INTRODUCTION TO PHYSICAL BIOCHEMISTRY AND BIOCHEMICAL SYSTEMS MODELING pdf

1: Chemistry and Biochemistry â€¢ Colorado College

The Physical Basis of Biochemistry is an introduction to the philosophy and practice of an interdisciplinary field in which biological systems are explored using the quantitative perspective of the physical scientist.

One additional credit selected from: Selected topical areas, such as forensic science, materials science, environmental science, history of chemistry, chemistry and art, or nutritional, medicinal and consumer chemistry taught at the introductory level from a chemical perspective. Intended for but not typically limited to non-science majors, these courses will usually include moderate lab or fieldwork and independent or group research projects. Meets the Critical Perspectives: Scientific Investigation of the Natural World lab or field requirement. First Year Experience Course. Must take Physics block 1 for credit. Students will complete lab safety and ethics training. Disciplinary-based literature research and interpretation will be emphasized as part of the research process. Students will maintain a laboratory notebook or appropriate data records, analyze and interpret data, and produce a final scientific report. Independent experimental practice research in areas such as biochemistry, organic chemistry, physical chemistry, inorganic chemistry, catalysis, analytical chemistry and environmental chemistry performed in affiliation with a staff member. A total of three units of Investigations may be taken for credit. Lewis structures, hybridized atomic orbitals, VSEPR theory, resonance structures, and acid-base chemistry. An introduction to drawing and interpreting three-dimensional bond-line representations of organic molecules will also be provided. Statistical methods and the analysis of environmental samples using instrumental methods as well as techniques in chemical waste treatment are covered. Scientific Investigation of the Natural World requirement. Nomenclature, structure, physical properties and spectroscopy of simple organic molecules. Fundamentals of thermodynamics and reaction kinetics. Mechanisms, rates and equilibria. The course depends heavily on concepts developed in Lewis acid-base interactions, coordination complexes, associated reaction mechanisms, and other aspects of transition metal chemistry. Atomic-level origins of special material properties such as ferromagnetism and electroluminescence. Selected by the student with the advice of the instructor. Class and laboratory arranged. No more than six of these courses, i. Only a total of three units of Investigations in Chemistry and Special Topics in Chemistry combined can be counted toward graduation. No more than three units of Investigations, Topics, and Advanced Topics may be taken for department credit. Students will read discipline-specific literature and contribute to research design. Students will learn experimental design and execution, as well as troubleshooting skills. Students will maintain a laboratory notebook, or appropriate data records, and analyze and interpret data. An ACS style paper is required upon completion of the block, in which their data is summarized and future experiments are proposed. Research at this level may contribute to research presented in CH The design and analysis of optimized experiments will be illustrated through research-oriented topics that also teach the instrumental methods being emphasized. Factors in the design of multistep syntheses such as functional group transformation, elaboration of carbon chains, protecting groups and reaction stereochemistry. Examples from the literature of laboratory syntheses of complex molecules such as steroids, alkaloids and pharmaceuticals will be examined. Research projects requiring novel syntheses are a major component of this course. Students are required to propose multi-step syntheses and then work to complete proposed syntheses in the laboratory. Elucidation of mechanisms via the use of molecular orbital theory, isotope effects, substituent effects and linear free-energy relationships, solvent effects, characterization of reactive intermediates, gas-phase chemistry and computations. Either or will count as the advanced organic chemistry requirement for the chemistry major, or as an elective for the biochemistry major. The two courses, however, are not the same and both can be applied toward graduation requirements. Homogeneous and heterogeneous equilibria and chemical potential as a driving force in biological reactions. Measurement and interpretation of rate behavior in biochemical systems. Diffusion, osmotic pressure and sedimentation. Laboratory focusing on biophysical experiments and error analysis included. Equilibrium relationships in various homogeneous and heterogeneous states. The central aspects of quantum behavior, elementary statistical mechanics and theories of reaction rates. Emphasis on analyzing spectroscopic data, and on computational approaches to quantum-mechanical systems. Topics covered are proteins, carbohydrates, lipids, bioenergetics, enzymology, and metabolism with an emphasis on interrelationships between metabolic pathways and regulation. Limited to 16 students. A special emphasis on the use of the original literature. It includes methods for improved listening skills, assessing student content knowledge, teaching problem solving, and conceptual analysis. Methods used in the course include peer tutoring, experiential exercises, journal writing, and supervised tutoring. The class is recommended for those students desiring chemistry department payment for tutoring. Model systems will include molecular mechanics, quantum theory based semi-empirical, ab initio Hartree-Fock, and density functional methods. Department has laptops available for students who do not have their own for this course. Topics will vary from year to year. No more than three units of Investigations, Topics and Advanced Topics may be taken for department credit. Principles of biochemistry, molecular biology, and organic chemistry will be applied to the interpretation, analysis, and critique of recent primary medicinal chemistry literature. An overview of the drug discovery, development, and approval process will include case studies of recently approved drugs. Quantum theory and chemical statistics are applied to the interactions of electromagnetic radiation with molecules. Special emphasis will be on presentation of scientific literature related to inborn errors of metabolism. CH Senior Seminar An adjunct course spread out over the whole year in which guest lecturers and juniors and seniors present their independent research either literature or laboratory to the department in both oral an poster disciplinary presentation formats.. One semester required in the senior year for both chemistry and biochemistry majors. Required for Chemistry Majors. CH Senior Thesis A thesis topic to be chosen by student with advice from a member or members of the department. Upon presentation of thesis proposal by the student, department faculty will authorize or deny registration in

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2: LifeScienceElectiveList - Biomedical Engineering - Purdue University

First semester of a comprehensive introduction to modern biochemistry. Structure, chemical properties, and function of proteins and enzymes, carbohydrates, lipids, and nucleic acids.

