Biochemistry

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A course of study in the Department of Biochemistry emphasizes the application of chemical principles to biological systems and leads to the Bachelor of Science in Biochemistry. The program requires rigorous course work in the basic sciences, culminating with a two course capstone experience of discipline specific problems and laboratory techniques. Students are encouraged to gain research experience through independent projects in faculty labs. The biochemistry degree prepares students for further study in graduate or professional school or for a career in biochemistry, biotechnology or the biological, chemical or medical sciences.

Faculty

Assistant Professor X. Heng**, A. Koo**
Research Professor L. Erb*
Associate Research Professor B. Mooney
Assistant Research Professor Z. Lei, V. Mossine, T. White*
Adjunct Professor J. Miernyk**
Associate Teaching Professor S. Freyermuth
Assistant Teaching Professor C. Lee

* Graduate Faculty Member - membership is required to teach graduate-level courses, chair master's thesis committees, and serve on doctoral examination and dissertation committees.
** Doctoral Faculty Member - membership is required to chair doctoral examination or dissertation committees. Graduate faculty membership is a prerequisite for Doctoral faculty membership.

Undergraduate

• BS in Biochemistry (http://catalog.missouri.edu/undergraduategraduate/collegeofagriculturefoodandnaturalresources/biochemistry/bs-biochemistry)

Graduate

• MS in Biochemistry (http://catalog.missouri.edu/undergraduategraduate/collegeofagriculturefoodandnaturalresources/biochemistry/ms-biochemistry)
• PhD in Biochemistry (http://catalog.missouri.edu/undergraduategraduate/collegeofagriculturefoodandnaturalresources/biochemistry/phd-biochemistry)

College of Agriculture, Food and Natural Resources; School of Medicine
117 Schweitzer Hall
(573) 882-4846
http://www.biochem.missouri.edu/

Director of Graduate Studies: Charlotte Phillips

Biochemistry at the University of Missouri is a division of the College of Agriculture, Food and Natural Resources and a department of the School of Medicine. As a nationally ranked top 10 biochemistry department among public medical schools, we offer outstanding training that help students achieve their goals. We have 39 core faculty members and approximately 10 additional members, all of whom are available to mentor students in biochemistry. Nearly all facets of contemporary biochemical research are represented in their collective research interests. Our highly interactive program is an integral part of a campus-wide network of research programs including life sciences, genetics, nutrition, plant biochemistry and structural biology.

Interdisciplinary Area Programs

• PhD in Nutrition Area Program (http://catalog.missouri.edu/undergraduategraduate/interdisciplinaryacademicprograms/nutritionarea/phd-nutrition-area-program)
• PhD in Genetics Area Program (http://catalog.missouri.edu/undergraduategraduate/interdisciplinaryacademicprograms/geneticsareaprogram)
• Minors in Business (http://catalog.missouri.edu/undergraduategraduate/collegeofbusiness/businessadministration/minor-business), and College Teaching (http://catalog.missouri.edu/undergraduategraduate/interdisciplinaryacademicprograms/additionalminorsandcertificates/collegeteaching)

The graduate programs of the Department of Biochemistry prepare students for professional careers in academic institutions, industry and government. The Department of Biochemistry is administered by the College of Agriculture, Food and Natural Resources and the School of Medicine. It provides a great range of opportunities for multidisciplinary study in plant, animal and microbial biochemistry, molecular biology, structural biology, and chemical biology.

Faculty Research

Virtually every important area of biochemistry and molecular biology is represented among the research interests of the faculty. These interests focus on plant biochemistry, hormonal control of plant and animal-cell metabolism, growth-factor structure and function, enzyme reaction mechanisms, biochemistry of development, biochemistry of human disease, lipid and carbohydrate metabolism, molecular biology, analytical biochemistry, proteomics, systems biochemistry, and structural biochemistry.

Facilities

The department has modern, well-equipped laboratories in the Life Sciences Center, Schweitzer Hall, Schlundt Annex, and Stephens Hall. Additional faculty are housed in the Animal Sciences Research Center, Chemistry Building, Dalton Cardiovascular Research Center, Mason Eye Institute, and the Truman Veterans Hospital.

