Fergusson College (Autonomous)
Pune

Learning Outcomes-Based Curriculum

for

F. Y. B. Sc. Biotechnology

With effect from June 2019

Program Outcomes (POs) for B.Sc. Programme	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of an graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	**Social competence:** Display the understanding, behavioural skills needed for successful social adaptation , work in groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	**Research-related skills and Scientific temper:** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Performing dependently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

PSO No.	Program Specific Outcomes(PSOs) Upon completion of this programme the student will be able to
PSO1	**Academic competence** (i) Demonstrate comprehensive knowledge, imparted by highly qualified and competent faculty, and develop interdisciplinary skills in the fields of Biotechnology. (ii) Acquire good experimental and laboratory skills applied in biotechnology and allied subjects in well-equipped and state of the art laboratories. (iii) Understand the scope and applications of biotechnology and acquire competence in the domain of Biotechnology to enable bright future prospects.
PSO2	**Personal and Professional Competence** (i) Demonstrate conceptual learning through systematic thinking and self-study and lifelong learning that helps to solve scientific problems in the field of Biotechnology. (ii) Apply appropriate tools and techniques in biotechnology, to design and perform experiments proficiently and become competent to pursue higher studies or join the industry sector. (iii) Acquire good oral and written communication skills. (iv) Discuss the upcoming fields of Biotechnology. (v) Experience opportunity to participate in/manage/curate many co and extracurricular activities for overall development.
PSO3	**Research Competence** (i) Acquire an ability to identify, formulate, analyze and solve scientific problems in various areas of Biotechnology and allied fields. (ii) Demonstrate appropriate skills in design of experiments with proper scientific approach. (iii) Develop ability to apply scientific research methodology and achieve ethical research aptitude.
PSO4	**Entrepreneurial and Social competence** (i) Employ skills and knowledge acquired in skill imparting and entrepreneurial courses in upcoming fields of Biotechnology (ii) Develop a sense of environmental, social, ethical and professional responsibility.

Programme structure

Year	Course Code	Course Title	Course	No. of Credits
F. Y. B. Sc.	**Semester I**			
	BTH1101	Concepts and application in Biotechnology	T	02
	BTH1102	Biological Chemistry - I	T	02
	BTH1103	Biophysics	T	02
	BTH1104	Animal Sciences I	T	02
	BTH1105	Plant Sciences I	T	02
	BTH1106	Introduction to Microbial World	T	02
	BTH1107	Quantitative methods in Biology I	T	02
	BTH1108	Ecology	T	02
	BTH1109	Practicals in Biological Chemistry and Biophysics	P	02
	BTH1110	Practicals in Plant & Animal Sciences I	P	02
	BTH1111	Practicals in Microbiology and Ecology	P	02
	BTH1112	Practicals in Biostatistics and Computers I	P	02
	Semester II			
	BTH1201	Evolutionary Biology and Biodiversity	T	02
	BTH1202	Biological Chemistry - II	T	02
	BTH1203	Bioinstrumentation	T	02
	BTH1204	Animal Sciences II	T	02
	BTH1205	Plant Sciences II	T	02
	BTH1206	Microbial Growth, Control and Applications	T	02
	BTH1207	Quantitative methods in Biology II	T	02
	BTH1208	Cell Biology I	T	02
	BTH1209	Practicals in Biochemistry and Bioinstrumentation	P	02
	BTH1210	Practicals in Microbiology and Cell Biology I	P	02
	BTH1211	Practicals in Plant & Animal Sciences II	P	02
	BTH1212	Practicals in Biostatistics and Computers II	P	02
		Total		**24**

Year	Paper Code	Course Code	Course Title	No. of Credits
S.Y. B.Sc.	**Semester III**			
	Theory Paper - 1	BTH2301	Cell Biology -II	02
	Theory Paper - 2	BTH2302	Molecular Biology – I	02
	Theory Paper - 3	BTH2303	Metabolic Pathways	02
	Theory Paper - 4	BTH2304	Medical Microbiology	02
	Theory Paper - 5	BTH2305	Fundamentals of Genetics	02
	Theory Paper - 6	BTH2306	Plant Development	02
	Theory Paper - 7	BTH2307	English\German\French	02
	Practical Paper - 1	BTH2308	Biotechnology Practicals I	02
	Practical Paper - 2	BTH2309	Biotechnology Practicals II	02
	Practical Paper - 3	BTH2310	Biotechnology Practicals III	02
	Semester IV			
	Theory Paper - 8	BTH2401	Immunology	02
	Theory Paper - 9	BTH2402	Molecular Biology – II	02
	Theory Paper - 10	BTH2403	Protein Biochemistry and Enzymology	02
	Theory Paper - 11	BTH2404	Food and Dairy Microbiology	02
	Theory Paper -12	BTH2405	Environmental Biotechnology	02
	Theory Paper - 13	BTH2406	Animal Development	02
	Theory Paper - 14	BTH2407	Scientific Writing and Communication\German \French	02
	Practical Paper - 4	BTH2408	Biotechnology Practicals IV	02
	Practical Paper -5	BTH2409	Biotechnology Practicals V	02
	Practical Paper - 6	BTH2410	Biotechnology Practicals VI	02

Year	Paper No.	Course Code	Title	Credits	CE Maximum Marks	ESE Maximum Marks	Total Maximum Marks
T.Y. B.Sc.	**Semester V**						
	DSE-1A	BTH3501	Large Scale Manufacturing Processes - I	02	50	50	100
	DSE-1B	BTH3502	Introduction to Diagnostic Techniques	02	50	50	100
	DSE-2A	BTH3503	Genetics and Introduction to Genetic Engineering	02	50	50	100
	DSE-2B	BTH3504	Applications in Medical and Microbial Biotechnology	02	50	50	100
	DSE-3A	BTH3505	Bioanalytical Techniques - I	02	50	50	100
	DSE-3B	BTH3506	Principles in Enzymology	02	50	50	100
	DSE-1	BTH3507	Biotechnology Practical - I	02	50	50	100
	DSE-2	BTH3508	Biotechnology Practical - II	02	50	50	100
	DSE-3	BTH3509	Biotechnology Practical - III	02	50	50	100
	SEC-1*	BTH3511	Biotechnological Skills in Agriculture Industry **OR**	02	50	50	100
	SEC-1*	BTH3512	Phytochemistry				
	SEC-2*	BTH3513	Biosafety and Bioethics **OR**	02	50	50	100
	SEC-2*	BTH3514	Model systems in Biotechnology				

Year	Paper No.	Course Code	Title	Credits	CE Maximum Marks	ESE Maximum Marks	Total Maximum Marks
T.Y. B.Sc.	**Semester VI**						
	DSE-4A	BTH3601	Large Scale Manufacturing Processes - II	02	50	50	100
	DSE-4B	BTH3602	Plant Tissue Culture	02	50	50	100
	DSE-5A	BTH3603	Techniques and applications in Genetic Engineering	02	50	50	100
	DSE-5B	BTH3604	Animal Tissue Culture	02	50	50	100
	DSE-6A	BTH3605	Bioanalytical Techniques - II	02	50	50	100
	DSE-6B	BTH3606	Applications in Agriculture and Environmental Biotechnology	02	50	50	100
	DSE-4	BTH3607	Biotechnology Practical - IV	02	50	50	100
	DSE-5	BTH3608	Biotechnology Practical - V	02	50	50	100
	DSE-6	BTH3609	Biotechnology Practical - VI	02	50	50	100
	SEC-3*	BTH3611	Introduction to Bioinformatics **OR**	02	50	50	100
	SEC-3*	BTH3612	Soil Analysis				
	SEC-4*	BTH3613	Survey Methodology **OR**	02	50	50	100
	SEC-4*	BTH3614	Research Proposal Writing and Presentation				