Students supported by these training grants must be U. In addition, several research assistantships funded by grants and contracts awarded to faculty by outside agencies may be available to qualified students. University fellowships providing remission of tuition are also available. Graduate students in biophysics are eligible for and encouraged to apply for various nationally administered fellowships, such as National Science Foundation fellowships. Fellowships Thomas Jefferson St. It is anticipated that financial support covering normal living costs and tuition will be made available to accepted students. Support for foreign students is extremely limited. For current course information and registration go to https: Introduction to Biomedical Research and Careers I. Lecture Series designed for those curious about a career in life sciences, medicine and public health. A novel format combining presentation with didactic interviews gives a broad view of a range of research topics, experimental approaches and logistics, and practical applications as well as career paths. Emphasis is on the excitement of scientific explorations not an abundance of the technical facts and figures. Freshmen and non-science majors. Freshman Seminar in Biophysics. Introduction of contemporary biophysics research topics through presentations, discussion and hands-on exercise. Freshmen and sophomores only. This course is useful for many disciplines not only the life sciences. It will introduce students to basic computing concepts and tools useful in many applications. Students learn to work in the Unix environment, to write shells scripts, and to make use of powerful Unix commands e. They will learn to program using the Python programming language, graphing software, and a package for numerical and statistical computing, such as Mathematica or MATLAB. At the end of the semester students will complete a project coupling all components of the semester together. Brief lectures followed by extensive hands-on computer laboratories with examples from many disciplines. Course offered every semester. You cannot take AS. Protein Engineering and Biochemistry Lab. This laboratory examines the relationship between genes and proteins in the context of disease and evolution. It is a research project lab in which the structural and functional consequences of mutations are determined for a model protein. Students will learn basic protein science and standard biochemical techniques and methods in protein engineering. They will perform experiments in site-directed mutagenesis, protein purification, and structural, functional and physical characterization of proteins. Courses offered in Fall and Spring semesters. Protein Biochemistry and Engineering Laboratory. Algorithms and databases for biological information. A mostly computer lab course covering basic programming; algorithms for comparison of sequence, protein structure and gene expression; protein structure prediction and an introduction to major databases. Students will complete a genomics database project and will prepare and discuss on-line presentations on topics related to the use of genomic information. No programming experience necessary. Preference to Biophysics majors. Laboratory in Molecular Evolution: The availability of genomic sequences from a vast number of species has enabled the reconstruction of ancestral proteins. In this course we will reconstruct the genes of ancestral proteins and study the physical properties of proteins coded for by "extinct" genes. To examine the evolutionary mechanisms whereby modern proteins obtained their remarkable physical and functional properties, we will focus on understanding how the physical properties of proteins evolved hand-in-hand with changing environmental conditions such as pH, temperature, pressure, ionic strength, oxidative stress, etc. Modeling the Living Cell. Previously titled "Models and Algorithms in Biophysics. Students will learn algorithms for implementing models computationally and perform basic implementations. We will discuss the types of approximations made to develop useful models of complex biological systems, and the comparison of model predictions with experiment. NMR is a spectroscopic technique which provides unique, atomic level insights into the inner workings of biomolecules in aqueous solution. A wide variety of biophysical properties can be studied by NMR. For example, we can use the technique to determine three dimensional structure of biological macromolecules such as proteins and nucleic acids, probe their dynamical properties in solution, study their interaction with other molecules and understand how physico-chemical properties such electrostatics and redox chemistry affects and modulates structure-function relationships. NMR exploits the exquisite sensitivity of magnetic properties of atomic nuclei to their local electronic and therefore, chemical environment. As a result, biophysical properties can be studied at atomic resolution. That is to say, we can deconstruct global properties of a molecule in terms of detailed, atomic level information. In addition, interactions between nuclei can be exploited to enhance the information content of NMR spectra via multi-dimensional 2D and 3D spectroscopy. Since these properties can be studied in solution, NMR methods serve as an effective complement to X-Ray crystallography, which also provides detailed, atomic level information in the solid state. In this course, we will learn about the basics of NMR spectroscopy, acquire 1D and 2D NMR spectra and use various NMR experiments to characterize and probe biophysical properties of proteins at an atomic level. Juniors and Seniors Only. Molecular and Cellular System Biology. This course covers the principles of biological networks, with an emphasis on computational analysis. Networks ranging from simple biochemical pathways to genome-scale metabolic, regulatory, and signaling networks will be studied. Topics include dynamic modeling of biochemical pathways, steady-state analysis of cellular metabolic networks, inference of gene regulatory networks using â€”omics data, and systems biology approaches to studying signal transduction. Research in Protein Design and Evolution. Foundation for advanced classes in Biophysics and other quantitative biological disciplines. Lecture and computer laboratory. This class is the first semester of a two semester course in biochemistry. Topics in Biochemistry I include chemical and physical properties of biomolecules and energetic principles of catabolic pathways. Computer labs include extensive use of molecular graphics and modelling of reaction kinetics and pathway flux. If you have completed AS. Biochemical anabolism, nucleic acid structure, molecular basis of transcription, translation and regulation, signal transduction with an emphasis on physical concepts and chemical mechanisms. Format will include lectures and class discussion of readings from the literature. All biological processes require the interactions of macromolecules with each other or with ligands that activate or inhibit their activities in a controlled manner. This course will discuss theoretical principles, logic, approaches and practical considerations used to study these binding processes from a quantitative perspective. Topics will include thermodynamics, single and multiple binding equilibria, linkage relationships, cooperativity, allostery, and macromolecular assembly. Some biophysical methods used in the study of binding reactions will be discussed. Computer simulation and analysis of binding curves will be used to analyze binding data, and binding schemes and examples from the scientific literature will be reviewed and discussed.

3: Biophysics - Wikipedia

The Department of Biochemistry and Biophysics is an administrative division of the School of Medicine and a member of The Graduate School. The graduate program offers instruction and research opportunities leading to the Ph.D. degree.

