Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Biotechnology

(Faculty of Science & Technology)

F.Y. B. Sc. (Biotechnology)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2019-2020

Preamble of the Syllabus:

Biotechnology has expanded and established as an 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 work force 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.

The restructures syllabus is a choice based credit system with semester pattern. Biotechnology has grown extensively in last couple of decades. 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. The proposed credit based curriculum ensures the requirement of academia and industry. 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.

The basic aim of the revised course curriculum is to integrate various disciplines of life sciences which will cater the needs of human resources in academia and industry. The Overall objective of the Program is to promote education and research in biotechnology and provide academic and professional excellence for immediate productivity in academics, government organization, biomedical sectors, health and nutrition settings for ultimate benefit of society and sustainable development.

The objectives of the course curriculum are:

- To introduce the concepts in various allied subjects
- To enrich students' knowledge in basic and applied aspects of life sciences.
- To help the students to build interdisciplinary approach in teaching/ learning & in research.
- To inculcate the sense of scientific responsibilities and social awareness
- To help students build-up a progressive and successful career in academia and industry.

  The present course curriculum will generate skilled human resource required in academia and Industry. In general, as a result of this program, the student will be able to achieve basic and advance knowledge based proficiency in applied subjects of life sciences, create and develop students with interdisciplinary mind set for learning science, improve problem solving aptitude using scientific methods in biotechnology and allied subjects, will adopt scientific approach for implications of biotechnology in society, environment and education, will demonstrate knowledge and learn various biological processes at cellular and molecular level and get expertise in the different techniques used in the fields of Biotechnology.

Title of the Course: B.Sc. (Biotechnology)
Structure of the course:
Semester: I

Theory

Course Code	Course Title	Credits	Number of Lectures	Marks
BBt-101	Fundamentals of Chemistry-I	2 Credits	30	50 (35 External +15 Internal)
BBt-102	Fundamentals of Physics	2 Credits	30	50 (35 External +15 Internal)
BBt-103	Biochemistry I	2 Credits	30	50 (35 External +15 Internal)
BBt-104	Biophysics	2 Credits	30	50 (35 External +15 Internal)
BBt-105	Animal Sciences I	2 Credits	30	50 (35 External +15 Internal)
BBt-106	Plant Sciences I	2 Credits	30	50 (35 External +15 Internal)
BBt-107	Microbiology I	2 Credits	30	50 (35 External +15 Internal)
BBt-108	Biomathematics and Biostatistics-I	2 Credits	30	50 (35 External +15 Internal)

PRACTICAL

BBt-109	Practical In Chemistry and Biochemistry	1.5 Credits	15 P	50 (35 External +15 Internal)
BBt-110	Practical In Plant and Animal science	1.5 Credits	15 P	50 (35 External +15 Internal)
BBt-111	Practical In Microbiology & Biostatistics-I	1.5 Credits	15 P	50 (35 External +15 Internal)
BBt-112	Practical In Physics and Biophysics	1.5 Credits	15 P	50 (35 External +15 Internal)
Total Credits (Theory + Practical)		**22 Credits**		

Semester II

Course code	Course Title	Credits	Number of Lectures	Marks
BBt-201	Fundamentals of Chemistry II	2 Credits	30	50 (35 External +15 Internal)
BBt-202	Biochemistry II	2 Credits	30	50 (35 External +15 Internal)
BBt-203	Bioinstrumentation	2 Credits	30	50 (35 External +15 Internal)
BBt-204	Animal Sciences II	2 Credits	30	50 (35 External +15 Internal)
BBt-205	Plant Sciences II	2 Credits	30	50 (35 External +15 Internal)
BBt-206	Microbiology II	2 Credits	30	50 (35 External +15 Internal)
BBt-207	Biomathematics and Biostatics-II	2 Credits	30	50 (35 External +15 Internal)
BBt-208	Computer in biology	2 Credits	30	50 (35 External +15 Internal)

PRACTICAL

BBt-209	Practical In Chemistry & Biochemistry II	1.5 Credits	15 P	50 (35 External +15 Internal)
BBt-210	Practical In Plant and Animal science II	1.5 Credits	15 P	50 (35 External +15 Internal)
BBt-211	Practical In Microbiology & Bioinstrumentation	1.5 Credits	15 P	50 (35 External +15 Internal)
BBt-212	Practical In Computer & Biostatistics	1.5 Credits	15 P	50 (35 External +15 Internal)
Total Credits (Theory + Practical)		**22 Credits**		

B. Sc. Biotechnology (CBCS Semester Pattern)

S. Y. B. Sc. Biotechnology

Semester III

Course Code	Course Title	Credits	Number of Lectures	Marks
BBt-301	Cell Biology I	2 Credits	30	50 (35 External +15 Internal
BBt-302	Molecular Biology I	2 Credits	30	50 (35 External +15 Internal
BBt-303	Genetics	2 Credits	30	50 (35 External +15 Internal
BBt-304	Metabolism	2 Credits	30	50 (35 External +15 Internal
BBt-305	Environmental Biotechnology	2 Credits	30	50 (35 External +15 Internal
BBt-306	Bio analytical Techniques	2 Credits	30	50 (35 External +15 Internal
EVS-231	AECC-I Environment science theory paper 1	2 Credits	30	50 (35 External +15 Internal
LA-231	AECC-II Language theory paper 1	2 Credits	30	50 (35 External +15 Internal

PRACTICAL

BBt-309	Practical in Cell Biology and Genetics	2 Credits	15 P	50 (35 External +15 Internal
BBt-310	Practical in Bio analytical Techniques	2 Credits	15 P	50 (35 External +15 Internal
BBt-311	Practical in Molecular Biology and Environmental Biotechnology	2 Credits	15 P	50 (35 External +15 Internal
Total Credits (Theory + Practical)		**22 Credits**		

Semester IV

Course code	Course Title	Credits	Number of Lectures	Marks
BBt-401	Cell Biology II	2 Credits	30	50 (35 External +15 Internal
BBt-402	Molecular Biology II	2 Credits	30	50 (35 External +15 Internal
BBt-403	Immunology	2 Credits	30	50 (35 External +15 Internal
BBt-404	Animal Development	2 Credits	30	50 (35 External +15 Internal
BBt-405	Plant Development	2 Credits	30	50 (35 External +15 Internal
BBt-406	Microbial Biotechnology	2 Credits	30	50 (35 External +15 Internal
EVS- 241	AECC-III Environment science theory paper 2	2 Credits	30	50 (35 External +15 Internal
LA-241	AECC- IV Language theory paper 2	2 Credits	30	50 (35 External +15 Internal

