DOCTOR OF PHILOSOPY IN COMPUTATIONAL AND SYSTEMS BIOLOGY

Computational and Systems Biology Program (*https://catalog.mit.edu/interdisciplinary/graduate-programs/computational-systems-biology*)

Program Requirements

Core Curriculum		
CSB.100[J]	Topics in Computational and Systems Biology	12
Biology Requirement		**12**
Select one of the following:		
7.51	Principles of Biochemical Analysis	
7.52	Genetics for Graduate Students	
7.58	Molecular Biology	
7.61[J]	Eukaryotic Cell Biology: Principles and Practice	
7.63[J]	Immunology	
7.68[J]	Molecular and Cellular Neuroscience Core II	
Computational Biology Requirement		**12**
Select one of the following:		
6.C51 & 20.C51[J]	Modeling with Machine Learning: from Algorithms to Applications and Machine Learning for Molecular Engineering [1]	
6.8700[J]	Advanced Computational Biology: Genomes, Networks, Evolution	
7.81[J]	Systems Biology	
20.490	Computational Systems Biology: Deep Learning in the Life Sciences	
Research Rotations		
CSB.110	Research Rotations in Computational and Systems Biology	24
Restricted Electives		
Four subjects from the list below, including two subjects in the student's research area or department that are topically related, one engineering subject, and one biology subject [2]		48
Teaching Experience		
CSB.199	Teaching Experience in Computational Systems Biology	12
Professional Development		
Select one of the following: [3]		2
CSB.195	Professional Development in Computational and Systems Biology	
7.930[J]	Research Experience in Biopharma	
8.396[J]	Leadership and Professional Strategies & Skills Training (LEAPS), Part I: Advancing Your Professional Strategies and Skills	
8.397[J]	Leadership and Professional Strategies & Skills Training (LEAPS), Part II: Developing Your Leadership Competencies	
Thesis		
CSB.THG	Graduate Thesis [4]	252
Total Units		**374**

[1] 6.C51 and 20.C51[J] must be taken concurrently for credit for a letter grade.

[2] Other subjects may be approved on a case-by-case basis by the program directors.

[3] With permission of their advisor, students may substitute another MIT subject of at least 2 units that supports career exploration or professional development.

[4] The units listed here represent an average number taken during the doctoral program.

Restricted Electives [1]

Civil and Environmental Engineering		
1.545[J]	Atomistic Modeling and Simulation of Materials and Structures	12
1.685[J]	Nonlinear Dynamics and Waves	12
1.89	Environmental Microbial Biogeochemistry	12
1.873	Mathematical Modeling of Ecological Systems	12
1.881[J]	Genomics and Evolution of Infectious Disease	12
Mechanical Engineering		
2.18	Biomolecular Feedback Systems	12
2.717	Optical Engineering	12
Chemistry		
5.64[J]	Advances in Interdisciplinary Science in Human Health and Disease	12
5.70[J]	Statistical Thermodynamics	12
Electrical Engineering and Computer Science		
6.C51 & 20.C51[J]	Modeling with Machine Learning: from Algorithms to Applications and Machine Learning for Molecular Engineering [2]	12
6.3702	Introduction to Probability	12
6.3722	Introduction to Statistical Data Analysis	12
6.5060	Algorithm Engineering	12
6.5150	Large-scale Symbolic Systems	12

