B.Sc. Biotechnology Syllabus
(2008-09)

Total Marks = 3100 [1200 (F.Y.) + 1000 (S.Y.) + 900 (T.Y.)]

Course structure

First Year

Course Code	Title of the Course	Theory/ Practical	Marks	Lecture/ Practical
Bb- 101	Fundamentals of Chemistry	Theory	100	90L
Bb- 102	Fundamentals of Physics	Theory	100	90L
Bb- 103	Basic Biosciences	Theory	100	90L
Bb- 104	Mathematics & Statistical Methods for Biologists	Theory	100	90L
Bb- 105	Fundamentals of Biological Chemistry	Theory	100	90L
Bb- 106	Biophysics & Instrumentation	Theory	100	90L
Bb- 107	Microbiology	Theory	100	90L
Bb- 108	Use of Computers	Theory	100	90L
Bb- 109	Techniques in Chemistry & Biochemistry	Practical	100	30 P
Bb- 110	Techniques in Physics, Biophysics & Instrumentation	Practical	100	30 P
Bb- 111	Laboratory Exercises in Biosciences	Practical	100	30 P
Bb- 112	Quantitative Methods in Biology	Practical	100	30 P

Second Year

Course code	Title of the Course	Theory/ Practical	Marks	Lecture/ Practical
	Semester I			
Bb- 211	Genetics & Immunology	Theory	100	90L
Bb- 212	Cell Biology	Theory	100	90L
Bb- 213	Molecular Biology	Theory	100	90L
Bb- 214	Techniques in Molecular Biology	Practical	100	30P
Bb- 215	Exercises in Cell Biology & Genetics	Practical	100	30P
	Semester II			
Bb- 221	Environmental Biology and Biotechnology	Theory	100	90L
Bb- 222	Plant & Animal Tissue Culture	Theory	100	90L
Bb- 223	English	Theory	100	90L
Bb- 224	Metabolic Pathways	Theory	100	90L
Bb- 225	Tissue Culture Techniques	Practical	100	30P

Third Year

Course Code	Title of the course	Theory/ Practical	Marks	Lecture/ Practical
	Semester III			
Bb- 331	Microbial Biotechnology	Theory	100	90L
Bb- 332	Animal & Plant Development	Theory	100	90L
Bb- 333	Biodiversity & Systematics	Theory	100	90L
Bb- 334	Developmental Biology & Microbial Biotechnology	Practical	100	30P
Bb- 335	Project (to be continued in semester IV)		50	
	Semester IV			
Bb-341	Large scale Manufacturing process	Theory	100	90L
Bb- 342	Biotechnology in Agriculture & Health	Theory	100	90L
Bb- 343	Recombinant DNA Technology	Theory	100	90L
Bb- 344	Techniques in Genetic Engineering	Practical	100	30P
Bb- 345	Project		50	

N.B. For assessment of each course, 80% will be for Semester-end examination and 20% for internal assessment. Internal assessment will be continuous throughout the semester, and the marks should be submitted to the Examination section before the commencement of Semester-end examination.

B.Sc. Biotechnology
Detailed Syllabus (2008-09)
First Year
Bb- 101 Fundamentals of Chemistry
First Term

Sr. No.	Topic	Lecture
1.	Gaseous State: Kinetic theory of gases, and deviation of kinetic gas equation, Deduction of gas laws such as Boyl's law, Charle's law, Graham's law of diffusion. Avogadro's principle, velocity of gas molecules, kinetic energy of translational motion. Dalton's law of partial pressure.	3
2.	Chemical Kinetics – Order-molecularity. First and second order-nth order rate equation, temp dependence of rate of reactions, collision theory.	7
3.	Colligative properties; lowering of vapour pressure of solvent, elevation of boiling point, freezing point lowering of solutions, Osmosis and osmotic pressure, relation of osmotic and vapour pressure, Van't Hoff equation for osmotic pressure. Electrolytes, Arrhenius theory for dissociation of electrolytes, Debye Huckel theory of inter-ionic attractions.	10
4.	Phase Rule: Gibbs phase rule, One component/two component systems, determination of solid liquid equilibria, determinature of nature of solid phases, Classification of two-component solid-liquid eqilibrium, simple eutectic diagram.	13
5.	Ionic equilibrium: Electrolytic conductance, Faraday's Law of electrolysis, transference and transference numbers, variation of conductance with concentration, effect on infinite dilution and other factors on conductance, inter-ionic attraction theory of conductance, conductometric titration, activity coefficients and their determination, Debye-Huckel theory of activity coefficients, ionization constants of weak acids and bases, pH, buffers, solubility products, salt effects and solubility.	12
Second Term		
6.	Principles of electrochemistry: EMF and its measurements, single electrode potentials, calculation of single electrode potentials, thermodynamics of electrode potentials, classification of electrodes, amalgam, gas, metal/insoluble salt and oxidation-reduction electrodes, electrochemical cells, the junction potentials, solubility product and EMF potentiometric determination of pH, potentiometric titrations.	20

7	Basics of stereochemistry:	10
	1. Representation of molecules a. Projection formulae. b. Sawhaorse Newman, Fisher 2. Conformation isomerism a. Conformation of isomers b. 'C' rotation about C-C bond, Propane, Ethane, Butane. c. Relative stability 3. Optical Isomerism a. Optical isomers b. Isomeric number and tetrahedral carbon atom c. Reduction of optical activity d. Plane of activity –simple plane, Centre of symmetry, Alternating axcess of symmetry, Properties, Recemic modification 4. Geometrical isomerism a. Open chain molecule b. Condition of geometric isomer c. Cis-trans and E-Z nomenclature] Physical and chemical properties of geometric isomerism.	
8.	Chemical bonding-various theories, covalent, hydrogen bondings and other weak interactions Atomic chemistry-electromagnetism. Principles of oxidation-reduction,	6
9	Basics in organic chemistry- Nomenclature, Hydrocarbons, alcohols, amines, alkyl indices Conformation of alkanes; alkyl halides, alcohols, ethers, amines Cycloalkanes. Oxidations, reductions, eliminations, addition and substitution reactions Synthesis of small molecules Quantitative structure-activity relationships (QSAR)	9

Reference Books:

1 University General Chemistry by C.N. R. Rao, Macmillan
2 Principles of Physical Chemistry, 4th edition by S.H. Marron and C.F. Prutton
3 Essentials of Physical Chemistry by B.S. Bahel and G.D. Tuli
4 College Chemistry by Linus Pauling
5 Concise Inorganic Chemistry by J. D. Lee 5th Edition
6 Basic Inorganic Chemistry by Cotton and Wilkinson
7 Organic Chemistry, 5th Edition by Marrison Prentice Hall of India Pvt. Ltd. Boyd, New Delhi
8 Guide book to Mechanism in Organic Chemistry by Peper Sykes, 6th Edition, Orient Longman
9 Organic Chemistry by I.L. Finar, Volume-II, 5th Edition
10 An introduction to Electrochemistry by Samuel Glasstene
11 The elements of Physical Chemistry by P.W. Atkins
12 Physical Chemistry for biological sciences by Raymond Chang (University science)
13 Physical Chemistry by David Ball

Bb- 102 Fundamentals of Physics
First Term

Sr. No	Topic	Lecture
1.	Interrelationship between Physics and Life sciences	2
2.	**Measurements** Physics quantities, standards and units: Length: radius of proton to size to astronomical distances. Mass: atomic mass unit to mass of earth. Time: time for fast elementary particle to pass through nucleus to age of earth. Electric current. Thermodynamic temperature. Amount of substance. Luminous intensity. International systems and units: Units used to measure physical quantities and their inter-conversion.	6
3.	**Elasticity** Stress and strain in solids, Hook's law, Stress-strain curves, Limit of elasticity. Relevance of elasticity to life sciences	3
4.	**Fluid Statics** Fluids: Definition, Pressure and Density. The variation of pressure in a fluid at rest. Pascal's Principle. Measurement of pressure. Various units of pressure and their inter-conversion.	6
5.	**Fluid Dynamics (Viscosity)** Streamline and turbulent flow (definition and explanation). Equation of continuity. Flow of liquids through capillaries. Poiseulles equation: Derivations and physical significance. Reynolds number: Derivation and physical significance. Concept of pressure energy. Bernoulli's theorem and its applications- Venturi meter and Pitot's tube. Viscosity estimation by Oswald's viscometer. Relevance to life sciences.	10
6.	**Surface tension** Surface tension and surface energy: Definition, concept and derivation. Capillary action. Angle of contact. Wettability. Temperature dependence of surface tension. Relevance to life sciences and applications.	8
7	**Sound waves :** Types of waves (Longitudinal and transverse wave). Principles of superposition. Audible, ultrasonic and infrasonic waves. Vibrating systems and source of sound. Beats. The Doppler effect. Applications in life sciences.	10

