

UNIVERSITY OF MUMBAI & DEPARTMENT OF ATOMIC ENERGY

CENTRE FOR EXCELLENCE IN BASIC SCIENCES

Outline of course structure for the MSc (Integrated) Life Science Stream

SEMESTER -I

<i>Subject Code</i>	<i>Subject</i>	<i>Contact hrs/per week</i>	<i>Credits</i>
		<i>Theory + Tutorials</i>	
<i>M 101</i>	<i>Mathematics I</i>	<i>[2 +1]</i>	<i>3</i>
<i>P101</i>	<i>Mechanics and Waves</i>	<i>[2 +1]</i>	<i>3</i>
<i>C 101</i>	<i>Chemical Structures and Bonding</i>	<i>[2 +1]</i>	<i>3</i>
<i>B 101</i>	<i>General Biology</i>	<i>[2 +1]</i>	<i>3</i>
<i>G 101</i>	<i>Computer Basics</i>	<i>[2 +1]</i>	<i>3</i>
<i>H 101</i>	<i>Communication Skills</i>	<i>[2 +0]</i>	<i>1</i>
		<i>Contact hrs/per week</i>	<i>Credits</i>
		<i>Lab</i>	
<i>PL102</i>	<i>Physics Laboratory</i>	<i>[3]</i>	<i>2</i>
<i>CL 102</i>	<i>Chemistry Laboratory</i>	<i>[3]</i>	<i>2</i>
<i>BL 102</i>	<i>Biology Laboratory</i>	<i>[3]</i>	<i>2</i>
<i>ML 102</i>	<i>Computer Laboratory</i>	<i>[3]</i>	<i>2</i>

## GENERAL BIOLOGY (B101)

*LIFE: History and origin of life, biological evolution, natural selection, speciation, taxonomy.*

*ECOLOGY & ECOSYSTEM: Concept of ecology and ecosystem, ecological succession, ecosystem dynamics, flow of ecology and matter, biogeochemical cycling, ecosystem changes, biotic and abiotic factors and stresses, food web, adaptation of individual organism to the environment through genetic changes.*

*CLASSIFICATION OF LIVING THINGS: Classification and domains of life, Plants & animals (Phyla and chordates) and microorganisms, Prokaryotes and Eukaryotes*

*CELL BIOLOGY: Discovery of cell, cell theory, classification of cell types, cell membrane, cell-cell interactions, energy and metabolism, respiration, photosynthesis, sexual reproduction.*

*CELL DIVISION AND SYSTEM DEVELOPMENT: cell cycle, mitosis, meiosis, DNA recombination, chromosome abnormality, mechanism of development (stem cells), formation of tissues.*

*PHYSIOLOGY- BODY SYSTEMS: Digestive system, circulatory system, Lymphatic system, nervous system, respiratory system, sensory system, homeostasis.*

## SEMESTER –II

<i>Subject Code</i>	<i>Subject</i>	<i>Contact hrs/per week</i>	<i>Credits</i>
		<i>Theory + Tutorials</i>	
<i>M 201</i>	<i>Mathematics II</i>	<i>[2 +1]</i>	<i>3</i>
<i>P 201</i>	<i>Electricity &amp; Magnetism</i>	<i>[2 +1]</i>	<i>3</i>
<i>C 201</i>	<i>Thermodynamics &amp; Properties of Matter</i>	<i>[2 +1]</i>	<i>3</i>
<i>B 201</i>	<i>Molecular Biology (Basic)</i>	<i>[2 +1]</i>	<i>3</i>
<i>G 201</i>	<i>Electronics &amp; Instrumentation</i>	<i>[2 +1]</i>	<i>3</i>
<i>H 201</i>	<i>History of Science</i>	<i>[2 +0]</i>	<i>1</i>
		<i>Contact hrs/per week</i>	<i>Credits</i>
		<i>Lab</i>	
<i>PL201</i>	<i>Physics Laboratory</i>	<i>[3]</i>	<i>2</i>
<i>CL 201</i>	<i>Chemistry Laboratory</i>	<i>[3]</i>	<i>2</i>
<i>BL 201</i>	<i>Biology Laboratory</i>	<i>[3]</i>	<i>2</i>
<i>GL 201</i>	<i>Electronics Laboratory</i>	<i>[3]</i>	<i>2</i>