X Ray Crystallography of Macromolecules. Principles of protein crystallography, characterization of crystals, theory of diffraction, phasing of macromolecular crystals and structure refinement. Course intended primarily for graduate students. Principles of and Simulation of Macromolecular Dynamics. Summer Research in Biophysics. This class is a week summer course in biophysics. A lecture module that introduces students to mass spectrometry-based proteomics in new biology discovery and precision medicine. Ion Channels Transporters Grading status: Electrical Signals from Macromolecular Assemblages. An intensive, six-hour per week introduction to the fundamentals of ion channel biophysics, including laboratory sessions to demonstrate principles and methods. Graduate-level Courses The following seminar courses are designed for students majoring or minoring in biochemistry who wish to further their knowledge in particular areas. Unless otherwise stated, two semesters of biochemistry are prerequisites for seminar courses. Most of these courses are given in alternate years by interested staff members. Unless otherwise stated, these seminars may not be repeated for credit. Seminar courses provide teaching experience, which is required for a graduate degree in biochemistry and biophysics. In addition, the courses provide experience in giving a critical review of the current literature. Origins and Early Evolution of Life. Critical reading and discussion in the origins of, metabolism, inheritance, and natural selection, and biological complexity Grading status: Critical Analysis in Biochemistry. Permission of the instructor. Critical analysis of research papers from departmental seminar series, student presentations, meet seminar speakers, learn about departmental research and current techniques. Permission of the department for nonmajors. Designed to introduce the student to research methods. Minor investigative problems are conducted with advice and guidance of the staff. May be repeated for credit. Students present seminars coordinated with the visiting lecturer series of the Program in Molecular and Cellular Biophysics. Letter grade Same as: Permission of the program director. Designed to introduce students in the Molecular and Cellular Biophysics Program to research methods. Minor investigative projects are conducted with advice and guidance of the staff. Biochemistry of Human Disease. Graduate level, involves lectures, critical readings, and discussions of biochemical aspects of human diseases. Core biochemical principles and cutting edge approaches are considered in the following: Cellular Metabolism and Human Disease. Open to 1st year BBSP or advanced graduate students with background in basic cellular biochemistry. Addresses the role of cellular metabolism in human disease, including the roles and regulation of biochemical pathways. Recent advances will be emphasized. Diseases addressed will include cancer and diabetes. Research Concepts in Biochemistry. A series of lectures and exercises on formulating a research plan to attack a specific scientific problem, and on presenting the research plan in the form of a grant proposal. Doctoral candidates in biochemistry and biophysics only. A course of lectures and workshops on the principles of clear scientific exposition with emphasis on the design and preparation of research grants. Senior graduate students present original research results as a formal seminar. Feedback on presentation effectiveness and style will be provided by faculty instructors and classmates. Discussion of polymerases, proteases, protein-protein interactions, protein degradation pathways, protein-nucleic acid recognition, transcriptional control, RNA splicing and transport, and mechanisms of drug resistance. Cell Regulation by Ubiquitination. Required preparation, two semesters of biochemistry. Lecture and literature-based discussion course on ubiquitin-mediated regulation of hormone receptor signaling, trafficking, and degradation. Cellular and Molecular Neurobiology: Introduction and Electrical Signaling. Permission of the department. Introduces topics as brain cell biology, molecular biology applied to neurons, membrane potentials and imaging methods. The second half of this block introduces such topics as resistance, capacitance, passive membranes, classes of ion channels, potassium and calcium channels, and action potential initiation. Consideration of membrane receptor molecules activated by neurotransmitters in the nervous system with emphasis on ligand binding behavior and molecular and functional properties of different classes of receptors. Course meets for four weeks with six lecture hours per week. This block focuses on neurotransmitter signaling through distinct receptor subclasses. Topics include G-protein coupled receptors and associated signaling, receptor binding theory, ionotropic and metabotropic glutamate and GABA receptors, receptor trafficking and localization. Course meets for five weeks with six lecture hours per week. Development of the Nervous System. This block covers neural induction, neural stem cells, glial development, neural cell death and neurotrophin during development, and synaptic adhesion molecules. Anatomy and Function of Sensory and Motor Systems. This block introduces the sensory pathways of vision, audition, taste, olfaction, pain, and touch, as well as the motor pathways of the spinal cord, basal ganglia, cerebellum, and motor cortex. Discusses mechanisms of sensory information processing and motor execution. Includes peripheral and central mechanisms of pain. This course offers an introduction to the interdisciplinary field of nanomedicine for students with a physical, chemical, or biological sciences background. This course will emphasize emerging nanotechnologies and biomedical applications including nanomaterials, nanoengineering, nanotechnology-based drug delivery systems, nano-based imaging and diagnostic systems, nanotoxicology, and translating nanomedicines into clinical investigation. Contemporary Topics in Cell Signaling: This graduate-level course is an in-depth analysis of how protein kinases and protein phosphorylation regulates key aspects of cell signaling. This class is one of the "Contemporary Topics in Cell Signaling" modules. This graduate-level course conveys principles of signal transduction controlled by GTPases and emphasizes in-depth discussion of current literature and unanswered questions. This graduate-level course conveys principles of eukaryotic cell proliferation control emphasizing in-depth discussion of current literature and unanswered questions. This class is one of the Contemporary Topics in Cell Signaling modules. Acquire the scientific vocabulary of the signaling network field. Master key concepts from mathematical characterization of signaling circuits. Develop and apply critical analysis skills. Topics on Stem Cells and Development. Required preparation, coursework in genetics, cell biology, and molecular biology. Course addresses key issues in developmental biology focused on the role of stem cells and emphasizes in-depth discussion of current literature and unanswered questions. One of the Contemporary Topics in Cell Signaling modules. Intercellular Signaling in Development and Disease. Signaling mechanisms that will be discussed include autocrine, paracrine, juxtacrine signaling and cell-matrix interactions. Image formation is treated from a quite general point of view, drawing from Fourier transform methods used in X-ray crystallography. Isomorphous replacement, multiple wavelength anomalous scattering, and Bayesian direct methods are covered. One two-hour seminar a week. Seminar on Cell Signaling. Signal transduction in embryonic development. Review of current literature on structural, thermodynamic, and kinetic aspects of binding to DNA of proteins involved in replication, regulation, recombination, and repair. Introduction to computer-assisted molecular design, techniques, and theory with an emphasis on the practical use of molecular mechanics and quantum mechanics programs. Introduction to modeling and simulation techniques for biological macromolecules. Two lecture and three to four laboratory hours per week. Required preparation, graduate-level courses one each in molecular biology and biochemistry. A seminar course on the enzymology of DNA repair and damage tolerance and the regulation of genes involved in these processes. Both classic and recent literature are discussed. From Force to Phenotype: Forces and biological outcomes will be considered through specific examples. Six or more hours a week throughout both semesters. Doctoral Research and Dissertation.