F.Y. B.Sc. Semester I		
Title of the Course and Course Code	**Concepts and Application in Biotechnology BTH1101**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Define and describe the concept of biotechnology as a science. Outline the important milestones in the history of biotechnology.	
CO2	Associate the science of biotechnology with other streams of life sciences Distinguish between traditional know-how in the field of agriculture, medicine etc. and the advances introduced in these fields due to biotechnology.	
CO3	Outline the use of recombinant DNA technology in field of biotechnology. Apply this knowledge to design new vectors, build new processes and find solutions against current lacunae in the field of energy, agriculture, medicine and environment conservation.	
CO4	Relate the role of biotechnology to the agriculture industry, pharmaceutical industry, and the field of research and development. Analyze and explain the need of biotechnology in developing novel therapeutics and vaccines against emerging diseases; developing nutritionally enriched crop varieties; and developing newer biofuels to replace non-renewable fuel sources.	
CO5	Determine the need for genetic engineering, molecular cloning and expression in improving the quality of life. Evaluate and decide the necessity of these techniques in developing novel products with improved features in comparison to the non-transgenic products.	
CO6	Devise new methods to address the current issues and enhance the production of recombinant proteins in transgenic organisms	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**What is Biotechnology** Introduction, Milestones in the history of biotechnology, Biotechnology in day to day life	2
II	**Agriculture biotechnology** Recent developments in the field of agriculture biotechnology Visit to agriculture research institute/ agro-industry and report writing, one guest lecture	8
III	**Medical biotechnology** Recent development in the field of medical biotechnology, Visit to medical research institute/ diagnostic lab/ and report writing, one guest lecture	8
IV	**Applied biotechnology** Recombinant DNA technology-basics and applications, Visit to RDT product manufacturing units/labs and report writing, one guest lecture	8

V	**Environmental biotechnology** Need for biotechnology in environment conservation, Current environmental issues and use of biotechnology in solving these issues	5
VI	**Introduction to national research funding institutes** (UGC, DBT, CSIR, ICMR, DST etc.), national and international research institutes (NIH, MIT, NIV, NCL, NCCS, ISSER, DRDO etc.)	5

References:

1. Milestones in Biotechnology: Classic papers in Genetic Engineering: J. A. Davis, W. S. Resnikoff
2. Plant biotechnology - J Hammond & P. McGravey, V.Yushibov, Springer-Verlag
3. Principles of Gene Manipulation & Genomics – Primrose and Twyman (2006, 7thEdition)
4. Amann, R.I. Stromley, J. Stahl: Applied & Environmental Microbiology
5. Official websites for NCL, NIV, IISER, NCCS, DST, DRDO, and DAE can be used as references

Title of the Course and Course Code	**Biological Chemistry-I BTH1102**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe macromolecules in the cell in terms of their structure and function and state the strong and weak bonds which influence their interactions with other biomolecules	
CO2	Interpret the energy flow in metabolic reactions from various high energy molecules in the cell and demonstrate the coupling of endergonic and exergonic reactions	
CO3	Demonstrate acid base titrations, titration curves and compute the charge on biomolecules as a function of pH which affects biochemical interactions	
CO4	Analyse conditions of reaction equilibrium, derive the Henderson-Hasselbach equation and solve related problems	
CO5	Review key concepts in electrochemistry, determine free energy changes in redox reaction and EMF of a cell	
CO6	Plan and perform simple titration experiments to measure acid-base strengths as well as perform tests to identify the macromolecule composition of a sample	

Unit. No.	Title of unit and Contents	No of Lectures
I	**Chemical bonding:** Types of bonds and factors affecting the bond formation, various theories, bond parameters, types of bonds in biomolecule [Covalent (glycoside, peptide, phosphodiester), ionic, hydrogen, Van der Waals, hydrophobic, coordinate)], Hydrophilic and hydrophobic interactions	7
II	**Introduction to biomolecules:** **Carbohydrates**: Introduction, biological importance. Definition, Classification (glyceraldehydes, Simple Aldose, Simple Ketoses, D-glucose, Conformation of D-glucose), disaccharides, polysaccharides (starch, glycogen) **Proteins**:- Amino acids; Structure and properties, Primary, Secondary, Tertiary and Quaternary structure **Lipids:** - Introduction, classes, fatty acids; physical and chemical properties, simple lipids **Nucleic acids**: Nucleosides, nucleotides, Polynucleotide, DNA and RNA,	9
III	**Thermodynamics and chemical equilibrium:** Theromodynamics: Introduction, scope and limitations, terms and basic concepts, types of systems, intensive and extensive properties, equilibrium and non-equilibrium states, reversible and irreversible processes, laws of thermodynamics, internal energy, enthalpy, endo and exothermic reactions, free energy and work, Gibb's Helmholtz equations, ATP and its role in bioenergetics. **Chemical Equilibrium:** Equilibrium constant, Le Chatelier's principle, Acid and bases, strength of acid & bases, pH of aqueous solutions, Acid–base titrations, indicators in titrations, Titration curves Solubility product & applications, ionic product, Condition for precipitation, Buffers, buffer action, Henderson 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	13
IV	**Electrochemistry:** Redox reactions; basic concepts, free energy changes in redox reactions, EMF of a cell and its measurements, Nernst Equation Computation of cell EMF, Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K), standard electrode potential, sign conventions, electrochemical series	7

References:

1. The elements of Physical Chemistry, 5th edition (2009), Atkins P, de Paula J. W. H. Freeman Publication, USA
2. An Introduction to Electrochemistry, edition reprint, 2011, Samuel Glasstone, Biblio Bazaar, USA
3. Physical Chemistry for biological sciences, 1st edition, (2005), Chang R., University Science Books, USA
4. Organic Chemistry, 6th edition, (1992), Morrison Robert Thornton, Pearson Publication, Dorling Kindersley (India Pvt. Ltd.)
5. Biochemistry, 4th Edition, (2011), Voet and Voet, John Wiley and Sons, Inc.
6. Principles of Biochemistry,7th edition (2017), Lehninger, Freeman W.H. and Company
7. Biochemistry, Berg J., Tymoczko J., Stryer L., 8th edition (2015), Freeman W. H. and Company

Title of the Course and Course Code	**Biophysics BTH1103**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe Bohr's model for atomic structure and Pauli's exclusion principle and discuss their significance.	
CO2	Interpret the effect of biomolecules on energy generation and consumption for tissue specific metabolism.	
CO3	Classify nuclear radiation and describe their properties. Outline applications of nuclear radiation, quantitation and detection.	
CO4	Compare and contrast the ways of maintaining balance of the human body (homeostasis) and describe the role of organs for it. Explain the working of instruments meant for measurement of radiation	
CO5	Compare the molecular motor proteins and describe their role in energy generation and utilization.	
CO6	Specify the role of visible light for different biological processes(photobiology).	

Unit. No.	Title of unit and Contents	No of Lectures
I	**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.	4
II	**Radioactivity**: Nuclear radiations and their properties - alpha, beta and gamma. Introduction, classification of radiations in radiobiology, irradiation of cells, type of radiation damage. Radioimunoassay. Radiopharmaceuticals, Measurement of radiation - Dosimetry and detectors. Principle, construction and working of – GM counter. Scintillation Counter (Solid and liquid).	5
III	**Energy production, movement and force**: Tissue Specific metabolism: Kidney, Brain, Liver, Muscles, Blood: use of energy for their function Role of ATP, ADP and Phosphocreatine for energy generation. Glycolysis: reaction, energy production and need, fates of Pyruvate Mitochondria: ETC and ATP production overview Molecular motors: Cardiac and smooth muscle contraction. proteins involved and interrelation between energy, movement and force. Generation of action potential	12
IV	**Homeostasis**: human as an example. Gaseous exchange: respiration, cellular and intracellular respiration. Thermoregulation: role of hormones, heat production by mitochondria. Osmoregulation: role of kidney	6
V	**Biophysics of light**: Properties of light, Photosynthesis, Photomorphogenesis, Visual processing, Circadian rhythms, Bioluminescence, and UV radiation effects.	9

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. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson and Michael Cox, W.H. Freeman and company, NY.
4. *Biophysical Chemistry*: Principles and Techniques by *Upadhyay, Upadhyay, Nath*
5. Principles and Techniques of Biochemistry and Molecular Biology. Seventh edition. Edited by Keith *Wilson* and John *Walker*.

