



University of Wisconsin-Madison

Computation and Informatics in Biology and Medicine

<http://www.cibm.wisc.edu/>

CURRICULUM REQUIREMENTS

CIBM trainees are expected to gain knowledge in Bioinformatics / Biostatistics, Biological Sciences, and Computer Sciences. Required courses (marked with *) and suggested courses in these three areas are listed below. The CIBM Student Advisory Committee will review each trainee's course curriculum and expects that approximately five or six courses will be taken to fulfill the core curriculum of CIBM. Courses taken as an undergraduate can be used, pending approval, to satisfy the CIBM course requirements. Substitutions can be made with the approval of the CIBM Trainee Advisory Committee.

Students must receive a grade of B or better for a course to count toward the CIBM requirements. Students should also note that the University of Wisconsin–Madison requires that Ph.D. students complete a minor, which typically involves four courses (12 credits) taken outside of one's home department. Courses taken can count for both the Ph.D. minor and for the CIBM requirements.

In addition, all predoctoral and postdoctoral trainees will be required to take a one-semester course in Scientific Ethics (BacT 901, Sect 15, or Chem 901).

BIOINFORMATICS / BIOSTATISTICS (3 REQUIRED)

(1) *Stat 541 - Introduction to Biostatistics. 3 cr. Course designed for the biomedical researcher. Topics include: descriptive statistics, hypothesis testing, estimation, confidence intervals, t-tests, chi-squared tests, analysis of variance, linear regression, correlation, nonparametric tests, survival analysis and odds ratio. Biomedical applications used for each topic. OR

***Stat 571 - Statistical Methods for Bioscience I** (Crosslisted with Forest, Hort). 4 cr. Descriptive statistics, distributions, one- and two-sample normal inference, power, one-way Anova, simple linear regression, categorical data, non-parametric methods; underlying assumptions and diagnostic work.

(2) *BMI 576 - Introduction to Bioinformatics (Crosslisted with Comp Sci). 3 cr. Algorithms for computational problems in molecular biology. The course will study algorithms for problems such as: genome sequencing and mapping, pairwise and multiple sequence alignment, modeling sequence classes and features, phylogenetic tree construction, and gene-expression data analysis.

(3) The third course may be chosen from one of the following:

BMI 776 - Advanced Bioinformatics (Crosslisted with Comp Sci). 3 cr. Advanced course covering computational problems in molecular biology. The course will study algorithms for problems such as: modeling sequence classes and features, phylogenetic tree construction, gene-expression data analysis, protein and RNA structure prediction, and whole-genome analysis and comparisons.

Bioch 711 - Sequence Analysis (Crosslisted with Ahabs). 2 cr. Topics will include overviews of: RNA, DNA and protein structure; mechanisms of genetic change; sequence generation methods;

comparison and alignment algorithms; motif recognition; 2D predictions; phylogeny calculations; database searching; discriminating coding criteria; phenotypic selection; phylogenetic reconstruction.

CBE 782 - Modeling Biological Systems

ISyE 617 - Health Information Systems (Crosslisted with LIS) 3 cr. Provides grounding in core concepts of health information systems. Major applications include clinical information systems, language and standards, decision support, image technology and digital libraries. Evaluation of IE tools and perspectives designed to improve the quality, efficiency and effectiveness of health information.

BIOLOGICAL COURSES (3 REQUIRED)

Credit for one of the three required courses will be granted for:

* **An introductory molecular biology course** OR

* **Chem 341 / Chem 343 - Introductory Organic Chemistry.** 3 cr. OR

* **Chem 561 - Physical Chemistry.** 3 cr. Macroscopic theory: equilibrium thermodynamics, chemical kinetics, and transport properties.

Gen 466 - General Genetics (Crosslisted with Botany, Zoology). 3 cr. Genetics in eukaryotes and prokaryotes. Includes Mendelian genetics, mapping, molecular genetics, genetic engineering, cytogenetics, quantitative genetics, and population genetics. Illustrative material includes viruses, bacteria, plants, fungi, insects, and humans.

Gen 612 - Prokaryotic Molecular Genetics (Crosslisted with Bact, Biochem) 3 cr. Molecular basis of bacterial physiology and genetics with emphasis on molecular mechanisms; topics include nucleic acid-protein interactions, transcription, translation, replication, recombination, regulation of gene expression.

Bioch 602 - Biochemical Mechanisms of Regulation in the Cell. 2 cr. Control of major cellular metabolic pathways of biosynthesis and degradation; signal transduction; membrane biogenesis and cell compartmentation; intracellular protein and lipid traffic.

Bioch 501 - Introduction to Biochemistry. 3 cr. Chemistry, nutrition, and metabolism of biological systems.

