40. Contents and dynamics of the Milky Way. Stellar populations: the interstellar medium. Evolution of galaxies. Active galactic nuclei. Senior Thesis. Fall, Spring. 1 to 4 credits. May reenroll for a maximum of 4 credits. R: Open only to seniors in Astronomy. Design and execute an original experiment or computation. A written and oral report of the research is required. QA: AST 406

Astronomy and Astrophysics

380A. Cosmology
 Fall, Spring. 3(3-0) R: Open only to graduate students in Astronomy, Astrophysics and Physics. Current research in cosmology: observational basis for the Big Bang, the cosmic background radiation, primordial nucleosynthesis, content and distribution of matter, cosmic geometry, growth of perturbations. QA: PHY 861

380B. Gravitational Astrophysics
 Fall, Spring. 3(3-0) P: PHY 820, PHY 841. Experimental foundations, theory, and applications of gravitational physics and general relativity. Tests of the equivalence principle, modern solar system tests of general relativity, Schwarzschild metric, Hawking effect; Einstein’s field equations. QA: PHY 860

810. Introduction to Astrophysics
 Fall. 3(3-0) Survey of contemporary astrophysics. Stellar evolution, the structure of the Milky Way, the properties of external galaxies, and cosmology.

815. Radiation Astrophysics
 Spring of odd-numbered years. 3(3-0) P: AST 801. Transfer of radiation through plasmas and processes of emission and absorption of photons. Interpretation of the spectra of stars, interstellar medium, and galaxies. QA: AST 842

820. Advanced Topics in Astrophysics(MTC)
 Fall, Spring. 3(3-0) May reenroll for a maximum of 6 credits. P: AST 801. Advanced work in a specialized astrophysical topic. QA: AST 920

820A. Astrophysics of the Interstellar Medium
 Fall. 3(3-0) P: AST 810, PHY 851. Relationships of the physical processes and radiative properties of diffuse interstellar material to observed characteristics. QA: PHY 837 QA: AST 820

339. Galactic and Extragalactic Dynamics
 Fall of even-numbered years. 3(3-0) P: AST 801, PHY 820. Implications of gravitational dynamics and stellar evolution on galactic and extragalactic systems.

440. Stellar Astrophysics
 Spring of even-numbered years. 3(3-0) P: AST 801. Physics of stellar interiors. Methods for calculating stellar models. Principles of stellar evolution. QA: AST 820

560. Gravitational Astrophysics and Cosmology(MTC)
 Fall, Spring. 3(3-0) May reenroll for a maximum of 6 credits. Topics in general relativity, gravitational astrophysics, and cosmology. QA: PHY 860 PHY 861

860A. Cosmology
 3(3-0) R: Open only to graduate students in Astronomy, Astrophysics and Physics. Current research in cosmology: observational basis for the Big Bang, the cosmic background radiation, primordial nucleosynthesis, content and distribution of matter, cosmic geometry, growth of perturbations. QA: PHY 861

860B. Gravitational Astrophysics
 3(3-0) P: PHY 820, PHY 841. Experimental foundations, theory, and applications of gravitational physics and general relativity. Tests of the equivalence principle, modern solar system tests of general relativity, Schwarzschild metric, Hawking effect; Einstein’s field equations. QA: PHY 860

870. Astronomical Instrumentation and Data Analysis
 Fall of odd-numbered years. 3(3-0) P: AST 801. Theory and techniques of astronomical data acquisition and analysis.