	Second Term	
8.	**Heat** A form of energy. Quantity of heat and specific heat. Molar heat capacity of solid. Concept of temperature. Thermal equilibrium – zeroth law of thermodynamics. Measuring temperature. International practical temperature scale.	5
9.	**Thermodynamics and real gases:** Mechanical equivalent of heat. Heat and work. First law of thermodynamics: Mathematical form and limitations, applications. Indicator diagram and concept of cyclic process. Second law of thermodynamics. Concept of entropy with examples. Carnot cycle and its efficiency: Four steps involved, Derivations of efficiency. Van der Waals equation of state, Critical constants: Derivation. Liquification of gases: Concept used in refrigerator.	10
10	**Refrigeration** Introduction to refrigeration principle: Difference between Heat Engine and Refrigerator with the help of Carnot cycle. Adiabatic and isothermal process. Coefficient of performance. Conditions for good refrigerant. Simple structure, and working of gas refrigeration – vapor and air.	6
11.	**Optics**: Properties of light: Reflection, refraction, dispersion, diffraction, Interference and Polarization. Concept of polarization. Polarization by reflection – Brewster's law. Polarization by double refraction – Nicol Prism. Lasers: Stimulated emissions, Optical pumping, Concept of population inversion, Laser action, Working of He-Ne laser. Applications of Laser.	8
12.	**Charge and Matter** Electromagnetism – preview, Electric charge. Conductor, Semiconductor and Insulator. Coulomb's law. Charge is quantized. Charge and matter. Charge is conserved. Electricity with minimum 3 examples.	8
13.	**Magnetism** The magnetic field. The definition of B. Poles and dipoles. Gauss' law of magnetism. Magnetism of earth. Paramagnetism. Diamagnetism. Ferromagnetism. Nuclear magnetism. Biomagnetism with minimum 3 examples.	8

Reference Books :

1 Physics - David Hallday and Robert Resnick(Vol. I and II) (Willey Eastern Ltd.)
2 Fundamentals of mechanics - S.K. Saxena (Himalaya Publication)
3 Perspectives of modern physics - Arthur Beiser (Mc Graw Hill)
4 Heat and thermodynamics - Zemansky (Mc Graw Hill)
5 Fundamentals of optics - Jenkins, White (Mc Graw Hill)
6 Optics -Ajoy Ghatak (Tata Mc Graw Hill)
7 Solar Energy - Suhas Sukhatme (Tata Mc Graw Hill)
8 Digital principles and applications - Malvino and Leach (Tata Mc Graw Hill)

9 Elements of spectroscopy - Gupta, Kumar, Sharma (Pragati Prakashan)
10 Introduction to atomic spectra - H.E. White (Mc Graw Hill)

Note: Students have learned most of the topics from this course at 10+2 level, but they need better understanding to apply or realize the relevance of these concepts with life, which is necessary while learning biotechnology. Teacher must highlight and emphasize the applications or relevance of Physics concepts in life science.

Bb- 103 Basic Biosciences

First Term

	Plant Sciences	
Sr. No.	**Topic**	**Lecture**
1.	General & Unique features of plants as a category of living organisms 'Plant' as a life form.	3
2.	Major aspects of plant sciences a) Structural Morphology - of vegetative and reproductive plant organs Anatomy – Internal organization of vegetative and reproductive plant organs Plant cell biology – Unique features of a plant cell b) Functional Principles and fundamental processes of plant growth and development, *In vivo* morphogenesis, Introduction to *in vitro* morphogenesis Pigments in plant growth and development, Major pathways in plant metabolism. Introduction to physiology of flowering a) photoperiodism b) vernalisation Plant growth regulators introduction to site of synthesis and effects Seed – Development, structure, germination, control of seed germination, Development of special prenneting organs – bulb, tuber, corm, rhizome	 3 4 1 6 2 5 4 2
3.	Plant groups with respect to increasing complexity in organization of plant body Key characters of each group. At least three examples of biologically economically and biotechnologically important forms from each of the following major groups: 1. Algae 2. Fungi 3. Bryophytes 4. Pteridophytes 5.	10

	Gymnosperms 6. Angiosperms	
4.	Life cycle patterns in major plant groups	5
	Second Term **Animal Sciences**	
Sr. No.	**Topic**	**Lecture**
1.	Comparative account of sponges to mammals(with representative examples)	20
2.	Host parasite relationship 1. Global feature of parasite and host interaction 2. Protozoan parasites 3. Nematode parasites 4. Platehelminthes parasites	10
3	Economic zoology 1. Beneficial and harmful organisms 2. Vermiculture 3. Aquaculture 4. Sericulture 5. Apiculture	15

Reference Books:

1. Devlin R.M. Fundamentals of Plant Physiology (Mac. Millan)
2. Malik C.P. Plant Physiology, Kalyani Publishers
3. Dube H.C. Text of Fungi, Bacteria and Viruses
4. Bold H.C. The Plant Kingdom, Prentice- Hall India
5. Chopra G.L. Class book of algae, ii. Class book of fungi
6. Dutta A.C. A Classbook of Botany, Oxford University Press
7. Kumar H.D. Biodiversity and sustainable development (Oxford & IBH)
8. Mukherji H. Plant groups (New central book depot)
9. Parihar N.S. An introduction to embryophyta (Central Book Depot)
10. Vasishtha P.C. Botany for degree students-Gymnosperms
11. Naik V.N. Taxonomy of Angiosperms
12. Lawrence G.H. Taxonomy of flowering plants
13. Chopra G.L. Angiosperms (Systematic and life cycle)
14. Shivarajan V.V. Introduction to principles of Taxonomy
15. Pandey B.P. Text book of Angiosperms
16. Eames A.J. and Mac Daniels L.H. An introduction of Plant Anatomy
17. Esau K. Anatomy of seed plants
18. Esau K. Plant Anatomy
19. Fahn A. Plant Anatomy
20. Mathur R.C. Systematic Botany
21. Kochar S. L. Economic Botany in tropics
22. Wareing and Philips. Control of growth and differentiation in plants

Bb- 104 Mathematics and Statistical Methods for Biologists

	First Term – Mathematics (45L) **Pre-requisites:** Sets, Number system (in brief) Matrices: Definition, types of matrices, addition, multiplication of matrices, inverse of a matrix Limits, differentiation, integration Graphs of standard functions:- X, X^2, X^3, 1X1, $\log_a X$, e^X	
Sr. No.	**Topic**	**No. of Lectures**
1	Complex numbers :- addition, subtraction, multiplication, division, De-Moiver's theorem, finding roots of polynomial equation	**6**
2	Sequences and series :- definition of convergent, divergent and oscillatory sequence. Following results without proof. (i) A monotonic increasing sequence bounded above is convergent. (ii) Geometric sequence {an} is convergent if -1< -1 Definition of convergent, divergent, oscillatory series Convergence of i) geometric series, ii) P-series (without proof) Tests of convergence i) comparison test, ii) D'Alembert's ratio test (limit form), iii) Cauchy's root test (limit form) Taylor's theorem, Maclaurin's theorem (without proof). Power series expansion of c^x, sinx, cosx, $(1+x)^n$	12
3	Partial Differentiation :- Maxima and minima (up to 2 variables) Rules of partial differentiation Higher order partial derivatives	3
4	Differential equations :- Homogeneous and non-homogeneous differential equations, exact d.e. (including integrating factor). Linear differential equation. Applications to growth and decay, law of cooling	6
5	Matrices and system of linear equations, row echelon form, rank of a matrix, homogeneous and non-homogeneous systems AX = B, consistency, gaussian elimination method.	6
6	Vector spaces :- IR^n and Mmxn ®, subspace of a vector space, linear dependence of vectors, eigenvalues and eigenvectors, diagonalization **References:** 1. Malick, S.C. and Arora Mathematical Analysis 2. Jenny Olive – Maths :- a self study Guide – Cambridge Low prices edition 3. R.G. Bartle and D.R. Sherbert (2^{nd} edition)-1992, John Wiley, New York 4. E.D. Rainville and P.E. Bedient (1989), Elementary Differential equations – McMillan, New York 5. System of Linear Equations 6. Eigen values and Eigen vectors 7. Partial Differentiation and differential equations 8. Sequences and series.	12