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4: Department of Biochemistry and Biophysics (GRAD) < University of North Carolina at Chapel Hill

Molecular Modeling Overview []. Molecular modeling refers to abstract methods and techniques for finding the molecular structures and properties by using computational chemistry and graphical visualization techniques to 'model' or copy the behavior of the molecule.

Requirements for the Major: To enroll in Humanities and the Arts 6 credits See suggested courses in the Degree Requirements chapter. Multicultural and International Studies 6 credits See suggested courses in the Degree Requirements chapter. Experience-Based Education 3 credits Proficiency in Biochemistry 94 credits The major in Integrated Biochemistry consists of the six parts A through F listed immediately below. They are described briefly here; the specific requirements are listed below. Life and Physical Sciences Core These courses prepare students to enter the major. These courses are normally completed in the first two years of college. Quantitative Methods Quantitative reasoning, computational facility and a grasp of the calculus are essential skills for people to be well educated in the molecular biosciences. As with the Life and Physical Sciences Core, students should normally complete this requirement within the first two years of college. Biochemistry Core This set of courses is required of all majors and prepares the student for both advanced course work and for research experience. Professional Ethics Ethical conduct has at least two components: Although Contemporary Issues in Biochemistry will meet the formal requirement, all courses within the major will include ethical components and examples. In addition, all students in the major and in any of our courses will be required to adhere to a strict honor code. Research Experience It is important that students be able to apply their knowledge of biochemistry in a laboratory setting. Therefore, all students will be required to take 6 cr. This can be accomplished through working in an academic laboratory at Rutgers, either at SEBS or the other campuses. This requirement can also be met through the George H. Cook Honors program, or through research experience through the Cooperative Education option. Biochemistry of Microbial Systems This option blends biochemistry with microbiology, allowing students to become proficient in the biochemistry of microbial organisms and systems. This will include aspects of clinical microbiology and infection, as well as environmental microbiology. Microbial infections of higher organisms are of continuing importance in human and animal heath. Microorganisms also have profound environmental implications. Microbial systems detoxify toxic substances and contribute to nutrient cycling in the ecosphere. Another area of study is the use of microbial organisms to synthesize useful materials and to convert biomass to fuels. Biochemical Toxicology This option will allow the student to gain specific understanding of the study of toxic compounds. Toxicology is of critical importance in food and nutrition, the environment and in pharmacological science. Understanding the biochemical effects allows one to design appropriate treatments of illness, and to learn what exposures must be avoided. An equally important second purpose, the study of how biochemical systems are made to go awry by toxic substances, illuminates normal functioning and development of organisms. This understanding applies equally to all animals, including humans, as well as to plants and microorganisms. It applies also to ecological communities of organisms, as toxic substances alter the interactions within ecosystems. Understanding their biochemistry is a large and growing area of basic and applied research and public policy development.

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5: Biophysics < Johns Hopkins University

The modeling process consists of the following steps: (i) model implementation consisting in describing by a formal language the objects/relationships identified in the system under study using a mathematical structure and/or a computer code; (ii) use the model to forecast the system behavior and (iii) evaluate the model adherence to reality by.

Subjects vary, but have included biochemical basis of the origin of life, biochemical genetics, biochemical aspects of memory and behavior, mutagenesis, bioenergetics and nutrition, and environmental biochemistry. Emphasizes cell structure and function at the molecular level. Topics cover scientific theory, communications, and critical evaluation. Writing Intensive Course Attributes: The course will involve the conceptual background necessary to appreciate the applications of molecular biology. Throughout the course opportunities will be given to discuss public policy issues and questions: Does the scientific or public value of knowing the entire DNA sequence of the human genome justify a situation in which individual or small-scale research cannot be supported? What issues arise when the fruits of biological research, mostly publicly funded, are commercialized? Should a novel organism be patented? How can biotechnology be applied to environmental problems? Bacc Core Course Attributes: Advances in knowledge of the human genome arising from DNA sequencing efforts and major leaps in understanding of the regulating cellular growth and division are presented in an easy-to-understand fashion appropriate for students in all majors. Course discussions and assignments will cover implications of advances in molecular medicine from ethical, economic, technical and societal standpoints. The aim of the course is to present technical material in a way that non-scientists will understand and conversely to summarize ethical, economic, and philosophical considerations in a way that the scientists understand the implications of these technologies. Topics include structure of neurons, outline of signaling in the central nervous system, Nernst equation, action potentials, synaptic transmission, chemical signaling in vision, disease and drugs. This course is repeatable for 99 credits. Offered every other fall in odd years. Introduces students to the vocabulary and tools of this discipline, covering both the fundamental physico-chemical principles governing the structure and function of biological macromolecules and a selected set of widely used experimental and theoretical approaches to their characterization. This is done through lectures, and textbook and literature readings. Graduate students receive additional experience in scientific reading, writing and presentation through a literature-based term project. Explores techniques and their applications to macromolecules as well as the scientific process. Techniques discussed include in vitro, in vivo, and in silico methods, with an emphasis on biomolecular interactions. Specific examples of long-lasting gene regulation across cell cycles will be used to describe the concept of "epigenetic" gene regulation by modification of DNA or proteins. The class will combine more traditional lectures with discussion periods where primary research papers will be analyzed. The target audience is third- and fourth-year students as well as graduate students. The student will gain a working knowledge of the bioinformatics analysis of contemporary techniques such as databases, gene and genome annotations, functional annotations, sequence alignment, motif finding, secondary structure prediction, phylogenetic tree construction, high-throughput sequence data, ChIP-Seq peak identification, transcriptome profiling by RNA-Seq, microRNA discovery and target prediction. These include examples among the bacteria, plants, fungi, worms, flies and mammals. The organic chemistry of biochemistry will be a focus, including the mechanisms by which enzymes catalyze biological reactions. Includes some programming and practical experience with web-based and command-line tools. A pass will be given to all students who complete the exam. Contact the Biochemistry and Biophysics Program for more information. This course is repeatable for 16 credits. Descriptions of campus research programs in biochemistry and biophysics, 1 credit fall. Student presentations of current research literature, 1 credit winter and spring. Should be taken by all entering departmental graduate students. Presentation of departmental research seminar, 2 credits any term. PhD candidates in biochemistry and biophysics present a departmental research seminar in the third or fourth year. One registers in the term the seminar is presented.

