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### **Biochemistry Program**

**Program Advisors: Dr. Bulent Terem, Dr. Joel Kawakami, Ms. Janet Jensen**

Biology advisors: Dr. Jolene Cogbill, Dr. Michael Dohm, Dr. Joan Kuh, Ms. Lisa Perry, Mr. Ron Iwamoto, Dr. Helen Turner

Pre-health advisors: Ms. Patricia Lee-Robinson; Ms. Lisa Perry, Ms. Janet Jensen.

#### **Biochemistry Mission Statement.**

Biochemistry is the study of the living organism at the molecular level. It draws on techniques from a broad spectrum of specialized branches of chemistry to study the molecular basis of vital processes. The mission of the Biochemistry Major program at Chaminade is to deliver an excellent education in biological chemistry, preparing students to be innovative, rigorous and well-trained scientists, educators or health practitioners. The biochemistry degree program recognizes that chemistry is ‘the central science’ and that biochemical processes are essential to all life on our planet. The biochemistry major is composed of sophisticated intellectual content and practical experiences. Students will be exposed to contemporary ideas in biology, a challenging range of chemistry courses and rigorous laboratory courses involving modern techniques and advanced instrumentation. Application of the scientific method, statistical and presentation skills, and critical evaluation of data are foundational to the course progression in the major, which culminates in a capstone research experience. Our undergraduate students experience an education that reflects the research interests and expertise of the faculty, specifically targeting the areas of natural products, synthetic and computational chemistry, cell and molecular biology, signal transduction, genetics and genomics, and integrative biology. The curriculum is synthesized with a rich program of available development activities including internships, conference attendance and preparation activities for the health professions and graduate school.

The vision of the Biochemistry major is linked to key components of the Chaminade educational experience. Our close-knit faculty fosters education in the family spirit, and the rapid progress in techniques and ideas that hallmark biology and chemistry drive our determination to prepare students who can adapt and change. Ultimately, the goal of science is to understand the mysteries of nature and improve the human condition, while recognizing the crucial hierarchy of all organisms within multi-level ecosystems. In particular, the goal of modern biochemistry is to develop novel molecules that address global problems, such as innovative therapies for disease, novel energy sources, and new biomaterials. Therefore, our program prepares graduates who will serve society and promote justice.

#### **Biochemistry Program Learning Outcomes.**

Upon completion of the B.S. degree program in Biochemistry the student will demonstrate:

1. An understanding of the scientific method and the ability to design and test a hypothesis;
2. The ability to visualize, statistically evaluate, validate and interpret scientific data, and to communicate science effectively both orally and in writing;
3. The ability to acquire and comprehend information from published scientific literature and to employ computational resources in the resolution of biological and chemical problems;
4. An understanding of the chemical and physical principles that unite all life forms, and of biological organization at the molecular, genetic and epigenetic, cellular, tissue, organ, organism and system levels;
5. An understanding of the principles of organic, inorganic, analytical and physical chemistry, with particular relationship to the biochemical processes of living organisms;
6. An understanding of the linkage between perturbations in biochemical pathways and the etiology of human disease, and of the potential for chemistry and biochemistry to yield therapeutic approaches;

7. An understanding of the entry requirements, career pathways and progression for the major post-graduate fields of research, education and the health professions.

**Biochemistry Program Features:**

The biochemistry program is supervised collaboratively between the Biology and Chemistry faculty at Chaminade University. Two degree programs are supported by the Biology discipline, the BS in Biology and the BS in Biochemistry. Two tracks are available within the BS in Biology, emphasizing Cellular and Molecular Biology and Integrative and Organismal Biology, respectively. When selecting a major program, students should be aware that the individual curricula are tailored to specific post-graduate preparation for careers. These are outlined in the table below.

Degree Awarded	B.S. in Biochemistry	B.S. in Biology	
		Cell and Molecular Biology Track	Integrative and Organismal Biology Track
Is there an undergraduate research requirement?	One semester Second semester elective	One semester Second semester elective	Optional as one semester elective
Is there an internship requirement?	Optional*	Optional *	Yes
What are the target post-graduate destinations for which this degree is designed?	Health professions (MD, Pharm.D etc)  Graduate School in Chemistry/Biochemistry/Biomedical Sciences/Pharmacology  Pharmaceutical Industry Biotechnology Industry	Health professions (MD, Pharm.D etc)  Graduate School in Biological/Biomedical Sciences  Pharmaceutical Industry Biotechnology Industry	Health professions (MD, Pharm.D etc)  Graduate School in Biology  Biotechnology Industry State and Federal Agencies
Is this program suitable for students who seek to enter medical or other health professional schools?	Yes – specifically pre-med seminar series, other enrichment activities and candidacy for Medical and other health professions Early Admissions Program.  <i>*students who intend to apply for medical, dental, veterinary or other professional schools are encouraged to use internships to complete a professional shadowing experience.</i>		

Within the BS program in biochemistry, it is possible to elect the ‘pre-med’ area of emphasis. Here, students are enrolled in a seminar series and other activities that specifically prepare for standardized tests such as MCAT, and for entry into professional areas such as medicine, dentistry, pharmacy, physical therapy and others. In addition, this election admits the student to candidacy for the Chaminade Medical School Early Admissions Program. Here students may be guaranteed seats at medical schools including Western University College of Osteopathic Medicine, A.T. Stills College of Medicine and Boston University School of Medicine, following the successful completion of a specific course of study at Chaminade. Interested students should contact a pre-health advisor at their earliest opportunity to discuss this program.

