

Annexure-I: Minor area in "Biological Sciences"

Preamble

21st Century is a golden era for biological sciences. Academia and industry are realizing the rapid transformation of society into a knowledge-based one that will be soon driven by bio-based economy. Due to the broad impact range of biological sciences and various pressing issues such as human healthcare, utilization of biodiversity for sustainable future, a need exists for immediate addressal in the form of creating skilled human resources in the field of biological sciences. The potential of biological sciences distinctly indicates multidisciplinary approach for the emerging novel technologies in the field. Majority of the areas of biological sciences ranging from utilization of biodiversity to synthetic biology for the creation of new life for several commercial applications require development of various algorithms, software - computational methods/mathematical models and more importantly engineering skills. True multidisciplinary nature of the field has already encouraged many mathematicians, computer scientists and engineers to contribute towards a better understanding of biological sciences. Engineering nature inspired materials, engineering drug delivery systems are but a few of a plethora of opportunities to contribute towards human welfare. Keeping in view, the potential of biological sciences in various spheres of life, the Kusuma School of Biological Sciences proposes a "Minor Area in Biological Sciences" for the engineering and technology students at IIT Delhi.

Scope of the Programme & Inputs

Utilizing a Design and Function based approach (Nature and Evolution as designer and designing tool) to explore the Interface between Biology and Engineering, the minor area in biological sciences aims to:

1. Train Engineering (Non-biology) students in Biological Sciences.
2. Promote multidisciplinary way of understanding Biological problems.
3. Create skilled human resource (workforce: thinkers & solvers) from various science and technology backgrounds that can contribute effectively for developing novel life science based technologies and approaches for human healthcare and sustainable development.
4. Attract the best students into the vibrant Ph.D. programme of the School - UG Students of CSE, EE, ME, CHE, MA & PH are expected to be the main beneficiaries at this point of time. However, the Programme will be open to all B.Tech. students of the Institute and possibly M.Sc. students in future.

Expected Student Intake: 50 per year (25 per semester). Two core courses and the associated lab will run both semesters.

Benefits

1. Promotion of multidisciplinary research (Applied: in Health care areas; Basic: Understanding-fundamentals of life yet unresolved).
2. Creation of job opportunities for the students in the life science industry and meeting the market demand. E.g Agilent Technologies, GE Healthcare-Multidisciplinary (Hybrid) Background preference (Push/Need for Breakthrough/groundbreaking Technologies).

Faculty Strength & Infrastructure

All faculty of the School & Interested faculty of DBEB, Chemistry, CBME, CS, ME, EE, CHE, CPSE, CARE and all other units. BSL-1, 2 & 3 Level Laboratories in the School are expected to be ready in less than a year. Additionally, a UG Biology Laboratory is being developed in the upcoming Academic Complex. The recurring & non-recurring costs to be supported by the Institute will be augmented in a major way by the Kusuma Trust at least during the initial stages.

Structure: Minor Area in Biological Sciences

Eligibility: As per Section 3.12 in Registration & Attendance Rules

Requirements: Minimum completion of 20 credits including:

1. 8 credits of core courses.
2. Minimum of 12 credits (from any combination of 3 electives + minor project).

Core Courses:

*SBL101	Modern Biology for Engineers	(3-0-0)	3 credits
SBL201	High-Dimensional Biology	(3-0-0)	3 credits
SBP200	Introduction to Practical Modern Biology	(0-0-4)	2 credits

Elective Courses: Currently available in the School, DBEB, CBME and Chemistry.