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Courses include enzyme kinetics, cell cycle and cancer, neurochemistry, oxidative stress, cell adhesion and motility. Most courses offered alternate years. This course is repeatable for 18 credits. Courses include cell surfaces, enzyme kinetics, metabolism, neurochemistry, trace element metabolism, biological oxidations, and bioenergetics. Courses include enzyme kinetics, metabolism, neurochemistry, trace element metabolism, biological oxidations, and bioenergetics.

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6: Biochemistry Undergraduate Program at Rutgers SEBS

The Physical Basis of Biochemistry is an introduction to the philosophy and practice of an interdisciplinary field in which biological systems are explored using the quantitative perspective of the physical scientist. As with the first edition, the idea that a fundamental understanding of the basic physical principles underlying chemical.

A sample time-series of the Lotkaâ€”Volterra model. Note that the two populations exhibit cyclic behaviour. Creating a cellular model has been a particularly challenging task of systems biology and mathematical biology. It involves the use of computer simulations of the many cellular subsystems such as the networks of metabolites and enzymes which comprise metabolism , signal transduction pathways and gene regulatory networks to both analyze and visualize the complex connections of these cellular processes. Craig Venter Institute and published on 20 July in Cell. Multi-cellular organism simulation[edit] An open source simulation of C. So far the physics engine Gepetto has been built and models of the neural connectome and a muscle cell have been created in the NeuroML format. It is one of the most important goals pursued by bioinformatics and theoretical chemistry. Protein structure prediction is of high importance in medicine for example, in drug design and biotechnology for example, in the design of novel enzymes. Every two years, the performance of current methods is assessed in the CASP experiment. Human biological systems[edit] Brain model[edit] The Blue Brain Project is an attempt to create a synthetic brain by reverse-engineering the mammalian brain down to the molecular level. Model of the immune system[edit] The last decade has seen the emergence of a growing number of simulations of the immune system. The goal is to produce a virtual liver, a dynamic mathematical model that represents human liver physiology , morphology and function. Simulated growth of plants Electronic trees e-trees usually use L-systems to simulate growth. L-systems are very important in the field of complexity science and A-life. A universally accepted system for describing changes in plant morphology at the cellular or modular level has yet to be devised. Ecosystem model Ecosystem models are mathematical representations of ecosystems. Models in ecotoxicology[edit] The purpose of models in ecotoxicology is the understanding, simulation and prediction of effects caused by toxicants in the environment. Most current models describe effects on one of many different levels of biological organization e. A challenge is the development of models that predict effects across biological scales. Ecotoxicology and models discusses some types of ecotoxicological models and provides links to many others. Modelling of infectious disease[edit] Main articles: Mathematical modelling of infectious disease and Epidemic model It is possible to model the progress of most infectious diseases mathematically to discover the likely outcome of an epidemic or to help manage them by vaccination. This field tries to find parameters for various infectious diseases and to use those parameters to make useful calculations about the effects of a mass vaccination programme.

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7: Biochemistry (BCHM) < University of New Hampshire

modeling, biochemistry and biophysics, including ab initio quantum mechanics, semi-empirical MO theory, molecular mechanics, molecular dynamics simulation, coarse-grained models, electrostatic methods and biomolecular structure prediction.