Plans of Study

All students participate in individually planned research programs and have a supervised teaching experience along with course work. Students are expected to complete a program of courses in biochemistry and selected courses in modern biology and chemistry.
Careers
Biochemistry at the University of Missouri provides world-class training that can open the door to a wide variety of career opportunities in the life sciences. Our graduates have career opportunities available in academia, industry, agriculture or medicine.

Required Application Materials
All pre-requisites and application materials must be submitted by the annual deadline.

MD/PhD in Biochemistry Dual Degree Program
Students already accepted into the School of Medicine at MU may apply to the Department for acceptance into the MD/PhD program. Students matriculating in the MD/PhD degree program must complete degree requirements of both the School of Medicine and the Graduate School. For information and for application forms, email gradprogram@missouri.edu or write the Director of Graduate Admissions in Biochemistry, 117 Schweitzer Hall, Columbia, MO 65211, or visit the website http://www.biochem.missouri.edu.

BIOCHM 1090: Introduction to Biochemistry
Fundamental concepts in biochemistry and molecular biology: structure function relationships, reactivity, thermodynamics, gene expression. Professional skills for biomedical careers. Graded on A-F basis only.

Credit Hours: 3
Prerequisites or Corequisites: CHEM 1320
Prerequisites: MATH 1100 or MATH 1160 or MATH 1500 and Freshman or Sophomore standing

BIOCHM 1094: Introductory Biochemistry Laboratory
Techniques course involving analytical experiments with carbohydrates, lipids, proteins, nucleic acids; use of instrumentation in biochemistry; purification and kinetics of enzymes, PCR and cloning. Graded on A-F basis only.

Credit Hours: 2
Prerequisites: BIOCHM 1090; Biochemistry majors only

BIOCHM 2110: The Living World: Molecular Scale
Survey of modern biochemistry and biotechnology. Structure and function of DNA, proteins, lipids and carbohydrates. The role of biopolymers in life processes and everyday living is emphasized.

Credit Hours: 3
Prerequisites: for non-Biochemistry majors only

BIOCHM 2112: Biotechnology in Society
Biotechnology in a social context covers three areas: introduction to terminology and concepts, specific biotechnological applications to modern problems, and ethical questions.

Credit Hours: 3
Prerequisites: for non-biochemistry majors only

BIOCHM 2480: Introduction to Macromolecular Structure and Function
The function of biochemical macromolecules is directly related to their structure. The three-dimensional structures of proteins, nucleic acids, polysaccharides and membranes are each explored in the context of their functions and their microenvironments within living organisms. Graded on A-F basis only.

Credit Hours: 2
Prerequisites: C- or higher in BIOCHM 1090
Corequisites: CHEM 2100 or CHEM 2110

BIOCHM 2484: Macromolecular Techniques Laboratory
The laboratory experiments include DNA isolation, DNA cloning, PCR, plasmid transformation, protein expression, affinity-tagged chromatography, SDS-polyacrylamide gel electrophoresis, enzyme isolation, enzyme assay, buffer preparation, and Michaelis-Menten kinetics. Graded on A-F basis only.

Credit Hours: 2
Prerequisites: sophomore standing; restricted to Biochemistry majors only

BIOCHM 2484H: Macromolecular Techniques Laboratory - Honors
The laboratory experiments include DNA isolation, DNA cloning, PCR, plasmid transformation, protein expression, affinity-tagged chromatography, SDS-polyacrylamide gel electrophoresis, enzyme isolation, enzyme assay, buffer preparation, and Michaelis-Menten kinetics. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: sophomore standing; Biochemistry majors only. Honors eligibility required

BIOCHM 2484HW: Macromolecular Techniques Laboratory - Honors/Writing Intensive
The laboratory experiments include DNA isolation, DNA cloning, PCR, plasmid transformation, protein expression, affinity-tagged chromatography, SDS-polyacrylamide gel electrophoresis, enzyme isolation, enzyme assay, buffer preparation, and Michaelis-Menten kinetics. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: sophomore standing; Biochemistry majors only. Honors eligibility required

BIOCHM 3630: General Biochemistry
Survey of biochemistry; static/dynamic aspects of carbohydrates, lipids, proteins, nucleic acid. Discussion of metabolic pathways, energy production, and metabolic regulatory mechanism.