	Second Term – Statistics (45L)	
1	Introduction to statistics with scope in biosciences (examples) Statistics as statistical data : various types of data (Raw data, grouped data) Representation of data using frequency distribution diagram (Simple/Multiple/Subdivided bar diagram, Pie diagram), Graphs (Histogram, polygon, curve)	3
2	Population, sample, sampling methods (SRS, Stratified sampling)….1L	1
3	Descriptive statistics a)Measure of central tendency: Mean (Definition & simple problems) Medion, Quarliles (Definition, Graphical calculation) Mode (Definition, graphical calculation) Situations where one is preferred over others b)Measures of dispersion: Variance (Definition, simple problems) Standard deviation Coefficient of variance c)Skewness (Definition, types of skewness and graphical representation, no formula, and real life example) d)Kurtosis (Definition, types of Kurtosis, graphical representation, no formula, and real life example)	3 3 1 1
4	Probability a)Classical definition and its limitations, axiomatic approach (laws of problem only statement and no proof) b)Independence and conditional problem (real life examples in biology)	2
5	Standard probability distribution a)Binomial (Definition, biological example, additive property (only statement), simple examples b)Poisson (Definition, biological example, additive property (only statement), simple examples c)Namal (Definition, biological example, linear property (only statement, simple examples (using statistical tables), central limit theorem	8
6	Inferential statistics a)Hypothesis- definition, types (0ne tailed, two tailed) b)Sampling distribution and errors c)Types of errors (Type I, II)	2
7	Testing of hypothesis (two tailed only) a)For mean (one population) Mean (2 populations- dependent and independent) b)For variance (one population) Variance (2 populations) c)Chi-square test for 1) fitting of distribution 2) Independence of attributes	12
8	ANOVA 1) one way, 2) two way followed by t test (pairwise)	6

9	Correlation (Definition, types of correlation with simple biological problems) Scatter diagram Covariance Multiple correlation (definition, formula when matrix is given) Partial correlation (definition, formula when matrix is given)	3

Bb- 105 Fundamentals of Biological Chemistry

First Term

Sr. No.	Topic	Lecture
1	Origin of life, Origin of amino acids, nucleotides, Urey Miller's expt., Unicellular organism, multicellular organisms. Concept of biomolecules, polymerisation, formation of polymers i.e. proteins, nucleic acids, Molecular interactions, biological functions.	7
2	Chiral interactions, pH, pK, buffers. Reaction mechanism. Nucleophile, electrophile, Acid base reaction, nucleophilic addition, nucleophilic substitution, electrophilic addition, electrophilic substitution reaction.	14
3	Carbohydrates: Intoduction, biological importance. Definition, Classification,{glyceraldehydes, Simple Aldose, Simple Ketose, D-glucose, Conformation of D-glucose] Monosaccharides other than glucose, glyocosidic bond, disaccharides, polysaccharides [starch, glycogen, peptidoglycan, proteoglycan matrix.	12
4	Lipids: Introduction, Classes, Fatty acids [Physical prop. Chemical prop, Sap value, acid value, iodine number, rancidity]. Glycerolipid, Sphingolipid, Lipid derived from isoprene, Behavior of lipid in water, Bile acids, bile salts, plasma lipoproteins, Vesicles, membrane transport	12
	Second Term	
5	Amino acids: Structure and properties of amino acids. Acid base behavior/ amino acids analysis/ reactions/ Zwitterions/ classification.	3
6	Protein structure: Peptide bond/ Determination of primary structure/ Sanger's method, Edmann's method, dansylchloride, dabsyl- chloride/ Forces stabilizing secondary structure, Ramachandran plot, Hb and antibody examples of quaternary structure.	10
7	Protein purification: Methods of cell disruption, Salt ppt.- salting in, salting out, organic solvent ppt., Dialysis, Ultrafilteration, Paper chromatography, TLC, HPTLC, Column chromatography, Electrophoresis.	9

8	Enzymes: Basic concept, active site, energy of activation. Transition state hypothesis, Lock and key hypothesis, induced fit hypothesis. Allosteric enzymes, Enzyme inhibition, classification. MM equation, Lineweaver-Burk plot, Eadie-Hofstee plot.	9
9	Co-enzymes: Thiamine, riboflavin, niacin, PLP, Lipoid acid, Pantothinate, Folic acid, Cynocobalamine.	6
10	Nucleic acids: Nucleosides, nucleotides, Polynucleotide, DNA and its different forms [A, B, C, D, E and Z], RNA and its types. Forces stabilizing nucleic acid structure.	8

Reference Books:

1 Outlines of Biochemistry: Conn and Stumpf
2 Principles of Biochemistry: Jeffory Zubey
3 Biochemistry: Stryer

Bb- 106 Biophysics and Instrumentation

First Term

No	Topic	Lectures
1	**Atomic structure** Historical background upto Bohr model. Significance of second and third postulate of Bohr's model. Derivation of radius and energy value. Quantization of energy levels. Using Rydburg's constant, Atomic spectra is signature of the element. Bohr – Sommerfeld model. Vector atom model. Quantum numbers. Selection rules. Pauli's exclusion principle. Emission spectra with respect to Na atoms to understand selection rules.	**10**
2	**Spectroscopy** Definition. Electromagnetic wave. Electromagnetic spectrum. Applications of each region of electromagnetic spectrum for spectroscopy. Introduction to molecular energy levels. Excitation. Absorption. Emission. Rotational spectra. Energy levels of rigid diatomic molecules. Vibrational and rotational spectra. Energy levels of diatomic vibrating molecules. Rotational Vibrational Spectroscopy - IR spectroscopy. Principle, construction and working of IR spectrometer. Applications of IR spectroscopy to biomolecules. Electron spectroscopy. UV-visible spectroscopy. Principle, construction and working of colorimeter, Spectrophotometer, Flurometer. Application to biomolecules (proteins, DNA, Hb, chlorophyll).	**20**

3	**Radioactivity** Nucleus. Properties. Nuclear forces. Nuclear models (liquid drop and shell model). Radioactive nucleus. Revision of nuclear radiations and their properties - alpha, beta and gamma. Half life-physical and biological. Handling and standardization of alpha and beta emitting isotopes. Radioimunoassay. Radiopharmaceuticals and its uptake. Production of radionuclides. Measurement of radiation - Dosimetry and detectors. Principle, construction and working of – pen and batch dosimeter, GM counter, Scintillation counter (solid and liquid).	**15**
	Second Term	
4	**Thermodynamics as applied to biological systems** Enthalpy. Entropy. Free energy. Gibb's free energy (G). Helmholtz free energy (A). Chemical potential. Half cell potential. Redox potential. Structure and bioenergetics of mitochondria and chloroplast.	**10**
5	**Cell membrane** Organization of plasma membrane. Mass transport. Diffusion – basics. Passive and active transport. Membrane potential, Nernst equation. Passive electrical properties of cell (capacitance, resistance). Active electrical properties. Electrical model (equivalent) of cell membrane. Depolarization, hyperpolarization of membrane (neuronal). Generation of action potential. Types of biopotentials. Biopotential measurement instrument	**10**
6	**Thermoregulation** Thermometric properties and types of thermometers (clinical, thermocouple, bimetallic, platinum resistance, thermistor - thermometers). Body temperature and its regulation.	**05**
7	**Bioinstruments** Concepts- Analytical techniques, analyte, method, procedure and protocol. Principle construction, working and applications for analysis of biomolecules of following instruments. pH meter. Centrifuge (RCF, sedimentation concept), different types of centrifuges. Mass spectroscopy (Bainbridge mass spectrometer). Atomic absorption spectrometer (AAS). Nuclear magnetic resonance spectrometer (NMR).	**10**