Life Science Elective List At least 6 credit hours must be established from the following areas: Life Science Electives by Subject Area: Topics will include understanding the evolutionary organization of genes genomics , the structure and function of gene products proteomics , and the dynamics of gene expression in biological processes transcriptomics. Inherently, bioinformatics is interdisciplinary, melding various applications of computational science with biology. This jointly taught course introduces analytical methods from biology, statistics and computer science that are necessary for bioinformatics investigations. Analysis of crystal structures by X-ray diffraction methods. Growth and properties of protein crystals. Intensity of diffracted waves. Structure refinement and analysis. Crystallography is a primary method for the determination of the structures of biological macromolecules at near atomic resolution. As such it has a tremendous impact on aspects of biological and biochemical research as diverse as the protein folding problem, the regulation of gene expression, signal transduction, the catalytic functions of enzymes, and the design of therapeutic agents to bind to known receptors. The purpose of the course is to expose students to the application of these techniques to specific problems in biological systems, the interpretation of the resulting data, and analysis of the strengths and limitations of each technique. Specific techniques to be covered are: Students will also develop an appreciation for some of the contributions that have been made by biochemistry to society, including improvements to medicine, agriculture, and the economy. CHM or CHM or CHM or CHM or MCMP Protein structure and function, introduction to nucleic acids and molecular biology, properties of enzymes, mechanisms of enzyme action, basic concepts of metabolism, sugar and fatty acid metabolism, introduction to membranes and hormone action. Amino acid metabolism, photosynthesis, biosynthesis of membrane lipids and steroids, biosynthesis of nucleotides, structure and function of nucleic acids, protein synthesis, and control of gene expression. The first half of the course includes an analysis of the function of membrane bound organelles especially the endoplasmic reticulum, Golgi apparatus, and lysosomes. Protein targeting to these organelles is examined in detail. The second half covers muscle and actin-based non-muscle motility, cilia and other microtubule-based movements, and ends with the regulation of the cell cycle and growth control. Cell biology of neurons and glial cells, electrophysiological properties of neurons, electrical and chemical signaling between neurons, synaptic integration and plasticity, development and regeneration of the nervous system and nervous system diseases. Up-to-date research findings and techniques will be included. A basic knowledge of cell biology and protein structure and function is strongly recommended. Recent progress in molecular neuroscience has begun to reveal the mechanisms of several human neurological diseases and to suggest potential therapies. Biology explores topics in basic cellular, molecular and developmental neuroscience and their connections to neural disease and injury. Readings are derived from the current literature. The course will address the structure and function of specific neural systems such as the motor systems, somatosensory systems, visual and auditory systems, learning and memory, and higher cortical function. It will draw extensively on subject matter concerning the molecular and cellular biology of the nervous system presented in BIOL N Introduction to Neurobiology, while combining and integrating this material with the relevant neuroanatomy. Principles of development will be studied in a lecture format course. Emphasis will be on a pattern formation in model systems, such as Drosophilia embryogenesis, vertebrate nervous system and vertebrate limbs. A strong background in cell and molecular biology is recommended. The next section involves discussions of microbial diversity centering on mechanisms for generating energy and synthesizing essential cell components. The importance of these mechanisms to environmental cycling of key elements is included. The last section deals with the interaction of bacteria with their environments and includes the role of plasmids and viruses, interactions with plants and pathogenicity. A brief description will be given of the immune system and its roles in fighting against infection followed by criteria used to determine whether a microorganism is responsible for a disease. Discuss pathogenic mechanisms of several groups of important infections agents, including transmission, route of infection and means to avoid the detection by the immune system. Treatment of infectious disease and the current challenges in this aspect will also be covered. Discuss strategies and methods used to study bacterial pathogenesis. Describe bioterrorism and biodefense. All topics will be discussed along with reading assignments of relevant up-to-date research articles. The classical genetics section includes discussions on Mendelian genetics, linkage and meiotic mapping, sex determination, cytoplasmic inheritance, and chromosomal aberrations. The molecular biology section continues with discussions on DNA structure and replication, chromosomal organization, transcription, translation, the genetic code, mutations, DNA repair, and transposable elements. Basic regulatory mechanisms in prokaryotic and eukaryotic gene expression, as well as current developments recombinant DNA technology, cancer-causing genes, imprinting, developmental genetics are also presented. Emphasis will be placed on experimental procedures and model systems, such as site-directed mutagenesis of isolated genes and their subsequent introduction into mammalian cells. Topics will include the molecular control mechanisms associated with RNA transcription and processing, protein-DNA interactions, gene regulation in development and growth control. It will emphasize the use of viruses as model systems for the study of macromolecules. The first third of the course will be an introduction to virology and examination of the molecular techniques used to study viruses. The second third of the course will focus on specific virus systems and how molecular biology, biochemistry, and structural biology have impacted our understanding of viruses and the disease process. The final third of the course will concentrate on HIV, and viruses as vectors for gene therapy or weapons of bioterrorism, the AIDS virus from the molecular to the clinical. BIOL An intermediate level survey course of human genetics with emphasis on the impact of molecular information. We focus not only on the fundamentals of genome organization, function and variation in molecular terms, but extend our understanding to molecular interpretations of patterns of inheritance, genetic disease, diagnosis and treatment. For all topics, an emphasis is placed on the molecular mechanisms governing growth regulation and how alterations in these mechanisms can give rise to disease states such as cancer. Reading of current literature is required. The course is divided into "theoretical" and "application" sections. In the theoretical section, general principles of protein structure are discussed in detail. In the application section, the structural principles learned in the first part of the course are applied to particular protein systems. Topics covered in the theoretical section of the course include covalent structure of proteins; protein secondary, tertiary and quaternary structure; physical forces influencing protein structure; protein surface areas and internal packing; internal motion in protein molecules; protein folding; comparison of protein primary and prediction of tertiary structures; and structural features of integral membrane proteins. Anatomy and Physiology Prerequisites: Relevant aspects of anatomy and histology are also included. Use of examples from current medical practice encourages application of knowledge to predict symptoms of disease and rationale for treatment. Topics covered include histophysiology of cells and tissues, nerve and muscle physiology, the nervous system, and cardiovascular dynamics. Each section begins by describing fundamental commonalities of a reproductive event in a variety of species. This is followed by an emphasis on the details in the details of that event among species. Some of the topics to be covered include ovarian and testicular functions, puberty and the hypothalamic-pituitary-gonadal axis, fertilization, establishment of the placenta, maternal support of pregnancy, parturition, and lactation. Introductory course for graduate and senior undergraduate students interested in how the body protects itself from infectious disease. What constitutes the immune system, how it functions, and what might go wrong. Work in a peer-learning team to understand and present research papers. An experimental approach to a variety of topics is emphasized. Normal relationships between physiological mechanisms and their subsequent phenomena, both empirical and theoretical. These relationships will be reinforced by homework assignments utilizing software models of these phenomena. This foundation in normal physiological systems will also be complemented by subsequent topics on system pathologies. The effects of these pathologies, as well as their amelioration via medical interventions devices or drugs will be explored through software. Introduction to the regional study of the human body lower limb, upper limb, abdomen, pelvis, thorax, head, and neck. Supplemented by observations and demonstrations of prosected cadaver materials, radiographs, osteology, and surface anatomy. The first of two courses offered to graduate students and advanced undergraduate students. It covers the general physiological processes of mammals with special emphasis on domestic animals. These processes are presented as interactions between large populations of cells, organs, organ systems, and the integrated functions of an entire animal. This course covers the nervous system, musculoskeletal system, circulatory system, and the regulation of body fluids. BMS 3 Systemic Mammalian Physiology II Comparative mammalian domesticated and human physiology, with emphasis upon principles, concepts, and mechanism of the cardiovascular, respiratory, renal, endocrine, and reproductive systems. Topics cover fundamental aspects of mammalian nervous system structure at gross and microscopic levels. Logical principles of neural circuits and their specificity will be examined by example, and their overall functionality will be explored within the context of respective systems. Offered in alternate years. BME will need to request an override This course examines basic principles related to the causes of disease, its mitigation and prevention. The relationship between heredity, behavior, the immune response and chronic disease is explored. Risk factors for the leading causes of morbidity and mortality are contrasted and compared. The three principal divisions of the course deal with a heredofamilial disorders, b infectious diseases, and c chronic conditions. The public health promotion strategies that might prevent, ameliorate or otherwise mitigate the consequences of disease in a population. HK 3 Principles of Epidemiology Prerequisites: A fundamental understanding of the nature of epidemiologic study as related to human morbidity, mortality, and injury disability is provided. Examples of other topics to be presented include the utility of public health vital statistics, concepts of disease transmission, types of epidemiological studies, and causality. The course covers those aspects of acoustics most pertinent to understanding auditory processing of simple and complex sounds e.

