell biology, neuroscience, and immunology. Develops critical thinking, predictive, and problem-solving abilities that prepare students for health-related professional/graduate schools and the biotech industry.

BIOL 424. Protein Structure and Function. 4 Hours.
PR: BIOL 219 and (CHEM 231 or CHEM 233). Explores fundamentals of the protein structure; methods of structure determination; features of globular, membrane, and fibrous proteins; and approaches to protein classification.

BIOL 425. Developmental Genetics. 3 Hours.
PR: BIOL 219. This course covers the mechanisms by which genetics instructs the process of development. The complex interactions between cells, the environment, and the genome are presented.
BIO 426. Molecular Biology of Cancer. 3 Hours.
PR: BIOL 219. Exploration of molecular pathways leading to the development of cancer with emphasis on gene expression, cell cycle regulation, and signaling pathways targeted in conventional therapies.

BIO 430. Bioinformatics. 3 Hours.
PR: BIOL 219 or Consent. An introduction to algorithms and tools for analysis of genetic and genomic data in an evolutionary context.

BIO 432. Forensic Biology. 3 Hours.
PR: BIOL 219. Biological applications and advances in forensic identification technologies, including advantages and limitations of different approaches. Focuses on isolation, quantification, amplification, and analysis of DNA.

BIO 433. Herpetology. 3 Hours.
Investigation into the biology, ecology, and evolution of reptiles and amphibians, emphasizing North American species especially those found in the state of West Virginia. (One field exercise outside of regular time is required.).

BIO 434. Forensic Biology Laboratory. 1 Hour.
PR or CONC: BIOL 432. Prepares students in the processing of biological samples for DNA analysis, including presumptive and confirmatory testing, isolation of nuclear DNA, quantification, amplification, and analysis of DNA. Extensive hands-on practical experience and application of knowledge.

BIO 436. General Animal Physiology. 3 Hours.
PR: BIOL 221. In-depth, current treatment of physiological principles which operate at various levels of biological organization in animals of diverse taxonomic relationships. Understanding is developed from background lectures and student analyses in discussion sessions of research literature.

BIO 438. Animal Behavior. 4 Hours.
PR: BIOL 221. Introduction to animal behavior (ethology) emphasizing the ecology and evolution of individual and social behaviors. Laboratory includes independent investigation of behavioral phenomena. (Offered in even numbered years.).

BIO 439. Neuroethology. 3 Hours.
PR: BIOL 219. Explores the way sensory systems process information to mediate behavior in a wide variety of animals in order to understand similarities and differences in neural mechanisms.

BIO 440. Comparative Anatomy. 4 Hours.
PR: WVU sections require BIOL 219 and BIOL 221 or consent, WVUIT sections require BIOL 112. A functional and evolutionary study of vertebrate structure. (Dissection kit required.).

BIO 441. Vertebrate Microanatomy. 5 Hours.

BIO 446. Freshwater Ecology. 4 Hours.
PR: (BIOL 101 and BIOL 102 and BIOL 103 and BIOL 104) or BIOL 115 or WMAN 224 or consent. Physical, chemical, and biological characteristics of inland waters with emphasis on the structure and function of stream ecosystems. (Also listed as WMAN 446.).

BIO 450. Plant Systematics. 4 Hours.
PR: BIOL 117. Study of the taxonomy of flowering plants worldwide and related topics in angiosperm classification and evolution. Laboratories emphasize characteristics of selected families of monocotyledons and dicotyledons using living and herbarium material.

BIO 451. Plant Development. 4 Hours.
PR: BIOL 221 and (CHEM 235 or AGBI 410). Experimental studies of plant growth and development.

BIO 453. Molecular Basis of Disease. 3 Hours.
PR: BIOL 219. Examine medical, ethical, and legal/regulatory issues emerging from the Human Genome Project and its applications to personalized medicine.

BIO 454. Immunology. 3 Hours.
PR: BIOL 240 or BIOL 219. Explores the fundamental principles and practices of immunology including how the immune system is organized, how it functions to keep us healthy, and how it can cause allergies and autoimmune disease.

BIO 455. Evolution of Infectious Diseases. 3 Hours.
PR: BIOL 221. The application of phylogenetics, microbiology, immunology, and epidemiology towards understanding the evolution of infectious diseases. Students will develop a fundamental understanding of the significance of evolution and ecology in infectious disease emergence and control.