AUDIOLoGY AND SPEECH SCIENCES

113. Oral Communication Principles and Skills
 Fall, Spring, Summer. 3(2-0) Study, development and enhancement of oral communication skills including speech, voice, language and listening. QP: COL 115 QA: ASC 108

202. Introduction to Communication Sciences and Disorders
 Fall, Spring. 3(3-0) R: Not open to students with credit in ASC 403. Survey of research and practice regarding speech, hearing and language disorders in children and adults. QA: ASC 201

214. Anatomy and Physiology of the Speech and Hearing Mechanism
 Fall, Spring. 3(3-0) P: ASC 203 or concurrently. Structural and functional analysis of the central and peripheral audito- and proprioceptive, phonatory, and articulatory mechanisms for speech. QA: ASC 108 QA: ASC 274

232. Descriptive Phonetics
 Spring. 2(1-2) Principles of speech production: transcription of speech using the International Phonetic Alphabet. QA: ASC 274

255. Speech and Hearing Sciences
 Fall, Spring. 5(4-2) P: ASC 214, ASC 232 or concurrently, MTH 110 or MTH 116, one ISP course. R: Not open to freshmen. Application of the scientific method to the study of audition, speech perception and speech production. QA: ASC 274 ASC 276 QA: ASC 271

333. Oral Language Development
 Fall. 3(3-0) P: ASC 203 or one LIN course or one PSY course. R: Not open to freshmen. Development of receptive and expressive aspects of child language. QA: ASC 222

344. Evaluation Procedures in Audiology
 Spring. 3(3-2) P: ASC 255. R: Open only to Audiology and Speech Sciences majors.

403. Communication Sciences and Disorders
 Fall. 3(3-0) R: Not open to audiology and speech sciences majors. Not open to seniors with credit in ASC 203. Research and practice regarding communication disorders and the professions of speech-language pathology and audiology. QA: ASC 201 QA: ASC 470

443. Aural Rehabilitation
 Fall. 3(3-0) P: ASC 444 R: Open only to Audiology and Speech Sciences majors. Fundamental aspects of auditory rehabilitation, including individual and group amplification systems, auditory training, speechreading, and counseling with children and adults. QA: ASC 454 QA: ASC 460

453. Intervention Procedures in Speech-Language Pathology
 Fall. 3(3-2) P: ASC 454. R: Open only to Audiology and Speech Sciences majors.

576. School-Based Communication Disorders Programs
 Spring. 3(3-2) P: ASC 453, ASC 494 or concurrently. R: Open only to Audiology and Speech Sciences majors. Intervention procedures for individuals with developmental and acquired communication disorders. QA: ASC 373 QA: ASC 476

E-18 Courses with an asterisk (*) have not been approved by the University Committee on Curriculum.
### Descriptions of Courses