Title of the Course and Course Code	Animal Science I - BTH1104	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Outline and recall classification and characterization of non-chordates and chordates with examples.	
CO2	Differentiate and illustrate various Honey bee body parts. Explain the morphology, life history of honey bees.	
CO3	Outline rearing methods of beneficial organisms from an economic perspective. Apply knowledge of agro based Small scale industries like sericulture, fish farming and Apiculture	
CO4	Explain and distinguish the immune mechanisms in parasitic disease control, lifecycle of various parasites and process of immune interactions.	
CO5	Compare and Contrast contributions and applications of various model organisms in research.	
CO6	Specify and analyze the structural, functional and organizational and economic importance of kingdom animalia.	

Unit. No.	Title of unit and Contents	No of Lecture
I	**Introduction to Kingdom Animalia:** Outline of classification and characterization of non-chordates and chordates with examples. Adaptations in animal kingdom (with respect to environment in which they live).	6
II	**Type Study: Honey bee** Morphology, Structure of Head , Mouthparts , Legs, wings, Sting Apparatus and Pollen Basket., Social Organization of Honey Bee and Bee Products (apiculture).	8
III	**Parasitology:** Study of Plasmodium sp., Entamoeba histolytica, Fasciola hepatica, Taenia solium on lifecycle, adaptations and evolution of host-parasite interactions, infectivity, control and treatment measures.	9
IV	**Model System:** Drosophila as a model system Zebra fish as a Model system Chick embryo as a model system	8

V	**Economic Zoology:** Vermiculture, aquaculture, sericulture, pearl culture, lac culture.	5

References:

1. Jordan, E.L. and Verma P.S. 1978, (i) Chordate Zoology S. Chand & CompanyLtd. 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 Publishers.

Title of the Course and Course Code	**Plant Sciences I - BTH1105**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe these plant specimens morphologically. Identify in which group of kingdom Plantae they belong to.	
CO2	Discuss and Distinguish on the basis of similarities and differences exhibited by them.	
CO3	Demonstrate their anatomical features. Apply Taxonomic criteria and Classify, identify and find out scientific name	
CO4	Analyse the relationship between different groups of plant Kingdom.	
CO5	Conclude how plants must have conquered the land.	
CO6	Compile the collected information. Write evolutionary aspects in plants. Collect different plant specimens from surrounding or from a particular area and discuss their characteristics.	

Unit. No.	Title of unit and Contents	No of Lecture
I	**Unique features of plants-** Cell wall, plasmodesmata, Chloroplasts, Growth and Development Plant Tissue Systems- Epidermal, Ground, Vascular, Mechanical tissue systems	5
II	**Conquest of land** **Cryptogams-** General characters (Habit, habitat, Reproduction, Alternation of generations) and Economic Importance of Algae, Fungi, Bryophytes and Pteridophytes **Phanerogams-**	8 5

	General characters (Habit, habitat, Reproduction, Alternation of generations) and Economic Importance of Gymnosperms and Angiosperms	
III	**Major Aspects of plant sciences-** **Structural** Morphology- Vegetative and reproductive plant parts Anatomy- Vegetative and reproductive plant parts Taxonomy-Binomial nomenclature, Systems of Classification, ICBN, Study of some families	18

References:

1. Botany for Degree Students-Algae by B. R. Vashishta
2. Botany for Degree students- Fungi by B. R. Vashishta
3. Botany for Degree students- Bryophyta by B. R. Vashishta
4. Botany for Degree students- Pteridophyta by B. R. Vashishta
5. Botany for Degree students- Gymnosperms by B. R. Vashishta
6. Botany for Degree students- Angiosperms by B. R. Vashishta
7. Class book of Botany- by A.C.Dutta
8. College Botany Vol.I, II, III by Ganguli, Das dutta.
9. Taxonomy of Vascular Plants by G H. Lawrence
10. Plant Physiology- by Taiz,L. and Zeiger E.

Title of the Course and Course Code	**Introduction to Microbial World BTH1106**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall and describe the landmarks and important developments leading to major discoveries: (pre golden, golden and post golden era) in Microbiology. Define and describe different Types of stains with principles and methodology techniques used to observe microorganisms.	
CO2	Associate and Differentiate between Morphological characters of microorganisms	
CO3	Outline the study on structure, chemical composition and functions of the components in bacterial cell.	
CO4	Analyse the structures Internal and external to Cell Wall of bacteria	
CO5	Compare and Contrast Prokaryotic and Eukaryotic cells	
CO6	Design Bright field microscopy and its use in Microbiology.	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**HISTORY OF MICROBIOLOGY** Important developments leading to major discoveries: (pre golden, golden and post golden era) Discovery of microscope (Anton von Leeuwenhoek and Robert Hooke), Abiogenesis v/s biogenesis, Contributions of various Scientists (Aristotle, Francesco Redi, Louis Pasteur, Tyndall and others), Germ theory of Diseases, Discovery of microbes as pathogens, Koch's, postulates & River's postulates, concept of antiseptic surgery, Role of microorganisms in transformation of organic matter, anaerobes, germ theory of fermentation, Vaccination and Chemotherapy, Contributions of Nobel Laureates in Immunology, Molecular Biology &Biotechnology	5
II	**CLASSIFICATION AND MORPHOLOGY** **Classification:** Principles in classification of Bacteria (Introduction to Bergey's Manual of Determinative and Systemic Bacteriology) and viruses (ICTV) **Morphological and differentiating characters of microorganisms:** Bacteria, Rickettsia, Protozoa, Algae, Fungi (Molds and Yeasts), Viruses, viroids and prions	4
III	**Studies on structure, chemical composition and functions of the following components in bacterial cell**: Size, shape and arrangement of bacterial cells, Structures External to Cell Wall, Cell wall (Gram Positive, Gram Negative, Archaea), Glycocalyx, Capsule, Flagella, Fimbriae and Pili, Axial Filaments **c**. **Structures Internal to Cell Wall** Cell membrane (Gram Positive, Gram Negative, Archaea), Chromosomal & extra-chromosomal material Ribosomes, Cell inclusions (Gas vesicles, carboxysomes, PHB granules, metachromatic granules and glycogen bodies) **Endospores** Formation and Germination	13
IV	**EUKARYOTIC CELL STRUCTURE AND FUNCTION:** Overview of eukaryotic cell structure: General structure and types of cells, Comparison of Prokaryotic and Eukaryotic cells, Structure & Function	2
V	**Units of measurement:** **I.** Modern SI units (Length, volume, Weight) **II. Microscopy**: Bright field microscopy: Structure, working and principle of a compound light microscope; Concepts of magnification, numerical aperture and resolving power. Focal Length, Working distance,	12

	Depth of Focus. **III. Staining Techniques:** Definitions of Stain; Types of stains (Basic and Acidic), Leuco compounds, Properties and role of Fixatives, Mordants, Decolorisers and Accentuators Principles of staining techniques for following: Monochrome staining and Negative (Relief) staining, Differential staining - Gram staining ,Acid fast staining, Special staining- Spore, flagella, cell wall, nucleic acid, capsule	

References:

1. Brock Biology of Microorganisms, Michael .T. Madigan, John. M. Martinko, Paul V. Dunlap, David P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
2. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.
3. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition.Pearson Education Inc.
4. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata MacGraw Hill Press.
5. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill Companies Inc.
6. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education
7. Willey J. M., Sherwood L. M. and Woolverton C. J. (2013) Prescott's Microbiology,8th Edition, McGraw-Hill Higher Education
8. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw
1. Hill Publishing Co.
9. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd.
10. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc

Title of the Course and Course Code	**Quantitative methods in Biology I - BTH1107**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe various generations of computers and how computers are evolved. Identify and classify the computers based on memory, capacity, size, price and uses. Outline how word, excel and powerpoint will help biotechnologists to organize, analyze and interpret the data in a scientific manner.	
CO2	Classify the variables into categories such as discrete and continuous, qualitative and quantitative and so on.	
CO3	Apply the knowledge obtained to solve problems in biological mathematics. Calculate the various parameters used in biochemistry, such as normality, molarity, molality and so on.	
CO4	Differentiate various operating systems and explain their interface or GUI. Explain about various input and output devices of the computers.	
CO5	Compare various types of antivirus programs for cleaning the infection of computer viruses to the computer system. Outline the computer viruses definition and life cycle.	
CO6	Create frequency tables, summarize data, represent data visually. Calculate the measures of central tendency and dispersion and describe the data.	

