University of Pune

Three Year B. Sc. Degree Course in

BIOTECHNOLOGY

F.Y.B.Sc. BIOTECHNOLOGY

Syllabus

(To be implemented from Academic Year 2013-14)

Preamble:

Biotechnology, being one of the youngest branch of Life Science, has expanded and established as advanced interdisciplinary applied science. The study of Life itself is at the core of it and the interdisciplinary networking potential of biotechnology has given it a separate status in fundamental research as well as in modern industrial enterprise. Global and local focus has slowly shifted to not only current "Century of Knowledge" but also on to technology development and application in life sciences. In the milieu of research and industrialization for economic development and social change, biotechnology is an ideal platform to work.

The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and their studies from molecular biology to cell biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology to biodiversity, from microbiology to bioprocess engineering, from bioremediation to material transformation and so on. The relevance and application of these studies on living organisms and their bioprocesses is extensively covered in this field with the help of technology. Green revolution and white revolution was possible in India thanks to the deeper and intrinsic understanding of biotechnology.

Economic and social renaissance is staged on biotechnology especially, since it's biomedical and cutting edge technological applications are tremendously powerful in shaping this century and exciting future.

Biotechnologists are always in demand as an efficient work force in fundamental research and industries. Education and research sectors require such interdisciplinary trained workforce to develop future generations of science leaders. Career opportunities for graduate students are created and expanding at the biotechnology parks and in manufacturing industries, teaching, research institutes and IT industry.

Introduction:

The syllabi till today had been sufficient to cater to the needs of students for building up their careers in industry and research. However, with the changing scenario at local and global level, we feel that the syllabus orientation should be altered to keep pace with developments in the education and industrial sector. The need of the hour is to design appropriate syllabi that emphasize on teaching of

technological as well as the economical aspects of modern biology. Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions) , without any additional training. Thus, the university / college itself will be developing the trained and skilled man-power.

Biotechnology being an interdisciplinary subject, this restructured syllabus will combine the principles of physical, chemical and biological sciences along with developing advanced technology.

Biotechnology curricula are operated at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles while postgraduate syllabus emphasizes on more applied courses. In addition, students are to be trained to apply this knowledge particularly in day-to-day applications of biotechnology and to get a glimpse of research.

Objectives to be achieved:

- To introduce the concepts in various allied subjects
- To enrich students' knowledge
- To help the students to build interdisciplinary approach
- To inculcate sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career

Eligibility

1. First Year B.Sc.:

Higher Secondary School Certificate (10+2) or its equivalent Examination with English and Biology; and two of the science subjects such as Physics, Chemistry, Mathematics, Biotechnology.

2. Second Year B.Sc.:

Students are not directly admitted to second year of B.Sc. for Biotechnology course. Those who complete first year biotechnology course are promoted to second year.

3. Third Year B. Sc.:

Students are not directly admitted to third year of B.Sc. for Biotechnology course. Those who complete first year Biotechnology course and completed Second year examination with due A.T.K.T are promoted to Third year B.Sc. course

Reservation and relaxation will be as per the Government rules.

Standard of Passing

i. In order to pass in the first year theory examination, the candidate has to obtain 40 marks out of 100 in each course. (Minimum 32 marks out of 80 marks must be obtained in the University Theory Examination.)
ii. In order to pass in the Second Year and Third Year theory examination, the candidate has to obtain 40% marks in each course of each semester. (Minimum 40% must be obtained in the University Theory Examination.)
iii. In order to pass in practical examination, the candidate has to obtain 40 in each course. (Minimum 40% marks must be obtained in the University Examination.)

Award of Class

The class will be awarded to the student on the aggregate marks obtained during the second and third year in the Principle subject only. The award of the class shall be as follows:

1	Aggregate 70% and above	First Class with Distinction
2	Aggregate 60% and more but less than 70%	First Class
3	Aggregate 55% and more but less than 60%	Higher Second Class
4	Aggregate 50% and more but less than 55%	Second Class
5	Aggregate 40% and more but less than 50%	Pass Class
6	Below 40%	Fail

A.T.K.T. Rules

While going from F. Y. B. Sc. to S. Y. B. Sc. at least 8 courses (out of total 12) should be cleared; **however all F. Y. B. Sc. courses should be cleared while going to T. Y. B. Sc.**

While going from S. Y. B. Sc. to T. Y. B. Sc., at least 12 courses (out of 21) should be cleared (Practical Course at S. Y. B. Sc. will be equivalent to 2 courses).

Equivalence of Previous Syllabus

No equivalence required at F. Y. B. Sc. level, the course titles are same as previous syllabus ??.

External Students

There shall be no external students.

University Terms

Dates for commencement and conclusion for the first and second terms will be declared by the University authorities. Terms can be kept by only duly admitted students. The term shall be granted only on minimum 80 percent attendance at theory and practical course and satisfactory performance during the term.

Course Structure:

Duration: The duration of B.Sc. (Biotechnology) Degree Program shall be three years.