8	**Microscopes** Concepts - Resolving power. Chromatic and achromatic aberrations. Construction and working of following microscopes–Dissecting, Compound light and Darkfield. Inverted. Phase contrast. Fluorescence. Electron microscopes: Concept of vacuum, Working of electron gun. Construction and working of SEM, TEM, STEM. Sample preparation.	**10**

Reference Books :

1. Perspectives of modern physics – Arthur Beiser (Mc Graw Hill)
2. Nuclear physics an introduction – S.B. Patel (New Age International)
3. Introduction to atomic spectra – H.E. White (Mc Graw Hill)
4. Textbook of optics and atomic physics – P.P. Khandelwal (Himlaya Publishing House.
5. Molecular cell biology – Ladish, Berk, Matsudara, Kaiser, Krieger, Zipursky, Darnell (W.H. Freeman and Co.)
6. Biophysics - Cotrell (Eastern Economy Edition)
7. Clinical Biophysics –Principles and Techniques- P. Narayanan (Bhalani Pub., Mumbai)
8. Biophysics – Pattabhi and Gautham (Narosa Publishing House)
9. Instrumentation measurements and analysis – Nakara, Choudhari (Tata Mc Graw Hill)
10. Handbook of analytical instruments – R.S. Khandpur (Tata Mc Graw Hill)
11. Biophysical Chemistry- Upadhyay, Upadhyay and Nath – (Himalaya Pub. House, Delhi)

Bb- 107 Microbiology

Sr. No.	Topic	Lecture
1	**Introduction to Microbial World.** i. Biocomplexity of Microorganisms. ii. Historical Account – Important developments leading to major discoveries. Path breaking discoveries. Product Development (18^{th} – 20^{th} Century including pregolden, golden and post golden era) Outline Classification of all 5 major groups of microorganisms. Procaryotic and Eucaryotic Bacteria, Fungi, Algae and viruses.	1 7 22

2	**Basic Methods in microbiology.** a) Introduction to instruments and equipments needed in Microbial studies b) Observations – **Macroscopic:** Colony formation patterns, Biofilm formation. **Microscopic:** Wet mount and dry mount. Staining Techniques (Monochrome, Negative, Differential, Special staining) c) Cultivation – *In vitro and in Vivo* Basic Considerations – Nutritional, Hydrogen ion concentration, Temperature and Oxygen. Concept of Pure culture, co-culture and Mixed culture. Design of media : Composition, Sterlisation. Preservation and Maintenance Methods for microbial cultures.	35
4. 5.	**Microbial Growth** Reproduction in microorganisms :Binary Fission, Asexual, Sexual, Lytic, Lysogenic Cycle. Cell Enumeration and quantification of Growth **Microbial interaction** Plants, Rhizosphere , mycorrhiza, Plant pathogens, nodules.	15 10

Reference Books:

General Microbiology - Stanier, 5th ed.
Introduction to Microbiology - Ingraham, 2nd ed.
Brock Biology of Microorganisms - Madigan et al, 9th ed.
Industrial Microbiology - An introduction, Waites, M.J.

Bb- 108 Use of Computers

First Term

Sr. No.	Topic	Lecture
1.	**Introduction to computers:** Overview and functions of a computer system Input and output devices Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP devices, Digital tape, CD-ROM, DVD (capacity and access time) Main Circuit Board of a PC: Chips, Ports, Expansion Slots Memory: Register, buffer, RAM, ROM, PROM, EPROM, EEPROM (comparison) Types of Processing : Batch, Real-Time, Online, Offline	5
2.	**History:** Evolution, Generation of computers (I, II, III,IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost, size	3
3.	**Modern computers:** ▪ The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & The Super Computer	3
4	**Introduction to operating systems:** ▪ Operating System concept, ▪ Windows 98/XP, ▪ Windows server NT/2000, ▪ Unix/Linux & servers	10
5	**Data processing & presentation:** ▪ Introduction ▪ MS office (World, Excel & Power Point)	16
6	**Computer viruses:** ▪ An overview of Computer viruses ▪ What is a virus ? Virus symptoms, How do they get transmitted ? What are the dangers ? ▪ General Precautions	3

Second Term

Sr. No.	Topic	Lecture
7.	**Computer Networking:** Introduction to networking: various terminologies Associated hardware devices, gadgets (Router, Switch	10

	etc.), tools, services, and resources Network Topologies and Protocols LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls	
8.	**Internet searches:** Search engines: Google, Yahoo etc. Concepts in text-based searching Searching Medline, bibliographic databases	10
9.	**Algorithms, Flowcharts & Programming concepts:** ▪ Algorithms: Concepts & definitions ▪ Converting algorithms to flowcharts ▪ Coding: flowcharts to programs ▪ Comparing algorithms, flowcharts & programs	12
10.	**Databases:** ▪ Introduction & need of databases ▪ Types of databases ▪ Basic concepts in: o Data Abstraction o Data Models o Instances & Schemes o E-R Model (Entity and entity sets; Relations and relationship sets; E-R diagrams; Reducing E-R Diagrams to tables) ▪ Network Data Model: Basic concepts ▪ Hierarchical Data Model: Basic concepts ▪ Multimedia Databases: Basic concepts and Applications ▪ Indexing and Hashing o B+ Tree indexed files o B Tree indexed files o Static Hash functions o Dynamic Hash functions ▪ Text Databases ▪ Introduction & Overview of Biological databases	13
11	**Introduction to Bioinformatics:** Nature of Biological data Overview of Bioinformatics Major Bioinformatics Resources: NCBI, EBI & ExPASY	5

Reference Books:

1. Introduction to Computers Data processing & Networking
2. Computer Fundamentals – P.K. Sinha
3. Introduction to Bioinformatics- Attwood
4. Instant Notes in Bioinformatics

Bb- 109 Techniques in Chemistry & Biochemistry (Practical)

Sr. No.	Topic	Practical (30P)
	First Term	
1	Determination of gas constant	
2	Crystal models	
3	Freezing point depression	
4	Thermochemistry	
5	Determination of an order of reaction	
6	Acid-base titrations	
7	Molarity , molality , normality	
8	Unit volume & weight measurements	
9	pH measurement	
10	Optical activity of a chemical compound by polarimeter	
11	Conductometry	
	Second Term	
1	Preparation of solutions, buffers – sensitivity, specificity, accuracy	
2	Spot test for carbohydrates	
3	Estimation of reducing sugars by Benedict's Method	
4	Spot tests for Amino Acids	
5	Quantitative methods for Amino acids	
6	Protein estimation	
7	Saponification of Fats	
8	Estimation of Cholesterol	
9	Enzyme assays	

Bb-110 Techniques in Physics, Biophysics & Instrumentation (Practical)

Sr. No.	Topic	Practical (30P)
	First Term	
1	Flat spiral spring : Y & n	
2	Y of a rectangular thin bar by bending	
3	Viscosity measurement using Ostwalds viscometer	
4	Surface – tension measurement: Using Jaeger's method, soap bubble Method	
5	Temperature measurement: using thermocouple, RTD	
6	Study of Lambert's & Beer's law	
7	Absorption spectrum of protein	

8	Fluorescence spectrum of protein	
9	Counting statistics using G.M. counter	
10	Study of DNA melting	
11	Study of transport across membrane by potential measurement	
12	To find out isoelectric point of amino acid	
	Second Term	
1	Instrumentation – Colorimeter	
2	pH meter	
3	Safety measure – time	
4	Study of electronic components (resistance capacitance)	
5	Microscopy – light	
6	Viscosity	

Bb-111 Laboratory Exercises in Biosciences (Practical)