## MOLECULAR BIOLOGY (B201)

*CELL – OVERVIEW: Cellular organization, Biomembranes, Nucleus, Cytoplasmic organelles, Bacteriophages.*

*PROTEIN STRUCTURE AND FUNCTION: Building blocks- amino acids, peptides, secondary structure, three dimensional structure, membrane proteins, miscellaneous proteins, enzymes.*

*NUCLEIC ACIDS, GENOMES AND PROTEOMICS: Building blocks- nucleotides, DNA structure, RNA structure and function, chromatin structure, genome code, genes, repetitive DNA sequences.*

*GENE TRANSCRIPTION: Overview of gene expression, overview of transcription, gene's regulatory elements, transcription mechanisms in prokaryotes and eukaryotes, regulation of transcription factors, transcription of RNA genes.*

*CELL SIGNALING: Overview, signaling via hydrophobic molecules, signaling via ion channels, Signaling via G-protein coupled receptors, signaling via cell surface enzymes, intracellular signaling.*

*BIOTECHNOLOGY: DNA cloning, recombinant DNA technology, genomic library and cDNA library, Gel electrophoresis, Blotting methods and applications, Polymerase chain reaction (PCR), DNA sequencing, Production of recombinant proteins, and SDS-PAGE.*

*GENES AND DISEASES: Gene mapping, cloning disease genes, gene therapy, cancer, Alzheimer's disease, obesity and diabetes, monogenetic diseases, Other diseases.*

SECOND YEARSEMESTER –III

<i>Subject Code</i>	<i>Subject</i>	<i>Contact hrs/per week</i>	
		<i>Theory + Tutorials</i>	<i>Credits</i>
B 301	<i>Chemistry of life</i>	[3 +1]	4
B 302	<i>Biological Principles and Comparative Physiology</i>	[3 +1]	4
B 303	<i>Molecular Biology II</i>	[3 +1]	4
G 301	<i>Statistical Techniques and Methods (Mathematical Biology)</i>	[2 +1]	3
O 301	<i>Humanities course</i>	[3 +1]	4
O 302	<i>Basic Computer Programming and Applications</i>	[2 +0]	1
		<i>Contact hrs/per week</i>	
		<i>Lab</i>	
BL 304	<i>Biology Laboratory</i>	6	6
BL 305	<i>Biology Laboratory</i>	3	3

MOLECULAR BIOLOGY (ADVANCED, B303)

1. *DNA – AS A STRECTCH OF NUCLEOTIDES: A detailed history of Molecular Biology (special mention on inventions and discoveries), recognizing consensus sequences on a DNA stretch (coding, non-coding and regulatory elements), emphasis is placed on storage and transmission of genetic information, analysis of the molecular mechanisms by which stored genetic information directs cellular development, regulation of gene expression, and the role of these processes in development, recombination, replication and repair of DNA.*

2. *RECOMBINANT DNA TECHNOLOGY: Site directed mutagenesis, Organismal cloning, Bioinformatics, DNA microarrays, Real-time PCR*