Medium of Instruction: The medium of instruction for the course shall be English.

To accommodate more advanced topics in the syllabi, it is necessary to build the basic science knowledge at the level of first year of students those who have chosen the Biotechnology discipline. Curricula of courses of state and central boards of higher secondary level were reviewed to avoid repetitions of introductory subjects.

At **first year of under-graduation**, students will be given the basic information that includes – all basic science subjects like chemistry, physics, plant and animal sciences, microbiology, computer, statistics and mathematics. Relevant experimentation on these topics are included in practical course which include study of all forms of life, plants, animals and microorganisms for their morphological and structural characterization. Practical exercises include chemical and biochemical analysis. Students will also learn biostatistic principles and use of computers for data analysis and interpretation. In practical course, students will be trained in preparing **laboratory manuals**, standard operating practices and log books.

At **second year under-graduation**, students will be introduced to different areas necessary to form the basis of biotechnology like genetics, immunology, molecular biology, cell biology, animal and plant development, environmental biotechnology. They will also be introduced to scientific writing and communication skills. The relevant practicals are included to enrich their knowledge.

At **third year under-graduation**, six theory papers are divided into two semesters which deal with broad applied areas of Biotechnology .

F. Y. B. Sc. Biotechnology

Course Code	Theory/ Practical	Marks	Lecture/ Practical per year
Bb- 101 Fundamentals of Chemistry	Theory	100	90L
Bb- 102 Fundamentals of Physics	Theory	100	90L
Bb- 103 Basics of plant and animal sciences	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 Computers and applications	Theory	100	90L
Bb- 109 Practicals in Chemistry & Biochemistry	Practical	100	30P
Bb- 110 Techniques in Physics, Biophysics & Instrumentation	Practical	100	30P
Bb- 111 Laboratory Exercises in Biosciences	Practical	100	30P
Bb- 112 Quantitative Methods in Biology	Practical	100	30P

Examination Pattern

Theory paper:	University Examination – 80 marks (at the end 2nd term)
	Internal Examination – 20 marks
Practical course:	University Examination – 80 marks (at the end of 2nd term)
	Internal Examination – 20 marks

Theory examination will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks. The pattern of question papers shall be:

Question 1	8 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, all compulsory questions
Question 2 and 3	4 out of 6– short answer type questions; answerable in 6 – 8 lines, each of 4 marks
Question 4	2 out of 4 – long answer type questions; answerable in 15-20 lines, Each 8 marks
Question 5	1 out of 2 – long answer type questions; answerable in 20-25 lines, Each 16 marks

Internal examination: Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test, 10 marks each term. The written test shall comprise of objective type questions – Multiple Types Questions, True / False, Definitions, Tricky computational problems with minimum calculations. There shall be 20 questions, each question of 0.5 marks.

Practical Examination: Practical examination shall be conducted by the respective college at the end of the academic year. Practical examination will be of minimum 4 hours duration. There shall be 10 marks for laboratory log book and journal, 10 marks for viva-voce and minimum three experiments. Certified journal is compulsory to appear for practical examination. There shall be two experts and two examiners per batch for the practical examination.

Setting question papers: Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

S. Y. B. Sc. Biotechnology

Course Code	Theory/ Practical	Marks	Lecture/ Practical
Semester I			
Bb- 211 A Genetics & B Immunology	Theory	75 25	45L 15L
Bb- 212 Cell Biology	Theory	100	60L
Bb- 213 Environmental Biology and Biotechnology	Theory	100	60L
Bb- 214 Practicals in Environmental Biotechnology	Practical	100	30P
Bb- 215 Practicals in Cell Biology & Genetics	Practical	100	30P
Semester II			
Bb- 221 Molecular biology	Theory	100	60L
Bb- 222 Animal and Plant development	Theory	100	60L
Bb- 223 Scientific writing and communication	Theory	50	30L
Bb- 224 Metabolic Pathways	Theory	50	30L
Bb- 225 Practicals in Molecular biology	Practical	100	30P
Bb- 226 Practicals in Developmental biology	Practical	100	30P

Examination Pattern

Theory paper: University Examination – 20/40/60/80 marks (at the end of each semester)
Internal Examination – 5/10/15/20 marks
Practical course: University Examination – 80 marks (at the end of each semester)
Internal Examination – 20 marks

Theory examination will be of two/three hours duration for theory course.

