

## 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 Computer Science programme degree requires at least 160 modular credits. Modules are classified as follows (note that every module can only be counted towards satisfying exactly one requirement):

(i) **PROGRAMME REQUIREMENTS (Total of 110 Modular Credits)**

**a. Common Essentials**

CS1104	Computer Organisation
CS2103	Software Engineering
CS2105	Introduction to Computer Networks
CS2301	Business and Technical Communication

**b. Major Requirements**

CS1101/C/S	Programming Methodology
CS1102/C/S	Data Structures and Algorithms
Either CS1231	Discrete Structures

or	MA2214	Combinatorial Analysis
	LSM1102	Molecular Genetics
	CS2102	Database Systems
Either		
	CS2220	Introduction to Computational Biology
or		
	LSM2104	Essential Bioinformatics and Biocomputing
	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 eight MCs from the following list:

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

Either

CS4101	Honours Project <sup>9</sup>
Complete eight 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 Modeling 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
CS5234	Combinatorial & Graph Algorithms
CS5238	Combinatorial Methods in Bioinformatics

<sup>9</sup> The theme of the project must be on Computational Biology. Students with CAP of 4.00 or above must do CS4101 Honours Project as partial fulfillment towards their degree requirement. Students with CAP below 4.00 will not do CS4101 Honours Project; instead they are required to complete 12 MCs (in place of the 12 MCs from CS4101) by taking modules from the CB Elective list.

(ii) **UNIVERSITY LEVEL REQUIREMENTS**

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

(iii) **UNRESTRICTED ELECTIVES**

**Table 2: Summary of degree requirements for B.Comp. (Computational Biology)**

Please refer to the section on *(i) PROGRAMME REQUIREMENTS* for detail.

Modules	MCs	Subtotals	
<b>UNIVERSITY LEVEL REQUIREMENTS</b>			
2 x GEMs	8	<b>28</b>	
1 x Singapore Studies	4		
1 x Breadth CM1121 Basic Organic Chemistry LSM1101 Biochemistry and Biomolecules PC1432 Physics IIE	16		
<b>PROGRAMME REQUIREMENTS</b>			
<b><i>Common Essentials</i></b>			
CS1104 Computer Organisation	4	<b>16</b>	
CS2103 Software Engineering	4		
CS2105 Introduction to Computer Networks	4		
CS2301 Business and Technical Communications	4		
<b><i>Major Requirements</i></b>			
<b><i>Level 1000/2000 Essential</i></b>			
CS1101/S or CS1101C Programming Methodology	5	<b>68</b>	
CS1102/S or CS1102C Data Structures and Algorithms	5		
CS1231 Discrete Structures <b>or</b> MA2214 Combinatorial Analysis	4		
LSM1102 Molecular Genetics	4		
MA1101R Linear Algebra	4		
MA1102R Calculus	4		
CS2102 Database Systems	4		
CS2220 Introduction to Computational Biology <b>or</b> LSM2104 Essential Bioinformatics and Biocomputing	4		
LSM2101 Metabolism and Regulation	4		
LSM2102 Molecular Biology	4		
LSM2201 Experimental Biochemistry <b>or</b> LSM2202 Experimental Molecular and Cell Biology	6		
ST2131 Probability	4		
ST2132 Mathematical Statistics	4		
<b><i>Level 3000 Essential</i></b>			
CS3230 Design & Analysis of Algorithms	4		
LSM3231 Protein Structure and Function	4		
MA3259 Mathematical Methods in Genomics	4		
<b><i>Level 3000 Electives</i></b> ; Choose any <u>two</u> from the following: CS3103 Computer Networks and Protocols <sup>10</sup> CS3103L Computer Networks Laboratory CS3225 Post-Genome Informatics CS3240 Human-Computer Interaction CS3241 Computer Graphics			
		<b>8</b>	

<sup>10</sup> Students who take CS3103 (Computer Networks and Protocols) in Semester 2, 2006-7 must also take CS3103L (Computer Networks Laboratory).

CS3243 Foundations Of Artificial Intelligence		
CS3244 Machine Learning & Neural Networks		
<b>Level 4000 Essential</b>		
CS4220 Computational Analysis of Biological Data	4	<b>28</b>
LSM4241 Functional Genomics	4	
Either CS4101 Honours Project <sup>11</sup> Sufficient number of modules from <b>CB Elective course list</b>	20	
Or Sufficient number of modules from <b>CB Elective course list</b>		
<b>UNRESTRICTED ELECTIVES</b>		<b>12</b>
<b>Grand Total</b>		<b>160</b>

<sup>11</sup> Students with CAP of 4.00 or above must do CS4101 Honours Project as partial fulfillment towards their degree requirement. Students with CAP below 4.00 will not do CS4101 Honours Project; instead they are required to complete 12 MCs (in place of the 12 MCs from CS4101) by taking modules from the CB Elective list.