*GENETICS (B303)*

*Basic genetics*

*Chromosome*

*DNA*

*Genetic variation*

*Heredity*

*Branches of genetics*

*Behavioural genetics*

*Classical genetics*

*Conservation genetics*

*Ecological genetics*

*Evolutionary genetics*

*Genetic engineering (Metagenics)*

*Genetics of intelligence*

*Genomics*

*Human genetics (Human evolutionary genetics and Human mitochondrial genetics)*

*Medical genetics*

*Microbial genetics*

*Molecular genetics*

*Population genetics (Archaeogenetics and Archaeogenetics of the Near East)*

*Psychiatric genetics*

*Quantitative genetics*

*Multi-disciplinary fields including genetics*

*Evolutionary anthropology*

*History of genetics*

*Ancient Concepts of Heredity*

*History of evolutionary thought*

*History of plant systematics*

*Experiments on Plant Hybridization*

*History of genomics*

*Neanderthal genome project*

*STATISTICAL METHODS FOR BIOLOGISTS (B304)*

*1. Introduction; 2. Estimation; 3. Hypothesis testing; 4. Graphical exploration of data; 5. Correlation and regression; 6. Multiple regression and correlation; 7. Design and power analysis; 8. Comparing groups or treatments - analysis of variance; 9. Multifactor analysis of variance; 10. Randomized blocks and simple repeated measures: unreplicated two-factor designs; 11. Split plot and repeated measures designs: partly nested anovas; 12. Analysis of covariance; 13. Generalized linear models and logistic regression; 14. Analyzing frequencies; 15. Introduction to multivariate analyses; 16. Multivariate analysis of variance and discriminant analysis; 17. Principal components and correspondence analysis; 18. Multidimensional scaling and cluster analysis; 19. Presentation of results.*

*(i) The theoretical Normal Distribution, and its application to data analysis.*

*(ii) Null Hypotheses, Type I and II Errors, Sample Strategies, and Independence.*

*(iii) One- and Two-Tailed Tests, and Experimental Design.*

*(iv) Analysis of Variance, and Chi-Squared.*

*(v) Bivariate Data, Regression Analysis and Correlation Coefficients.*

*(vi) Practical Application of SPSS Statistical Software.*

*CHEMISTRY OF LIFE (B301)*

*Chemical Elements and Water*

*Most frequently occurring chemical elements in living things are carbon, hydrogen and oxygen.*

*A variety of other elements are needed by living organisms including nitrogen, calcium, phosphorus, iron and sodium.*

*One role for each of the elements (Nitrogen is a major element of proteins and nucleic acid (for DNA and RNA). Calcium is necessary for bone and tooth formation, blood clotting, and nerve impulse transmission. Phosphorus is also used for bone and tooth formation, and to balance acid and base concentrations in the body. Iron is a part of hemoglobin, a molecule needed to carry oxygen in the blood. Sodium balances both water in the body and acid/base concentration. It also functions in nerve function).*

*Outline the difference between an atom and an ion.*

*Outline the properties of water that are significant to living organisms including transparency, cohesion, solvent properties and thermal properties. Refer to the polarity of water molecules and hydrogen bonding where relevant.*

*Explain the significance to organisms of water as a coolant, transport medium and habitat, in terms of its properties.*

## *Carbohydrates, Lipids and Proteins*

*Define organic (Compounds containing carbon that are found in living organisms, except hydrogencarbonates, carbonates and oxides, are organic).*

*Draw the basic structure of a generalized amino acid.*

*Draw the ring structure of glucose and ribose.*

*Draw the structure of glycerol and a generalized fatty acid.*

*Outline the role of condensation and hydrolysis in the relationships between monosaccharides, disaccharides, and polysaccharides; fatty acids, glycerol and glycerides; amino acids, dipeptides and polypeptides. (For monosaccharides, fatty acids, and amino acids to become disaccharides, glycerol, and dipeptides, a condensation reaction needs to occur. When these monomers covalently bond, a water molecule is released; this is a condensation reaction. When many monomers join together through condensation reactions, polymers result. \_\_\_\_\_ In a hydrolysis reaction, the addition of a water molecule breaks down the covalent bonds and polymers break down into monomers).*

*Draw the structure of a generalized dipeptide, showing the peptide linkage.*

*List two examples for each of monosaccharides, disaccharides and polysaccharides. (Two examples of monosaccharides are glucose and fructose. Two examples of disaccharides are maltose and lactose. Two examples of polysaccharides are starch and cellulose).*

*State one function of a monosaccharide and one function of a polysaccharide. (One function of a monosaccharide is that they are major nutrients for the cell. One function of a polysaccharide is that provide structural support for the cell).*

*State three functions of lipids. (One function of lipids is that they are great insulators. Also, some lipids function as hormones. In addition, lipids are used for long term energy storage).*