Sr. No.	Topic	Practical (30P)
	First Term	
1	Study of example of each type of the following: algae, fungi, bryophytes, pteridophytes, gymnosperms, angiosperms – dicotyledones and monocotyledones.	3P
2	Study of different parts of plants –Qualitative histochemistry of root, stem and leaf of monocotyledon and dicotyledon.	2P
3	Study of the shoot apex, and dissection of shoot apical meristem.	1P
4	Study of plant cell types using squash techniques and maceration.	1P
5	In vitro seed germination	1P
6	Regeneration of plant in vivo	2P
7	Introduction to Microbiology Laboratory	1P
8	Aseptic Transfer Techniques	1P
9	Observation of microorganisms a) Wet mount b) Monochrome staining c) Gram staining d) Spore staining e) Fungal staining	5P
	Second Term	
1	Isolation of bacteria by Streak Plate Technique	1P
2	Enumeration techniques a) Pour plate method	3P

	b) Spread plate method c) Neubauer Chamber d) Plaque Count	
3	Study of paramecium, Hydra	1P
4	Study of Drosophila – characters, sexual dimorphism – eye & wing mutations	1P
5	Study of collection, preservation & presentation of insects	1P
6	Study of different types of eggs, larvae & pupae of insects	1P
7	Use of microscope	1P
8	Preparation of media (bacterial & fungal)	1P
9	Enrichment techniques Winogradsky's Column	1P
10	Observation of motility a) Hanging drop technique b) Craigie's tube method c) Swarming growth	1P
11	Report	1P

Bb-112 Quantitative Methods in Biology (Practical)

Sr. No.	Topic	Practical (30P)
	First Term	
1	Exercise based on mathematics & statistical methods for biologists	4P
2	Computer – Getting familiar with the hardware, booting & operating	1P
3	Getting started: Hands-on experience (Tutors are recommended)	1P
4	Tutorials operating systems: DOS, Windows 98/XP, UNIX etc.	4P
5	File handling: copy, rename, delete, type etc. Directory structure: make, rename, move directory	2P
6	Scanning for viruses & using anti-virus programs	1P
7	Word Processing (Microsoft Word): Creating, Saving & Operating a document, Editing, Inserting, Deleting, Formatting, Moving & Copying Text, Find & Replace, Spell Checker & Grammar Checker, Document Enhancement (Borders, Shading, Header, Footer), Printing document (Page layout, Margins), Introduction to the use of Wizards & Templates, Working with Graphics (Word Art), Working with Tables & Charts, Inserting Files (Pictures, Databases, Spreadsheets)	2P
	Second Term	

1	Exercise based on mathematics & statistical methods for biologist I.	6P
2	Use of internet – Downloading & Installing software/plug-ins on Windows 98/XP (Acrobat Reader, Post Scripts Viewer, etc.)	1P
3	Searching/Surfing on the WWW	2P
4	Spreadsheet Applications (Microsoft Excel): Worksheet Basics: Entering information in a Worksheet, Saving & Opening a Worksheet, Editing, Copying & Moving data, Inserting, Deleting & Moving Columns & Rows, Clearing Cells & Formatting Cells, Printing Worksheets	2P
5	Database Applications (Microsoft Access): Fields, Records, Files, Organization of Files, Access Modes; Updating Records, Querying, Reports, Forms & subforms	2P
6	Usage of multimedia – Creation of Computer Presentations with graphics (Microsoft Power Point): Creation of slides, Rapid Presentation design using wizards	2P

B.Sc. (Biotechnology) Second Year Course Structure

Course code	Title of the Course	Theory/ Practical	Marks	Lecture/ Practical
	Semester I			
Bb-211	Genetics & Immunology	Theory	100	90L
Bb-212	Cell Biology	Theory	100	90L
Bb-213	Molecular Biology	Theory	100	90L
Bb-214	Techniques in Molecular Biology	Practical	100	30P
Bb-215	Exercises in Cell Biology & Genetics	Practical	100	30P
	Semester II			
Bb-221	Environmental Biology and Biotechnology	Theory	100	90L
Bb-222	Plant & Animal Tissue Culture	Theory	100	90L
Bb-223	English	Theory	100	90L
Bb-224	Metabolic Pathways	Theory	100	90L
Bb-225	Tissue Culture Techniques	Practical	100	30P

Detailed Syllabus Second year (Semester I)

Bb- 211 Genetics & Immunology

Sr. No.	Topic	Lecture
1	Mendelian inheritance patterns & laws of heredity	5
2	Co-dominance, linkage & linkage maps	8
3	Mutations, variations & chromosomal alterations	8
4	Varieties of gene expressions – Multiple alleles, lethal genes, Pleiotropic genes, gene interactions etc.	6
5	DNA transfer mechanism: Prokaryotes, Eukaryotes & Viruses with examples. Mobile genetic elements & transposons	17
6	Bacterial plasmids – structure & properties	3
7	Operon concept – with examples	3
8	Overview of immune system a) History b) Adaptive immunity c) Innate immunity	10
9	Antigens, Antibodies – Structure & functions	15
10	Antigen – Antibody interactions, principle & applications	10
11	Introduction to Vaccines : Active & Passive immunization, types of Vaccines	5

Reference Books:

1 Strickberger “Genetics” (Macmillan)
2 Freifelder “Genetics”
3 Riott “Essential Immunology”

Bb- 212 Cell Biology

Sr. No.	Topic	Lecture
1.	Cell – Shapes , morphology, Cell theory	5
2.	Cells , Structure-function relationship including organelles (e.g., Endoplasmic reticulum, Mitochondria, Chloroplast, Golgi body, nucleus, lysosomes, vacuoles)	24
3.	Membrane structure , Membrane transport	6
4.	Cytoskeleton, Extracellular matrix , Cell junctions	10
	Second Term	
5.	Tissues : Types and functions	10
6.	The mechanism of cell division	5
7.	Cell division cycle and its regulation	5
8.	Cell Signaling	10
9.	Cell differentiation, Neoplasia & Cell death	10
10.	Methods (including microscopy) in Cell biology	5

Reference Books :

1 Lodish et al (2004) Molecular Cell Biology " (Scientific American Book)
2 Eduard Gasque – "Manual of Loboratory Expts in Cell Biol ."(W. C. …Wilson Pub)
3 Alberts et al. (2002) The Biology of the Cell
4 Cooper & Hausman (2004) The Cell – A Molecular Approach

Bb- 213 Molecular Biology

Sr. No.	Topic	Lecture
1.	DNA as the genetic material	4
2.	Nucleic acids- structure, properties and function; DNA forms; RNA: tRNA, rRNA & mRNA	10
3.	Organization of Genomes- Viral, Bacterial, Organelles, human	12
4.	Eukaryotic genomes: Chromosomal organization and structure. Euchromatin, heterochromatin, centromere, telomere. Chromatin structure (nucleosomes)- histone, non-histone proteins	14
5.	Definition of gene – introns/exons, Regulatory sequences, promoters, enhancers	10
6.	Central dogma of Molecular Biology. DNA replication in prokaryotes and eukaryotes	10
8	DNA damage and repair, mutations	5
9	Transcription and regulation of transcription	10
10	Genetic code, Protein synthesis	10
11	Post-translational modifications and transport of proteins	5

Reference Books :

1 Genes VIII : Benjamin Lewin
2 Genome : T. A. Brown
3 Molecular biology of Gene : Watson
4 Cell and Molecular Biology : Lodish
5. Mol. Biol.: Weaver

Bb- 214 Techniques in Molecular Biology (Practical)

Sr. No.	Topics	Practicals (30P)
1	Importance of clean handling, sterility, cleanliness, reagent preparation	3P
2.	DNA isolation- a) Bacterial DNA, b) Eukayotic DNA	6P
3.	Absorption spectra of Proteins, Nucleic acids	4P
4.	Analysis of DNA by Agarose gel electrophoresis	6P
5.	Restriction enzyme digestion	3P
6.	Protein estimation by Biuret and Lowry procedures	4P
7.	SDF-PAGE separation of proteins	4P

Bb- 215 Exercises in Cell Biology & Genetics (Practical)