S. No.	Course No.	Course Title	L-T-P	Credits
1	SBL701	Biometry	3-0-0	3
2	SBL702	Systems Biology	3-0-0	3
3	BEL421	Metabolic Regulation and Engineering	3-0-0	3
4	CYL726	Chemoinformatics and Molecular Modeling	3-0-0	3
5	BEL412	Immunology	3-0-2	4
6	SBL704	Human Virology	3-0-0	3
7	SBL707	Bacterial Pathogenesis	3-0-0	3
8	SBL 708	Epigenetics in Health and Disease	3-0-0	3
9	BEL311	Physical and Chemical Properties of Biomolecules	3-0-0	3
10	SBL705	Biology of Proteins	3-0-0	3
11	BEL714	Protein Science and Engineering	3-0-0	3
12	BEL722	Genomics and Proteomics	3-0-0	3
13	SBL703	Advanced Cell Biology	3-0-0	3
14	SBL706	Biologics	3-0-0	3
15	SBL709	Marine Bioprospecting	3-0-0	3
16	SBL710	Chemical Biology	3-0-0	3
17	BML700	Introduction to Basic Medical Sciences for Engineers	3-0-0	3
18	CHL291	Introduction to Biochemical Engineering	3-1-0	4
19	SBD301	Mini Project	0-0-6	3

Guidelines: It is expected that students would complete the requirements of the Minor Area by exploring any of the above elective courses to be able to explore a variety of areas within the diverse field of biological sciences. However, an option of focusing on a particular aspect of biological sciences in the Minor Area has also been provided based on grouping of electives. For example: Choosing any 3 electives from S. Nos. 1-4 will equip students with background in computational biology, S. Nos. 5-8 will equip students with background in infectious diseases, S. Nos. 9-12 will equip students with proteomics, and, S. Nos. 13-18 will equip students with background in applied biological sciences. On the same lines, S. Nos. 2, 3 and 12 will equip the students with background in systems biology.

* SBL101 has been superseded by SBL100 (Introductory Biology for Engineers)

Core courses: Minor Area in Biological Sciences

SBL100 Introductory Biology for Engineers

4 credits (3-0-2)

Darwinian evolution & molecular perspective; Introduction to phylogeny - Classification systems in biology and relationships; Cellular assemblies – From single cell to multi-cellular organisms: Geometry, Structure and Energetics; Comparing natural vs. human-made machines; Infection, disease and evolution – synergy and antagonism; Immunology – A classic example of permutations and combinations in biology; Cancer biology – Control and regulation; Stem cells – Degeneracy in biological systems; Engineering designs inspired by biology – Micro- to Macro- scales.

Laboratory: Biosafety; Buffers in biology - Measuring microlitres, Preparation of standard biological buffers, buffering capacity and pKa of buffers, biomolecules, whole cells and plant tissues in different buffering conditions; Observing cell surface and intracellular contents using light and fluorescence microscopy, real-time video microscopy of motile cells; Measuring and visualizing intracellular molecular components - Proteins and Genomic DNA.

SBP200 Introduction to Practical Modern Biology

2 credits (0-0-4)

Biosafety lab practices - use of lab coats, gloves, safety goggles, eye wash, shower, chemical and biological waste disposal; Buffers in biology - Preparation of standard biological buffers, buffering capacity and pKa of buffers, biomolecules such as enzymes, whole cells and plant tissues in different buffering conditions; Observing cell surface and intracellular contents using light and fluorescence microscopy, "autofluorescence" of cells, real-time video microscopy of motile cells, cell growth and division; Plant genomic DNA isolation; Protoplast isolation and viability; Computer Modeling- From Genome Sequence to Protein Sequence and structure to screening for a "Hit" Molecule.

SBL201 High dimensional Biology

3 credits (3-0-0)

Introduction to Genomics, proteomics, Metabolomics & Cellomics; Size vis-a-vis packaging and replication challenges, Biomolecular architecture and assemblies leading to function, Immortal cells and aging, Minimalist Genomes & Designer Genomes; Molecular Engines: Proteins as nano-biomachines; network circuits for genome organization and protein-protein interactions, date hubs, party hubs, structure-function axioms, Biochemical cycles and feedback loops, Omics Applications, forensics, drug targets.

SBD301 Mini Project

3 credits (0-0-6)

Systems Biology, Plant Molecular Biology, Bioprospecting, Tissue culture and Developmental Biology, Virology, Structural Biology, Cell Biophysics, Cellular Signalling, Protein folding and misfolding, Computational Biology