PRACTICAL

BBt-409	Practical in Molecular Biology and Microbial Biotechnology	2 Credits	15 P	50 (35 External +15 Internal
BBt-410	Practical in Animal and Plant Development	2 Credits	15 P	50 (35 External +15 Internal
BBt-411	Practical in Cell biology and immunology	2 credit	15 P	50 (35 External +15 Internal
Total Credits (Theory + Practical)		**22 Credits**		

B. Sc. Biotechnology (CBCS Semester Pattern)

T. Y. B. Sc. Biotechnology

Semester V

Course code	Course Title	Credits	Number of Lectures	Marks
BBt-501	Industrial Microbiology	2 Credits	30	50 (35 External +15 Internal
BBt-502	R- DNA technology	2 Credits	30	50 (35 External +15 Internal
BBt-503	Plant Tissue Culture	2 Credits	30	50 (35 External +15 Internal
BBt-504	Animal Tissue Culture	2 Credits	30	50 (35 External +15 Internal
BBt-505	Applied biotechnology I	2 Credits	30	50 (35 External +15 Internal
BBt-506	Biodiversity and Systematics	2 Credit	30	50 (35 External +15 Internal
BBt-507	SEC – I : Summer Industrial Internship / Review writing/ Start up Design or Case study Report	2 Credits	30	50 (35 External +15 Internal
BBt-508	SEC – II : Project formulation and presentation	2 Credits	30	50 (35 External +15 Internal

PRACTICAL

BBt-509	Practical in Industrial Microbiology	2 Credits	15 P	50 (35 External +15 Internal
BBt-510	Practical in Plant Tissue Culture and Animal Tissue Culture	2 Credits	15 P	50 (35 External +15 Internal
BBt-511	Practical in R- DNA technology and Biodiversity	2 Credit	15 P	50 (35 External +15 Internal
Total Credit (Theory + Practical)		**22 Credit**		

Semester VI

Course code	Course Title	Credits	Number of Lectures	Marks
BBt-601	Enzyme and Enzyme Technology	2 Credits	30	50 (35 External +15 Internal
BBt-602	Agriculture Biotechnology	2 Credits	30	50 (35 External +15 Internal
BBt-603	Applied Biotechnology II	2 Credits	30	50 (35 External +15 Internal
BBt-604	Food and Pharmaceutical Biotechnology	2 Credits	30	50 (35 External +15 Internal
BBt-605	Bioinformatics	2 Credits	30	50 (35 External +15 Internal
BBt-606	Bio safety and Bioethics and IPR	2 Credits	30	50 (35 External +15 Internal
BBt-607 & 608	SEC – III & SEC – IV : Project	4 Credit	60	100 (70 External +30 Internal

PRACTICAL

BBt-609	Practical in Enzyme Technology	2 Credits	15 P	50 (35 External +15 Internal
BBt-610	Practical in Agriculture Biotechnology and Bioinformatics	2 Credits	15 P	50 (35 External +15 Internal
BBt-611	Practical in Food and Pharmaceutical Biotechnology	2 Credits	15 P	50 (35 External +15 Internal
Total Credit(Theory + Practical)		**22 Credit**		

Note:
- Each Credit = 15 Lecture
- Each credit will be equivalent to 15 clock hours of teaching and each practical credit is equivalent to 30 clock hours of teaching in a semester.

Equivalence of previous syllabus along with proposed syllabus:

S. No.	Paper Title of Previous Syllabus	Equivalent Paper Title of New Syllabus
1	Bb- 101 Fundamentals of Chemistry	BBt- 101 Fundamentals of Chemistry-I BBt - 201Fundamentals of Chemistry-II
2	Bb- 102 Fundamentals of Physics	BBt- 102 Fundamentals of Physics BBt- 203 Bioinstrumentation
3	Bb- 103 Basics of plant and animal sciences	BBt- 105 Animal Sciences I BBt - 106Plant Sciences I
4	Bb- 104 Mathematics & Statistical Methods for Biologists	BBt- 108 Biomathematics and Biostatics-I BBt- 207 Biomathematics and Biostatics-II
5	Bb- 105 Fundamentals of Biological Chemistry	BBt- 103 Biochemistry I BBt- 202 Biochemistry II
6	Bb- 106 Biophysics & Instrumentation	BBt- 104 Biophysics BBt- 203 Bioinstrumentation
7	Bb- 107 Microbiology	BBt- 107 Microbiology I BBt- 207 Microbiology II
8	Bb- 108 Computers and applications	BBt- 208 Computer in Biology BBt- 108 Biomathematics and Biostatics-I
9	Bb- 109 Practical in Chemistry & Biochemistry	BBt- 109 Practical In Chemistry and Biochemistry I BBt- 209 Practical In Chemistry and Biochemistry II
10	Bb- 110 Techniques in Physics, Biophysics & Instrumentation	BBt- 112Practical In Physics and Biophysics BBt-211Practical In Microbiology & Bioinstrumentation
11	Bb- 111 Laboratory Exercises in Biosciences	BBt- 110 Practical In Plant and animal science BBt- 111 Practical In Microbiology
12	Bb- 112 Quantitative Methods in Biology	BBt-212 Practical In Computer & Biostatistics

Course Code: BBt-101 Fundamentals of Chemistry-I (2 Credit Course)
Total Lectures=30

Unit	Topics	No. of Lectures
I	**Atomic Structure** Historical background electronic structure of atom, atomic & molecular orbitals, Shapes of atomic orbitals molecular orbital method, selection rules to find electronic configuration of elements.	4
II	**Molecules** Diatomic molecules, Valence bond theory, VSEPR theory, hybridization involving s, p, d, orbitals($sp,sp^2,sp^3,dsp^2,sp^2d,sp^3d,sp^3d^2$), homo and heteronuclear diatomic molecules, bond order, magnetic properties	6
III	**Chemical Bonding** Types of bond covalent, ionic, hydrogen bonding, inter and intramolecular hydrogen bonding, dipole- dipole, dipole-induced dipole interaction, structure of water molecule, oxidation state. Hydrophobic & hydrophilic interaction,	6
IV	**Thermodynamics-** Types of systems, intensive and extensive properties, equilibrium and non-equilibrium states, reversible and irreversible processes, laws of thermodynamics, internal energy, enthalpy, entropy Endothermic and exothermic reactions, free energy and work, Gibb's Helmholtz equations, ATP and its role in bioenergetics, biological oxidation reduction reactions(in terms of electrons),	8
V	**Basics of Organic & Stereochemistry**-IUPAC nomenclature, Reactions of functional groups- Alkane, Alkene, alkyne, alcohol, amines, alkyl halides, ether. Organic reactions- oxidation, reduction, elimination, addition, substitution (electrophilic/ Nucleophilic) Conformations, configurations, isomerism (structural and stereoisomers), Enantiomers ,Chiral centers, Geometric isomers Newman's & Fisher Projection formulae, epimers, anomers, furanose and pyranose form, free radical reactions.	6

Recommended Textbooks and References:
1. 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
3. An Introduction to Electrochemistry, edition reprint, 2011, Samuel Glasstone, biblioBazaar, USA
4. 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.