Sr. No.	Topic	Practical (30P)
1	Cell Structure – prokaryotes and eukaryotes	2P
2	Separation of cells using sedimentation and velocity centrifugation	2P
3	Study of subcellular organelles	2P
4	Isolation and characterization of subcellular components, isolation of nuclei from rat liver	2P
5	Isolation of mitochondria	2P
6	Demonstration of phenolase /phoshatase in tissue section	2P
7	Cell harvesting and cell lysis- methodology	2P
8	Observation of Drosophila – wild type and mutant	3P
9	Problem sets in Mendalian inheritance, single point & two point crosses and gene mapping in bacteria	5P
10	Isolation of mutants, isolation and enumeration of phages	3P
11	UV survival curve	2P
12	Immunoprecipitation	1P
13	Demonstration of Antigen- Antibody reaction through clinical approach	2P

Semester II

Bb- 221 Environmental Biology and Biotechnology

Sr. No.	Topic	Lecture
1.	**Basic Ecological Concepts & Principles**	**45 T**
	a) Our Environment: Geological consideration	5
	➢ Atmosphere	
	➢ Hydrosphere	
	➢ Lithosphere	3
	b) Scope of Ecology	3
	c) Development & Evolution of Ecosystem	6
	d) Principles & Concepts of Ecosystem	
	➢ Structure of ecosystem	
	➢ Strata of an ecosystem	
	➢ Types of ecosystem including habitats	
	➢ Cybernettics & Homeostasis	
	➢ Biological control of chemical environment	7
	e) Energy trasfer in an Ecosystem	
	➢ Food chain, food web	
	➢ Energy budget	
	➢ Production & decomposition in a system	
	➢ Ecological efficiencies	
	➢ Traphic structure & energy pyramids	
	➢ Ecological energetics	4
	f) Priciples pertaining of limiting factors	7
	g) Bio-geochemical cycles (N,C,P cycles)	
2.	**Pollution & Environmental Health**	20
	1. Pollution & environmental Health	
	➢ Soil	
	➢ Water	
	➢ Air	
	➢ Food	
	➢ Pesticides, Metals, Solvents, Radiations, Carcinogen, Poisons	
	2. Detection of Environmental pollutant	
	3. Indicators & detection systems	
	4. Biotransformation	
	➢ Plastic , Aromatics , Hazardous wastes	
	5. Environmental cleanup : Case studies	
3.	Environmental biotechnologies Biotechnologies in protection and preservation of environment Bioremediation Waste disposal	20

Reference Books:

1. E.P. Odum : Fundamentals of Ecology

2. Amann, R.I. Stromley, J. Stahl : Applied & Environmental Microbiology
3. Dash : Concepts of Ecology
4. Chattergy : Environmental Biotechnology
5. Varma & Agarwal : Environmental Biology
6. B.K. Sharma : Environmental Chemistry
7. Peavy & Rowe : Environmental Pollution
8. Asthana & Asthana : Environment Problems & Solutions
9. Manahan : Environmental Chemistry
10. Saigo, Canninhham : Environmental Science

Bb- 222 Plant & Animal Tissue Culture

Sr. No.	Topic	Lecture
1	**A) Plant Tissue Culture: 45L** Introductory History – Concepts of Cell theory & Cellular totipotency, Milestones in plant tissue culture.	3
2	Infrastructure & Organization of plant tissue culture laboratory – General & aseptic laboratory, different work areas, equipments & instruments required, other requirements.	3
3	Aseptic techniques – Washing & preparation of glassware, packing & sterilization, media sterilization, surface sterilization, aseptic work station, precautions to maintain aseptic conditions.	3
4	Culture Medium – Nutritional requirements of the explants, PGR 's & their in vitro roles, media preparation.	4
5.	'Explant' for plant tissue culture – histological and/or cellular characteristics Response of explants *in vitro* – Dedifferentiation and redifferentiation a) callus formation b) organogenesis (direct and indirect) c) embryogenesis (direct and indirect)	3
6	Callus culture technique – Introduction, principle, protocol, factors affecting, Morphology & internal structure, genetic variation	3
7	Suspension culture technique – Introduction, principle, protocol, types, growth & growth measurement, synchronization	3
8	Organ culture technique – Introduction, principle, protocol factors affecting w.r.t. root tip culture, leaf culture, shoot tip & meristem culture,	3
9	Anther & pollen culture technique – Introduction, principle, protocol, factors affecting,	3
10	ovary, ovule, embryo and endosperm culture.	2

11	Protoplast – protoplast isolation, protoplast culture. Somatic hybridization – Protoplast fusion techniques, selection of hybrids, production of symmetric & asymmetric hybrids & cybrid production. Genetic transformations – DNA uptake by seeds, pollens, transformation of protoplasts, agrobacterium mediated transformations, direct DNA transfer methods – electroporation, microprojectile bombardment, microinjection, use of marker genes, integration & expression of foreign DNA	6
12	Different routes of multiplication *in vitro* – a) axillary bud proliferation, b) somatic embryogenesis, c) organogenesis Production of artificial seeds – techniques, factors affecting	3
13	Somaclonal variation – Introduction, terminology, origin, selection at plant level, selection at cell level, mechanism, assessment,	3
14	Introduction to secondary metabolite production *in vitro* Biotransformations – Introduction, principle, optimization of yield	3
	B) Animal Tissue Culture :	
1.	Animal Tissue culture – Principles & practice, cleanliness, precautions, care to be taken.	6
2.	Nutrition & Physiology media components – Serum, balanced salt solutions, washing, packing, sterilization	6
3.	practices, instruments.	6
4.	Primary cell culture, establishing & maintenance of	6
5.	lymphocyte culture.	6
6.	Cell lines – Insects & Animals cells, subculture.	3
7.	Organ & tissue culture.	3
8	Karyotyping, biochemical & genetic characterization of cell lines.	5
9	Cell Repositories, their function.	2
10.	Application of Animal cell cultures.	2

Reference Books :

1. Animal Tissue culture : J. Paul
2. Introduction to Plant Tissue culture : M.K. Razdan
3. Plant Tissue Culture : Theory & Practice : S.S. Bhojwani & M.K. Razdan
4. Micropropagation : Debergh & Zimmermann
5. Plant tissue culture : Kalyankumar Dey

Bb- 223 English

Sr. No.	Topic	Lecture
1	Programme of writing: Thinking & planning, information, ideas, topic outline, order of paragraph writing, revising.	9
2	Use of vocabulary: Meaning of words, precise usages synonym, technical terms, nomenclature, context, superfluous words.	9
3	Use of Good English: Noun, pronoun, verb, adverb, adjective, conjunction, article, tense, spelling etc.	9
4	Compilation of experimental records, writing progress reports.	9
5	Communication skill: Letters & memoranda, communication as a part of science.	9
6	Reading: How to read, making notes as you read, writing a book review.	9
7	Helping the reader: Easy reading (how to begin, control, explain, sentence length, rhythm, style), Capture & hold readers interest – effective communication.	8
8	The art of illustrations, figures.	6
9	The art of thesis & report writing.	12
10	Editing & correcting.	10

Reference Books:

1 Written communication in English - Sarah Freeman
2 English for students of science - A. Roy & P.L. Sharma
3 McMillan Grammar: A hand book of “Augustine & Joseph” - Orient Longman
4 A new guide to précis writing - R.W. Jepson (O.L.)