Credit Hours: 3
Prerequisites: CHEM 2030 or CHEM 2100

BIOCHM 4001: Topics in Biochemistry
Experimental courses; highly specialized topics taught infrequently or courses taught by visiting professors.

Credit Hour: 1-99

BIOCHM 4120: Medicinal Plant Science
Presentation of core topics, including an overview of plant groups with medicinal properties, botanical nomenclature, important biochemical pathways, exposure to journals, texts, and online databases that facilitate evidence-based research involving medicinal plants. Content of world-
wide application. Has an international flavor. The course facilitates students to be independent learners and critical thinkers in this important knowledge area (of value to diverse academic backgrounds). The important role of collaborative inter-disciplinary studies will also be emphasized. Graded on A-F basis only.

**Credit Hours: 3**

**Prerequisites:** CHEM 1100 or CHEM 1320

**Recommended:** BIO_SC 1200 or BIO_SC 1500 or BIOCHM 1090

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**BIOCHM 4270: Biochemistry**

(cross-leveled with BIOCHM 7270). First semester of comprehensive biochemistry course: metabolic pathways, amino acids/proteins, carbohydrates, lipids, nucleic acids, kinetics, energy requirements, metabolic regulation in living cells.

**Credit Hours: 3**

**Prerequisites:** CHEM 2110

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**BIOCHM 4272: Biochemistry**

(cross-leveled with BIOCHM 7272). Second semester of a comprehensive biochemistry course, including metabolism of carbohydrates, fatty acids, steroids, amino acid synthesis and metabolism, molecular genetics, hormones, photosynthesis and integrated metabolism.

**Credit Hours: 3**

**Prerequisites:** C- or higher in BIOCHM 4270

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**BIOCHM 4300: Physical Chemistry of Biological Systems**

To present fundamental principles of physical chemistry in the context of the structure and function of biological macromolecules. Graded on A-F basis only.

**Credit Hours: 3**

**Prerequisites or Corequisites:** BIOCHM 4270

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**BIOCHM 4376: Computer Assisted Sequence Analysis and Molecular Modeling**

(cross-leveled with BIOCHM 7376). Employs the use of computer-based interactive molecular graphics and sequence analysis software to analyze the three dimensional structures of macromolecules.

**Credit Hours: 3**

**Prerequisites:** CHEM 2110

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**BIOCHM 4385: Problems in Biochemistry**

**Credit Hour:** 1-3

**Prerequisites:** departmental consent

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**BIOCHM 4510: Single Molecule Biophysics**

(same as PHYSCS 4510; cross-leveled with BIOCHM 7510, PHYSCS 7510). The course provides an overview of the biophysics of enzymes, nucleic acids and the cytoskeleton. Topics covered will include diffusion, molecular motors, polymerization and the cytoskeleton and the polymer properties of nucleic acids and microtubules.

**Credit Hours: 3**

**Prerequisites:** PHYSCS 2760

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**BIOCHM 4950: Advanced Undergraduate Research in Biochemistry**

Research credit for students doing an independent research project under the guidance of a faculty member. Project must be arranged by student and faculty member prior to registration. Graded on A-F basis only.

**Credit Hour:** 1-3

**Prerequisites:** departmental consent

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**BIOCHM 4964: Industrial Internship with ABC Laboratories**

This 5-credit course is a school and field-based learning experience combining the study, observation, and employment with ABC Laboratories in Columbia, MO. The internship provides opportunities to apply skills, concepts and theories about biochemistry and analytical chemistry in a practical context. The purpose of the internship experience is to provide the intern with the opportunity to develop knowledge and skills deemed desirable for a career in the biotechnology industries. During the time indicated in this agreement for the internship experience, the intern is expected to become a productive employee of ABC Laboratories. This course will provide technical instruction on commonly used laboratory skills and instrumentation at the University of Missouri followed by technical instruction on software and instrumentation at ABC Laboratories. After the training period, the interns will have the opportunity to work at ABC Laboratories full time for the summer.