Unit. No.	Topic	No. of. Lecture
I	**Introductory Mathematics** Linear equations, functions: slopes-intercepts, forms of two-variable linear equations; constructing linear models in biological systems	3
II	**Mathematical Operations** Imaginary numbers, complex numbers, adding-subtracting-multiplying complex numbers, basics of vectors, introduction to matrices	3
III	**Biochemical calculations** Atomic and molecular mass, Avogadro's law and Avogadro's number Per cent composition Concentration of solutes in solutions	3

	Normality, molarity, molality and their conversions	
IV	**Introductory Statistics** The need of statistics in biology Variables and constants Types of variables – discrete, continuous Types of data – raw, grouped Graphical representation of data – bar graphs, scatter plots, frequency diagrams, pie chart, histogram, polygon, curve	3
V	**Descriptive Statistics** Definition and simple problems related to Measures of Central Tendency – Mean, median and mode Quartiles, quartile plots, box plots Measures of dispersion – Standard deviation, variance, coefficient of variance Skewness and kurtosis	5
VI	**Probability** Classical definitions and its limitations Independence and conditional probability Probability sampling Population, sample, sampling methods – Simple random, stratified	4
VII	**History of Computers** Evolution, generations of computers – I to V Classification of computers – mainframe, mini, micro, workstations, parallel processing and super Comparison with respect to memory, power, cost and size Client server architecture	
VIII	**Introduction to Operating systems** Operating system concept, Windows 98/XP and later versions, Unix, Linux **Data processing and presentation** – Introduction to MS Office (Word, Excel and PowerPoint)	
IX	**Computer Viruses** An overview of computer viruses – What is virus? virus symptoms, how do they get transmitted? What are the dangers? General precautions Various types of Antiviruses	

References:

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 YieldTMBiostatistics. (2001) Antony N Glaser. Lippincott Williams and
4. Wilkins, USA
5. Introduction to Mathematics for Life Scientists. 3rd edition (1979). Edward
6. Batschalet,

7. Mathematics for the Biological Sciences. Illustrated edition (1979) J.C. Acharya and
8. Lardner, Prentice Hall, USA.
9. Sinha P. & Sinha P. 2011. Computer Fundamentals. BPB Publications, Connaught Place, Delhi, 478 pp.

Title of the Course and Course Code	**Ecology - BTH1108**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall basic concepts of Ecology and identify various kinds of ecosystems in the surroundings.	
CO2	Explain the role of each of the structural components of the ecosystem Interpret the different kinds of behaviours shown by animals.	
CO3	Generalize the habitats and ecosystems in the immediate surroundings. Examine, tabulate and report the health and the status of the ecosystems and biodiversity of regions in the surroundings.	
CO4	Analyze the various kinds of interactions that take place between the biotic and the abiotic components in the ecosystems. Relate these interactions with those taking place between the human beings and the environment.	
CO5	Evaluate the consequences of the anthropogenic activities on the environment. Judge the various long-term impacts of these activities. Determine the preferred ranges of plants, animals and microorganisms for the various environmental variables.	
CO6	Design models to visualize the rise and fall in populations over time, in response to interactions such as predation and design experiments to learn how plants and animals respond to the gradients in the environmental variables.	

Unit. No.	**Topic**	**No. of Lectures**
I	**Ecology:** Introduction, Concept, Scope	1
II	**Ecological Factors:** Tolerance, Optimal ranges, Ecological Niches – fundamental and realized	4
III	**Ecosystems - Concept of Ecosystem** Biotic & Abiotic components and their interactions, Types of Ecosystem, Dynamics (Food Chain, Food Web, Ecological pyramids) B, Biogeochemical cycles (C, N, P, Water)	10

IV	**Habitat Ecology:** Aquatic, Terrestrial and Desert, Animal adaptations to water, temperature, salinity, predation, Plant adaptations to water, temperature, salinity, predation, Plant-animal relationships	12
V	**Concept of Population and Community Ecology**	2
VI	**Animal Behavior:** Sensory inputs, Habituation, Imprinting, Cognition and Problem Solving, Spatial Learning, Associative Learning, Altruism, Inclusive Fitness.	4
VII	**Biogeography in Indian context:** Patterns and types of distribution; role of geology, climatic fluctuations in shaping the distribution patterns of plant and animal species	**3**

References:

1. An Introduction to Geographic Information Technology (2009) Suchandra Choudhury I K International Pvt Ltd., New Delhi
2. Concepts and Techniques of Geographic Information Systems C.P.Lo.AlbertK.W.Yeung 2nd edition, Prentice Hall, Inc., New Jersey
3. Ecology and environment (2005) Sharma PD Rastogi Publication, New Delhi
4. Ecology and environmental biology (2011) Saha T K Books & Allied (p) Ltd, Kolkata
5. Ecology science and practice (2001) Faurie et al Oxford & IBH Publ. Co. Pvg. Ltd, New Delhi
6. Ecology: Principles and Applications (1998) J. L. Chapman, M. J. Reiss Cambridge
7. The biology of biodiversity: M.Kato Ridley M.

Title of the Course and Course Code	Practicals in Biological Chemistry and Biophysics BTH1109	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
Description (Biophysics)		
CO1	Identify and compare the instruments required to carry out the experiments in the laboratory. Tell whether the instruments they use are calibrated.	
CO2	Solve mathematical problems for preparation of chemicals in the laboratory and radiation biology.	
CO3	Design experiments to study the effect of light for photosynthesis and concept of osmosis.	
Description (Biological Chemistry)		
CO4	Analyze the pI of an amino acid by performing titration.	
CO5	Test and validate carbohydrates from a natural source and perform its qualitative estimation.	
CO6	Design an experiment to determine Absorption maxima of proteins.	

Sr. No.	Topic	No. of Practical (15Px2H)
1	Calibration and use of micropipettes and glass pipettes	3
2	Problems on radioactivity	1
3	To determine hemolysis in solutions of different osmolarity	1
4	To study the effect of light on pigment production.	1
5	Mathematical Calculations, problems based on normality, molarity, stock and working standard preparation	2
6	Isolation of Carbohydrates from a natural source and its qualitative estimation	2
7	Determination of Absorption maxima of proteins isolated from natural sources and its estimation by Biuret/ Bradford reagent	2
8	Determination of pI by titration	2
9	Saponification of fats	1

Title of the Course and Course Code	Exercises in Animal Science I and Plant Science I (BTH110)	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
Description (Plant Science I)		
CO1	State and describe distinguishing features Algae, Fungi, lichens, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms with the help of available suitable material.	
CO2	Apply different morphological terms and describe the specimens to study plant families. Classify and identify the plant and find out the family in which it belongs.	
CO3	Discuss Anatomical features of different plant parts- Root, Stem, leaf of Dicotyledonous and Monocotyledonous plants. Compare anatomical characters of Dicot and Monocot plants. Employ different techniques like Sectioning, Staining and Maceration. Explain various types of tissues in plants.	
Description (Animal Science I)		
CO4	Identify the animals of invertebrate and vertebrate phyla and recognize their distinguishing features. Explain theoretical basis and dissection skills. Standardize mounting of Honey Bee parts.	
CO5	Discuss, distinguish and understand the life cycle of important invertebrate model organisms like Hydra.	
CO6	Identify , recall and demonstrate life cycle of various parasites.	