6.5210[J]	Advanced Algorithms	15
6.5420	Randomness and Computation	12
6.6220	Power Electronics	12
6.6500[J]	Integrated Microelectronic Devices	12
6.7100[J]	Dynamic Systems and Control	12
6.7300[J]	Introduction to Modeling and Simulation	12
6.7310[J]	Introduction to Numerical Methods	12
6.7330[J]	Numerical Methods for Partial Differential Equations	12
6.7700[J]	Fundamentals of Probability	12
6.7710	Discrete Stochastic Processes	12
6.7720[J]	Discrete Probability and Stochastic Processes	12
6.7800	Inference and Information	12
6.7810	Algorithms for Inference	12
6.7830	Bayesian Modeling and Inference	12
6.7900	Machine Learning	12
6.7920[J]	Reinforcement Learning: Foundations and Methods	12
6.7930[J]	Machine Learning for Healthcare	12
6.7960	Deep Learning	12
6.8610	Quantitative Methods for Natural Language Processing	12
6.8700[J]	Advanced Computational Biology: Genomes, Networks, Evolution [3]	12
6.8710[J]	Computational Systems Biology: Deep Learning in the Life Sciences	12
6.S982	Special Subject in Electrical Engineering and Computer Science	12
Biology		
7.493[J]	Microbial Genetics and Evolution	12
7.51	Principles of Biochemical Analysis [3]	12
7.52	Genetics for Graduate Students [4]	12
7.58	Molecular Biology [4]	12
7.60	Cell Biology: Structure and Functions of the Nucleus	12
7.61[J]	Eukaryotic Cell Biology: Principles and Practice [4]	12
7.63[J]	Immunology	12
7.64	Molecular Mechanisms, Pathology and Therapy of Human Neuromuscular Disorders	12
7.66	Molecular Basis of Infectious Disease	12
7.69[J]	Developmental Neurobiology	12
7.70	Regulation of Gene Expression	12
7.71	Biophysical Technique	12
7.72	Stem Cells, Regeneration, and Development	12
7.75	Human Genetics and Genomics	12
7.77	Nucleic Acids, Structure, Function, Evolution, and Their Interactions with Proteins	12
7.83	Design Principles of Biological Systems	12
7.84	Advanced Concepts in Immunology	12
7.85	The Hallmarks of Cancer	12
7.86	Building with Cells	12
7.91	The CRISPR Revolution: Engineering the Genome for Basic Science and Clinical Medicine	12
7.95	Cancer Biology	12
Physics		
8.333	Statistical Mechanics I	12
8.334	Statistical Mechanics II	12
8.431[J]	Nonlinear Optics	12
8.591[J]	Systems Biology [3]	12
8.592[J]	Statistical Physics in Biology	12
8.593[J]	Biological Physics	12
Brain and Cognitive Sciences		
9.013[J]	Molecular and Cellular Neuroscience Core II [4]	12
9.015[J]	Molecular and Cellular Neuroscience Core I	12
9.520[J]	Statistical Learning Theory and Applications	12
Chemical Engineering		
10.544	Metabolic and Cell Engineering	12
10.555[J]	Bioinformatics: Principles, Methods and Applications	12
10.557	Mixed-integer and Nonconvex Optimization	12
10.637[J]	Computational Chemistry	12
Aeronautics and Astronautics		
16.391	Statistics for Engineers and Scientists	12
16.940	Numerical Methods for Stochastic Modeling and Inference	12
Mathematics		
18.0651	Matrix Methods in Data Analysis, Signal Processing, and Machine Learning	12
18.0751	Methods for Scientists and Engineers	12
18.0851	Computational Science and Engineering I	12

18.0861	Computational Science and Engineering II	12
18.408	Topics in Theoretical Computer Science	12
18.417	Introduction to Computational Molecular Biology	12
18.418[J]	Topics in Computational Molecular Biology	12
18.4531	Combinatorial Optimization	12
18.455	Advanced Combinatorial Optimization	12
18.6501	Fundamentals of Statistics	12
18.677	Topics in Stochastic Processes	12

Biological Engineering

20.201	Fundamentals of Drug Development	12
20.405[J]	Principles of Synthetic Biology	12
20.409	Instrumentation and Measurement for Biological Systems	12
20.410[J]	Molecular, Cellular, and Tissue Biomechanics	12
20.415	Physical Biology	12
20.420[J]	Principles of Molecular Bioengineering	12
20.430[J]	Fields, Forces, and Flows in Biological Systems	12
20.440	Analysis of Biological Networks	15
20.463[J]	Biomaterials Science and Engineering	12
20.490	Computational Systems Biology: Deep Learning in the Life Sciences [3]	12
20.535[J]	Protein Engineering	12

Data, Systems, and Society

IDS.136[J]	Graphical Models: A Geometric, Algebraic, and Combinatorial Perspective	12
IDS.147[J]	Statistical Machine Learning and Data Science	12

Health Sciences and Technology

HST.176	Cellular and Molecular Immunology	12
HST.508[J]	Evolutionary and Quantitative Genomics	12

[1]   *Other subjects may be approved on a case-by-case basis by the program directors.*

[2]   *6.C51 and 20.C51[J] must be taken concurrently for credit and a letter grade.*

[3]   *Can also fulfill the Computational Biology Requirement.*

[4]   *Can also fulfill the Biology Requirement.*