**Credit Hours:** 5

**Prerequisites or Corequisites:** BIOCHEM 4272, CHEM 3200

**Prerequisites:** BIOCHM 1090, BIOCHM 2484, BIOCHM 4270

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**BIOCHM 4970: Senior Capstone in Biochemistry**

Problem-based course on fundamental concepts of biochemistry. Requires written and oral presentations. One of two capstone courses required for biochemistry majors. Graded on A-F basis only.

**Credit Hours:** 2

**Prerequisites:** Departmental consent required

**Recommended:** Corequisite of BIOCHM 4974

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**BIOCHM 4974: Biochemistry Laboratory**

(cross-leveled with BIOCHM 7274). Techniques course involving analytical experiments with carbohydrates, lipids, proteins, nucleic acids; use of instrumentation in biochemistry; purification and kinetics of enzymes. One of two capstone courses required for biochemistry majors.

**Credit Hours:** 5

**Prerequisites or Corequisites:** BIOCHM 4272

**Corequisites:** BIOCHM 4970

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**BIOCHM 4974W: Biochemistry Laboratory - Writing Intensive**

(cross-leveled with BIOCHM 7274). Techniques course involving analytical experiments with carbohydrates, lipids, proteins, nucleic acids; use of instrumentation in biochemistry; purification and kinetics of enzymes. One of two capstone courses required for biochemistry majors.

**Credit Hours:** 5

**Prerequisites or Corequisites:** BIOCHM 4272

**Corequisites:** BIOCHM 4970

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**BIOCHM 4978: Cancer Biology**

(same as BIO_SC 4978; cross-leveled with BIOCHM 7978, BIO_SC 7978). The cellular and molecular basis of cancer, with emphasis on the
application of genomics, proteomics, and genetic manipulations in model organisms to the study of cancer biology.

**BIOCHM 4996H: Honors Thesis Research in Biochemistry**
Laboratory research for honors students doing an honors thesis research project in their final two semesters. Enrollment limited to Honors eligible students with senior standing who have CAFNR honors approval. Graded on A-F basis only.

**Credit Hours:** 3  
**Prerequisites:** departmental consent

**BIOCHM 7085: Problems in Biochemistry**
Problems in Biochemistry.

**Credit Hours:** 1-6  
**Prerequisites:** Consent of Director of Graduate Studies required

**BIOCHM 7270: Biochemistry**
(cross-leveled with BIOCHM 4270). First semester of comprehensive biochemistry course: metabolic pathways, amino acids/proteins, carbohydrates, lipids, nucleic acids, kinetics, energy requirements, metabolic regulation in living cells.

**Credit Hours:** 3  
**Prerequisites:** BIO_SC 2200 and BIO_SC 2300 or BIOCHM 4270

**Recommended:** BIO_SC 4976 or BIOCHM 4272

**BIOCHM 7272: Biochemistry**
(cross-leveled with BIOCHM 4272). Second semester of a comprehensive biochemistry course, including metabolism of carbohydrates, fatty acids, steroids, amino acid synthesis and metabolism, molecular genetics, hormones, photosynthesis and integrated metabolism.

**Credit Hours:** 3  
**Prerequisites:** BIOCHM 7270

**BIOCHM 7274: Biochemistry Laboratory**
Techniques course involving analytical experiments with carbohydrates, lipids, proteins, nucleic acids; use of instrumentation in biochemistry; radioisotope tracers in metabolism; isolation, purification and kinetics of enzymes.

**Credit Hours:** 5  
**Corequisites:** concurrent enrollment in BIOCHM 7270

**BIOCHM 7376: Computer Assisted Sequence Analysis and Molecular Modeling**
(cross-leveled with BIOCHM 4376). This course uses advanced computer graphics and computational techniques to analyze protein and nucleic acid sequences and their three-dimensional structures.