Sr. No.	Topic	No. of Practical (15Px2H)
	Plant Science:	
I	Study of one example each of the following- Algae, Fungi, Bryophytes, Pteridophytes Gymnosperms and Angiosperms	2
II	Study of anatomical features of root, stem and leaves of Dicotyledons and Monocotyledons. Study of plant tissues by sectioning, staining , maceration	2
III	Study of Morphological features of plants and plant families.	2
IV	Study of plant diseases	2

V	**Animal Science:**	
VI	**Study of Paramecium:** Morphology Reproduction	1
VII	**Study of Hydra:** Morphology Reproduction Regeneration	1
VIII	Dissection of Honey Bee, Mounting of Mouth parts, pollen basket, Sting Apparatus, legs and wings.	2
IX	**Study of Fasciola, Plasmodium and Taenia:** Morphology Life cycle	3

Title of the Course and Course Code	**Practicals in Microbiology and Ecology BTH1111**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe the safety rules when in the Microbiology Laboratory and become proficient in Aseptic techniques	
CO2	Explain the use of Micropipettes and glass pipettes	
CO3	Use the Compound Microscope and to successfully focus and observe stained bacteria	
CO4	Analyse the ecological adaptations in Plants (Hydrophytes/mesophytes/Xerophytes)/	
CO5	Test Winogradskys column and compare the conditions under dark and light conditions	
CO6	Design method to observe motility of bacteria.	

Sr. No.	**Topic**	**No. of Practical (15Px2H)**
I	Biosafety in the Microbiology Laboratory- practices and rules involved 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	1
II	Use and care of bright field microscope Observation of microorganisms using bright field microscope -	2

	Bacteria, Protozoa, Molds and Yeasts, Algae – from natural habitat	
III	Observation of microorganisms using staining techniques: Monochrome staining and, Negative /Relief staining (Capsule staining), Gram staining of bacteria, Endospore staining, Staining of yeast and fungi	5
IV	Observation of motility in bacteria using: Hanging drop method , Swarming growth methods	2
V	Activity for students: SOP's of the instruments, Preparation of charts, depicting size, shape and arrangements of bacteria, motility types. Quiz etc. activity	2
VI	Isolation of nitrogen fixing /phosphate solublizing bacteria from soil(Demonstration)/Winogradskys Column	2
VII	Study of ecological adaptations in Plants (Hydrophytes/mesophytes/Xerophytes)/ FC adaptations (Botanical gardens) --- Photo documentation	1

Title of the Course and Course Code	**Practicals in Biostatistics and Computers - I** **BTH1112**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
Biostatistics		
CO1	Describe the basic concepts of Biostatistics. Arrange, classify, summarize data collected opportunistically or through experimentation.	
CO2	Apply the theoretical concepts to the collected data to describe the data.	
CO3	Create an MS Excel workbook to enter the data, analyze the data using Excel workbook and compare the parameters of the collected data.	
Computers		
CO4	Describe the steps for formatting the word document, tabulation of the data, converting the data into meaningful information.	
CO5	Examine, tabulate, organize and convert the primary data using Microsoft excel into information and process the data for statistical validation by using various formulae and calculate the values for mean, mode, median, std. deviation etc using excel. Analyse the data using excel by creating various graphs, bar diagrams charts.	
CO6	Analyse and explain the information generated through excel, process data and make a powerpoint presentation using Microsoft PowerPoint with the help of different tools. Design and organize the document using features of Microsoft word	

- By the end of this course students should be able to do the statistical analysis independently, and able to use the computational tools for data analysis

F.Y. B.Sc. Semester II		
Title of the Course and Course Code	**Evolutionary Biology and Biodiversity BTH1201**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Differentiate between the actions of the various evolutionary forces including natural selection, genetic drift and so on, and between the different kinds of processes giving rise to the biological diversity on the planet. Explain and summarize these evolutionary processes leading to speciation and diversification.	
CO2	Compare between the morphology, behaviour and other biological aspects of the taxa occurring in the various geological periods. Compare between the various hypotheses and the theories put forth to explain the origin of life and diversity on the planet.	
CO3	Explain the processes giving rise to and maintaining the secondary sexual characters such as elaborate ornamentation and attractive colouration in males or females of various sexually reproducing organisms.	
CO4	Apply the theoretical aspects learnt in class to design experiments to test hypotheses related to evolutionary biology.	
CO5	Identify, arrange and classify species into their respective taxonomic ranks (kingdoms, phyla, genus etc.) based on the data obtained from morphological, genetic, behavioral observations.	
CO6	Evaluate the consequences of the anthropogenic activities on the environment. Judge the various long-term impacts of these activities.	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Evolution:** Concept, time line of evolution Origin of Life: Earliest life on Earth, Unicellular to Multi cellular, Diversification of life Evidence of Evolution: Index fossils, common descent, chemical and anatomical similarities	10

	Species concepts – What exactly is a species? Origin of Species: Speciation: Allopatric, Sympatric	
II	**Theories of Evolution:** Historical Evolutionary Thought, Lamarck's theory of acquired characters, De Vries theory of Mutation, Darwin's theory of Natural Selection, and Neo-darwinism Evolution of Sexual Reproduction Sexual selection – Fisher's Runaway and Zahavi's Handicap Evolution and Biogeography of Islands – Dispersal, establishment and extinction, adaptive radiation	10
III	**Biological Systematics and Conservation Biology** Systematics and taxonomy History of systematic Characters – Shared, derived, reversal and convergence Taxonomic Characters Phenetics and Phylogenetics Biodiversity and the need for conservation Conservation of Biodiversity – Shortfalls (Linnean and Wallacean), IUCN, CITES Protected Areas (Wildlife Protection Act, 1972), Schedules of the WPA.	13
IV	**Effects on Ecosystems:** Human and Natural Changes Greenhouse effect Global warming Climate change	3

References:

1. Strickberger's Evolution by Brian K. Hall and BenediktHallgrimsson 5th Ed 2013
2. Handbook of Evolutionary Biology by Richard Arber 2015
3. The Origin of Species by Charles Darwin.
4. An Introduction to Geographic Information Technology (2009) SuchandraChoudhuryI K International Pvt Ltd., New Delhi
5. Concepts and Techniques of Geographic Information Systems C.P.Lo. AlbertK.W. Yeung2nd edition, Prentice Hall, Inc., New Jersey
6. Ecology science and practice (2001) Faurie et al Oxford & IBH Publ. Co. Pvg. Ltd, NewDelhi
7. Ecology: Principles and Applications (1998) J. L. Chapman, M. J. Reiss Cambridge
8. The biology of biodiversity: M.Kato

Title of the Course and Course Code	Biological Chemistry-II - BTH1202	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Define reaction rate, rate laws, molecularity and order of reaction, differentiate zero, first, second and pseudo-order reactions. Outline and describe factors affecting reaction rate.	
CO2	Discuss various methods of representation of the molecules in stereochemistry. Explain various projection formulae of the molecules (Newman and Fisher formula) and the different types of isomerism (Conformational, Optical and Geometrical isomerism)	
CO3	Illustrate why enzymes are powerful biocatalysts. Outline general modes of rate enhancement by enzymes.	
CO4	Analyze the importance of enzymes and their classification. Explain why coenzymes are equally important and why vitamins are required in our diet	
CO5	Determine the nomenclature system of organic molecules. Review and specify various classes of organic molecules (Alkanes,Alkenes,Alkyne,Alkyl halides,esters ethers alcohols and amines) and its methods of synthesis, organic reactions.	
CO6	Specify the differences between oxidation, reduction, addition and substitution reactions.	