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

Course Code: BBt-102 Fundamentals of Physics (2 Credit Course)

Total Lectures=30

Unit	Topics	No. of lectures
I	**Measurements:** Physical quantities, fundamental and derived units, System of Units, order of magnitude. Length: radius of proton to astronomical distances. Mass: atomic mass unit to mass of Earth. Time: fast elementary particle to age of Earth. Amount of substance. Luminous intensity. Inter-conversion of units.	4
II	**Fluid mechanics:** Fluids: Definition, Pressure, density. Variation of pressure with depth in a fluid at rest. Measurement of pressure. Various units of pressure and their inter conversion. Streamline and turbulent flow. Equation of continuity. Flow of liquids through capillaries. Viscosity, Newton's law of viscosity, coefficient of viscosity. Ostwald's viscometer. Relevance to life sciences.	5
III	**Surface Tension:** Surface tension and surface energy. Cohesive and adhesive forces. Capillary action, angle of contact, wettability. Factors affecting surface tension. Applications. Relevance to life sciences.	5
IV.	**Waves and oscillations:** Difference. Types of waves (transverse and longitudinal). Reflection of waves. Principle of superposition of waves. Standing and travelling waves. Sound waves as pressure waves. Audible, ultrasonic, and infrasonic waves. Characteristics of sound waves. Beats. Doppler Effect. Applications in life sciences.	8
V	**Geometrical Optics:** Reflection, Refraction (Snell's Law). Types of lenses, combinational lenses, radius of curvature, focal length, Lens maker equation. Microscopes. Optical power, diopter. Magnification. Mirrors. Aberrations.	8

Recommended Textbooks and References
1.   Concepts of Physics. Volume I and Volume II. (2010). H. C. Verma.
2.   Fundamentals of Physics, 9th edition (2010). David Halliday, Robert Resnick, Jearl Walker.
3.   Sears and Zeemansky's University Physics, 13th edition (2012). Hugh Young, Roger Freedman, A. Lewis Ford.
4. A Textbook of Optics (2001). Dr. N. Subrahmanyan, BrijLal, Dr. M. N. Avadhanulu. By S. Chand publications.

Course Code: BBt-103 Biochemistry I (2 Credit Course)

Total Lectures=30

Unit	Topics	Lectures
I	**Historical perspective**: • Origin of life, abiotic production of biomolecules, cellular and chemical foundation of life.	3
II	**Water**: • Properties of water, Hydrogen bonding, ionization of water, interaction of biological molecules in water, osmosis, pH, titration curves, buffers, Biological buffers. • Types of bond, Covalent and noncovalent interactions in biomolecules with suitable example, functional groups and modification of functional group relevant to biomolecules.	8
III	**Carbohydrates:** • Classification of carbohydrates, sugars and nonsugars, Monosaccharides: Oligosaccaharides and Polysaccharide. • Monosaccharides: Structure & properties of Monosaccharides, ketoses and aldoses D and L configuration, mutarotaion, epimers, anomers, chemical and physical properties; glycosidic bond, • Oligosaccharides: reducing and non-reducing sugars inversion of sugar • Polysaccharides and its classification based on function Storage polysaccharide: eg starch, glycogen and inulin Structural polysaccharides: eg. cellulose, chitin • Functions of Carbohydrate	10
IV	**Lipid:** • Classification of lipids: Simple & complex lipids, fatty acids. • Structure & chemical and physical properties, • Complex lipids: Triacylglycerol, Sphingolipids, Phospholipids and Glycolipids. Steroids. • Lipoproteins • Storage and structural lipids. • Function of lipids	9

Recommended Textbooks and References
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), JefforyZubey, McGraw-Hill College, USA

4. Biochemistry: 7th Edition, (2012), Jeremy Berg, LubertStryer, 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

Course Code: BBt-104 Biophysics (2 Credit Course)

Total Lectures=30

Unit	Topics	No. of lectures
I	**Structure:** Introduction, Scope and definition of Biophysics. Biophysics at macroscopic, microscopic level and at the molecular level.	2
II	**Atomic structure:** Historical background, Bohr model. Significance of second and third postulate of Bohr's model. Derivation of radius and energy value. Quantization of energy levels. Vector atom model. Quantum numbers. Selection rules. Pauli's exclusion principle. Emission spectra with respect to Na atoms to understand selection rules.	7
III	**Radioactivity:** Nucleus, Properties. Nuclear forces. Nuclear models (liquid drop and shell model). Radioactive nucleus. Nuclear radiations and their properties - alpha, beta and gamma. Half life, physical and biological handling of alpha and beta emitting isotopes. GM counter- Principle, construction and working .	7
IV.	**Cell membrane:** Organization of plasma membrane. 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. Biopotentials : types and measurement	8
V	**Biophysical properties:** Surface tension, adsorption, diffusion, osmosis, dialysis and colloids	6

Recommended Textbooks and References:
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). Nakraand Choudhari, Tata McGraw Hill, India.
5. Nuclear Physics: An Introduction. 2nd edition (2011). S. B. Patel. Anshan Publication, India
6. Skoog & Lerry, Instrumental Methods of Analysis, Saunders College Publications, New York
7. H. H. Willard, Instrumental Methods of Analysis, CBS Publishers.
8. D.C. Harris, Quantitate Chemical Analysis, W. H. Freeman
9. Christian G.D, Analytical Chemistry, John & Sons, Singapore
10. Skoog, West and Holler, Analytical Chemistry, Saunders College Publications, New York

11 Vogel's Textbook of Qualitative Chemical Analysis, ELBS
12. J.A. Dean, Analytical Chemistry Notebook, McGraw Hill
13. John H. Kennedy, Analytical Chemistry: Principles, Saunders College Publication
14. W. Kemp, Organic Spectroscopy, ELBS
15. Hand book of Instrumental Techniques for Analytical Chemistry, Frank Settle, editor, Prentice Hall