**Credit Hours:** 2  
**Prerequisites:** CHEM 2110

**BIOCHM 7510: Single Molecule Biophysics**
(same as PHYSCS 7510; cross-leveled with BIOCHM 4510, PHYSCS 4510). The course provides an overview of the biophysics of enzymes, nucleic acids and the cytoskeleton. Topics covered will include diffusion, molecular motors, polymerization and the cytoskeleton and the polymer properties of nucleic acids and microtubules.

**Credit Hours:** 3  
**Prerequisites:** PHYSCS 2760

**BIOCHM 7978: Cancer Biology**
(same as BIO_SC 7978). The course will cover major molecular and cellular aspects of cancer. Students will read original research articles, present overviews and lead class discussions.

**Credit Hours:** 3  
**Prerequisites:** BIOCHM 4270, BIO_SC 2300 and BIO_SC 4976

**BIOCHM 8060: Ethical Conduct of Research**
(same as BIO_SC 8060). Discussion of ethical issues in biological research, including the rules and conventions for appropriate research conduct. Graded on S/U basis only.

**Credit Hours:** 1

**BIOCHM 8090: Research in Biochemistry**
Research in biochemistry for qualified students, with counsel of faculty. Includes preparation of dissertation. Graded on a S/U basis only.

**Credit Hours:** 1-99  
**Prerequisites:** Consent of Director of Graduate Studies required

**BIOCHM 8120: Advanced Medicinal Plant Science**
Presentation of core topics in pharmacognosy, including an overview of plant groups with medicinal properties, essentials of botanical nomenclature, overview of pharmacological activities of plant-sourced products and evidence-based research, phytochemical variation and significance, important biochemical pathways, origins of secondary metabolites, some major groups of phytochemicals, observations on economic and social trends in the use of medicinal plant products in developed and developing countries, overview of modern technology, high throughput screening, bioinformatics. Considerable exposure to key articles in journals, based on internationally accepted text (Trease & Evans), exposure to online databases - all sources of information that facilitate evidence-based research involving medicinal plants. Content of world-wide application. Has considerable international flavor and directly applicable to medicinal flora world-wide. The course facilitates students to be independent learners and critical thinkers in this important knowledge area (of value to diverse academic backgrounds). The important role of collaborative inter-disciplinary studies is also emphasized. Graded on A-F basis only.

**Credit Hours:** 3  
**Prerequisites:** CHEM 1100 or CHEM 1320 or BIOCHM 1090 and BIO_SC 1200 or BIO_SC 1500 or the equivalent of these courses for non-MU students

**Recommended:** A Freshman level course in the Life Sciences or General Botany will also be advantageous but not essential
BIOCHM 8130: Commercial Use of Biodiversity
Biological diversity/biodiversity - provides the basis for life on earth. The variability among living organisms and among the ecological complexes of which they are part - forms the basis of many commercial products and underpins our very existence by providing essential ecosystem services e.g. water purification, prevention of soil erosion and floods, and regulation of the climate. But biodiversity is declining. The rapidly growing demand for access to genetic resources, is raising the commercial value of biological diversity (especially plant diversity) for providing new genetic resources for enhancing existing crops species, developing new crops, phytopharmaceuticals, botanical medicines, horticulture - via GMO and plant breeding technologies. The course will address the commercial use of biodiversity - access to genetic resources and benefit-sharing via the following topics: Regulating access to genetic resources and benefit-sharing (legal aspects); Natural products and the pharmaceutical industry; Botanical medicine industry; Development of major crops by the seed industry; Horticulture; Crop protection; Biotechnology in fields other than healthcare and agriculture; Natural personal care and cosmetics industry; Industry and the Convention on Biodiversity (CBD). The areas of Technical Barriers to Trade (TBT) and the Regulatory Frameworks that govern the release of new crops and other plant-based products will also be addressed. Course is of world-wide appeal, facilitated by being 100% online and asynchronous (independent of time zones). This course is recommended (as an elective) for students desiring more understanding of the complexities associated with the commercial use of biodiversity (specifically the commercial use of genetic resources). Graded on A-F basis only.