Unit. No.	Title of Unit and Contents	No. of. Lectures
I	**Chemical Kinetics:** Definition, Reaction rate, Rate laws, Molecularity of reaction, Zero order, Pseudo-order, first order, second order reactions, Half-life of a reaction, Methods to determine order of reaction, Collision theory, effect of temperature on reaction rate, Activation energy.	10
II	**Catalysis:** Catalysis types, characteristics of catalysed reactions, classification of catalysis, enzyme catalysis; classification of enzymes, modes of enhancement of bond cleavage rate by enzymes, rate enhancement and activation energy, role of non-protein organic and inorganic molecules, coenzymes, prosthetic	11

	groups, role of vitamins as coenzyme precursors	
III	**Organic reaction mechanism:** Biologically important nucleophiles and electrophiles. Group transfer reactions: acyl, phosphoryl and glycosyl group transfer. Oxidations and reductions: reactions of FAD and NAD. Eliminations: Dehydration reaction. Isomerizations and Rearrangements: aldose-ketose isomerisation. Reactions that make and break carbon-carbon bonds	10
IV	**Stereochemistry:** Representation of molecules; projection formulae, Newman and Fisher formula. Isomerism; conformational, optical and geometrical isomerism	5

References:

1. The elements of Physical Chemistry, 5th edition (2009), Atkins P, de Paula J. W. H. Freeman Publication, USA
2. Organic Chemistry, 6th edition, (1992), Morrison Robert Thornton, Pearson Publication, Dorling Kindersley (India Pvt. Ltd.)
3. Biochemistry: 4th Edition, (2011), Voet and Voet, John Wiley and Sons, Inc.
4. Principles of Biochemistry,7th edition (2017), Lehninger, Freeman W.H. and Company
5. Biochemistry, Berg J., Tymoczko J., Stryer L., 8th edition (2015), Freeman W. H. and Company

Title of the Course and Course Code	**Bioinstrumentation - BTH1203**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe the principle, construction and working of pH meter and conductivity meter and outline their applications.	
CO2	Explain the principle behind spectroscopy, compare and contrast the different forms.	
CO3	Classify different types of centrifuges and describe their construction, working and applications.	
CO4	Classify microscopes and explain the types, their construction, working and applications.	
CO5	Justify the role of instruments.	
CO6	Design experiments to test the applications of the instruments used.	

Unit. No.	**Title of Unit and Contents**
I	**pH meter& conductivity meter**: Principle, construction, working, calibration, maintenance and applications.
II	**Spectroscopy**: Definition. Electromagnetic wave. Electromagnetic spectrum. Applications of each region of electromagnetic spectrum for spectroscopy. Beer Lambert's law. Introduction to molecular energy levels. Excitation. Absorption. Emission. Rotational spectra. Energy levels of rigid diatomic molecules.

	Electron spectroscopy. UV-visible spectroscopy. Applications of spectroscopy. Principle, construction and working of colorimeter, Spectrophotometer, Fluorimeter. Applications.
III	**Centrifuge:** RCF and sedimentation concepts, principle, construction, working, centrifuge types, rotor types and application of preparative & analytical centrifuges, gradient centrifuge.
IV	**Microscopes:** Construction and Biophysical working principles of the following Microscopes: - Stereozoom (Dissecting) - Compound - Bright and Dark field - Inverted - Electron microscopes: TEM and SEM (compare and contrast and applications)
V	**Electrophoresis:** Agarose gel electrophoresis, Poly acrylamide gel electrophoresis, Application for isolation and characterization of biomolecules.
VI	**Basic principles of Chromatography:** elaborate paper chromatography and Thin Layer Chromatography

References:

1. Instrumentation measurements and analysis – 2nd edition (2003). Nakra and Choudhari, Tata McGraw Hill, India.
2. Nuclear Physics: An Introduction. 2nd edition (2011). S. B. Patel. Ansha Publication, India.
3. Biophysical Chemistry: Principles and Techniques by Upadhyay, Upadhyay, Nath
4. Principles and Techniques of Biochemistry and Molecular Biology. Seventh edition. Edited by Keith Wilson and John Walker

Title of the Course and Course Code	**Animal Sciences II BTH1204**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe homeostatic regulation of different body processes.	
CO2	Identify and classify cells, tissues and organ systems. Identify the structural and functional properties of different types of cells.	
CO3	Demonstrate basic proficiency in utilizing principles of introductory animal histology	
CO4	Explain how organisms function at the level of, cell, tissue, organ and organ-system.	
CO5	Compare and Contrast various tissues and organ systems.	
CO6	Specify the diversity and similarity of different organisms at organization levels	

Unit No.	Title of Unit and Contents	No. of Lecture (Total 36)
I	**Introduction to principles of Physiology:** Homeostasis, concept of pH and maintenance of body temperature.	5
II	**Types of animal cells**: Concept of different cell types, specialized cell types (photoreceptors, auditory hair cells, egg as a single cell, ciliated cells) and functions.	7
III	**Tissues:** Different types of animal tissues (columnar, cuboidal, squamous epithelium, osteoblasts, blood cells) and extracellular matrix.	5
IV	**Organ systems:** Sensory systems, cardiovascular system, urino-genital system, nervous system, endocrine system, gastro-intestinal system.	14
V	**Animal histology methods:** Principles of cell type specific detection staining methods.	5

References:

1. Principles of Anatomy and Physiology by Gerard Tortora and Bryan Derrickson14th Edition. 2014
2. Animal Physiology by Christopher Moyes and Patricia Schulte, second edition (Pearson), 2014.
3. Animal Physiology by Hill, Wyse and Anderson, third edition, 2012.
4. Practical Manual of Histology for Medical students by Neelkanth Kote, Jaypee Brothers Medical Publishers; second edition (2014)

Title of the Course and Course Code	**Plant Sciences II BTH1205**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Retrieve major functional aspects of plants - Photosynthesis, respiration, Mineral nutrition, Uptake of water, Plant water relation. Describe these primary metabolic pathways in plants. Extrapolate the information.	
CO2	Discuss plant resources and their utilization, secondary metabolites which are commercially important. Describe Forest as potential resource, plant resources used in Cosmetics and Pharmaceuticals, plants with respect to areas where they are cultivated, environmental conditions they favour, Cultivation practices, uses. Explain secondary metabolism in plants. List economically important plants- Cereals, Pulses, Vegetable oils, Sugarcane, Cotton etc.	
CO3	Demonstrate different physiological processes in plants. Explain Plant Breeding programmes, their need and methods to improve quality of plant products and to develop novel varieties of plants	
CO4	Categorize different plants with focus on their economic importance. Explain the concept and need of GreenHouse technology- with respect to site selection, climate, basic facilities while raising greenhouse. Integrate information about Plant diseases- various pathogens, how they enter the plant , symptoms, eradication, control measures.	
CO5	Select different plants of economic importance. Recommend to exploit them biotechnologically for the benefit of mankind.	
CO6	Compile information and write how plants are useful to mankind, how we can modify and make use of these characteristics of plants by using recent biotechnological tools.	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	Major aspects of plant sciences- Functional- Plant Physiology- Photosynthesis, Respiration, Mineral Nutrition, Plant water relation	12
II	Plant Breeding-Introduction, need and methods	3
III	Plant Resources and their Utilization- Plants as natural resources Forest as potential resource, Secondary metabolites in plants Plant resources used in Cosmetics and Pharmaceutics Bioprospecting- Introduction, Concept and scope, Untapped potential resources like sea weeds, Lichens Economic Botany	13
IV	Horticulture, Floriculture and Green house technology	4
V	Plant Pathology- Introduction, Concept, Pathogens, Diseases (2-3 examples)	4

References:

1. Plant Physiology- by Taiz,L. and Zeiger E.
2. College Botany Vol.I, II, III by Ganguli Das Dutta.

Title of the Course and Course Code	Microbial Growth, Control and Applications BTH1206	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Classify bacteria according to nutritional requirements, Design of media , Articulate concept of Pure culture, axenic culture, co- culture , mixed culture and isolation of microorganisms and pure culture techniques	
CO2	Define sterilization and disinfection methods used to control the growth of microorganisms. Outline various physical, chemical and biological principles used to study sterilization and disinfection.	
CO3	Define Growth curve Generation time, Growth rate and specific growth rate. Discuss the Reproduction in microorganisms by various methods like Binary Fission, Asexual, Sexual, Lytic, Lysogenic Cycle.	
CO4	List and summarize methods of enumeration of bacteria Formulate factors affecting bacterial growth (pH, Temperature, Solute concentration (Salt and Sugar) and Heavy metals.	
CO5	Outline and analyse Microbial Interactions with examples	
CO6	Apply and review the knowledge of microbiology to understand Significance of normal flora and probiotics in human health and Microbes as Biofertilizers and Biocontrol Agents and Fermentation Industries	

Unit. No.	Title of Unit and Contents	No. of Lecture (Total 36)
I	**Cultivation and isolation** Nutritional requirements and classification of bacteria Design of media: Common ingredients, Types of media and Composition with examples Handling of microorganisms and Biosafety measures. Concept of Pure culture, axenic culture, co-culture and Mixed culture Isolation of microorganisms and pure culture techniques: Streak , Spread, Serial Dilution, Pour plate, Enrichment (Role of dyes), Single cell isolation Colony characteristics Preservation and maintenance of microorganisms Culture collection centers and their role.	8
II	**Sterilization and Disinfection** Definition: Sterilization, disinfection, antisepsis, different cidal and static agents Chemical agents and their mode of action - Aldehydes, Halogens, Quaternary ammonium compounds, Phenol and phenolic compounds, Heavy metals, Alcohol, Detergents and Ethylene oxide. Physical Agents - Heat, Radiation, Filtration Characteristics of an ideal disinfectant Checking of Efficiency of Sterilization – Biological and Chemical Indicators Checking of Efficiency of Disinfection - Phenol Coefficient	10
III	**Microbial Growth** Growth curve; definitions of Generation time, Growth rate and specific growth rate Reproduction in microorganisms: Binary Fission, Asexual, Sexual, Lytic, Lysogenic Cycle. Methods of enumeration: Microscopic methods (Direct Microscopic Count, Counting cells using Neubauer chamber) ii.Plate counts (Total Viable Count) Estimation of Biomass (Dry mass, Cell volume) Chemical methods (Cell Carbon and Nitrogen estimation) Turbidometric methods Factors affecting bacterial growth (pH, Temperature, Solute concentration (Salt and Sugar) and Heavy metals. Diauxic and Synchronous growth	10
IV	**Microbial Interactions (Tabulation of good bacteria and bad bacteria)** (Any 2 examples each) Microbe-Plant, Microbe-Animal, Microbe-Microbe interaction	4

V	**Applications of Microbiology** Significance of normal flora and probiotics in human health. Microbes as Biofertilizers and Biocontrol Agents (e.g. Nitrogen fixers, Phosphate Solubilizers and *Bacillus thuringensis*) Microbes in Fermentation Industries	4

References:

1. Brock Biology of Microorganisms, Michael.T.Madigan, John.M.Martinko, Paul V. Dunlap, David P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
2. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3nd Edition.Thomson Brooks / Cole.
3. Michael J Pelczar, JR. E.C.S. Chan, Noel R. Krieg. (1993) Microbiology, 5th Edition, Tata MacGraw Hill Press.
4. Prescott, Lancing. M., John, P. Harley and Donald, A. Klein (2006) Microbiology, 6th Edition, McGraw Hill Higher Education
5. Willey J. M., Sherwood L. M. and Woolverton C. J. (2013) Prescott's Microbiology, 8thEdition, McGraw-Hill Higher Education
6. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGrawHillPublishing Co.
7. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition.Macmillan Press Ltd.
8. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc

Title of the Course and Course Code	**Quantitative methods in Biology - II BTH1207**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Apply the knowledge obtained to solve problems in biological mathematics.	
CO2	Identify statistical gaps in biological research. Formulate statistical questions in biology. Build, construct, state hypotheses to answer the formulated questions. Design experiments to collect data. Test the hypothesis based on the collected data.	
CO3	Compare mean, variance and other parameters and statistics, between groups, samples, populations. Test the goodness of fit and independence of attributes.Make judgement about observed patterns in the data collected, based on the outcomes of hypothesis testing.	
CO4	Define the networking and communication. Differentiate different forms of network topologies and protocols Explain the concept of world wide web and internet. Discuss about network security, firewalls and various types of networks.	

CO5	Explain the importance of the database management system in biotechnology. Discuss various types of data models, concept of entity and attributes, entity relationship diagrams, Concept of primary key and relational data models, Define and discuss methods of data retrieval from the biological databases.
CO6	Illustrate the methods of retrieval of the literature databases and understand the searching through text- based methods. Discuss the uses of search engines for biological data retrieval such as google and yahoo

Unit . No.	**Title of Unit and Contents**	**No. of Lecture (Total 36)**
I	**Advanced Equations and functions** Quadratic equations (solving, graphing, features of, interpreting quadratic models *etc*.), introduction to polynomials, graphs of binomials and polynomials; Symmetry of polynomial functions	3
II	**Basic Trigonometry** Basics of trigonometric functions, Pythagorean theory, graphing and constructing sinusoidal functions	3
III	**Differential Equations** Differential calculus (limits, derivatives), integral calculus (integrals, sequences and series *etc*.)	3
IV	**Standard Probability Distributions** Normal – Gaussian Curve, *z*-test Binomial – Bernoulli's trials, Binomial theorem Poisson distribution Central Limit Theorem	3
V	**Experimental Design** Types of questions, Types of hypothesis, Experimental design – sample size, trials	5
VI	**Inferential Statistics** Sampling distributions Hypothesis testing Type I and Type II error One-tailed and two-tailed tests Alpha values Comparison of means – paired, unpaired; population vs. sample mean Independence of attributes and goodness of fit – Chi-square test	10
VII	**Computer Networking** Introduction to Networking, associated hardware devices or gadgets (routers, switches), services and resources **Network topologies and protocols** LAN, WAN, MAN, PAN, CAN	

	Star, bus, hybrid, ring topologies World Wide Web (www) **Network security, Firewalls**	
VIII	**Databases** Types of Databases Basic concepts in: Data abstraction, Data models Instances and 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, multimedia databases Text databases Introduction and overview of biological database Concepts in text-based searching – MEDLINE, PubMed, bibliographic databases	

References:

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 T M Biostatistics. (2001) Antony N Glaser. Lippincott Williams and Wilkins, USA
4. Introduction to Mathematics for Life Scientists. 3rd edition (1979). Edward Batschalet,
5. Mathematics for the Biological Sciences. Illustrated edition (1979) J.C. Acharya and R. Lardner, Prentice Hall, USA
6. Sinha P & Sinha P. 2011. *Computer Fundamentals*. BPB Publications, Connaught Place, Delhi, 478 pp.

Title of the Course and Course Code	**Cell Biology I - BTH1208**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe the structure of cellular organelles and discuss their functions in detail.	
CO2	Interpret the events in cell cycle and effect of certain chemicals on regulation of cell cycle. Classify cell junctions and arrange them according to their roles	
CO3	Classify processes of cell division and describe phases of cell cycle. Classify and describe the checkpoints involved in regulation of cell cycle.	
CO4	Compare archaebacterial, prokaryotic and eukaryotic cells with respect to their properties, cellular diversity and cell types. Explain the components and function of the ExtraCellular Matrix	
CO5	Comparestructureandfunctionofplasma membranes. Compare and contrast types of cell walls, their structure and function.	
CO6	Compile the information on the structural aspect of cellular biology.	