Course Code: BBt-105 Animal Sciences I (2 Credit Course)

Total Lectures=30

Unit	Topics	No. of lectures
I	**Introduction to Kingdom Animalia** • Outline classification of non-chordates with examples • Kingdom Protista General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa • Phylum Porifera General characters and classification up to classes; Canal System in Sycon • Phylum Cnidaria General characters and classification up to classes; Polymorphism in Hydrozoa • Phylum Platyhelminthes General characters and classification up to classes • Phylum Nemathelminthes General characters and classification up to classes • Phylum Annelida General characters and classification up to classes • Phylum Arthropoda General characters and classification up to classes; Metamorphosis in Insects(Drosophila) • Phylum Mollusca General characters and classification up to classes • Phylum Echinodermata General Characters and classification up to classes; Water-vascular system in Asteroidea.	6
II	**Outline classification of chordates with examples** • Protochordates General features and examples • Agnatha General features of Agnatha and classification of cyclostomes • Pisces General features and Classification up to classes • Amphibia General features and Classification up to classes • Reptiles General features and Classification up to classes • Aves General features and Classification up to classes • Mammals General features and Classification up to classes	6
III	**Animal Tissues:(Histology)** • Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue • Bone and Cartilage - Structure and types of bones and cartilages	6
IV	**Introduction to Invertebrate and vertebrate model system** • Type of Invertebrate: i. Hydra ii. celegans iii. Drosophila iv. Honey bee: *Apissp.* I Morphology ii. Mouthparts, sting apparatus iii.Social organization iv. Communication in Bees Type: • Vertebrate i. Frog/Toad	12

Recommended Textbooks and References
1. Jordan, E.L. and VermaP.S. 1978, (i) Chordate Zoology S. Chand & Company

Ltd. Ram Nagar. New Delhi.
2. Jordan, E.L. and VermaP.S. 1978 (ii) Invertebrate Zoology. S. Chand &
Company Ltd. Ram Nagar. New Delhi.
3. Modern Text Book of Zoology: Invertebrates.,R.L.Kotpal. Publisher,
RastogiPublications, 2012.

Course Code: BBt-106 Plant Sciences I (2 Credit Course)

Total Lectures=30

Unit	Topics	No. of lectures
I	**Introduction to plant world & classification** • General & Unique features of plants • Principles, aims and objectives of plant classification , outline of the classification with example • A general account of different groups and their characters with oneexample each of Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms • Angiosperms – Characteristic features of Dicot and Monocot	10
II	**Structure of Plant organs** • Structure of plant Cell, characteristic feature and cell wall • Morphology & modifications of • Vegetative plant organ : Stem , Leaf and Root • Reproductive plant organs – Flower & Types of Inflorescence	8
III	**Internal structure of plant organs** • Plant Tissues and tissue systems, • Meristematic Tissue and its Type - with example • Permanent Tissue - Simple and Complex - with example	4
IV.	**Internal organization of plant body** • Primary structure of shoot, root & leaf. • Secondary growth, growth rings formation: cambium and its activities, periderm- cork cambium, secondary cortex and cork.	8

Recommended Textbooks and References
1. Dutta A.C. (2000) A Classbook of Botany (Oxford University Press, UK)
2. Ganguli, Das Dutta (2011) – College Botany Vol I, II and III (New Central BookAgency, Kolkata)
3. Esau K. (1977) Anatomy of seed plants (Wiley, USA)
4. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.

Course Code: BBt-107 Microbiology I

(2 Credit Course)
Total Lectures=30

Unit	Topics	No. of lectures
I	**Introduction to Microbial World:** • History of Microbiology, Abiogenesis vs Biogenesis, Discovery of Microorganisms, Germ theory of diseases, Koch's postulates, Pre golden era, Golden Era, post golden Era, Contributions of various scientists in path breaking discoveries, inventions and Product Development. • General Characters and their importance of Prokaryotes, Eubacteria, Archaebacteria, Eukaryotic Microorganisms-(Fungi, Algae, protozoa) , Viruses, viroid and prions. • Importance of study of Microbiology and relevance in Biotechnology (Brief discussion of application of Microbiology in various fields)	8
II	**Classification of Microorganisms:** • All 5 major groups of microorganisms, Similarities and dissimilarities in relation to evolution. • Difference between Prokaryotic and Eukaryotic organisms. • Bacterial Classification: Bergey's Manual of Systemic Bacteriology	4
III	**Bacterial cell structure:** • Ultrastructure of Bacteria- Cell wall (Gram Positive and Gram negative), Cell Membrane, • Capsule, Flagella, Pili, slime layer, Ribosome, Nucleoid, Mesosomes, Endospore, Cell inclusions (Gas vesicles, carboxysomes,magnetosomes, PHB granules, Glycogen bodies, metachromatic granules)	8
IV.	**Observation of Microorganisms:** • Bright field Microscope, Dark Field Microscope, Magnification, Resolution, Numerical aperture, Sample Preparation • Wet Mount, hanging drop technique • Theory of staining: Classification of stains, Stain (Basic and Acidic), Fixative, Mordant, Decoloriser, Accentuator • Principles and methods of staining techniques for following (Monochrome, Negative, Differential (Gram, Acid fast), Special staining- Endospore, flagella, cell wall, nucleic acid, capsule)	10

Recommended Textbooks and References

1. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology.3rd Edition. Thomson Brooks / Cole.

2. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.

3. Prescott L.M., Harley J.P., AND Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill Companies Inc.

4. Salle A.J. (1971) Fundamental Principles of Bacteriology.7th Edition. Tata MacGraw Publishing Co.

5. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd.

6. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc.