Bb-224 Metabolic Pathways

Sr. No.	Topic	Lecture
1	Bioenergetics : General concepts of Thermodynamics – Laws of Thermodynamics, Enthalpy, Entropy, Free energy & Chemical Equilibria, High Energy Bonds & Compounds, Oxidation-reduction Reactions & Redox potential	15
2	Enzymes: Coenzymes, Classification, Kinetics, Properties, Catalysis and Regulation	15
3	Metabolism: Introduction (Anabolism & catabolism), Experimental Approaches	2

4	Carbohydrate metabolism: Glycolysis, Fermentation, Citric acid cycle, Oxidative Phosphorylation & ETC, Gluconeogenesis , Pentose phosphate pathway, Glyoxalate shunt, Glycogen metabolism, Diseases associated with Carbohydrate disorder	20
5	Photosynthesis and Photorespiration: Light and Dark reactions	10
6	Lipid metabolism: Fatty acid degradation, Fatty acid synthesis, Regulation of fatty acid metabolism, Metabolic disorders	10
7	Amino acid metabolism: Amino acid degradation & Biosynthesis, Urea cycle, Nitrogen fixation, Metabolic disorders	08
8	Nucleotide metabolism: Synthesis of purine & pyrimidine nucleotides, nucleotide degradation	07
9	Mathematical problems	03

Reference Books:

1 Outlines of Biochemistry: Conn & Stumpf
2 Principles of Biochemistry: Voet & Voet
3 Principles of Biochemistry: Jeffory Zubey
4 Clinical Biochemistry: D.C Deb
5 Biochemistry: Stryer
6 Lehninger's Principles of Biochemistry : Nelson & Cox

Bb- 225 Tissue Culture Techniques (Practical)

Sr. No.	Topics	Practical (30P)
A	**Plant Tissue Culture**	
1	PTC Laboratory organization of facility and equipment	1P
2	Aseptic manipulation – washing, capping, packing & sterilization, laminar flow operation & general precautions	2P
3	Stock solutions & media preparation	2P
4	Callus culture technique – Initiation of culture, callus morphology & internal structure	2P
5	Suspension culture technique – Initiation of culture, sub culture and growth measurement	2P
6	Effect of plant growth regulators on *in vitro* response of tobacco explants.	2P
7	Initiation of shoot tip & axillary bud culture and sub culture.	2P
8	Ovary / ovule / anther / embryo culture	2P
B	**Animal Tissue Culture**	
1	Animal cell culture media preparation, sterilization, washing, packing	3P
2	Observation of cells in culture – Principles & practice	4P

3	Lymphocyte culture	3P
4	Maintenance of cell lines (Sp2O), viable cell count and growth studies	4P
5	Visit to cell culture facilities / Production set up	1P

B. Sc. Biotechnology Third Year

Course structure

Course Code	Title of the course	Theory/ Practical	Marks	Lecture/ Practical
Semester III				
Bb-331	Microbial Biotechnology	Theory	100	90L
Bb-332	Animal & Plant Development	Theory	100	90L
Bb-333	Biodiversity & Systematics	Theory	100	90L
Bb-334	Developmental Biology & Microbial Biotechnology	Practical	100	30P
Bb-335	Project (to be continued in semester IV)		50	
Semester IV				
Bb-341	Large scale Manufacturing process	Theory	100	90L
Bb-342	Biotechnology in Agriculture & Health	Theory	100	90L
Bb-343	Recombinant DNA Technology	Theory	100	90L
Bb-344	Techniques in Genetic Engineering	Practical	100	30P
Bb-345	Project		50	

Detailed Syllabus (Semester III)

Bb- 331 Microbial Biotechnology

Sr. No.	Topic	Lecture
1	Microbial Biotechnology –Historical perspectives	1
2	Microbial growth kinetics Continuous culture, Batch fed culture, Cell constituents, quantification of growth, Thermodynamics of Growth, YATP, Yx/s, YO2 Effect of different factors on growth Study of growth with respect to product formation Fermentation concept and types	12
3	Basic nutrition & metabolism. Novel pathways of microorganisms	6
4	Microbial strain improvement Bacterial genetics Operon concept with examples (lac, tryptophan, arabinose) Gene mapping–Transformation, conjugation & transduction	10
5	Microbial & Viral diseases Normal flora of the body Infection of different systems Chemotherapy –use of antibiotics, antiviral agents	20

6	Food & Dairy Microbiology ¾ Microbial flora ¾ Microbial spoilage ¾ Preservation Microbes as single cell proteins	15
7	Treatment schemes of Waste water Assessment of waste water (water potability) Sewage treatment plants Aerobic & anaerobic treatment processes	20
8	Integration of genetic engineering & applied microbiology Uses of genetically engineered microbes in Agriculture Industries Medicine	6

Reference Books :

1 Microbiology - Pelczar
2 General Microbiology - Stanier
3 Food Microbiology -Frazier
4 Principles of Fermentation Technology - Whitaker, A. 2nd edition

Bb-332 Animal and Plant Development

Sr. No.	Topic	Lecture
1.	Gametogenesis, Fertilization, Development	7
2.	Types and patterns of cleavage, blastulation	5
3.	Gastrulation in frog and chick up to formation of three germinal layers	5
4.	Concepts of competence, determination, commitment and differentiation, dedifferentiation, redifferentiation, transdifferentiation, developmental plasticity in plant (7L) and animal (8L) development	15
5.	Role of gene/s in patterning and development. Concept of Stem cells, Progenitor cells, cell lineages in plants and animals	8
6.	Ageing and apoptosis, abnormal development and teratogenesis in plants and animals: cancer	10
7.	Cloning in mammals, transgenic technology in plants and animals.	8
8.	Cell fusion and somatic cell genetics, hybridomas, Immunoglobulin genes and antibody diversity	8
9.	Embryogenesis in plants (monocotyledons and dicotyledons), Mertistem structure and activity, Plant hormones- role in development	8
10.	Organogenesis, somatic embryogenesis, regeneration of plants.	8
11.	*Arabidopsis*- as a plant development model system- shoot and root patterning, floral patterning	8

Reference Books:

1. An Introduction to Embryology - B.I. Balinsky
2. Development Biology - S.F. Gillbert
3. Developmental Biology - K.V. Rao
4. Developmental Biology - S.C. Goel
5. Developmental Biology – Wolpert
6. Embryology of Angiosperms – S.S. Bhojwani and S.P. Bhatnagar
7. An Introduction to Plant Cell Development – J. Burgess

Bb- 333 Biodiversity & Systematics

Sr. No.	Topic	Lecture
1	a) Biodiversity – Concept, definition, species diversity, ecosystem diversity, genetic diversity, Magnitude of biodiversity, distribution of biodiversity, assessment of biodiversity, utilization of biodiversity, conservation of biodiversity	10
2	Population dynamics a) Population density & relative abundance b) Population age distribution c) Growth forms & carrying capacity d) Population structure : isolation & territoriality e)Interactions	5
3	The species & individual in the ecosystem a) Habitat & niche b) Ecological equivalence c) Biological clock d) Basic behavioral patterns	
4	Biodiversity & major biomes of world Biogeography : Specific flora & fauna	5
5	Conservation of Biodiversity a) Importance b) Conservation strategies – *in situ* and *ex situ* methods – advantages, limitations and applications.	10
6	Conservation laws, policies & organizations	4
7	Bioprospecting (microbes, plants and animals)	6
8	Biological systematics – principles and practices a) Aims & objective Tools & techniques of biological systematics [systematics of microorganisms (10L), plants (10L) & animals (10L)] w.r.t. following sources of data as applicable for the group a) Morphology b) Anatomy c) Histology d) Chemistry e) Cytology f) Molecular biology g) Micromorphology h) Palenology	30

	i) Embryology	
9	Biosystematics	10
10	Analysis of Biodiversity a) biodiversity indices b) Mathematical modeling for analysis of population, variation	10

Reference Books:

1. Ecology : Begon & Hareper
2. The biology of biodiversity : M.Kato
3. Biodiversity : E.O. Willson
4. Evolution : Stearns & Hoekstra
5. Animal behaviour : Alcock
6. Ecological analysis : Freeman & Herron
7. Elements of taxonomy : E. Mayor
8. Plant Taxonomy & Biodiversity : Stace
9. Fundamentals of Plant Systematics : Radford
10. Taxonomy of Angiosperms : Naik, V.N.