BIO 466. Microbial Symbiosis. 3 Hours.
PR: BIOL 221. An understanding of the significance of microbial symbioses towards ecological and health processes will be developed. Molecular techniques used towards identifying the composition and functions of microbial communities will be discussed. (Also listed as BIOL 615.).

BIO 461. Principles of Evolution. 3 Hours.
PR: BIOL 112 or BIOL 221. Introduction to the study of evolution, including genetics of evolutionary change, speciation and adaptation molecular evolution, the history of life, extinction, co-evolution and the origins of humans. Students on the Morgantown campus will be required to complete BIOL 221.

BIO 463. Global Ecology. 3 Hours.
PR: BIOL 221. The Earth viewed as a changing biogeochemical system. Topics include the structure, composition and dynamics of the ecosphere, nutrient cycles, changing atmospheric composition, climate change, ozone depletion, land-use change, biological invasions, and changes in biodiversity.
BIOL 464. Population and Quantitative Genetics. 3 Hours.
PR: BIOL 221. Relationship of gene and genotype frequencies in populations of diploid organisms and the effects of mutation, selection, and non-random mating in relation to single gene pairs. Application of these concepts to multigenic inheritance of quantitative traits.

BIOL 475. Neurobiological Diseases. 3 Hours.

BIOL 476. Computational Neuroscience. 4 Hours.
PR: BIOL 348 or consent. Tools and concepts used to probe and characterize the dynamics of neurons, neural networks and neural coding mechanisms. Lectures introducing concepts and discussion sessions focusing on current research literature complement computer laboratories where the student learns programming skills, analytical tools and neural modeling methods used in computational neuroscience research.

BIOL 477. Central Nervous System Evolution and Development. 3 Hours.
PR: BIOL 348. Origin and evolution of the central nervous system, focusing on developmental and genetic mechanisms underlying structural modifications that serve as the basis for the evolution of animal behavior.

BIOL 478. Sensory Neural Systems and Behavior. 3 Hours.
PR: BIOL 348. This course explores how brains acquire information about the external world and process this information to produce sensory perceptions. Students gain a deep understanding of sensory transduction and neural processing at the cellular, network and systems levels. Additionally the class is aimed at enhancing science communication.

BIOL 479. Current Topics in Neuroscience. 3 Hours.
PR: BIOL 348. Fundamental principles of nervous system organization with an emphasis on interactions between neurons and the consequences for behavior. There will be a focus on recent advances in our understanding of each organizational principle.

BIOL 486. Honors Investigation and Thesis. 1-4 Hours.
(May be repeated for credit; max credit 12 hr.) PR: Second semester of junior year, recommendation of advisor, biology majors only. Permission required. Supervised readings, investigation, and study.

BIOL 490. Teaching Practicum. 1-3 Hours.
PR: Consent. (May be repeated for a maximum of 9 credit hours.) Teaching practice as a tutor or assistant.

BIOL 491. Professional Field Experience. 1-18 Hours.
PR: Consent. (May be repeated up to a maximum of 18 hours.) Prearranged experiential learning program, to be planned, supervised, and evaluated for credit by faculty and field supervisors. Involves temporary placement with public or private enterprise for professional competence development.

BIOL 492. Directed Study. 1-3 Hours.
Directed study, reading, and/or research.

BIOL 493. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 494. Seminar. 1-3 Hours.
PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

BIOL 495. Independent Study. 1-6 Hours.
Faculty supervised study of topics not available through regular course offerings.

BIOL 496. Senior Thesis. 1-3 Hours.
PR: Consent.

BIOL 497. Research. 1-6 Hours.
Independent research projects.

CHEMISTRY COURSES

CHEM 110A. Introduction to Chemistry A. 1 Hour.
PR: Satisfy the minimum ACT/SAT math score, or satisfactory performance on placement examination, or C- in MATH 122 or higher. Students must register for CHEM 110A and CHEM 110B in the same term. Required for students whose performance on ACT/SAT/placement examination indicates need for introductory work before enrolling in other chemistry courses. Elementary scientific terminology and concepts; simple chemical arithmetic's; chemical symbols, formulae and equations; and mole concepts.