*Discuss the use of carbohydrates and lipids in energy storage. (The use of carbohydrates in energy storage is through its sugar polymers, glycogen in animals and starch in plants. These sugars are released when the demand for sugar increases. Animals use lipids, mainly fats, for long-term energy storage).*

## *Enzymes*

*Define enzyme and active site. (An enzyme is a globular protein functioning as a biological catalyst. An active site is the site on the surface of an enzyme to which substrate or substrates bind).*

*Explain enzyme-substrate specificity. (An enzyme has an active site that fits with one specific substrate, like a lock and key).*

*Explain the effects of temperature, pH and substrate concentration on enzyme activity. (For all enzymes, there is an optimum temperature at which the maximum amount of collisions occur in the active sites. As the temperature decreases, there is less movement and fewer collisions, so enzyme activity decreases. There is a limit to which the enzyme activity can increase because at a certain temperature the enzymes denature. This means that the enzyme changes shape and no longer fits with*

*its substrate. Also, as the substrate concentration increases, so does the enzyme activity, but there is also a limit to the increase in enzyme activity because there is a limit to how quickly the enzymes can catalyze each reaction. There is a specific pH at which the enzyme will denature, and so pH also plays a part in enzymatic activity).*

*Define denaturation. (Denaturation is a structural change in a protein that results in a loss of its biological properties).*

*Explain the use of pectinase in fruit juice production, and one other commercial application of enzymes in biotechnology. (Pectinase is used in fruit juice production to break down the acidity of the juices. Also, during oil spills, oil-digesting bacteria are used to clean up the spills since these bacteria have enzymes that can break down oil).*

SEMESTER –IV

<i>Subject Code</i>	<i>Subject</i>	<i>Contact hrs/per week</i>	
		<i>Theory + Tutorials</i>	<i>Credits</i>
<i>B 401</i>	<i>Biochemistry</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 402</i>	<i>Cell and Developmental Biology</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 403</i>	<i>Biodiversity</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 404</i>	<i>Biophysics</i>	<i>[3 +1]</i>	<i>4</i>
<i>G 401</i>	<i>Environmental Science</i>	<i>[2 +1]</i>	<i>3</i>
<i>H 401</i>	<i>History of Biology</i>	<i>[2 +0]</i>	<i>1</i>
		<i>Contact hrs/per week</i>	
		<i>Lab</i>	
<i>BL 405</i>	<i>Biology Laboratory</i>	<i>6</i>	<i>6</i>
<i>GL 401</i>	<i>Environmental Science Laboratory</i>	<i>3</i>	<i>3</i>

**BIOCHEMISTRY: MACROMOLECULES AND METABOLISM (B301)**

*Introduction to the principles of biochemistry, with an emphasis on the experimental approaches that elucidated these principles.*

*Major topics will include structure, function, and biosynthesis of biological molecules,*

*approaches for isolation and analysis of proteins and enzymes.*

*analysis of enzyme function and activity,*

*bioenergetics,*

*regulation of metabolic pathways.*

*Nucleic acids: nucleosides, nucleotides, structure of RNA, structure of DNA – A, B and Z forms, DNA as genetic material*

*Proteins: amino acids and their classification, protein conformation- primary, secondary, tertiary and quaternary structure, fibrous and globular proteins, enzymes*

Carbohydrates: structure of mono-, di- and poly-saccharides, types of bonds and functions

Lipids and vitamins: Classification, fatty acids, introduction to vitamins and their role.

THIRD YEAR

SEMESTER –V

<i>Subject Code</i>	<i>Subject</i>	<i>Contact hrs/per week</i>	<i>Credits</i>
<i>Theory + Tutorials</i>			
<i>B 501</i>	<i>Genetics (include Population genetics)</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 502</i>	<i>Neurobiology</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 503</i>	<i>Immunology</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 504</i>	<i>Genomics and Genetic engineering</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 505</i>	<i>Biophysics</i>	<i>[2 +0]</i>	<i>1</i>
<i>O 501</i>	<i>Biophysical techniques and Instrumentation in Biology</i>	<i>[2 +1]</i>	<i>3</i>
<i>Contact hrs/per week Lab Credits</i>			
<i>BL 506</i>	<i>Biology Laboratory</i>	<i>6</i>	<i>6</i>
<i>BL 507</i>	<i>Biology Laboratory</i>	<i>3</i>	<i>3</i>