### **BS in Biochemistry Major Requirements:**

*Pre-major:* BI 100, BI 104, BI 105L, BI 205, BI 205L, BI 206, BI 206L, BI 207, BI 207L, BI 208, BI 208L, BC 203, BC 203L, BC 204, BC 204L, BC 323, BC 323L, BC 324, BC 324L, BC 334, BC 334L, PHY 251, PHY 251L, PHY 252, PHY 252L, MA 210, MA 211.

*Major:* BI 300, BI 302, BC 360, BC 360L, BC 362, BC 362L, BI 320, BI 320L, BI 410, BI 410L, BI 420, BI 495, BC 430L, BC 420 and *two upper division electives chosen from:* CH 440 and CH 440L, CH 403, BI 430, BI 411 and BI 411L, BI 321 and BI 321L, CH 447, BI 435.

### **Biochemistry Minor Requirements:**

BC 360 and BC 360L, BC 362 and BC 362L, BC 490, and *one upper division elective chosen from* BC 334 and BC 334L, BC 420, CH 440 and CH 440L.

### **Course Descriptions**

#### **BC 203 General Chemistry I (4)**

A study of the general concepts and basic principles of chemistry: properties of matter, atomic and molecular structure, theories of bonding, chemical reactions and stoichiometry, equilibria, and ions in aqueous solution. Offered annually. *Prerequisites:* MA 103. *Concurrent registration in BC 203L required. Cross-listed as CH 203.*

#### **BC 203L General Chemistry Laboratory (1)**

Inorganic qualitative and quantitative analysis with emphasis on gravimetric, volumetric, and spectrophotometric techniques. One three-hour laboratory period per week to accompany BC 203. Offered annually. *Concurrent registration in BC 203 required. Cross-listed as CH 203L.*

#### **BC 204 General Chemistry II (4)**

Continuation of CH 203. Acids and bases, thermodynamics, electrochemistry, additional aspects of chemical equilibria, descriptive chemistry. Offered annually. *Prerequisites:* MA 110, and BC 203 or equivalent. *Concurrent registration in BC 204L required. Cross-listed as CH 204.*

#### **BC 204L General Chemistry Laboratory II (1)**

One three-hour laboratory periods per week to accompany BC 204. Offered annually. *Concurrent registration in BC 204 required. Cross-listed as CH 204L.*

### **English 102 and COM 101 are prerequisites for all upper division courses**

#### **BC 323 Organic Chemistry I (4)**

Chemistry of carbon compounds is investigated according to the functional group classification. A full understanding of organic reaction mechanisms is emphasized in order to guide the students through numerous reactions. Three-dimensionality of carbon compounds is introduced and referred to in the context of relevant reactions. Offered annually. *Prerequisites:* BC 204/BC 204L. *Concurrent registration in BC 323L required. Cross-listed as CH 323.*

#### **BC 323L Organic Chemistry Laboratory I (1)**

Separation and purification techniques such as distillation, recrystallization, liquid-liquid extraction are introduced. Having performed several functional interconversion reactions, students are competent enough to carry out multi-step syntheses by the end of the semester. Offered annually. *Concurrent registration in BC 323 required. Materials intensive fee applies. Cross-listed as CH 323L.*

**BC 324 Organic Chemistry II (4)**

Spectroscopic methods such as IR, NMR, MS, and UV/VIS are introduced to solve structural identifications of the different classes of compounds studied in the first semester. The chemistry of carbonyl compounds is investigated in detail and principles of multi-step syntheses are introduced. Biologically relevant molecules such as saccharides, amino acids, peptides, and nucleic acids are studied with the strong implication that structural features and principal chemical behaviors of these molecules are related to their biological functions. Offered annually. *Prerequisites: BC 323. Concurrent registration in BC 324L required. Cross-listed as CH 324.*

**BC 324L Organic Chemistry Laboratory II (1)**

Students are trained to carry out more complex reactions using sensitive reagents. Most of the semester is used to learn to determine partial and full structures of organic compounds utilizing qualitative chemical and spectroscopic analyses. Hands-on training with the actual instruments and with computerized simulations is offered. Students are also introduced to microscale reaction techniques and apparatus. Offered annually. *Concurrent registration in BC 324 required. Materials intensive fee applies. Cross-listed as CH 324L.*

**BC 334 Analytical Chemistry (3)**

A one-semester course in analytical chemistry where separation techniques and quantitative identifications of chemical entities are discussed. The quantitative techniques include gravimetric, volumetric, and potentiometric analyses. Sampling techniques and the statistical treatment of data are also discussed. Offered annually. *Prerequisites: BC 204, BC 323. Concurrent registration in BC 334L required. Cross-listed as CH 334.*