#### AUDIOLGY AND SPEECH SCIENCES

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>803*</td>
<td>Research Methods in Communication Sciences and Disorders</td>
<td>Fall, Spring, Summer</td>
<td>R: graduate students only audiology and speech science graduate students</td>
</tr>
<tr>
<td>813*</td>
<td>Neuroanatomy and Neurophysiology of Speech, Language, and Hearing</td>
<td>Fall, Spring</td>
<td>R: class 6 audiology and speech sciences</td>
</tr>
<tr>
<td>822A*</td>
<td>Acquired Language Disorders</td>
<td>Spring</td>
<td>R: ASC 813 or concurrently R: class 6 audiology and speech science majors</td>
</tr>
<tr>
<td>823A*</td>
<td>Motor Speech Disorders</td>
<td>Fall, Spring</td>
<td>R: graduate students audiology and speech science majors</td>
</tr>
<tr>
<td>823B*</td>
<td>Fluency Disorders</td>
<td>Fall, Spring</td>
<td>R: graduate students audiology and speech sciences</td>
</tr>
<tr>
<td>823C*</td>
<td>Assessment of Childhood Language Disorders</td>
<td>Fall, Spring</td>
<td>R: graduate students audiology and speech science majors</td>
</tr>
<tr>
<td>823D*</td>
<td>Language Intervention: Early Stages</td>
<td>Spring, Summer</td>
<td>R: ASC 823E or approval R: graduate students audiology and speech sciences</td>
</tr>
<tr>
<td>823E*</td>
<td>Language Intervention: Later Stages</td>
<td>Summer</td>
<td>R: graduate students audiology and speech sciences</td>
</tr>
<tr>
<td>823F*</td>
<td>Augmentative Communication</td>
<td>Fall</td>
<td>R: graduate students audiology and speech science majors</td>
</tr>
<tr>
<td>832*</td>
<td>Voice Disorders</td>
<td>Spring</td>
<td>R: graduate students audiology and speech sciences</td>
</tr>
<tr>
<td>833*</td>
<td>Auditory Psychophysics</td>
<td>Spring</td>
<td>R: ASC 803 or concurrently R: graduate students audiology and speech sciences</td>
</tr>
<tr>
<td>834A*</td>
<td>Hearing Amplification and Rehabilitation</td>
<td>Fall</td>
<td>R: graduate students ASC</td>
</tr>
<tr>
<td>834B*</td>
<td>Differential Diagnostic Audiology</td>
<td>Spring</td>
<td>R: ASC 843A R: graduate students ASC</td>
</tr>
<tr>
<td>834C*</td>
<td>Hearing Amplification and Rehabilitation</td>
<td>Spring</td>
<td>R: graduate students ASC</td>
</tr>
<tr>
<td>834D*</td>
<td>Electrophysiologic Assessment</td>
<td>Fall</td>
<td>R: ASC 813 or concurrently R: graduate students ASC</td>
</tr>
<tr>
<td>834E*</td>
<td>Special Populations in Audiology</td>
<td>Summer</td>
<td>R: graduate students audiology and speech science majors</td>
</tr>
<tr>
<td>834F*</td>
<td>Hearing Conservation</td>
<td>Fall</td>
<td>R: graduate students ASC</td>
</tr>
<tr>
<td>834G*</td>
<td>Voice Disorders</td>
<td>Spring</td>
<td>R: graduate students audiology and speech sciences</td>
</tr>
<tr>
<td>840*</td>
<td>Independent Study</td>
<td>Fall, Spring, Summer</td>
<td>R: class 7</td>
</tr>
<tr>
<td>894A*</td>
<td>Clinical Practicum in Speech-Language Pathology</td>
<td>Fall, Spring, Summer</td>
<td>R: graduate students ASC</td>
</tr>
<tr>
<td>894B*</td>
<td>Clinical Practicum in Audiology</td>
<td>Fall, Spring, Summer</td>
<td>R: graduate students ASC</td>
</tr>
<tr>
<td>899*</td>
<td>Master's Thesis Research</td>
<td>Fall, Spring, Summer</td>
<td>R: graduate students ASC</td>
</tr>
<tr>
<td>900*</td>
<td>Independent Study</td>
<td>Fall, Spring, Summer</td>
<td>R: graduate students ASC</td>
</tr>
<tr>
<td>914A*</td>
<td>Speech Production and Perception</td>
<td>II</td>
<td>R: graduate students audiology and speech science majors</td>
</tr>
<tr>
<td>914B*</td>
<td>Speech Production and Perception</td>
<td>II</td>
<td>R: graduate students audiology and speech science majors</td>
</tr>
<tr>
<td>930*</td>
<td>Seminar in Communication Sciences and Disorders</td>
<td>Fall, Spring, Summer</td>
<td>R: graduate level students ASC majors</td>
</tr>
<tr>
<td>934*</td>
<td>Research Practicum in Communication Sciences and Disorders</td>
<td>Fall, Spring, Summer</td>
<td>R: graduate students audiology and speech science majors</td>
</tr>
</tbody>
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BIOCHEMISTRY BCH

100. Introduction to Biochemistry
Fall. 3(3-0)
P: CEM 143, CEM 252, or MTH 120 or MTH 124 or MTH 122, BS 110, BS 111. R: Not open to students with credit in BCH 401 or BCH 461. This course is mandatory for students enrolled in the Biochemistry major.