The pattern of question papers for 80 marks shall be:

Question 1	10 sub-questions, each of 2marks; short answers based on entire syllabus, all compulsory
Question 2 and 3	3 out of 4 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
Question 4 and 5	1 out of 2 sub-questions, each of 15 marks; long answer type questions; answerable in 20 – 25 lines

The pattern of question papers for 60 marks shall be:

Question 1	10 sub-questions, each of 2marks; short answers based on entire syllabus, all compulsory
Question 2 and 3	3 out of 4 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
Question 4	1 out of 2 sub-questions, each of 10 marks; long answer type questions; answerable in 15 – 20 lines

The pattern of question papers for 40 marks shall be:

Question 1	5 sub-questions, each of 2 marks; short answers based on entire syllabus, all compulsory
Question 2	4 out of 6 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
Question 3	1 out of 2 sub-questions, each of 10 marks; long answer type questions; answerable in 15 – 20 lines

The pattern of question papers for 20 marks shall be:

Question 1	5 sub-questions, each of 2marks; short answers based on entire syllabus, all compulsory
Question 2	2 out of 4 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines

Internal examination: Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test, 10/20 marks each semester. The written test shall comprise of objective type questions– Multiple Types Questions, True/False, computational problems with minimum calculations etc. Different sets of question papers may be given in the same class-room. There shall be 20 questions to be answered in 40 minutes, each question of 1mark.

Practical Examination:

Setting question papers: Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

T. Y. B. Sc. Biotechnology

Course Code	Theory/ Practical	Marks	Lecture/ Practical
Semester I			
Bb- 331 Microbial Biotechnology	Theory	100	60L
Bb-332 Plant and animal tissue culture	Theory	100	60L
Bb- 333 Biodiversity & Systematics	Theory	100	60L
Bb-334 Tissue culture techniques	Practical	100	30P
Bb- 335 a Practicals in Microbial biotechnology b Practicals in Field studies and report writing	Practical	75 25	24P 06P
Semester II			
Bb-341 Large scale Manufacturing process	Theory	100	60L
Bb- 342 Biochemical and biophysical techniques	Theory	100	60L
Bb- 343 Recombinant DNA Technology	Theory	100	60L
Bb -344 Techniques in Genetic Engineering	Practical	100	30P
Bb- 345 a Practicals of large scale manufacturing process b Practicals in biochemical and Biophysical techniques	Practical	50 50	15P 15P

Examination Pattern:

80% of total marks for University examination and 20% of total marks for Internal Examination for both, theory and Practical, courses.

Theory examination will be of two hours duration for each theory course.

The pattern of question papers for 80 marks shall be:

Question 1	10 sub-questions, each of 2marks; short answers based on entire syllabus, all compulsory
Question 2 and 3	3 out of 4 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
Question 4 and 5	1 out of 2 sub-questions, each of 15 marks; long answer type questions; answerable in 20 – 25 lines

The pattern of question papers for 40 marks shall be:

Question 1	5 sub-questions, each of 2 marks; short answers based on entire syllabus, all compulsory
Question 2	4 out of 6 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines
Question 3	1 out of 2 sub-questions, each of 10 marks; long answer type questions; answerable in 15 – 20 lines

Internal examination: Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test, 10 marks each semester. The written test shall

comprise of objective type questions – Multiple Types Questions, True / False, Definitions, Tricky computational problems with minimum calculations. Different sets of question papers may be given in the same class-room. There shall be 20 questions to be answered in 40 minutes, each question of 1mark.

Practical Examination: Practical examination will be of minimum 6 hours duration, carried over on three subsequent days. There shall be 10 marks for laboratory log book and journal, 10 marks for viva-voce and minimum three experiments per practical course. Certified journals are compulsory for appearing for practical examination. There shall be two experts for each practical course and two examiners per batch; one of the examiners will be external.

Setting question papers: Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the

Eligibility criteria for appointment of teachers in biotechnology:

Minimum postgraduate degree in Microbiology/Zoology/Botany/Health Science/Environmental Science/ Biotechnology/Biochemistry or other equivalent branch of Life Science and qualified as per UGC regulations.

For subjects other than Life Sciences , appropriate faculty inputs from respective Departments may be sought or if required independent faculty members may be appointed as per the UGC rules.

Course structure: First Year B.Sc. Biotechnology

Course Code and Course Name	Theory/ Practical	Marks	Lecture/ Practical
Bb- 101 Fundamentals of Chemistry	Theory	100	90L
Bb- 102 Fundamentals of Physics	Theory	100	90L
Bb- 103 Basics of plant and animal sciences	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 Computers and application	Theory	100	90L
Bb- 109 Practicals in Chemistry and Biochemistry	Practical	100	30 P
Bb- 110 Practicals in Physics, Biophysics and Instrumentation	Practical	100	30 P
Bb- 111 Practicals in Biosciences	Practical	100	30 P
Bb- 112 Quantitative Methods in Biology	Practical	100	30 P

Course structure: Second Year B.Sc. Biotechnology

Course Code and Course Name	Theory/ Practical	Marks	Lecture/ Practical
Semester I			
Bb- 211 A Genetics & B Immunology	Theory	75 25	45L 15L
Bb- 212 Cell Biology	Theory	100	60L
Bb- 213 Environmental Biology and Biotechnology	Theory	100	60L
Bb- 214 Practicals in Environmental Biotechnology	Practical	100	30P
Bb- 215 Practicals in Cell Biology & Genetics	Practical	100	30P
Semester II			
Bb- 221 Molecular biology	Theory	100	60L
Bb- 222 Animal and Plant development	Theory	100	60
Bb- 223 Scientific writing and communication	Theory	50	30L
Bb- 224 Metabolic Pathways	Theory	50	30L
Bb- 225 Practicals in Molecular biology	Practical	100	30 P
Bb-226 Practicals in Developmental biology	Practical	100	30 P