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8: Courses | Biophysics | Johns Hopkins University

Biochemical Engineering has been oï¬•ered as one of the elective courses to the Univer- siti Sains Malaysia's Chemical Engineering undergraduates since under the topic of Bioprocess Engineering.

Advanced Search Abstract Mathematical and computational models are increasingly used to help interpret biomedical data produced by high-throughput genomics and proteomics projects. The application of advanced computer models enabling the simulation of complex biological processes generates hypotheses and suggests experiments. Appropriately interfaced with biomedical databases, models are necessary for rapid access to, and sharing of knowledge through data mining and knowledge discovery approaches. These advances are changing the way biomedical research, development and applications are conducted. Clinical data complements biological data, enabling detailed descriptions of both healthy and diseased states, as well as disease progression and response to therapies. The availability of data representing various biological states, processes and their time dependencies enables the study of biological systems at various levels of organization, from molecules to organism and even up to the population level [3â€”5]. Multiple sources of data support a rapidly growing body of biomedical knowledge, however, our ability to analyze and interpret this data lags far behind data generation and storage capacity. Mathematical and computational models are increasingly used to help interpret biomedical data produced by high-throughput genomics and proteomics projects. Computational models are set to exploit the wealth of data stored on biomedical databases through text mining and knowledge discovery approaches. Modeling is the human activity consisting of representing, manipulating and communicating real-world daily life objects. As one can easily realize, there are many ways to observe an object or, equivalently, there are many different observers for the same object. Each different observer collects data and generates hypothesis that are consistent with the data. Abduction is not infallible, though; with respect to a scientific unknown, we are all blind. A system is a collection of interrelated objects. For example, a biological system could be a collection of different cellular compartments e. An object is some elemental unit upon which observation can be made but whose internal structure is either unknown or does not exist. The choice of the elemental unit defines the representation scale of the system. A model is a description of a system in terms of constitutive objects and the relationships among them, where the description itself is, in general, decodable or interpretable by humans. Using this general definition, one can identify three primary scientific uses of models [12]: Secondary uses of models account for conceptual frameworks to design new experiments, methods to summarize or synthesize large quantities of data, tools to discover relationships among objects. In this article, we analyze models and modeling processes specific for the biology. We mainly focus on the use of models aiming at the points i and ii as tools for knowledge discovering in biology. The mathematical methods used in modeling biological systems vary according to different steps of the process. We focus on the mathematical representation of the system. However, other important steps in the modeling processes are parameters fitting and model selection. We will not analyze the mathematical methods in those two important aspects as these would require separate review papers. Methods for parameters fitting refer to wide area of mathematical optimization, whereas methods for model selection mainly use statistical techniques. On top of these, sensitivity analysis and phaseâ€”space analysis of the models may be required. Interested readers may find more information in these references: Models for technical use are formal models, but the strategy for building them is quite different and therefore, we leave them out of the present discussion. It is worth pointing out that, as we will mention later on, alternative systems can be considered parts of a large model to account for effects whose origin can be neglected without compromising the understanding of the whole phenomena. This article is organized as follows: Actually, one can identify four different types of models: In this article, we focus mainly on diagrammatic and formal models and we concentrate on the model building process. Verbal models In verbal models the system is described in words. These models, based on observations, usually evidence in a simple way the objects and relations among the objects in the system. A verbal model is a rough and sometime ambiguous qualitative representation of the knowledge of the system. These kinds of models are used in the first approach to the analysis of biological system. Conceptual or diagrammatic models. In conceptual or diagrammatic models the system is described by a graphical representation of the objects and the relationships describing the underlying dynamical processes. To develop these kind of models the understanding of the available data needs to be sufficient to have a detailed even if not exhaustive idea of the objects or entities and relations. In computer science, CM are also referred to as domain models. A CM is expressly independent from the design and free from implementation concerns. The CM aims to clarify the meaning of the usually ambiguous terms to minimize as much as possible problems arising from different interpretations of terms and concepts. Once the domain concepts have been modeled, the model becomes a stable basis for subsequent development of applications in that specific domain. Furthermore, the concepts behind the conceptual model can be mapped to physical design or implementation constructs using either manual or automated code generation approaches. In UML notation, the conceptual model is often described with a class diagram in which classes represent concepts, associations represent relationships between concepts and role-type of an association represents role types taken by instances of the modeled concepts in various situations. Physical models In physical models the representation is done using a mock-up of a real system or object like a scale model of an aircraft or of a ship. These type of models are mostly of interest for engineers. Formal models Formal models represent the knowledge of the system using mathematical structures. The mathematical representation of the model depends on the knowledge of the system, on some modeling choices for instance, the spatial scale of representation and the aim of the modeling process. Those questions are mainly related to the description of the system with respect to its different parts or components, the physical variables space and time, the type of relations between objects and the object representation per se. In systems biology, a system is viewed as an assembly of different parts or compartments i. Models can also represent physical variables in different ways. Besides, the model may or not consider the evolution of the system with respect to time dynamic versus static models. Time can be treated as continuous or discrete variable time-continuous versus time-discrete models. Likewise, spatial distribution of objects in each compartment may or not be relevant spatially-heterogeneous versus homogeneous models. Finally, similar objects may be treated as individuals or taken in bulk particle models versus population models. In the first case, individual objects are identified by a unique state or by a large, but finite number of states one-state particle versus finite-state automata. Lastly, the relations between objects can be described as deterministic or stochastic rules deterministic versus stochastic models. According to the different modeling choices, one can get single versus multicompartments models, including transport, evolutionary differential equations versus algebraic equations or spatial partial differential equation, differential equations versus difference equations, ordinary differential equations ODE versus partial differential equations PDE , kinetic methods, agent-based methods ABM or cellular automata CA versus ODE or PDE; deterministic methods ODE or PDE, etc. Statistical and artificial intelligence-based models A statistical model is a formalization of the relationships between variables i. When the relationship between two objects is too complex to be easily guessed, one can resort to probabilistic measures and statistical or artificial intelligence methods to reproduce the response relationship see e. Examples of this approach are the lumped models using equivalent circuits, neural network, etc. To find a good model is an issue. Modeling is a hard problem in itself and failure is not a rare event. The modeling procedure is a process in itself that follows a semi-formal set of rules. The methodology lean on four macro steps [31]: This step includes knowledge and data acquisition from field experts and literature, model structure, model hypothesis, conceptual model, choosing the appropriate mathematical formalism, solving the formal model, get the results, check model results matching to available data and so on; iii execute the plan, i. This last point is a major test to evaluate the hypothesis formulated when setting the model. As mentioned before, we are mostly interested in models for the analysis and predictions. For these models, the classical description of modeling process is shown in Figure 1. It is worth to mention that the schema illustrated in Figure 1 does not have the pretense to be the most general one: Figure 1 View large Download slide The description of the modeling process. The top part of the figure refers to the formulation of the model, i. Central part of the figure refers to calibration i. Finally, the bottom of the figure refers to analysis and evaluation, i. Model objectives As we already pointed out, a proper definition of the model objectives is a fundamental step as it implies a certain level of comprehension of the problem. The reason for building a model should by clear and a proper clarification of the objective must answer to major questions: All these questions need to be clarified before we proceed in searching the current knowledge on the system we wish to model, as some informations may be more relevant than the others. Current knowledge A second crucial step in the modeling process is to collect the knowledge on the system under investigation. In the biomedical field, data sets of literature record e. Pubmed can highly facilitate the task of browsing the vast amount of information available nowadays. In this respect, methods of data mining and data extraction may be very useful [17]. Model structure A model is a representation of a real system and has its own structure. Realism, Precision and Generality are competing properties. Each of these properties trades-off against the other two. Deciding a model structure is to find a proper balance between those competing properties, which satisfy the model objectives. Decision on the model structure is crucial for defining the model hypothesis, diagrammatic model construction and mathematical formulation. Hypotheses The next step in the modeling process is to translate objectives and current knowledge we wish to include in the model in a list of specific working hypothesis. These are usually verbal statements, but could also be quantitative relationships. Working hypotheses are the basis of the model we are going to built and model results will depend on them. In doing the cycle refinement of model, the starting hypothesis should be critically, repeatedly analyzed. Conceptual model The conceptual model is a graphical representation of the relevant system knowledge and model objectives that have been identified in the hypotheses. In the conceptual model compartments, objects and relations will be described in a diagram where the set of objects are fully clarified and relations bounded. Mathematical formulation This is usually the trickiest part of the modeling process, requiring the choice of a mathematical structure, which is appropriate for the model objectives and is able to describe in quantitative form the hypotheses. This step of the process requires a certain level of mathematical sophistication and, more importantly, it requires to define vague concepts and loose relations in strict mathematical terms. Noticeably, model objectives play an important role because, a detailed description of the biological system may turn out to be useless if not required by the model objectives. Choosing a mathematical formulations is a mapping of the model into the mathematical domain to obtain a formal model.