401. Basic Biochemistry
Fall. 4(4-0)
P: CEM 252 or concurrently. R: Not open to students with majors in Biochemistry. Not open to students with credit in BCH 200 or BCH 461. Structure and function of major biopolymers, metabolism, and regulation. Examples emphasize the mammalian organism.

402. Biochemistry II
Spring. 3(3-0)
P: BCH 461. Continuation of BCH 461 with emphasis on metabolic regulation and macromolecular structure, replication, and protein synthesis.

471. Biochemistry Laboratory
Spring. 2(2-0)
P: CEM 262, BCH 461. R: Biochemistry majors or approval of department. Modern biochemical techniques used in the study of enzymes, proteins, lipids, and cell organelles.

472. Biochemistry Laboratory
Fall. 2(2-0)
P: CEM 262, BCH 462. R: Biochemistry majors or approval of department. Methods of molecular biology and the underlying principles on which these methods are based.

490. Research
Fall, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 12 credits. R: Approval of department. Participation in laboratory or library research projects.

499*. Doctoral Dissertation Research
Fall, Spring, Summer. 2 to 12 credits in increments of 4 credits. May reenroll for a maximum of 98 credits. R: graduate level ASC.

500. Introduction to Biochemistry
Fall. 3(3-0)
P: CEM 143, CEM 252, or MTH 120 or MTH 124 or MTH 122, BS 110, BS 111. R: Not open to students with credit in BCH 401 or BCH 461. Basic structures of major classes of biologically important molecules and metabolic activities of major importance in living organisms.

521. Medical Biochemistry
Fall. 5(5-0)
R: Graduate professional students in colleges of Human and Osteopathic Medicine. Basic biochemical principles and terminology: metabolism and function of biopolymers of importance in medical biology and processes pertinent to human pathophysiology.

521*. Molecular Biology and Protein Structure
Fall. 4(4-0)
P: BCH 462, CEM 352, CEM 383 Organization of genes including recombination, regulation of gene expression, replication, and recombination. Protein structure and relationship of function to structure.

524*. Metabolic Regulation and Molecular Endocrinology
Spring. 4(4-0)
P: BCH 401 Molecular basis for metabolic regulation, molecular signalling mechanisms, and mechanisms for allosteric and covalent protein modifications.

526*. Biochemical Mechanisms and Structure
Fall. 3(3-0)
P: BCH 462, CEM 353, CEM 383 or concurrently. Structures, methods of structural analysis, synthesis, and reaction mechanisms of biological substances including proteins, carbohydrates, lipids, porphyrins, phosphate esters, enzymes, and coenzymes.

536*. Cell Structure and Function
Spring. 3(3-0) Interdepartmental with the Department(s) of Physiology, Microbiology and Public Health.

581. Medical Biochemistry
Fall. 5(5-0)
R: Graduate professional students in colleges of Human and Osteopathic Medicine. Basic biochemical principles and terminology: metabolism and function of biopolymers of importance in medical biology and processes pertinent to human pathophysiology.

599*. Doctoral Dissertation Research
Fall, Spring, Summer. 2 to 12 credits in increments of 4 credits. May reenroll for a maximum of 98 credits. R: graduate level ASC.

521. Medical Biochemistry
Fall. 5(5-0)
R: Graduate professional students in colleges of Human and Osteopathic Medicine. Basic biochemical principles and terminology: metabolism and function of biopolymers of importance in medical biology and processes pertinent to human pathophysiology.

521*. Molecular Biology and Protein Structure
Fall. 4(4-0)
P: BCH 462, CEM 352, CEM 383 Organization of genes including recombination, regulation of gene expression, replication, and recombination. Protein structure and relationship of function to structure.

524*. Metabolic Regulation and Molecular Endocrinology
Spring. 4(4-0)
P: BCH 401 Molecular basis for metabolic regulation, molecular signalling mechanisms, and mechanisms for allosteric and covalent protein modifications.

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