Course structure: Third Year B.Sc. Biotechnology

Course Code and Course Name	Theory/ Practical	Marks	Lecture/ Practical
Semester I			
Bb-331 Microbial Biotechnology	Theory	100	60L
Bb-332 Plant and animal tissue culture	Theory	100	60L
Bb- 333 Biodiversity & Systematics	Theory	100	60L
Bb-334 Practicals in Tissue culture	Practical	100	30P
Bb- 335 A Practicals in Microbial biotechnology B Practicals in Field studies and report writing	Practical	75 25	30P
Semester II			
Bb-341 Large scale Manufacturing process	Theory	100	60L
Bb- 342 Biochemical and biophysical techniques	Theory	100	60L
Bb- 343 Practicals in Recombinant DNA Technology	Theory	100	60L
Bb -344 Techniques in Genetic Engineering	Practical	100	30P
Bb- 345 A Practicals of large scale manufacturing process B Practicals in biochemical and Biophysical techniques	Practical	50 50	30P

Bb-101 Fundamentals of Chemistry (90L)

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-	10
4	Phase Rule: Gibbs phase rule, One component/two component systems, determination of solid liquid equilibrium, determination of nature of solid phases, Classification of two-component solid-liquid equilibrium, 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
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.	18

7	Basics of stereochemistry:	12
	1. Representation of molecules a. Projection formulae. b. Sawhaorse Newman, Fisher formula 2. Conformation isomerism a. Conformation of isomersb. 'C'rotation about C-C bond, b. 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 axes of symmetry, Properties, Racemic modification 4. Geometrical isomerism a. Open chain molecule b. Condition of geometric isomer c. Cis-trans and E-Z nomenclature]	
8	Chemical bonding-various theories, covalent, hydrogen bonding 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 , 1st edition (2000), C.N. R. Rao, Macmillan Publishers, India ,
2. Principles of Physical Chemistry, 4th edition (1965), S.H. Maron and C.F. Prutton, Collier Macmillan Ltd
3. The elements of Physical Chemistry, 5th edition (2009), Atkins P, de Paula J. , W. H. Freeman Publication, USA
4. An Introduction to Electrochemistry , edition reprint, 2011, Samuel Glasstone, BiblioBazaar, USA
5. Physical Chemistry for biological sciences, 1st edition, (2005), Chang R., University Science Books, USA
6. Physical Chemistry, 1st edition, (2003) David Ball, Thoson Learning, USA.

7. Essentials of Physical Chemistry, 24th edition, (2000), B S Bahl, G D Tuli, Arun Bahl, S. Chand Limited, India.
8. Concise Inorganic Chemistry . 5th edition (2008), Author: J. D. Lee, John Wiley & Sons, USA.
9. Organic Chemistry, 6th edition, (1992), Morrison Robert Thornton, Pearson Publication, Dorling Kindersley (India Pvt. Ltd.)
10. Guide book to Mechanism in Organic Chemistry by Peter Sykes, 6th edition, (1996), Prentice Hall, India.

Bb-102 Fundamentals of Physics (90L)

Sr. No.	Topic	Lectures
1	Interrelationship between Physics and Life sciences	2
2	**Measurements:** Physical 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 for measuring 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): S**treamline and turbulent flow (definition and explanation). Equation of continuity. Flow of liquids through capillaries. Poiseulles equation: Derivations and physical significance. Reynolds number: 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
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, Efficiency. Van der Waals equation of state, Critical constants. Liquification of gases: Concepts 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.	6
11	**Optics**: Properties of light: Reflection, refraction, dispersion, diffraction, Interference and Polarization. Concept of polarization. Lasers: Stimulated emissions, Optical pumping, Concept of population inversion, Laser action. 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. Fundamentals of Physics. 9th edition. (2010). David Halliday, Robert Resnick, Jearl Walker John Wiley & Sons, USA.
2. Perspectives of modern physics. Digitized edition (2007) Arthur Beiser, Mc Graw Hill, USA
3. Heat and thermodynamics. 7th edition (1996). Zemansky Mark. Mc Graw Hill, USA
4. Fundamentals of optics. 3rd edition digitized (2009) Francis Arthur Jenkins, Harvey Elliott White. Mc Graw Hill, USA
5. Solar Energy- Principles of thermal collection and storage. 3rd edition (2008) Suhas Sukhatme and J P Nayak. Tata Mc Graw Hill, India.
6. Digital principles and applications 2nd edition (1975) Donald Leach, Albert Malvino, Tata Mc Graw Hill, USA
7. Introduction to atomic spectra. (1934) H.E. White, Mc Graw Hill, USA