CHEM 110B. Introduction to Chemistry B. 1 Hour.
PR or CONC: CHEM 110A with a grade of C- or better. Required for students whose performance on the ACT/SAT/placement examination indicates need for introductory work before enrolling in other chemistry courses. Scientific terminology and concepts; chemical arithmetic's; chemical symbols, formulae and equations; and mole concepts.
CHEM 111. Survey of Chemistry. 4 Hours.
PR: WVU sections require MATH 122 with a minimum grade of C- or ALEKS Score of ML 20 or Math ACT Score of 22 or Math SAT Score of 540 or Math SAT (March 2016) Score of 570 or PR or CONC: MATH 126A or MATH 126B or MATH 126C or MATH 129 or MATH 150 or MATH 153 or MATH 155. WVUIT and PSC sections require MATH 122 with a minimum grade of C- or ALEKS Score of ML 10 or Math ACT Score of 19 or Math SAT Score of 460 or Math SAT (March 2016) Score of 500 or PR or CONC: MATH 126A or MATH 126B or MATH 126C or MATH 129 or MATH 150 or MATH 153 or MATH 155. Designed primarily for students taking only one year of college chemistry. Atomic structure; chemical bonding; acids, bases, and salts; periodicity; properties of gases, liquids, and solids; stoichiometry; oxidation-reduction. (3 hr. lec., 3 hr. lab.) (Students may not receive credit for CHEM 115 or CHEM 117 and for CHEM 111.).

CHEM 112. Survey of Chemistry. 4 Hours.
PR: CHEM 111. Continuation of CHEM 111. Nuclear chemistry; air and water pollution; useful natural materials; consumer chemistry; introduction to organic and biochemistry. (3 hr. lec., 3 hr. lab.) (Students may not receive credit for CHEM 116 or CHEM 118 and for CHEM 112.) (CHEM 111 and CHEM 112 cannot be used as pre-requisite courses for organic chemistry.) students anticipating the possibility or likelihood of taking organic chemistry must have credit for (CHEM 115 and CHEM 116) and (CHEM 117 and CHEM 118).

CHEM 115. Fundamentals of Chemistry. 4 Hours.
PR: Satisfactory ACT/SAT or placement exam performance, or minimum grade of C- in CHEM 110B, or minimum grade of C- in (MATH 126A or MATH 126B or MATH 126C) and MATH 128, or minimum grade of C- in MATH 129 or higher. For students who need more than one year of college chemistry and quantitative relationships on which subsequent chemistry courses are built. (3 hr. lec. 3 hr. lab.) (Students may not receive credit for CHEM 117 and CHEM 115.) Pre-requisite(s) and/or co-requisite(s) may differ on regional campuses.

CHEM 116. Fundamentals of Chemistry. 4 Hours.
PR: CHEM 115. Continuation of CHEM 115. (3 hr. lec., 3 hr. lab.) (Students may not receive credit for CHEM 118 and for CHEM 112 or CHEM 116.) Pre-requisite(s) and/or co-requisite(s) may differ on regional campuses.

CHEM 117. Principles of Chemistry. 5 Hours.
PR: Satisfactory ACT/SAT or placement examination performance, or a score of four or five on AP Chemistry examination. A more advanced treatment of the principles and theories of chemistry than offered in CHEM 115 and CHEM 116. Primarily for students specializing in chemistry. (3 hr. lec., two 3-hr. lab.) (Students may not receive credit for CHEM 117 and CHEM 115.)

CHEM 118. Principles of Chemistry. 5 Hours.
PR: CHEM 117. Continuation of CHEM 117. (3 hr. lec., two 3-hr. lab.) (Students may not receive credit for CHEM 118 and for CHEM 112, CHEM 116 or CHEM 215.)

CHEM 215. Introductory Analytical Chemistry. 4 Hours.
PR: CHEM 116. Volumetric analysis, gravimetric analysis, solution equilibria, spectrophotometry, separations, and electrochemical methods of analysis. (2 hr. lec., 2 hr. labs.) (Students may not receive credit for CHEM 215 and for CHEM 117 and CHEM 118.)

CHEM 231. Organic Chemistry: Brief Course. 4 Hours.
PR: CHEM 116. Emphasis on biological applications for students in medical technology, agriculture, and family resources. Nomenclature, structure, reactivity, and stereochemistry are stressed. (3 hr. lec., 3 hr. lab.) (Students may not receive credit for CHEM 231 and for CHEM 233 and CHEM 234.)