Credit Hours: 3
Recommended: Experience in some undergraduate course work in the life-science area would be advantageous

BIOCHM 8240: Introduction to Graduate Biochemistry I
Introduction to biochemistry for life science graduate students. Core course for Biochemistry students. Structures and interactions of biological macromolecules including thermodynamics, binding, enzyme action and biological membranes as well as techniques of analysis and structure determination.

Credit Hours: 4
Prerequisites: Undergraduate organic chemistry plus undergraduate biochemistry or molecular biology, their equivalent or permission of instructor

BIOCHM 8260: Macromolecular Systems Integration
To introduce graduate students to biochemistry at the graduate level with particular emphasis on genomics/gene expression and replication; proteomics/cell signaling and metabolism. Course graded on A-F basis only.

Credit Hours: 4
Prerequisites: BIOCHM 8240

BIOCHM 8362: Introduction to Plant Metabolism
(same as PLNT_S 8362 and BIO_SC 8362). This course is part of a series that aims to provide a solid conceptual foundation in interdisciplinary plant biology for graduate students with a research emphasis in plant biology. This course examines the basic concepts and techniques used to understand plant metabolism. Graded on A-F basis only.

Credit Hours: 2

BIOCHM 8365: Introduction to Molecular Cell Biology
(same as BIO_SC 8365 and PLNT_S 8365). This course is part of a series that aims to provide a solid conceptual foundation in interdisciplinary plant biology for graduate students with a research emphasis on plant biology. This course examines the basic concepts and techniques used to understand molecular cell biology. Graded on A-F basis only.

Credit Hours: 2

BIOCHM 8422: Enzymology and Metabolic Regulation
A basic introduction to the study of enzymes and their role in intermediary metabolism. Topics include enzyme kinetics, mechanisms of enzymatic catalysis and control of metabolic pathways.

Credit Hours: 3
Prerequisites: BIOCHM 7272

BIOCHM 8434: Signaling in Molecular Cell Biology
The objective of this course is to provide important foundations in cellular signaling in the context of biochemistry and cell biology for first and second year graduate students. The course focuses on cell-to-cell communication and intracellular signaling via different classes of cell surface receptors using specific receptor paradigms from human, other animals, plants, yeast and E.coli. Primary literature will be used for in-class discussions and homework assignments to highlight key experiments and introduce students to relevant experimental techniques. Graded on A-F basis only.

Credit Hours: 3
Recommended: BIO_SC 2300, BIOCHM 4270

BIOCHM 8450: Rotation Research
Introductory laboratory research. Graded on A-F basis only. Normally 1 hour per advisor per semester, two-1 hour sections can be taken per semester.

Credit Hour: 1-2

BIOCHM 9001: Topics in Biochemistry
Experimental courses, highly specialized topics taught infrequently or courses taught by visiting professors.

Credit Hour: 1-9

BIOCHM 9087: Seminar in Biochemistry
Review of current literature; individual presentation of research or classical science topics.

Credit Hour: 1

BIOCHM 9090: Research in Biochemistry
Research in biochemistry for qualified students, with counsel of faculty. Includes preparation of dissertation. Graded on a S/U basis only.

Credit Hour: 1-99
BIOCHM 9432: Molecular Biology II  
(same as MICROB and BIO_SC 9432) Detailed experimental analysis of eukaryotic cellular and molecular biology relevant to cellular and viral gene expression, post-transcriptional and post-translational modifications and genome replication. Models for developmental genetic analysis and genetic determinants controlling developmental processes utilizing the current literature will be examined.  
Credit Hours: 4

BIOCHM 9462: Hormone Action  
A lecture course with weekly assigned readings. Topics will include: a description of selected polypeptide, steroid and other hormones and their biological effects; receptors; second messengers; protein phosphorylation in hormone mediation; growth factors; cellular oncogenes.  
Credit Hours: 2  
Prerequisites: BIOCHM 7272

BIOCHM 9468: Molecular Biology of Plant Growth and Development  
(same as BIO_SC 9468). Molecular biology of plant hormones, signal transduction, environmental signals.  
Credit Hours: 3