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 Basics of Plant and animal sciences (90L)

Sr. No.	Topic	Lectures
	Plant Sciences	
1	Plant as a life form- General & Unique features of plants as a category of living organisms	1
	Introduction to plant groups and their characters with respect to increasing complexity in organization of plant body (Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms with one example each) (Excluding plant taxonomy)	6
2	**Major aspects of plant sciences**	
	a) Structural	
	Morphology of vegetative and reproductive plant organs	2
	Plant cell biology – Unique features of a plant cell, Cell wall	2
	Anatomy – Internal organization of vegetative and reproductive plant organs (leaf, shoot, root and flower)	5
	b) Functional	
	i) Permeability	
	Diffusion – Definition, significance, mechanism, laws and factors affecting diffusion	2 2
	Osmosis – Definition, mechanism, significance, osmotic pressure (OP), types of osmosis – endosmosis, exosmosis, turgor pressure (TP) and wall pressure (WP), relation between OP, DPD (Suction pressure) and TP	4 2
	ii) Absorption and adsorption of water	2
	Ascent of sap – Introduction and mechanism (Capillarity, Imbibition, Atmospheric pressure and Cohesion-tension)	4
	iii) Major pathways in plant metabolism- photosynthesis and respiration	4
	iv) **Nutrition:** Essential nutrients for growth and development of plants and their roles	3 2
	v) **Photo-biology:** Metabolism, movement and photo-morphogenesis (vegetative)	4
	vi) Introduction to physiology of flowering: a) photoperiodism and b) vernalisation	
	vii) Plant growth regulators and their role	

	Animal Sciences	
Sr. No.	**Topic**	**Lecture**
1	**Introduction** to Kingdom Animalia,- Outline classification of non-chordates and chordates with representative examples. **Animal Tissues (Histology)**-Introduction and Types with examples **Animal Physiology** 1.Blood pigments**:** Role in oxygen transport, Oxygen dissociation curves and their physiological significances, Transport of CO2 2.Chemical communication**:** Various types of communication systems with an emphasis on endocrine hormones and their action (Pituitary and Adrenal glands) 3. Neuroanatomy and Neurophysiology 4. Type Study : Chordate : Frog / Toad (Anatomy and Physiology : Circulatory System (Heart, Arterial, Venous and Portal Systems), Lymphatic system, Nervous System (CNS, PNS, ANS), and Sense Organs , Musculoskeletal System , Urinogenital System, Endocrine and Reproductive system 5. Type Study : Non-chordate Honeybee: ***Apis sp.*** (Morphology , Mouthparts, Sting Apparatus, Structure of Head , Social Organization , Communication in Bees, Apiculture	4 6 8 5 8 4
2	**Parasitology** 1.Study of ***Plasmodium sp.*** 2. Study of ***Fasciola hepatica*** 3. Study of ***Taenia sp.***	5
3	**Economic Zoology** 1. Vermiculture 3. Aquaculture 4. Sericulture	5

Reference books:

1. Jordan, E.L. and Verma P.S. 1978, (i) Chordate Zoology S. Chand & Company Ltd. Ram Nagar. New Delhi.
2. Jordan, E.L. and Verma P.S. 1978 (ii) Invertebrate Zoology. S. Chand & Company Ltd. Ram Nagar. New Delhi.
3. Modern Text Book of Zoology: Invertebrates., R.L.Kotpal. Publisher, Rastogi Publications, 2012.
4. Economic Zoology, Shukla & Upadhyaya, 4th Edition., Rastogi Publications, 2009.
5. Modern Parasitology: A Textbook of Parasitology, 2nd edition, (1993) F. E. G. Cox, Wiley & Sons, USA
6. Sericulture: www.csb.gov.in/publications/books by Central Silk Board, Ministry of Textiles - Govt of India
7. Devlin R.M. (1983) - Fundamentals of Plant Physiology (Mac. Millan, New York)
8. Dutta A.C. (2000) A Classbook of Botany (Oxford University Press, UK)
9. Kumar H.D. (1999) Biodiversity and sustainable conservation (Oxford & IBH, New Delhi)
10. An introduction to embryophyta, 5th edition (1972), Parihar N.S. (Central Book Depot, New Delhi)
11. Lawrence G.H. (2012) Taxonomy of vascular plants (Scientific Publ,)
12. Esau K. (1977) Anatomy of seed plants (Wiley, USA)
13. Cutler, Botha & Stevenson (2007) Plant anatomy: an applied approach (Blackwell Sci, USA)
14. Ganguli, Das Dutta (2011) – College Botany Vol I, II and III (New Central Book Agency, Kolkata)

Bb- 104 Mathematics and Statistical Methods for Biologists (90L)