Course Code: BBt-108Biomathematics and Biostatics-I

(2 Credit Course)
Total Lectures=30

Unit	Topics	No. of lectures
	Mathematics	
I	**Fundamentals Mathematical Calculations** **Exponents & Powers:** Definition and Simple Powers with Numbers, Algebraic rules for working with Powers. **Logarithm:** Definition, Laws of logarithm and Change of base theorem (without proofs) Examples based on laws. **Permutations & Combinations**: Counting Principle, Permutations with Repetitions (like & dislikes), Circular Permutations, Permutations with r-particular things included/excluded. **Co-ordinate geometry** – Area of triangle and quadrilateral, equation of straight line – in slope form, intercept form and perpendicular form. Conics (ellipse, parabola, hyperbola).	8
II	**Matrices:** - Definition, types of matrices, (zero, Identity, square, unit, scaler, triangular, diagonal, upper triangular, lower triangular, symmetric) Addition of matrices, multiplication of matrices, determinant (singular, non-singular). **Vector spaces** - Definition of vector spaces (10 axioms), subspace of vector space, linear combination, linear dependence, Independence of vectors, Dot and Cross product, Applications of vectors spaces in biology.	7
	Biostatistics	
III	**Introduction to Statistics** - Need of Statistics in biology, collection and organisation/classification, summarization and analysis of biological data - Data, Variables, parameters, populations and samples, types of sampling distribution. - Representation of data using frequency distribution diagram, histogram, ogive curves, bar and pie diagrams.	7
IV	**Descriptive biostatistics** - Measures of Central Tendency: Mean, Mode, Median. - Measures of Variability: Standard deviation, standard error, Range, Mean deviation, Quartile deviation and coefficient of variation. **Correlation and Regression**: - Positive and negative correlation, calculation of correlation coefficient, regression, linear regression and regression equation.	8

Recommended Textbooks and References

1. Fundamentals of Mathematical Statistics by S.C. Gupta and V. K. Kapoor. Sultan Chand & Co.
2. Discrete Mathematics By B.S. Verma, Vishwa Prakashan.
3. Mathematics for Biological Science by JagdishArya & Ladner.1979. Prentice Hall
4. Introduction to the Practice of Statistics, by David S. Moore, George P. McCabe, and Bruce A. Craig, 9th Edition, W.H. Freeman and Co., New York (2017).
5. Mathematics for Biological Scientists, M.Aitken, B. Broadhursts, S. Haldky, Garland Science (2009).
6. P.S.S. Sunderrao and J. Richards-An introduction to Biostatistics, Prentice Hall Pvt. Ltd. India
7. Fundamentals of Biostatistics. By Irfan A Khan.
8. Campbell R.C.- Statistics for Biologists, Cambridge University Press, Cambridge.

Course Code: BBt-109 Practical in Chemistry and Biochemistry - I
(1.5 Credit Course)
(Total Practical =15) (15x3 hrs.)

Sr.No.	Title of Experiment	No. of practical
	Chemistry	
1.	Titrations • To study Acid base titration based by conductivity measurement. • To determine alkali content in antacid tablet using HCl	**1**
2	Chemical Kinetics : To study kinetics of ester hydrolysis	**1**
3	Thermochemistry To determine enthalpy and entropy change of a reaction $2FeCl_3 + 3Mg \longrightarrow 2Fe + 3MgCl_2$	**1**
4	Hardness of water : To estimate hardness of water by using EDTA	**1**
5	Qualitative analysis : To perform qualitative test for – Hydrocarbons, alcohols, aldehyde, ketones, aniline, amide	**1**
6	pH-metry: To determine the pKa value of a given weak acid by pH-metry titration with strong base.	**2**
	Biochemistry	
1	Biochemical Calculations Preparation of solutions, buffers.	**1**
2	Working of Colorimetry and preparation of standard graph Calculate ⋏ max foe given sample.	**1**
3	Isolation & identification of starch from plant source	**1**
4	Saponification number : To find out saponification number of given lipid	**1**
5	:Qualitative analysis • Qualitative tests for sugars • Qualitative test for Lipids	**1**
6	To estimate concentration of reducing sugar in given sample by DNSA method	**1**
7	Quantitative Estimations : To estimate concentration of cholesterol in given sample.	**1**

Course Code: BBt-110 Practical in Plant and animal Science

(1.5 Credit Course)
Total Practical =15(15x3 hrs.)

Sr. No.	Title of Experiment	No. of Practical
	Plant Science	
1	Study of Algae, fungi, bryophytes, pteridophytes , gymnosperms with one example each	**2**
2	Study on morphological parameters of angiosperms	**2**
3	Study on anatomy of root, stem & leaf of dicot plant	**1**
4	Study on anatomy of root, stem & leaf of monocot plant	**1**
	Animal Science	
5	Study of Paramecium • Morphology • Reproduction-Binary fission & Conjugation	**1**
6	Culturing of Paramecium	**1**
7	Study of Hydra: Permanent slides • Morphology • Reproduction • Regeneration in Hydra	**2**
8	Study of Drosophila : Characters, sexual dimorphism – eye & wing mutations Life cycle	**2**
9	Culturing Drosophila using standard methods	**1**

Course Code: BBt-111 Practical in Microbiology & Biostatistics
(1.5 Credit Course)
(Total Practical =15) (15x3 hrs.)

Sr.No.	Title of Experiment	No. of practical
	Microbiology	
1.	Introduction to Microbiology Laboratory and common microbiology laboratory instruments e.g. Incubator, Hot Air Oven, Autoclave, Colorimeter, pH Meter, Distillation Unit, Chemical Balance, Laminar air flow hood, Clinical Centrifuge	**2**
2.	Handling of Microorganisms and Biosafety measures	**1**
3.	Observation of Microorganisms. • Use and Care of Compound Microscope • Wet Mount- pond water, fungal staining • Monochrome staining • Negative staining • Gram's staining • Spore staining • Motility- Hanging drop technique	**5**
	Biostatistics	
1	Introduction to MS Excel and use of spreadsheets for data organization and basic mathematics calculations	**2**
2	Data representation using various graphical types	**1**
3	Hypothesis testing using 'Data analysis tools': t-test, Chi square test	**2**
4	Analysis of variance	**1**
5	Correlation and regression analysis of data and graphical representation	**1**

Course Code: BBt-112 Practical in Physics and Biophysics
(1.5 Credit Course)
Total Practical =13 (13x3 hrs)

Sr.No.	Title of Experiment	No. of Practical
	Physics	
1	Study of Vernier Callipers and Micrometer Screw Gauge	**1**
2	To study the components and working of travelling microscope	**1**
3	Surface–tension measurement: Using Jaeger's method/, soap bubble Method	**2**
4	Viscosity measurement using Ostwald's viscometer (for known and Unknown viscosity	**1**
5	Study the Calibration of Spectrometer.	**1**
6	To study Plane diffraction grating	**1**
	Biophysics	
1	Study the process of Osmosis	**1**
2	Determine the surface tension of liquid	**1**
3	Determination of Diffusion Pressure Deficit using potato tubers	**1**
4	Dialysis	**1**
5	Working of a G.M. counter	**2**