SEMESTER –VI

<i>Subject Code</i>	<i>Subject</i>	<i>Contact hrs/per week</i>	<i>Credits</i>
		<i>Theory + Tutorials</i>	
B 601	Molecular Medicine	[3 +1]	4
B 602	Animal and Plant Behaviour (mimicry/migration/circadian rhythms)	[3 +1]	4
B 603	Microbiology	[3 +1]	4
B 604	Plant and Animal Systematics	[3 +1]	4
B 605	Cancer and Radiation Biology	[2 +1]	3
B 606	Stem cell biology and tissue engineering	[2 +0]	1
		<i>Contact hrs/per week</i>	<i>Credits</i>
		<i>Lab</i>	
BL 607	Biology Laboratory	6	6
BL 608	Biology Laboratory	3	3

FOURTH YEARSEMESTER –VII

<i>Subject Code</i>	<i>Subject</i>	<i>Contact hrs/per week</i>	<i>Credits</i>
		<i>Theory + Tutorials</i>	
B 701	Evolutionary and Ecological Biology	[3 +1]	4
B 702	Parasitology	[3 +1]	4
B 703	Human/other model organisms genome project and Human genetic disorder	[3 +1]	4
B 704	Biotechnology	[3 +1]	4
B 705	Molecular modeling and drug design	[2 +1]	3

<i>O 701</i>	<i>Imaging technology in biological research</i>	<i>[2 +0]</i>	<i>1</i>
		<i>Contact hrs/per week</i>	<i>Credits</i>
		<i>Lab</i>	
<i>BL 706</i>	<i>Biology Laboratory</i>	<i>6</i>	<i>6</i>
<i>BL 707</i>	<i>Biology Laboratory</i>	<i>3</i>	<i>3</i>

*SEMESTER –VIII*

<i>Subject Code</i>	<i>Subject</i>	<i>Contact hrs/per week</i>	<i>Credits</i>
		<i>Theory + Tutorials</i>	
<i>B 801</i>	<i>Toxicology and Clinical research</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 802</i>	<i>Reproductive biology and advances in intervention technology</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 803</i>	<i>Advanced analytical instrumentation based technologies in Modern Biology</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 804</i>	<i>Systems and Synthetic Biology</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 805</i>	<i>Computational and structural biology</i>	<i>[2 +1]</i>	<i>3</i>
<i>O 801</i>	<i>Translational biology and Entrepreneurship/study of successful cases</i>	<i>[2 +0]</i>	<i>1</i>
		<i>Contact hrs/per week</i>	<i>Credits</i>
		<i>Lab</i>	
<i>BL 806</i>	<i>Biology Laboratory</i>	<i>6</i>	<i>6</i>
<i>BL 807</i>	<i>Biology Laboratory</i>	<i>3</i>	<i>3</i>

FIFTH YEARSEMESTER –IX

<i>Subject Code</i>	<i>Subject</i>	<i>Contact hrs/per week</i> <i>Theory + Tutorials</i>	<i>Credits</i>
<i>B 901</i>	<i>Research methodology and skills in science writing/articulation</i>	<i>[3 +1]</i>	<i>4</i>
<i>B 902</i>	<i>Critical reading and presentation of classical papers in Biology</i>	<i>[ 1+2]</i>	<i>3</i>
		<i>Contact hrs/per week</i> <i>Lab</i>	<i>Credits</i>
<i>BL 903</i>	<i>Biology Laboratory</i>	<i>6</i>	<i>6</i>
<i>BL 904</i>	<i>Research Project and presentation of data</i>		<i>15</i>

SEMESTER –X

<i>Subject Code</i>	<i>Subject</i>	<i>Contact hrs/per week</i> <i>Theory + Tutorials</i>	<i>Credits</i>
<i>BL 1001</i>	<i>Research Project, thesis writing and oral defense</i>	<i>-</i>	<i>30</i>