Sr.No.	Topic	Lectures
	First Term – Mathematics	**(45L)**
1	**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	3
2	Complex numbers :- addition, subtraction, multiplication, division, De-Moiver's theorem, finding roots of polynomial equation	5
3	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)	10
4	Partial Differentiation :- Maxima and minima (up to 2 variables) Rules of partial differentiation Higher order partial derivatives	3
5	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
6	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
7	Vector spaces :- IR^n and Mmxn ®, subspace of a vector space, linear dependence of vectors, eigenvalues and eigenvectors, diagonalization	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) Stem and leaf diagram	3
2	Population, sample, sampling methods (SRS, Stratified sampling)	1
3	Descriptive statistics a)Measure of central tendency Mean (Definition & simple problems) Medion, Quarliles (Definition, Graphical calculation) Box Plot 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)	8
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 Concept of random variable p.m.f of discrete r.v. probability distribution	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

Reference Books:

1. R.G. Bartle and D.R. Sherbert 2nd edition, (1992), Introduction to real analysis, John Wiley, USA
2. Introductory biostatistics. 1st edition. (2003), Chap T. Le. John Wiley, USA
3. High Yield™ Biostatistics. (2001) Antony N Glaser. Lippincott Williams and Wilkins, USA
4. Introduction to Mathematics for Life Scientists. 3rd edition (1979). Edward Batschalet, Springer,
5. Mathematics for the Biological Sciences. Illustrated edition(1979) J.C. Acharya and R. Lardner, Prentice Hall, USA

Bb-105 Fundamentals of Biological Chemistry (90L)

Sr. No.	Topic	Lecture
1	Configuration and Information in 3D structure of biomolecules: Stereochemistry, chiral interaction, enantiomers etc. Interaction between biomolecules, stereospecificity Types of bonds in biomolecule[Covalent (glycoside, peptide, phosphodiester), ionic, hydrogen, Van der waals, hydrophobic, co-ordinate)] their formation and interaction	8
2	pH, pKa, concept of a buffer, biological buffers, ionisation, concept of osmosis: hypo- and hypertonic solution, Interaction of biological molecules in water, water as a reactant	7
3	Physical Foundation of biotechnology system: Dynamic steady state Energy transfer, entropy, enthalpy, free energy change Oxidation-reduction reaction, activation energy of a reaction, ionization state, intramoleculer reaction [with reference to metabolic (catabolic, anabolic) and role of energy]	8
4	Basic biomolecules: Carbohydrates: Introduction, biological importance. Definition, Classification,{glyceraldehydes, Simple Aldose, Simple Ketoses, D-glucose, Conformation of D-glucose} Monosaccharides other than glucose, glyocosidic bond, disaccharides, polysaccharides [starch, glycogen] peptidoglycan, proteoglycan matrix.	12
5	Lipids:- Introduction, classes, fatty acids [physical and chemical properties] simple lipids, complex lipids. Steroid lipids, structural, storage lipids. Uses as-signal, cofactor, pigment.	10
6	Protein :- Amino acids: Structure and properties of amino acids. Acid base behavior/ amino acid analysis/ reactions/ Zwitter ions/ classification. Structure-peptide bond, -S-S inter, intra Primary structure, Secondary structure, Tertiary structure - interaction [Myoglobin structure as an example], Quaternary structure - interaction in peptide Hb Protein sequencing - Sanger, Edman's method. Different types of Proteins in the living system ,	15
7	Enzymes: Basic concept, active site, energy of activation. Transition state hypothesis, Lock and key hypothesis, induced fit hypothesis. Allosteric enzymes, Enzyme inhibition, classification.	12
8	Co-enzymes and vitamins: Thiamine, riboflavin, niacin, PLP, Lipoic acid, Pantothenate, Folic acid, Cyanocobalamine	8
9	Nucleic acids: Nucleosides, nucleotides, Polynucleotide, DNA and RNA, Forces stabilizing nucleic acid structure.	10

Reference Books:

1. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf ; John Wiley and Sons, USA
2. Fundamentals of Biochemistry. 3rd Edition, (2008), Donald Voet & Judith Voet , John Wiley and Sons, Inc. USA
3. Principles of Biochemistry, 4th edition (1997), Jeffory Zubey, McGraw-Hill College, USA
4. Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company, NY
5. Lehninger , Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
6. Biochemistry. 5th Edition, (copu right 2013), Reginald Garett and Charles Grisham, Brook/Cole, Cengage Learning, Boston, USA.
7. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India
8. Biochemical Methods.1st , (1995), S.Sadashivam, A.Manickam, New Age International Publishers, India

Bb-106 Biophysics and Instrumentation (90L)