Course Code: BBt-201 Fundamentals of Chemistry-II

(2 Credit Course)
Total Lectures=30

Unit	Topics	Lectures
I	**Ionic equilibria** – • pH, buffer, Equilibrium constant, Le Chatelier's principle, Acid and bases, strength of acid & bases, dissociation constant, pK values, solubility product, Acid–base titrations, indicators used in titrations, Titration curves, Solubility product • Ionic product, Condition for precipitation, • Handerson Hasselbalch equation & related problems, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure • Properties of water, water as a reactant, interaction of biomolecules with water	10
II	**Chemical kinetics** – • Rates of reactions, order, zero, first & second order reactions, & molecularity • Differential and integrated rate equation • Half-life periods, Arrhenius equation, collision theory of reaction rate, temperature dependent reaction rates	6
III	**Electrochemistry-** • Electrochemical cell, half cell, reaction, reduction potential, electrochemical series, thermodynamic potential function from cell potential measurement, Liquid junction potential, Huckel theory, overvoltage/overpotential	7
IV	**Basics of mole concept** • Mole concept, Determination of molecular weight by gram molecular volume relationship, problems based on mole concept, Solutions, colligative properties, • Methods of expressing concentrations, strength, Normality, Molarity and Molality, ppm. • Volumetric experiments -acidimetry, alkalimetry, permanganometry, dichrometry, iodometry.	7

Recommended Textbooks and References

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.

6. Essentials of Physical Chemistry, 24th edition, (2000), B S Bahl, G D Tuli, ArunBahl, S. Chand Limited, India.

7. Concise Inorganic Chemistry.5th edition (2008), Author: J. D. Lee, John Wiley & Sons, USA.

8. Organic Chemistry, 6 th edition, (1992), Morrison Robert Thornton, Pearson Publication, Dorling Kindersley (India Pvt. Ltd.)

9. Guide book to Mechanism in Organic Chemistry by Peter Sykes, 6 th edition, (1996), Prentice Hall, India.

Course Code: BBt-202 Biochemistry II

(2 Credit Course)
Total Lectures=30

Units	Topics	Lectures
I	**Proteins:** • Functions of proteins, • Polymer of amino acids, Classification of amino acids, • Chemistry of amino acids: Ionisation of amino acid side chains, Configuration, zwitterion, reactions of amino acids, titration of amino acid, Isoelectric pH. • Protein structure: ,Primary structure and peptide bond formation , Secondary structure, secondary repeats Tertiary and Quarternary structure (eg. Haemoglobin). • Protein denaturation and renaturation.	10
II	**Vitamins :** • Classification**,** Structure and Biochemical functions of fat soluble and water soluble Vitamins. • Coenzymes: Thiamine , Riboflavin, Niacin, PIP, Coenzyme A, lipoic acid ,Folic acid and B12.	6
III	**Enzymes:** • General properties & classification of enzymes • Biocatalyst, Active site, Specificity, Energy of activation, Reaction Rate. Rate law for enzyme catalyzed reaction • Enzyme units, specific activity, turnover number. • Lock and key, Induced fit hypothesis. • Parameters affecting enzyme activity(temp, pH, substrate, cofactor, enzyme con.) • Enzyme inhibition	8
IV	**Nucleic acids**: • Purine, Pyrimidines, Nucleosides, Nucleotides, Polynucleotide. • Nucleoproteins • Covalent structure of DNA and RNA • Forces stabilizing nucleic acid structure • Properties of Nucleic Acid. • Denaturation & renaturation of Nucleic Acids. • Different forms of DNA	6

Recommended Textbooks and References

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), JefforyZubey, McGraw-Hill College, USA

4. Biochemistry:7th Edition, (2012), Jeremy Berg, LubertStryer, 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

Course Code: BBt-203 Bioinstrumentation

(2 Credit Course)
Total Lectures=30

Unit	Topics	No. of lectures
I	**Bio instrumentation :** Introduction, Concepts- Analytical techniques	2
II	**Spectroscopy:** • Definition. Electromagnetic wave. Electromagnetic spectrum. Applications of each region of electromagnetic spectrum for spectroscopy. • Lambert-Beer's Law, types of sources, Instrumentation of single beam and double beam instrument. Introduction to molecular energy levels. Excitation. Absorption. Emission. Rotational spectra. Energy levels of rigid diatomic molecules. • Electron spectroscopy. UV-visible spectroscopy. Principle, construction and working of colorimeter, Spectrophotometer. Application to biomolecules (proteins, DNA, Hb, chlorophyll).	8
III	**Separation methods**: Theory of chromatography; instrumentation and applications of Thin layer chromatography (TLC)	2
IV.	**Bioinstruments:** Concepts- Analytical techniques, .Principle construction, working and applications for analysis of biomolecules of following instruments. • **pH meter**, isoelectric pH. • **Centrifuge** (RCF, sedimentation concept), different types of centrifuges. different rotors, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, • **Mass spectroscopy** (Bainbridge mass spectrometer). • **Atomic absorption spectrometer** (AAS).	8
V	**Microscopes:** Concepts - Resolving power. Construction and working principles of the following microscopes– Stereo zoom (Dissecting), Compound , Light microscopy, Bright & Dark Field microscopy, Inverted, Phase contrast, Fluorescence.	6
VI	**Thermoregulation: T**hermometric properties and types of thermometers (clinical, thermocouple, bimetallic, platinum resistance, thermistor - thermometers). Body temperature and its regulation.	4

Recommended Textbooks and References

1. Biophysics, an introduction. 1st edition. (2002) Cotteril R. John Willey and SonsLtd., USA

2. Biophysics. 1st edition (2002), Pattabhi V and Gautham N. Kluwer AcademicPublisher, 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). NakraandChoudhari, Tata McGraw Hill, India.