Bioch 601 - Protein and Enzyme Structure and Function. 2 cr. Protein structure and dynamics. Protein folding. Physical organic chemistry of enzymatic catalysis. Analysis of enzyme kinetics and receptor-ligand interactions. Enzymatic reaction mechanisms.

Bioch 630 - Cellular Signal Transduction Mechanisms (Crosslisted with Zoology, Phmcol-M) 3 cr. Lecture-discussion. Comprehensive coverage of human hormones, growth factors and other mediators; emphasis on hormone action and biosynthesis, cell biology of hormone-producing cells.

Bioch 636 - Structural Biology

Bioch 665 - Biophysical Chemistry (Crosslisted with Chem). 4 cr. Equilibrium thermodynamics, chemical kinetics and transport properties, with emphasis on solution behavior and application to noncovalent interactions of biological macromolecules in solution. For graduate students interested in the biological applications of physical chemistry.

Gen 677 - (Special Topics) Genomic Science (also Chem 630)

COMPUTER SCIENCES COURSES (3 REQUIRED)

CS 367 - Introduction to Data Structures. 3 cr. Study of data structures (including stacks, queues, trees, graphs, and hash tables) and their applications. Development, implementation, and analysis of efficient data structures and algorithms (including sorting and searching). Experience in use of an object-oriented programming language.

CS 514 - Numerical Analysis (Crosslisted with Math). 3 cr. Polynomial forms, divided differences. Polynomial interpolation. Polynomial approximation: uniform approximation and

Chebyshev polynomials, least-squares approximation and orthogonal polynomials. Numerical differentiation and integration. Splines, B-splines and spline approximation. Numerical methods for solving initial and boundary value problems for ordinary differential equations.

CS 525 - Linear Programming Methods (Crosslisted with Ind Engr, Math, Stat). 3 cr. Real linear algebra over polyhedral cones; theorems of the alternative for matrices. Formulation of linear programs. Duality theory and solvability. The simplex method and related methods for efficient computer solution. Perturbation and sensitivity analysis. Applications and extensions, such as game theory, linear economic models, and quadratic programming.

CS 540 - Introduction to Artificial Intelligence. 3-4 cr. Principles of knowledge-based search techniques; automatic deduction; knowledge representation using predicate logic, semantic networks, connectionist networks, frames, rules. Applications in problem solving, expert systems, game playing, vision, natural language understanding, learning robotics, Lisp programming.

CS 559 - Computer Graphics. 3 cr. Survey of computer graphics. Image representation, formation, presentation, composition and manipulation. Modeling, transformation, and display of geometric objects in two and three dimensions. Representation of curves and surfaces. Rendering, animation, multi-media and visualization.

CS 564 - Database Management Systems: Design and Implementation. 3-4 cr. What a database management system is; different data models currently used to structure the logical view of the database: relational, hierarchical, and network. Hands-on experience with relational and network-based database systems. Implementation techniques for database systems. File organization, query processing, concurrency control, rollback and recovery, integrity and consistency, and view implementation.

CS 577 - Introduction to Algorithms. 3 cr. Survey of important and useful algorithms for sorting, searching, pattern-matching, graph manipulation, geometry, and cryptography. Paradigms for algorithm design, hints for efficient implementation.

CS 635 - Tools and Environments for Optimization (Crosslisted with Ind Engr). 3 cr. Formulation and modeling of applications from computer sciences, operations research, business, science and engineering involving optimization and equilibrium models. Survey and appropriate usage of software tools for solving such problems, including modeling language use, automatic differentiation, subroutine libraries and web-based optimization tools and environments.

CS 731 - Advanced Artificial Intelligence

CIBM SEMINAR SERIES REQUIRED

Attendance at a weekly seminar program is required for all CIBM trainees. This provides a opportunity for fellow trainees to describe their research. These seminars, plus presentations from speakers from academia or the private sector, expose students to new research advances within and outside their area of expertise and allow trainees the opportunity to meet with their fellow students and trainers. The Computation and Informatics in Biology and Medicine course meets every Fall and Spring semester (its course number is BMI 915 [also cross-listed in CS, Biochem, Gen, CHE, and BME]).

CIBM ANNUAL MEETING REQUIRED

The NLM (National Library of Medicine) provides funding for the CIBM Training Program. Each summer trainees attend a two-day meeting held at the NLM in Bethesda or at one of the NLM's training sites. The purpose of these meetings is to allow trainees, program directors, and NLM program staff to exchange ideas and information.

CIBM ANNUAL REVIEW REQUIRED

An annual review will take place between each postdoctoral fellow and the trainee advisory committee to measure progress, provide advice on research issues, solicit comments on

strengths and weaknesses of the program, remind fellows of their obligations to the program, and make recommendations for renewal of the postdoctoral fellowship.