Unit. No.	Title of Unit and Contents	No. of Lecture (Total 36)
I	**Introduction to Cell and its functions.** Comparative account of archeabacteria, prokaryotic and eukaryotic cells**.** Cell structure, cellular diversity, cell types.	6
II	**Structure and function of cell organelles:** Endoplasmic reticulum, Mitochondria, Chloroplast, Ribosomes, Golgi body, nucleus, lysosomes, vacuoles, peroxisomes and Glyoxysomes, Plastids	10
III	**Plasma membrane, cytoskeleton and extra cellar matrix**: Organization and properties of plasma membrane. Cytoskeleton-Structure- assembly and disassembly of cytoskeleton elements, Extracellular matrix and cell junctions- relevance to tissue structure, Plasmodesmata- structure and function Plant cell wall - primary and secondary, glycocalyx	10
IV	**Cell Cycle and its regulation:** Mitosis, meiosis in plants and animals, Phases of cell cycle. Checkpoints and regulation of cell cycle	10

References:

1. Molecular Cell Biology. Lodish H., Berk A, Kaiser C., K Reiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., 7th Edition, (2012) W.H. Freeman and Co., USA
2. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, 5th Edition (2007) Garland Science, USA
3. Cell Biology, Gerald Karp. 6th edition, (2010) John Wiley & Sons., USA
4. The Cell: A Molecular Approach, Geoffrey M. Cooper, Robert E. 6th edition (2013), Hausman, Sinauer Associates, Inc. USA
5. Becker's World of then Cell, Jeff Hardin, Gregory Bertoni, Lewis J.Kleinsmith, 8th Edition (2016), Pearson Education Limited, USA

Title of the Course and Course Code	**Practicals in Biochemistry and Bioinstrumentation BTH 1209**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
Bioinstrumentation		
CO1	Describe the components and working of Bright field compound microscope and analyze its working.	
CO2	Explain Beer Lambert's law and interpret working of the instruments that use the law.Test whether the pH meter is calibrated.Classify different types of centrifuges and their role.	
CO3	Design experiments to validate the use of instruments	
Biochemistry		
CO4	Determine amylase function by DNSA method.	
CO5	Determine order of reaction	
CO6	State biochemical redox reaction using DCPIP, describe model making-based conformational studies of biomolecules	

Sr. No.	**Topic**	**No. of Practicals (15P x 2 H)**
1	Standardization and calibration of pH meter	1
2	Working and components of various types of Centrifuges	2
3	Paper chromatography and detection of biomolecules viz. amino acids	1
4	TLC- to study separation of molecules viz. pigments	1
5	Microscopy – Components and working of Bright field compound microscope	1
6	Agarose gel electrophoresis	1
7	Determination of Amylase function by DNSA method	2
8	To find the order of given reaction	2
9	Biochemical tests for detection of: oxidation-reduction (DCPIP)	2
10	To study conformation of biomolecules through model making	2

Title of the Course and Course Code		**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
Description - Microbiology		
CO1	Design techniques of cultivation, isolation and preservation of bacteria, use and discuss physical and chemical methods to control the growth of micro-organisms	
CO2	Illustrate and assess the techniques of enumeration of micro-organisms and cells	
Description – Cell biology - 1		
CO3	Demonstrate the preparation of slides and identify the particulars of the specimen.	
CO4	Demonstrate and analyze the effect of chemicals on the stages cell division	
CO5	Illustrate the measurement of size of various types of cells and distinguish between specimens.	
CO6	Design simple experiments and assess the quality of the results.	

Sr. No.	**Topic**	**No. of Practicals (15P x 2 H)**
I	Cultivation of microorganisms: Preparation of simple laboratory nutrient media (solid and liquid) and using them to cultivate bacteria. Aseptic transfer techniques (slant to slant, broth to broth, broth to agar and Agar to agar using glass and micro pipettes)	2
II	Isolation of bacteria by streak plate technique, Enumeration of bacteria from fermented food / soil / water by: Spread plate method, Pour plate method, Observation of the growth of cultures and reporting of colony and cultural characteristics (Nutrient and MacConkey's agar)	2
III	To study the effect of different parameters on growth of *E. coli*: pH,temperature, sodium chloride concentration, Study of Oligodynamic action of heavy metal	2
IV	Activity for students: Evaluation of disinfectants(domestic disinfectants/Toothpaste) check their phenol coefficient (qualitative) , Study colonies of bacteria on differential and Specific media, Petri dish art, Quiz,	2

V	Study of mitosis (onion root tip) – preparation of slides and identification of different stages, Effect of colchicine on mitosis.	2
VI	Study of meiosis (grasshopper testis/*Tradescantia*)– preparation of slides and identification of different stages	2
VII	Enumeration of yeast cells using a counting chamber	1
VIII	Micrometry – measurement of cell size and nucleus from various cell types	2

Title of the Course and Course Code	**Practicals in Plant and Animal Sciences-II BTH1211**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Demonstrate the phenomenon of Osmosis. Determine Diffusion Pressure Deficit by using Potato tubers	
CO2	Determine the rate of Transpiration under different environmental conditions. Describe some economically important plants	
CO3	Organise Visit to GreenHouse.	
CO4	Demonstrate basic proficiency to understand tissues in the different organs. Characterize and describe the differences between tissues and organs. Describe regular morphology of the animal organism: cells, tissues, organs and systems	
CO5	Compare and Contrast circulatory immune system cells and perform total and differential blood cell count	
CO6	Discuss, classify and specify various physiological reflexes and responses.	

Sr. No.	**Topic**	**Practicals (15P x 2 H)**
Plant sciences		
I	Study the process of Osmosis	1
II	To determination of Transpiration under different conditions of shade, wind and light.	1
III	Determination of Diffusion Pressure Deficit by using potato	1
IV	Plant resources and their utilization- Food crops - Botanical and common names, description and Phytochemical tests for stored food material	3

	Medicinal and aromatic plants - Botanical and common names, plant parts used, medicinal uses, Herbarium of some medicinal plants Qualitative tests for secondary metabolites	
V	Visit to greenhouse	1
Animal Science		
VI	Study of tissue histology	2
VII	Peripheral blood smear for total and differential count	2
VIII	Study of sensory physiology (Gustatory/ visual/ auditory/ olfactory)	2
IX	Check response of tactile receptors to temperature changes	1
X	Testing reflexes and reactions	1

Title of the Course and Course Code	**Practicals in Biostatistics and Computers – II** **BTH1212**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Collect data on the field for analysis in the lab. Arrange, classify, summarise data collected opportunistically or through experimentation.	
CO2	Apply the theoretical concepts to the collected data to describe the data.	
CO3	Create an MS Excel workbook to enter the data. Analyse the data using Excel workbook. Compare the parameters of the collected data. Calculate biodiversity indices to measure the level of diversity.	
CO4	Design the database instances and schemas and organize the data using Microsoft Access Outline the steps for generating the forms and report using Microsoft Access. Create the relationship using the primary key concept .	
CO5	Explain various DOS commands for creation of directories, remove the directories, format the foreground and background colour. Use the DOS commands and Create the directories, change the date and time, manage the hardware components using DOS prompt.	
CO6	Illustrate the steps to retrieve the data from the various biological databases. Use various methods for data searching to create the knowledge pool.	

Sr. No.	Topic	Practicals (15P x 2H)
1	Regression and correlation of Biological Data	2
2	Biological data collection for analysis in lab	2
3	Fitting of the following standard distributions: binomial, Poisson, normal	2
4	Chi square test, T-test, ANOVA	2
5	Diversity indices – Shannon-Weaver, Simpson's, Similarity and Dissimilarity	2
6	Database Applications (Microsoft Access): Fields, Records, Files, Organization of Files, Access Modes; Updating Records, Querying, Reports, Forms & subforms, Demonstration of Searching and Information Retrieval of Biological Databases :Through Entrez and SRS Search Engines:	3
7	File handling: copy, rename, delete, type Directory structure: make, rename, move directory	2