Course Code: BBt-204 Animal Sciences II

(2 Credit Course)
Total Lectures=30

Unit	Topics	No of lectures
I	**Animal Physiology I** • Digestion: Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins • Respiratory: Physiology, External and internal Respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases.	6
II	**Animal Physiology II** • Functioning of Excitable Tissue (Nerve and Muscle) Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); Structure of skeletal muscle, Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction • Endocrine and Reproductive Physiology Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of spermatogenesis and oogenesis	6
III	**Parasitology** • Introduction to Host-parasite Relationship Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism • Parasitic Protozoa Life history and pathogenicity of Plasmodium vivax • Parasitic Helminthes Life history and pathogenicity of *Fasciola hepatica* • Parasitic Helminthes Life history and pathogenicity of *Taenia sp.*	10
IV	**Economic Zoology** • Vermiculture • Aquaculture • Sericulture • Apiculture	8

Recommended Textbooks and References
1.Economic Zoology, Shukla&Upadhyaya, 4th Edition., Rastogi Publications,2009.
2. Modern Parasitology: A Textbook of Parasitology, 2nd edition, (1993) F. E. G. Cox, Wiley & Sons, USA
3.Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology.XIEdition.Hercourt Asia PTE Ltd. /W.B. Saunders Company.
4.Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & son

Course Code: BBt-205 - Plant sciences II

(2 Credit Course)
Total Lectures=30

Unit	Topics	No. of lectures

I	**Plant water relationship and its importance**
	• Definition, significance and mechanism:
	  i. Permeability
	  ii. Diffusion& imbibition
	  iii Osmosis & its types
	• Relation between osmotic pressure (OP),turgor pressure(TP) and wall pressure (WP) , DPD (Suction pressure)
	• Absorption and Transport of water
	• Introduction and mechanism of Ascent of sap - transpiration and guttation, Translocation of mineral elements. (Capillarity, Imbibition, Atmospheric pressure and Cohesion-tension)
		9

II	**Plant Metabolism:** • Photosynthesis: - Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point. • Respiration: Mechanism - Glycolysis, Krebs's cycle and ETS • Nitrogen metabolism- inorganic & molecular nitrogen fixation	8
III	**Growth and development of plants** • Essential nutrients for Plant growth and their role • Plant growth regulators • Introduction to physiology of flowering: a) Photoperiodism b) Vernalisation	8
IV	**Economic importance of plants**: Cereals, Pulses, Oil seeds, Fiber plants, Medicinal Plants,Timber yielding, Beverages with examples	5

Recommended Textbooks and References

1. Devlin R.M. (1983) - Fundamentals of Plant Physiology (Mac. Millan, New York).
2. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
3. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4thedition, W.H.Freeman and Company, New York, USA.
4. Economic Botany: Hill, A.W ; McGraw Hill Book Co., New York.
5. Economic Botany: Pandey, B.P. ;S.Chand and Co., New Delhi.
6. Economic Botany: Sen, S. ; New Central Book Agency, Calcutta.

Course Code: BBt-206 Microbiology- II

(2 Credit Course)
Total Lectures=30

Unit	Topic	No. of lectures
I	**Cultivation, growth and isolation of microorganisms:** • Basic Nutritional (Macro and micro), and environmental requirements (Hydrogen ion concentration, Temperature and Oxygen and other), Nutritional classification of bacteria • Design of media (Bacterial and Fungal): Types of media and Composition: Liquid, semi-solid and solid media, Selective media, Enrichment media, Enriched media, differential media, selective and differential media, Minimal media and there uses. • Reproduction in microorganisms: Binary Fission and other asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate. • Cultivation –Concept of Pure culture, co-culture and Mixed culture, Colony characteristics. • Isolation of microorganisms and pure culture techniques: Streak, Spread, Serial Dilution, Pour plate, Enrichment, Single cell isolation Colony • Preservation and Maintenance methods	15
II.	**Control of microbial growth:** • Definition: Sterilization and Disinfection. • Physical Agents – Heat (Dry and Moist heat), pasteurization, Radiation, Filtration • Principle and working of Autoclave and Hot air oven. • Sterilization Efficiency • **Chemical Agents and their Mode of Action** - Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents • **Disinfectant**-Characteristics of an Ideal disinfectant, Examples of Disinfectants and Evaluation of Disinfectant • **Antibiotics and other chemotherapeutic agents-** Examples and mode of action (one example each), Concept of MIC and MBC	12
III.	**Microbial Interactions**(Any 2 examples each) • Microbe-Plant, • Microbe-Animal • Microbe-Microbe interaction • Handling of microorganisms and Biosafety measures.	3

Recommended Textbooks and References

1. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology.3rd Edition.Thomson Brooks / Cole.

2. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.

3. Prescott L.M., Harley J.P., AND Klein D.A. (2005). Microbiology, 6th Edition.MacGraw Hill Companies Inc.

4. Salle A.J. (1971) Fundamental Principles of Bacteriology.7th Edition. Tata MacGraw Publishing Co.

5. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd.

6. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc.

Course Code: BBt-207 Biomathematics and Biostatics-II

(2 Credit Course)
Total Lectures=30

Unit	Topics	No. of lectures
	Mathematics	
I	**Linear equations** • Homogeneous and non-homogeneous linear equation system • Eigen values and Eigen vectors, • Applications of linear equations in biology **Differentials equations** • Types (ordinary and partial), order and degree of differential equation. • Homogeneous and non-homogeneous differential equation. • Applications: growth and decay, low of cooling.	7
II	**Differential Calculus** • Derivative and its physical significance, derivative of a function, implicit function, basic rules for differentiation, maxima and minima – their applications in biology (wave equation, heat equation, laplace equation). **Integral Calculus** • Integration of functions, basic rules for integration, definite and indefinite integrals, geometric meaning of integration, applications in finding area under curves. Applications of integration in biology.	8
	Biostatistics	
III	**Probability and probability distribution** • Probability theory experiments • Discrete random variable, bionomial distribution and the poisson distribution, Normal distribution and application in biosciences	8
IV	**Hypothesis testing and correlation** • Purpose of hypothesis testing, data, assumptions and hypothesis, significance level, types of errors • Test statistics: Testing mean, testing variance, distribution of test statistics (t and z). • Student's t – test, chi square test, ANOVA (One and Two way)	7

Recommended Textbooks and References
1. Fundamentals of Mathematical Statistics by S.C. Gupta and V.K.Kapoor. Sultan Chand &Co.
2. Discrete Mathematics By B.S. Verma, VishwaPrakashan.
3. Mathematics for Biological Science by JagdishArya& Ladner.1979. Prentice Hall.