**BC 334L Analytical Chemistry Laboratory (1)**

One three-hour laboratory period per week to accompany BC 334. Offered annually. *Concurrent registration in BC 334 required. Cross-listed as CH 334L.*

**BC 360 Biochemistry (3)**

This is the first part of a year-long course where the vast knowledge of biochemistry is filtered through a rational perspective guided by general chemical and biological principles. Following a survey and review of common classes of biologically significant metabolites such as peptides, carbohydrates, lipids, nucleic acids, as well as equally important smaller molecules, the emphasis is shifted to biological thermodynamics and enzyme mechanisms. During the latter part of the course the broad spectrum of principles studied is utilized to cover individual metabolic pathways in detail. *Cross-listed as BI/CH 360. Prerequisites: BI 208/BI 208L, BC 204/BC 204L. Concurrent registration in BC 360L required.*

**BC 360L Biochemistry Laboratory (1)**

Students gain experience in the isolation, purification, identification, and quantification of biologically important molecules. Spectroscopic, chromatographic, as well as chemical modification techniques are used in identifying peptides and proteins. Enzyme kinetic studies are carried out for quantification purposes. *Cross-listed as BI/CH 360L. Concurrent registration in BC 360 required. Materials intensive fee applies.*

**BC 362 Biochemistry II (3)**

This is the second part of the year-long biochemistry course, which starts with photosynthesis giving students a chance to review topics discussed during the previous semester such as oxidative phosphorylation and carbohydrate metabolisms. Continuing with individual metabolic pathways, lipids and amino acids are explored. The second half of the semester is mostly dedicated to nucleic acids, starting with nucleotide metabolism followed by a detailed study of information flow involving DNA and RNA. The course will conclude with a discussion of some contemporary techniques used in recombinant DNA technology. *Prerequisite: BC 360/BC 360L. Cross-listed as CH 362.*

**BC 362L Biochemistry II Lab (1)**

Contemporary experiments and simulations involving DNA and other nucleic acid metabolites. *Prerequisite: BC 360/BC 360L. Concurrent registration in BC 362 required. Cross-listed as CH 362L.*

**BC 420 Physical Chemistry (3)**

A one semester course covering thermodynamics, chemical equilibria and kinetics, quantum theory and applications to chemical bonding and spectroscopy. *Prerequisites: MA 211, BC 324, BC 360 and PHY 252*

**BC 430L Instrumental Analysis (2)**

This is a lab course during which students are expected to get hands-on experience with modern instrumentation, including but not limited to UV/VIS, FT IR, LC-MS, GC-MS. Following a discussion on the basic principles of each instrument, students will perform specific experiments and gather data from each instrument. Experiments during part of the course designated for topics in NMR spectroscopy will mostly be simulated. *Prerequisites: BC 324/BC 324L, BC 334/BC 334L. Materials intensive fee applies. Cross-listed as CH 430L.*

**BC 490 Chemistry Seminar I (1-2)**

Special topics in organic, inorganic, physical, analytical, or biochemistry. Reading and discussion of current topics as well as expertise in modern library searching and retrieval methods to obtain information. One oral presentation by each participant required. *Prerequisites: BC 324/BC 324L. Cross-listed as CH 490.*

**Elective Chemistry Courses:****CH 403 Inorganic chemistry (3)**

Inorganic systems including bonding theories, structure, acid-base phenomena, and coordination compounds. *Prerequisite: CH 324.*

**CH 440 Natural Product Chemistry (3)**

The vast number of naturally occurring substances will be classified in terms of the biosynthetic-biogenetic pathways of their production. Polyketides, terpenes, alkaloids, as well as compounds with other and mixed biogenetic origins will be studied using mechanistic predictions introduced at the beginning of the course rather than a traditional descriptive approach. Secondary metabolites that are not emphasized in biochemistry courses will be highlighted with a view to understand their ecological significance, particularly in the field of chemical communication. Some interesting novel molecules isolated from marine organisms will be discussed. *Prerequisite: CH 362/CH 362L.*

**CH 440L Natural Product Chemistry Lab (1)**

The emphasis in this lab course will be on isolation and identification methods. Students will be introduced to various chromatographic techniques, from manual to automated, which they will apply to separation of particular natural products out of a crude mixture. Experiments using different methods such as normal/reversed phase, size exclusion, will enable students to select the best route for any specific purpose. During the second half of the course each student will be assigned to a mini-project, where students will be expected to learn how to use advanced instruments, such LC-MS, and evaluate the data for structure determination purposes. *Prerequisite: CH 362/CH 362L. Concurrent registration in CH 440 required.*

**CH 447 Pharmacology (3)**

Therapeutic actions of drugs at the cellular, tissue and organism level are discussed in areas of cancer, inflammation, cardiovascular, and endocrine related diseases. Preclinical and clinical results of each drug or drug class are discussed with respect to therapeutic effectiveness. Included in the discussion are pharmacokinetics and toxicology. The course will be reading and writing intensive involving scientific literature research. The student will demonstrate an understanding of small and large molecule drug discovery and their therapeutics. *Prerequisite: BI 208/BI 208L, and CH 360/CH 360L.*