CHEM 233. Organic Chemistry. 3 Hours.
PR: CHEM 116 or CHEM 118 and PR or CONC: CHEM 235. Basic principles of organic chemistry. Modern structural concepts, the effect of structure on physical and chemical properties, reactions and their mechanisms and application to syntheses. (3 hr. lec.) (Students may not receive credit for CHEM 233, CHEM 234, and for CHEM 231.)

CHEM 234. Organic Chemistry. 3 Hours.
PR: CHEM 233 and CHEM 235 and PR or CONC: CHEM 236. Continuation of CHEM 233. (3 hr. lec.)

CHEM 235. Organic Chemistry Laboratory. 1 Hour.
PR or CONC: CHEM 233. Fundamental organic reactions and the preparation of organic compounds. (3 hr. lab.)

CHEM 236. Organic Chemistry Laboratory. 1 Hour.
PR: CHEM 233 and CHEM 235 and PR or CONC: CHEM 234. Continuation of CHEM 235. (3 hr. lab.)

CHEM 293. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 310. Instrumental Analysis. 3 Hours.
PR: (CHEM 215 or CHEM 118) and (CHEM 341 or CHEM 346). Lectures and demonstrations. Fundamentals of instrumental methods applied to chemical analyses: electrochemistry, spectroscopy, mass spectrometry, and chromatography. (2 hr. lec., 1 hr. demonstration.)

CHEM 312. Environmental Chemistry. 3 Hours.
PR: CHEM 215 and CHEM 234 and physical chemistry. Study of the nature, reactions, transport, and fates of chemical species in the environment. (2 hr. lec., 1 hr. demonstration.)

CHEM 313. Instrumental Analysis Laboratory. 1 Hour.
PR: CHEM 310. Practical application of modern instrumental methods to problems in chemical analysis. (3 hr. lab.)
CHEM 335. Methods of Structure Determination. 4 Hours.
PR: CHEM 234 and CHEM 236. Use of chemical methods and UV, IR, NMR, and mass spectroscopy to elucidate structures of organic compounds. For students in chemistry and related fields who may need these methods in research and applied science. (2 hr. lec., 2 hr. lab.).

CHEM 337. Polymer Chemistry. 3 Hours.
PR: CHEM 234 and physical chemistry. Methods, mechanisms, and underlying theory of polymerization. Structure and stereochemistry of polymers in relation to chemical, physical, and mechanical properties. (3 hr. lec.).

CHEM 339. Organic Syntheses, 3 Hours.
PR: CHEM 234 and CHEM 236. Modern synthetic methods of organic chemistry. (1 hr. lec., two 3 hr. lab.).

CHEM 341. Physical Chemistry: Brief Course. 3 Hours.
PR: ((CHEM 116 with a minimum grade of C- and CHEM 215) or CHEM 118) and MATH 156 and (PHYS 102 or PHYS 112). Beginning physical chemistry covering the subjects of chemical thermodynamics, chemical dynamics, and the structure of matter. (Students may not receive credit for CHEM 346 and 348 and for CHEM 341.).

CHEM 342. Experimental Physical Chemistry. 1 Hour.
PR or CONC: CHEM 341. Laboratory work in physical chemistry designed to accompany CHEM 341. (One 3 hr. lab.).

CHEM 346. Physical Chemistry. 3 Hours.
PR: CHEM 234 and MATH 156 and PHYS 112. A first course in physical chemistry. Topics include a study of thermodynamics and chemical equilibria. (3 hr. lec.) (Students may not receive credit for CHEM 346 and for CHEM 341.).

CHEM 347. Physical Chemistry Laboratory. 1 Hour.
PR: (CHEM 118 or CHEM 215) and CHEM 346. Experimentation illustrating the principles of physical chemistry and offering experience with chemical instrumentation. (One 3 hr. lab.).

CHEM 348. Physical Chemistry. 3 Hours.
PR: CHEM 346 and MATH 251. Continuation of CHEM 346. Chemical dynamics and the structure of matter. (3 hr. lec.) (Students may not receive credit for CHEM 348 and for CHEM 341.).

CHEM 349. Physical Chemistry Laboratory. 2 Hours.
PR: CHEM 346 and CHEM 347 and CHEM 348. Continuation of CHEM 347. (Two 3 hr. lab.).