4. Thomas' Calculus, by George B. Thomas, Joel Hass, Christopher Heil, Maurice D. Weir, 14th edition,Pearson Publishers (2018).
5. Elementary Differential Equations and Boundary Value Problems, by William E. Boyce and Richard C.DiPrima, 10th edition, Wiley publication (2012).
6. Introduction to the Practice of Statistics, by David S. Moore, George P. McCabe, and Bruce A. Craig,9th Edition, W.H. Freeman and Co., New York (2017).
7. Mathematics for Biological Scientists, M.Aitken,B.Broadhursts,S. Haldky, Garland Science (2009).
8. Fundamentals of Biostatistics. byIrfan A Khan.
9. P.S.S. Sunderrao and J. Richards-An introduction to Biostatistics, Prentice Hall Pvt. Ltd. India.
10. Differential Calculus by Shanti Narain
11. Integral Calculus by Shanti Narain
12. Differential Equation by A.R.Forsyth

Course Code: BBt-208 Computers in biology

(2 Credit Course)
Total Lectures=3

Unit	Topics	No. of Lectures
I	**History:** • Generations of computers (I, II, III, IV, V) • Modern computers:The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & The Super Computer.	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)	3
	Introduction to operating system: • Operating system concept-Windows and unix/Linux	2
II	**Data processing & presentation:** • Introduction : MS office (Word, Excel & Power Point)	2
	Computer viruses: • An overview of Computer viruses • What is a virus? Virus symptoms, How do they get transmitted? • General Precautions	3
	Internet searches: • Concepts in text-based searching, Searching Medline. Pub Med, bibliographic database	3

III	**Databases**
	Introduction & need of databases, Types of databases
	Basic concepts in:
	• Data Abstraction
	• Data Models
	• Instances & Schemes
	• 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 Database: Basic concepts and Applications
	Indexing and Hashing
	    • B + Tree indexed files
	    • B Tree indexed files
	    • Static Hash functions
	    • Dynamic Hash functions
	Text Databases
	Introduction & Overview of Biological database, Types of Biological Database
		9

IV	**Bioinforma**tics: Introduction to bioinformatics, History, Goals, Relation to other fields.	**6**

Recommended Textbooks and References
1. Bioinformatics –Principles and Applications by ZhumurGhosh, BibekanandMallick-Oxford university press
2. Introduction to Bioinformatics by Teresa Attwood and David.J.Parry Smith-Pearson education
3. Computer Fundamentals , 4th edition (2004) P.K. Sinha, BPB publication, India
4. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
5. Introduction To Database Management Systems, 1st edition, (2004), AtulKahate, Pearson education, India.

Course Code: BBt-209 Practical in Chemistry and Biochemistry– II

(1.5 Credit Course)
(Total Practical =15) (15x3 hrs.)

Sr.No.	Title of Experiment	No. of Practical
	Chemistry	
1.	Viscometer : To determine viscosity of a given liquid by Ostwald's viscometer	**1**
2	Titration : To determine content of acetic acid in vinegar using NaOH	**1**
3	Titration : To determine normality/molarity using acid base volumetric titration	**2**
4	Stereochemistry : To study different conformations of biomolecules using models	**1**
5	Separation techniques : • To study Separation Techniques like Recrystallization, distillation, sublimation, • To separate plant pigments by TLC	**2**
	Biochemistry	
6	Estimations : • Estimation of concentration of protein by Biuret method • Estimation of concentration of protein by Lowery's method	**2**
7	Estimation of concentration of cholesterol	**1**
8	Melting temperature of nucleic acid : To determine T_m of DNA	**1**
9	Thin layer chromatography : To separate amino acids and sugars by thin layer chromatography (TLC)	**2**
10	Enzyme activity : To find out enzyme activity (amylase)	**1**

Course Code: BBt-210 Practical in Plant and Animal sciences II

(1.5 Credit Course)
Total Practical =15(15x3 Hrs.)

Sr.No.	Title of Experiment	No. ofPractical
	Plant Sciences	
1	Study the process of Osmosis and Turgor pressure and determination of Diffusion Pressure Deficit	**1**
2	Determination of rate of respiration	**1**
3	Estimation of chlorophyll content in photosynthesizing and non-photosynthesizing leaf	**1**
4	Effect of plant growth regulators on germination of seed	**1**
5	Studies on economically important plants: Students should prepare herbarium specimens with their uses	**2**
	Animal Sciences	
6	Study and Dissection of Honey Bee , Mounting of Mouth parts, pollen basket, Antenna Cleaner, Sting Apparatus , legs and wings	**2**
7	Study of ***Plasmodium sps.***	**1**
8	Study of ***Fasciola sp.***	**1**
9	Enumeration of red blood cells using haemocytometer.	**1**
10	Collection ,Classification and preservation of Insects	**2**

Course Code: BBt-211: Practical in Microbiology II and Bioinstrumentation
(1.5 Credit Course)
(12-15 Practical (15x3 hrs.)

Sr. No.	Title of Experiment	No. of Practical
Microbiology		
1	**Preparation of Media and Glassware** • Bacterial growth media- Nutrient broth, Nutrient agar plates, butts and slants, MacConkey's agar plates. • Fungal growth media- potato dextrose agar plates	1
2.	Aseptic transfer techniques	1
3.	Demonstration of microbes in air, on table surface, finger tips on nutrient media.	1
4.	**Cultivation of microorganisms:** Isolation and purification of bacteria by steak plate technique	1
	Enumeration of bacteria by using following techniques: • Spread plate • Serial dilution and Pour plate • Neubauer's chamber (yeast cells)	4
Bioinstrumentation		
1	Working and components of various types of Centrifuges	1
2	Microscopy – Components and working of Bright field compound microscope	1
3	Functioning and Standardization of pH meter and Preparation of buffers and measurement of pH	1
4	Separation and identification of amino acids by paper chromatography.	1
5	Separation and identification of sugars by TLC	1
6	Beer and Lambert's Law – Components and working of Colorimeter, Spectrophotometer	1
7	Absorption spectra of DNA melting and protein	1
8	To find out isoelectric point of amino acids	1

Course Code: BBt-212 Practical in Computer and Biostatistics

(1.5 Credit Course)
Total Practical= 15(15x3 hrs.)

Sr.No.	Title of Experiment	No of Practical
Computer		
1	A:Tutorials operating systems: DOS File handling: copy, rename, delete, type Directory structure: make, rename, move directory	1
2	Word Processing (Microsoft Word): Creating, Saving & Operating a document, Editing, Inserting, Deleting, Formatting, Moving & Copying Text, Find & Replace, Spell Checker & Grammar Check, Document Enhancement (Borders, Shading, Header, Footer), Printing Document (Page Layout, Margins),	1
3	Introduction to the use of Wizards & Templates, Working with Graphics (Word Art), Working with Tables & Charts, Inserting Pictures	1
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.	2
5	Database Applications (Microsoft Access): Fields, Records, Files, Organization of Files. Access Modes: Updating Records, Querying, Reports, Forms & sub forms.	2
Biostatistics		
1	Introduction to MS Excel and use of spreadsheets for data organization and basic mathematics calculations	2
2	Hypothesis testing using 'Data analysis tools': t-test, Chi square test.	2
3	Analysis of variance	1
4	Correlation and regression analysis of data and graphical representation	2