Sr. No.	Topic	Lecture
	First Term	
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 Rydberg'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.	12
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 diatomicmolecules. Electron spectroscopy. UV-visible spectroscopy. Principle, construction and working of colorimeter, Spectrophotometer, Flurometer. Application to biomolecules (proteins, DNA, Hb, chlorophyll).	17
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 biologicalhandling and standardization of alpha and beta emitting isotopes. Radioimunoassay. Radiopharmaceuticals and their uptake. Production of radionuclides. Measurement of radiation - Dosimetry and detectors. Principle, construction and working of – GM counter. Scintillation Counter (Solid and liquid).	16
	Second Term	
4	**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
5	**Thermoregulation: T**hermometric properties and types of thermometers (clinical, thermocouple, bimetallic, platinum resistance, thermistor - thermometers). Body temperature and its regulation.	7
6	**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).	15
7	**Microscopes:** Concepts - Resolving power. Chromatic and achromatic aberrations. Construction and working principles of the following microscopes– Stereozoom (Dissecting), Compound , bright and Dark field, Inverted, Phase contrast, Fluorescence. Electron microscopes: TEM and SEM.	13

Reference Books:

1. Biophysics, an introduction. 1st edition. (2002) Cotteril R. John Willey and Sons Ltd., USA
2. Biophysics. 1st edition (2002), Pattabhi V and Gautham N. Kluwer Academic Publisher, USA.
3. Textbook of optics and atomic physics, 8th edition (1989) P.P. Khandelwal, Himlaya Publishing House, India.
4. Instrumentation measurements and analysis – 2nd edition (2003). Nakra and Choudhari, Tata Mc Graw Hill, India.
5. Nuclear Physics: An Introduction. 2nd edition (2011). S. B. Patel. Anshan Publication, India

Bb- 107 Microbiology (90L)

Sr. No.	Topic	Lecture
1	Introduction to Microbial World: Biocomplexity of Microorganisms. Important developments leading to major discoveries. Path breaking discoveries. Product Development (18th – 20th Century including pre golden, golden and post golden era)	7
2	Outline Classification: of all 5 major groups of microorganisms. Prokaryotic and Eukaryotic. Bacteria, Fungi, Cyanobacteria and viruses.Life cycle, nutrition and growth	15
3	Prokaryotic Cell structure : Function and ultra-structure of - cell wall (Gram positive and negative) , plasma membrane, flagella, pili, endospore, capsule, nucleic acid.	15
4	Handling of microorganisms and biosafety measures:	3
5	Microscopy: Wet mount and dry mount. Staining Techniques - Definitions: Classification of stains, Stain(Basic and Acidic), Fixative, Mordant, Decoloriser,Accentuator Principles of staining techniques for following (Monochrome, Negative, Differential (Gram, Acid fast, Blood staining), Special staining- Spore, flagella, cell wall, nucleic acid, capsule)- Theory of staining..	12
6	Basic Considerations – Nutritional, Hydrogen ion concentration, Temperature and Oxygen. Nutritional classification of bacteria Design of media: Types of media and Composition Cultivation – *In vitro* (Streak plate method) - Concept of Pure culture, co-culture and Mixed culture, Colony characteristics and Biofilm formation. Preservation and Maintenance methods for microbial cultures.	12
7	Sterilization : Physical Agents - Heat, Radiation, Filtration Chemical agents and their mode of action - Aldehydes, Halogens, Quaternary ammonium compounds, Phenol and phenolic compounds, Heavy metals, Alcohol, Dyes, and Detergents, Ethylene oxide	8
8	Microbial Growth: Growth curve, introduction to kinetics of growth, generation time, growth rate. Reproduction in microorganisms : Binary Fission, Asexual, Sexual, Lytic, Lysogenic Cycle. Cell Enumeration and quantification of Growth Total Count- Breeds count, Direct microscopic count, haemocytometer, turbidity. Viable Count- Spread plate, pour plate method.	11
9	Microbial interaction: Microbe-Plant, Microbe-Animal, Microbe-Microbe interaction	7

Reference Books:

1. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
2. General Microbiology - Stanier R.Y., 5th edition, (1987)Macmillan Publication, UK.
3. Presscott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGrawHil Science Enginering, USA

Bb-108 Computers and Applications (90L)

Sr. No.	Topic	Lecture
	First Term	
1	**History:** Evolution, Generations of computers (I, II, III,IV, V) Classification of computers (mainframes,mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size ch, Real-Time, Online, Offline	3
2	**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)	5
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 and later versions, Windows server NT/2000, Unix/Linux & servers	10
5	**Data processing & presentation:** Introduction MS office (Word, 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	
7	**Computer Networking:** Introduction to networking: various terminologies Associated hardware devices, gadgets (Router, Switch) tools, services, and resources Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls	10
8	**Internet searches:** Search engines: Google, Yahoo . Concepts in text-based searching Searching Medline, PubMed, bibliographic databases	15

9	**Algorithms, Flowcharts & Programming concepts:** Algorithms: Concepts & definitions Converting algorithms to flowchart Coding: flowcharts to programs	12
10	**Databases** Introduction & need of databases Types of databases Basic concepts in: • Data Abstraction • 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

Reference Books:

1. Computer Fundamentals , 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Introduction To Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India

Bb-109 Practicals in Chemistry & Biochemistry (30P)

