

3.2.7 Bachelor of Computing in Computational Biology

Overview

The main objective of this programme is to provide a multidisciplinary education to produce graduates who would be equally at ease with algorithm design and mathematical and statistical analysis as they would be with biochemistry, biology/genetics, and wet-lab know-how. Besides an opportunity to pursue a career in IT, graduates from the programme will also be equipped for a career in the fast-paced pharmaceutical, biomedical or biotechnology industries. This will help meet the demand of the local market for talents with such skill sets. Moreover, the breadth of instructions will pave the way for good students to pursue graduate studies in Bioinformatics.

Programme Structure

The programme is structured such that both Computing and Faculty of Science students share a common core multidisciplinary curriculum (lower division) in their first two years of study.

The **lower division** embraces a fundamental body of knowledge in which a computational biologist should be proficient. This body of knowledge consists of the following:

- Discrete mathematics and combinatorics, i.e., logic, sets, graphs, counting techniques, etc.;
- Probability and statistics, i.e., sample spaces, random variables, conditioning, distributions, design of experiments, significance tests, statistical inference, etc.;
- Algorithm design and proficiency in some current programming language, i.e., combinatorial algorithms, algorithmic paradigms, analysis and design, working knowledge of current languages (for example, C, C++, Java) and experience in writing actual nontrivial code;
- Organic chemistry and biochemistry;
- Biology and genetics, including a moderate amount of wet-lab experience.

The **upper division** specialised track trains students in algorithmic design to facilitate the design of computationally efficient software and tools in both centralised and networking environments. Students in this track will pick up skills in software engineering, networking and advanced techniques in algorithmic design. Students may also take modules from the Computational Biology elective list.

Degree Requirements

The Computational Biology programme degree requires at least 160 MCs. Modules are classified as follows (note that every module can only be counted towards satisfying exactly one requirement):

(i) **PROGRAMME REQUIREMENTS (Total of 110 MCs)**

a. Common Essentials

CS1101 or CS1101S	Programming Methodology
CS1102 or CS1102S	Data Structures and Algorithms
CS1104	Computer Organisation
CS2102	Database Systems
CS2103	Software Engineering
CS2105	Introduction to Computer Networks

b. Major Requirements

CS1101 or CS1101S	Programming Methodology
CS1102 or CS1102S	Data Structures and Algorithms
Either CS1231	Discrete Structures
or MA2214	Combinatorial Analysis
LSM1102	Molecular Genetics
Either CS2220	Introduction to Computational Biology

or
LSM2104 Essential Bioinformatics and Biocomputing

CS2301 Business and Technical Communications
CS3230 Design & Analysis of Algorithms
CS4220 Computational Analysis of Biological Data
LSM2101 Metabolism and Regulation
LSM2102 Molecular Biology

Either
LSM2201 Experimental Biochemistry

or
LSM2202 Experimental Molecular and Cell Biology

LSM3231 Protein Structure and Function
LSM4241 Functional Genomics
ST2131 Probability
ST2132 Mathematical Statistics
MA1101R Linear Algebra
MA1102R Calculus
MA3259 Mathematical Methods in Genomics

Minimum of 8 MCs from the following list:

CS3103 Computer Networks and Protocols
CS3225 Post-Genome Informatics
CS3240 Human-Computer Interaction
CS3241 Computer Graphics
CS3243 Foundations of Artificial Intelligence
CS3244 Machine Learning & Neural Networks

Either
CS4101 Honours Project⁷
Complete 8 MCs by taking modules from CB Elective list

or
Complete 20 MCs by taking modules from CB Elective list

Computational Biology (CB) Electives

CS4221 Database Design
CS4231 Parallel and Distributed Algorithms
CS4234 Combinatorial & Graph Algorithms
CS4235 Computational Geometry
CS4237 Systems Modelling and Simulation
CS4242 Uncertainty Modeling In Artificial Intelligence
CS4243 Computer Vision and Pattern Recognition
CS4244 Knowledge-Based Systems
CS4248 Natural Language Processing
CS5228 Knowledge Discovery in Databases
CS5238 Combinatorial Methods in Bioinformatics

(ii) UNIVERSITY LEVEL REQUIREMENTS

As specified in Section 3.2.1. Students are required to read CM1121 Basic Organic Chemistry, LSM1101 Biochemistry and Biomolecules and PC1432 Physics IIE towards Breadth.

(iii) UNRESTRICTED ELECTIVES

As specified in Section 3.2.1.

⁷ The theme of the project must be on Computational Biology.

Table 7: Summary of degree requirements for B.Comp. (Computational Biology)

Modules	MCs	Subtotals	
UNIVERSITY LEVEL REQUIREMENTS			
2 x GEMs	8	28	
1 x Singapore Studies	4		
1 x Breadth CM1121 Basic Organic Chemistry LSM1101 Biochemistry and Biomolecules PC1432 Physics IIE	16		
PROGRAMME REQUIREMENTS			
<i>Common Essentials</i>			
CS1101/S Programming Methodology	5	26	
CS1102/S Data Structures and Algorithms	5		
CS1104 Computer Organisation	4		
CS2102 Database Systems	4		
CS2103 Software Engineering	4		
CS2105 Introduction to Computer Networks	4		
<i>Major Requirements</i>			
<i>Level-1000/2000 Essential</i>			
CS1231 Discrete Structures or MA2214 Combinatorial Analysis	4	58	
LSM1102 Molecular Genetics	4		
MA1101R Linear Algebra	4		
MA1102R Calculus	4		
CS2220 Introduction to Computational Biology or LSM2104 Essential Bioinformatics and Biocomputing	4		
CS2301 Business and Technical Communications	4		
LSM2101 Metabolism and Regulation	4		
LSM2102 Molecular Biology	4		
LSM2201 Experimental Biochemistry or LSM2202 Experimental Molecular and Cell Biology	6		
ST2131 Probability	4		
ST2132 Mathematical Statistics	4		
<i>Level-3000 Essential</i>			
CS3230 Design & Analysis of Algorithms	4		
LSM3231 Protein Structure and Function	4		
MA3259 Mathematical Methods in Genomics	4		
<i>Level-3000 Electives</i> ; Choose any <u>two</u> from the following: CS3103 Computer Networks and Protocols ⁸ CS3225 Post-Genome Informatics CS3240 Human-Computer Interaction CS3241 Computer Graphics CS3243 Foundations of Artificial Intelligence CS3244 Machine Learning & Neural Networks		8	
<i>Level-4000 Essential</i>			
CS4220 Computational Analysis of Biological Data	4	28	

⁸ Students who take CS3103 (Computer Networks and Protocols) must also take CS3103L (Computer Networks Laboratory)

LSM4241 Functional Genomics	4	
Either CS4101 Honours Project Sufficient number of modules from CB Elective course list Or Sufficient number of modules from CB Elective course list	20	
UNRESTRICTED ELECTIVES		12
	Grand Total	160