CHEM 376. Research Methods. 3 Hours.
PR: (CHEM 118 or CHEM 215) and PR or CONC: ARSC 220. An introduction to the tools and mathematics that scientists use to solve scientific problems. Mathematical modeling, experimental design, hypothesis formulation, data collection, use of statistics, reading and evaluating the scientific literature, writing and reviewing scientific papers, and oral presentation of scientific research.

CHEM 393. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 401. Chemical Literature. 1 Hour.
PR: CHEM 234 and (CHEM 341 or CHEM 346). Study of techniques for locating, utilizing, and compiling information needed by the research worker in chemistry. (1 hr. lec.).

CHEM 403. Undergraduate Seminar. 1 Hour.
PR: CHEM 401. Instruction in design and presentation of topics of current chemical interest. (1 hour individual instruction and/or lecture.).

CHEM 411. Intermediate Analytical Chemistry. 3 Hours.
PR: CHEM 215 and physical chemistry. Concepts underlying modern analytical procedures and their application to the solution of contemporary problems; presented at the intermediate level. (3 hr. lec.).

CHEM 422. Intermediate Inorganic Chemistry. 3 Hours.
PR: Physical chemistry. Structure, bonding, and reactivity of compounds of main-group and transition metal elements. Molecular structure and symmetry, solid state chemistry, ligand field theory, and coordination chemistry. (3 hr. lec.).

CHEM 423. Inorganic Synthesis Laboratory. 2 Hours.
PR: CHEM 422. Application of modern synthetic and spectroscopic methods of analysis to the preparation and characterization of main group, solid-state, transition metal, and organometallic compounds. (Two 3 hr. lab.).

CHEM 440. Quantum Chemistry. 3 Hours.
PR: CHEM 348. Introduction to the principles of quantum mechanics and its application to atoms, molecules, solids, spectroscopy, and computational chemistry.

CHEM 444. Colloid and Surface Chemistry. 3 Hours.
PR: Physical chemistry. Selected topics in the properties and physical chemistry of systems involving macromolecules, lyophobic colloids, and surfaces. (3 hr. lec.).

CHEM 460. Forensic Chemistry. 3 Hours.
PR:CHEM 115 and CHEM 116 and CHEM 117 and CHEM 118 and CHEM 233 and CHEM 236 and CHEM 215 or instructor permission. Analytical chemistry as applied in forensic science. Drug analysis, toxicology, arson, paints, polymers, fibers, inks, and gunshot residue.
CHEM 462. Biochemistry II. 3 Hours.
PR: AGBI 410. Second semester of undergraduate biochemistry with a focus on the molecular level processes that enable life and the integration of multiple hierarchies of mechanistic regulation.

CHEM 463. Forensic Chemistry Lab. 1 Hour.
PR: (CHEM 115 and CHEM 116) or (CHEM 117 and CHEM 118) and CHEM 233 and CHEM 236 required and CHEM 215 or instructor permission and PR or CONC: CHEM 460. Analytical chemistry as applied in forensic science. Drug analysis, toxicology, arson, paints, polymers, fibers, inks, and gunshot residue.

CHEM 464. Biochemistry II Laboratory. 1 Hour.
PR: AGBI 410 and AGBI 412 and PR or Conc:CHEM 462. Second semester of undergraduate biochemistry lab, familiarizes students with biochemical techniques used in the analysis of biological species/processes.

CHEM 490. Teaching Practicum: Peer-Led Team Learning. 1-3 Hours.
PR: Consent. Teaching practice as a tutor or assistant.

CHEM 491. Professional Field Experience. 1-18 Hours.
PR: Consent. (May be repeated up to a maximum of 18 hours.) Prearranged experiential learning program, to be planned, supervised, and evaluated for credit by faculty and field supervisors. Involves temporary placement with public or private enterprise for professional competence development.

CHEM 492. Directed Study. 1-3 Hours.
Directed study, reading, and/or research.

CHEM 493. Special Topics. 0-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 494. Seminar. 1-3 Hours.
PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

CHEM 496. Senior Thesis. 1-3 Hours.
PR: Consent.

CHEM 497. Research. 1-6 Hours.
Independent research projects.

CHEM 498. Honors. 1-3 Hours.
PR: Students in Honors Program and consent by the honors director. Independent reading, study, or research.