Sr. No.	Topic	Practicals (30P)
	First term	
1	Safety Measures and practices in chemistry laboratory	1
2	Determination of gas constant	1
3	Crystal models	1
4	Freezing point depression	1
5	Thermochemistry	2
6	Determination of an order of reaction	1
7	Acid-base titrations	1
8	Molarity , molality , normality	2
9	Unit volume & weight measurements	2
10	pH measurement	1
11	Optical activity of a chemical compound by polarimeter	1
12	Conductometry	1
	Second Term	
1	Reagent Preparation & biochemical calculations.	2
2	Spot test for carbohydrates & amino acids	2
3	Isolation of starch from potato	1
4	Isolation of protein from plant source	2
5	Isolation of oil from plant source	2
6	Estimation of protein by Biuret method	1
7	Estimation of protein by Lowry method	1
8	Thin layer chromatography for lipids	1
9	Saponification of fats	1
10	Enzyme assay (amylase)	1
11	Estimation of Reducing sugar by DNSA method	1

Bb-110 Practicals in Physics, Biophysics & Instrumentation (30P)

Sr. No.	Topic	Practical (30P)
	First Term	
1	Flat spiral spring : Y & n	2
2	Y of a rectangular thin bar by bending	1
3	Viscosity measurement using Ostwalds viscometer (for known and unknown viscocity	2
4	Surface–tension measurement: Using Jaeger's method/, soap bubble method	3
5	Temperature measurement: using thermocouple, RTD	2
6	Beer and Lambert's Law – Components and working of Colorimeter, Spectrophotometer	2
7	Absorption spectrum of protein	1
8	Working and components of various types of Centrifuges	1
9	Working of a G.M. counter	2
10	Absorption spectra of dsDNA and ssDNA melting	2
11	To find out isoelectric point of amino acids	2
	Second Term	
1	Functioning and Standardization of pH meter	1
2	Study of electronic components (resistance capacitance)	1
3	Microscopy – Components and working of Bright field compound microscope	2
4	Working of Electronic Balance for micro measurements	1

Bb-111 Practicals in Biosciences (30P)

Sr. No.	Topic	Practical (30P)
	First Term	
1	Study of one example each of the following: algae, fungi, bryophytes, pteridophytes, gymnosperms, angiosperms	2
2	Study of different parts of plants: Anatomy of root, stem and leaf of a monocotyledon and a dicotyledon.	2
3	Study of plant cell types using squash techniques and Maceration.	1
4	Determination of Diffusion Pressure Deficit using potato tubers.	1
5	Determination of rate of respiration	1
6	Study the process of Osmosis and Turgor pressure	1
7	Introduction to Microbiology Laboratory	1
8	Aseptic Transfer Techniques	1
9	Observation of microorganisms a) Wet mount b) Monochrome staining c) Gram staining d) Spore staining e) Fungal staining	4
	Second Term	
	Preparations of media for bacterial/fungal culture	1
1	Isolation of bacteria by Streak Plate Technique	1
2	Enumeration techniques a) Pour plate method b) Spread plate method c) Cell count by Neubauer's Chamber d) Plaque Count	3
3	Enrichment techniques Winogradsky's Column	1

4	Observation of motility a) Hanging drop technique b) Craigie's tube method c) Swarming growth	3
5	Wet mount of freshwater sample	1
6	Study of ***Paramecium,:*** a) Morphology, b) Reproduction	1
7	Study of ***Drosophila*** – characters, sexual dimorphism – eye & wing mutations	1
8	Establishment and Maintenance of ***Drosophila*** culture Dissection & Preparation of temporary mounts of ***Drosophila developmental stages (Egg, larva and pupa).***	2
9	Study of ***Plasmodium sps., Fasciola sp.***	1
10	Dissection of Honey Bee , Mounting of Mouth parts, pollen basket, Antenna Cleaner, Sting Apparatus, Cornea , legs and wings	1

Bb-112 Quantitative Methods in Biology (30P)

Sr. No.	Topic	Practical (30P)
	First Term	
1	Biological data analysis using mathematical and statistical methods	4
2	Computer – Getting familiar with the hardware, booting & operating	1
3	Getting started: Hands-on experience (Tutors are recommended)	1
4	Tutorials operating systems: DOS, Windows 98/XP and later versions, UNIX	4
5	File handling: copy, rename, delete, type Directory structure: make, rename, move directory	2
6	Scanning for viruses & using anti-virus programs	1
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)	2
	Second Term	
2	Use of internet – Downloading & Installing software/plug-ins on Windows 98/XP and later versions(Acrobat Reader, Post Scripts Viewer, etc.)	4
3	Searching/Surfing on the WWW	2
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	5
5	Database Applications (Microsoft Access): Fields, Records, Files, Organization of Files, Access Modes; Updating Records, Querying, Reports, Forms & subforms	2
6	Usage of multimedia – Creation of Computer Presentations with graphics (Microsoft Power Point): Creation of slides, Rapid Presentation design using wizards	2