INTRODUCTION TO PHYSICAL BIOCHEMISTRY AND BIOCHEMICAL SYSTEMS MODELING pdf

9: Biochemistry and Biophysics (BB) < Oregon State University

An introduction to dynamical modeling techniques used in contemporary Systems Biology research. We take a case-based approach to teach contemporary mathematical modeling techniques. The course is appropriate for advanced undergraduates and beginning graduate students. Lectures provide biological.

Overview[edit] Molecular biophysics typically addresses biological questions similar to those in biochemistry and molecular biology , seeking to find the physical underpinnings of biomolecular phenomena. Scientists in this field conduct research concerned with understanding the interactions between the various systems of a cell, including the interactions between DNA , RNA and protein biosynthesis , as well as how these interactions are regulated. A great variety of techniques are used to answer these questions. Protein dynamics can be observed by neutron spin echo spectroscopy. Direct manipulation of molecules using optical tweezers or AFM , can also be used to monitor biological events where forces and distances are at the nanoscale. Molecular biophysicists often consider complex biological events as systems of interacting entities which can be understood e. By drawing knowledge and experimental techniques from a wide variety of disciplines, biophysicists are often able to directly observe, model or even manipulate the structures and interactions of individual molecules or complexes of molecules. In addition to traditional i. It is becoming increasingly common for biophysicists to apply the models and experimental techniques derived from physics , as well as mathematics and statistics , to larger systems such as tissues , organs , populations and ecosystems. Biophysical models are used extensively in the study of electrical conduction in single neurons , as well as neural circuit analysis in both tissue and whole brain. Medical physics , a branch of biophysics, is any application of physics to medicine or healthcare , ranging from radiology to microscopy and nanomedicine. For example, physicist Richard Feynman theorized about the future of nanomedicine. He wrote about the idea of a medical use for biological machines see nanomachines. Feynman and Albert Hibbs suggested that certain repair machines might one day be reduced in size to the point that it would be possible to as Feynman put it " swallow the doctor ". The popularity of the field rose when the book What Is Life? Since , biophysicists have organized themselves into the Biophysical Society which now has about 9, members over the world. Depending on the strengths of a department at a university differing emphasis will be given to fields of biophysics. What follows is a list of examples of how each department applies its efforts toward the study of biophysics. This list is hardly all inclusive. Nor does each subject of study belong exclusively to any particular department. Each academic institution makes its own rules and there is much overlap between departments. Biology and molecular biology â€” Almost all forms of biophysics efforts are included in some biology department somewhere. Biochemistry and chemistry â€” biomolecular structure, siRNA, nucleic acid structure, structure-activity relationships.

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