

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
CS2100	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	Knowledge Discovery Methods in Bioinformatics
	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 ⁷ :	
	CS3103	Computer Networks and Protocols
	CS3225	Combinatorial Methods in Bioinformatics
	CS3240	Human-Computer Interaction
	CS3241	Computer Graphics
	CS3243	Foundations of Artificial Intelligence
	CS3244	Machine Learning & Neural Networks
Either	CS4101	Honours Project ⁸
	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
	CS4235	Computational Geometry
	CS4237	Systems Modelling and Simulation
	CS4243	Computer Vision and Pattern Recognition
	CS4244	Knowledge-Based Systems
	CS4248	Natural Language Processing
	CS5228	Knowledge Discovery in Databases
	CS5234	Combinatorial & Graph Algorithms
	CS5238	Advanced Combinatorial Methods in Bioinformatics
	CS5340	Uncertainty Modelling in Artificial Intelligence

(ii) UNIVERSITY LEVEL REQUIREMENTS

As specified in Section 3.2.1.

⁷ With the special permission from the UROP coordinator, CS3208/CS3209 Undergraduate Research in Computing I/II can be used to replace two of the level-3 Computational Biology electives if the project is on Computational Biology.

⁸ The theme of the project must be on Computational Biology.

(iii) **UNRESTRICTED ELECTIVES**

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 Unrestricted Electives.

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

Modules	MCs	Subtotals	
UNIVERSITY LEVEL REQUIREMENTS		20	
PROGRAMME REQUIREMENTS			
<i>Common Essentials</i>		26	
CS1101/S Programming Methodology	5		
CS1102/S Data Structures and Algorithms	5		
CS2100 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>		58	
CS1231 Discrete Structures or MA2214 Combinatorial Analysis	4		
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> ⁹ ; Choose any <u>two</u> from the following: CS3103 Computer Networks and Protocols ¹⁰ CS3225 Combinatorial Methods in Bioinformatics CS3240 Human-Computer Interaction CS3241 Computer Graphics CS3243 Foundations of Artificial Intelligence CS3244 Machine Learning & Neural Networks		8	
<i>Level-4000 Essential</i>		28	
CS4220 Knowledge Discovery Methods in Bioinformatics	4		

⁹ With the special permission from the UROP coordinator, CS3208/CS3209 Undergraduate Research in Computing I/II can be used to replace two of the level-3 Computational Biology electives if the project is on Computational Biology.

¹⁰ 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 ELECTIVES¹¹		20
Grand Total		160

¹¹ Students must take CM1121 (Basic Organic Chemistry), LSM1101 Biochemistry and Biomolecules and PC1432 Physics IIE under Unrestricted Electives to satisfy the degree requirement.