Bb- 334 Developmental Biology & Microbial Biotechnology (Practical)

Sr. No.	Topic	Practical (30P)
1.	Study of different types of eggs	1P
2.	Study of staging & staining of Chick embryos	2P
3.	Study of frog development, observation of frog embryo different development stages	2P
4.	Study of different types of sperms by smear preparation.	2P
5.	Frequency of genetic traits in human	1P
6.	Sex-linked inheritance	1P
7.	Multiple allelism	1P
8.	Study of plant development. ▪ Microsporogenesis ▪ Development of male and female gametophytes ▪ Developmental stages during plant Embryogenesis ▪ Analysis of histochemical changes during transition of vegetative shoot to reproductive apex ▪ Histochemical analysis of the activity of cambium	10P 1P 2P 3P 2P 2P
9	Growth curve study- Bacteria and yeast	2P
10	Production of primary and secondary metabolite (one organic acid and one antibiotic)	1P
11	Biomass production (Baker's yeast and Spirulina)	2P
12	Production of beverages (alcohol, wine)	2P

13	Immobilization of yeast on calcium alginate	2P
14	Estimation of the fermentation products by titration method	2P

Semester IV

Bb- 341 Large scale Manufacturing process

Sr. No.	Topic	Lecture
1	Introduction to Concepts of Bioprocess engineering Definition of Bioprocesses engineering Overview of Bioprocesses with their various components Scales of operation & their global impact on Bioprocesses	2
2	Introduction to Simple engineering calculations, Mass & Energy Balances	3
3	Fermenters, Bioreactors : Construction, Design & Operation Materials of Constructions, Welding, Surface treatment Components of the fermenters & their specifications	8
4	Air & Media sterilization : Air Sterilization Principles, Mechanisms of capture of particles in Air, Depth & Screen Filters, Sizing, Testing & validation of filters for air sterilization Principles of Media Sterilization, Decimal reduction, Design of sterilization cycle using kinetics of thermal depth of microbes Equipments used in sterilization; Batch & Continuous	4
5	Media for large-scale processes & their optimization : Constituents of media, their estimation & quantification. Design of media. Costing of media	3
6	Types of Bioprocesses : Biotransformations (enzyme, whole cell), Batch Fed-batch, Cell recycle & continuous	10
	fermentation processes. Monod model & constitutive equations used for expressing growth, substrate consumption & product formation, Solid State fermentation	
7	Enzyme & cell immobilization (industrial aspects) Properties of enzymes to be immobilized. Adsorption, Covalent binding, Entrapment or encapsulation. Properties of immobilized enzymes (Km, Ks, cycle time half life). Inactivation kinetics.	5

8	Measurement & Control of Bioprocesses Parameters. Cell growth. pH, temperature, Substrate consumption, product formation, Measurement of O2/CO2 uptake, evolution. Specific rates of consumption substrate & formation of product. Strategies for fermentation control. Computer controlled fermentations. Formation of heat, cooling requirements, Foam & its control. Oxygen uptake rate (OUR), Ka, Viscosity & its control. Scale up in Bioprocesses fermentations, Factors used in scale up	10
9	Quality Control, Quality assurance, Standard Operating Procedures (SOP) & Good Manufacturing Practices (GMP)	5
10	Product Recovery & Down Stream Processing in Fermentation & Bioprocess Technology. Solid-liquid separation (Flocculation, Filtration, Centrifugation), Cell disruption (Solid & liquid shear), Extraction, Precipitation, Distillation, Evaporation, Chromatographic separation, Adsorption, Concentration, Lyophilization, spray drying.	10
11	Industrial processes & applications; description of manufacture of enzymes (lipase, protease & nucleases), Antibiotics, amino acids, vitamins, ethanol, vaccines (FMD, DTP, New Castle disease), Single cell protein (Methanolic yeast, Spirulina).	20
12	Bioprocess Economics, Choice of process, process analysis, fixes & variable cost, Depreciation, Amortized costs, Selection of Pricing, Profitability, Scales of operations etc.	10

Reference Books:

1 Principles of Fermentation Technology - Whittaker & Stan bury, Pergamon Press
2 Bioprocess Engineering Principles - Pauline Doran, Academic Press 1995
3 Operational Modes of Bioreactors, BIOTOL series - Butter worth, Heinemann 1992
4 Bioreactor Design & Product Yield, BIOTOL series - Butter worth Heinemann 1992
5. Bioprocess Engineering : Systems, Equipment & Facilities - Ed. B. Lydersen, N.A. Delia & K.M. Nelson, John Wiley & Sons Inc,1993
6 Bioseparation & Bioprocessing - Ed. G. Subramaniam, Wiley –VCH,1998
7 Product Recovery in Bioprocess Technology, 'BIOTOL series, Butter worth Heinemann 1992
8 Bioseparation : Downstraem Processing for Biotechnology - Paul A. Belter, E.L Cussler, Wei-Shou Hu, Academic Press
9 Solvent Extraction in Biotechnology - Larl Schuger, Spinger Verlag, 1994

Bb- 342 Biotechnology in Agriculture & Health

Sr. No.	Topic	Lecture
1	Plant Tissue Culture – Micropropagation technology Haploids in agriculture Glasshouse and precision cultivation	4
2	Cryopreservation, slow growth & DNA banking of	7

	germplasm, cybrids & hybrids	
3	Plant transformation, Methodology of gene transfer in plants, metabolic engineering, Application of plant transformation for selection of desirable phenotypes	8
4	Transgenic plants Genetically modified crops, GM food, ethical & social aspects, IRR & patenting, Risk assessment	7
5	Molecular markers, RFLP, QTL, AFLP, Green house & green home technology	8
6	Production of secondary metabolites *in vitro*, metabolic engineering for large-scale production of plant based drugs.	
7	Application of animal cell culture, organ culture, cell cloning & micromanipulation	7
8	Growing cells in serum free media, scaling up, Hybridoma & monoclonals, tissue engineering	8
9	Vaccines – Principles & practice	7
10	Diagnostic technology – PCR, RFLP, Molecular markers	8
11	Biosensors – Principles & applications	3
12	Recombinant products for human health	8
13	Human genome mapping – its implications in health and disease	7

Reference Books :

1. Animal cell culture – J. Paul
2. Plant biotechnology - J Hammond & P. Mc Gravey, V.Yushibov, Springer-Verlag
3. Methods in cell biology - Volume 57
4. Culture of animal cells - R. Lan Freshny, Wiley less

Bb-343 Recombinant DNA Technology

Sr. No	Topic	Lecture
1.	Milestones of genetic engineering- Historical prespective. Recombinant DNA Technology- Introduction	7
2.	Molecular tools and applications -restriction enzymes, ligases, polymerases, alkaline phosphatase.	10
3.	Gene cloning Vehicles- vector, properties of plasmids and phages, host – properties of host	10
4.	Transformation- techniques of introducing DNA, Selection of transformants & characterization	5
5.	Nucleic acid purification, yield, yield analysis, plasmid characterization, isolation strategies.	10
6.	DNA sequencing techniques– Maxam-Gilbert's method, Sanger's Dideoxy method, Automated DNA sequencing	10
7.	Restriction enzyme digestion and restriction mapping Southern and northern analyses.	8
8.	Genomic library-screening of recombinants	5

9.	Gene manipulations by site-directed mutagenesis -PCR Technology	5
10.	cDNA library, reverse transcription, comparison between genomic and cDNA library	10
11.	Genome mapping, DNA fingerprinting	4
12.	Applications of Genetic Engineering, Recombinant DNA guidelines	6

Reference Books:

1 Molecular Biology of the Gene: Waston J. D.
2 Molecular Biotechnology: Glick
3 Milestones in Biotechnology : Classic papers in Genetic Engineering: J. A. Davis, W. S. Resnikoff
4 DNA Cloning – A Practical approach: D. M. Glover and B. D. Hames
5 Principles of Gene Manipulation & Genomics – Primrose and Twyman (2006, 7th Edition)
6 Molecular cloning – a laboratory manual – Sambrook and Russell (Vol. 1-3)

Bb- 344 Techniques in Genetic Engineering (Practical)

Sr. No.	Topic	Practical (30P)
1.	Isolation of plasmid DNA & Gel electrophoresis	2P
2.	Genomic (Plant/Animal) DNA- Isolation and quantitation	2P
3.	DNA Ligation	2P
4.	Preparation of Component Cells	1P
5.	Transformation of E. coil and selection of recombinants.	4P
6.	Agrobacterium-mediated transformation of plant cells	2P
7.	Colony PCR of recombinant and analysis	2P
8.	Restriction mapping of recombinant DNA	3P
9.	Southern blotting techniques	4P
10.	Searching for gene and protein sequences and accessing information from web, and databases	4P
11.	Information from genomes, BLAST, FASTA	2P
12.	Expression of genes in E. coli.	2P

---------- X ----------