CELL BIOLOGY AND GENETICS		Semester	III
Course Code	**BBT301**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To gain basic understanding of cellular processes, pathways and cytoskeletal organization.
- To be able to understand concepts of cell signalling
- To gain an understanding of classical genetics and apply the same to disorders.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 Hours)

CYTOLOGY AND CYTOSKELETON

Prokaryotic and eukaryotic cell, Cell Architecture, physio-chemical nature of plasma membrane and functions of cell organelle; nucleus, mitochondria, chloroplast, ribosomes, peroxisomes, Golgi bodies and endoplasmic reticulum. Cytosketal elements, Microtubules: structure & functions, shaping of the cells and mechanical support. Microfilaments: structure & functions. Structure of intermediate filaments. Cytoplasmic micro trabecular system (lattice). Covalent modifications of cytosmear proteins. Cytoskeletal architecture

Module-2(8 Hours)

CELL CYCLE AND CELL SIGNALLING:

Cell cycle studies; mitosis and meiosis. Cell Birth, lineage and death, Cellular senescence and ageing, Hayflick phenomenon, Senescence in ageing and age-related disease, Apoptosis and Necrosis, Cancer Cell Biology, Asymmetrical cell division, patterns of stem cell division. Signalling molecules and cell surface, receptors; intracellular signal transduction; G protein coupled receptors; plant growth factors and hormones, Eukaryotic and Prokaryotic cell to cell signalling, endocrine signalling, quorum sensing and intercellular signalling, Signal peptides, biofilm formation.

Module-3(8 Hours)

MEMBRANE TRANSPORT:

Membrane transport, passive and active transport; transport into prokaryotic cells; Endomembrane System: Golgi, Lysosomes Vesicular Traffic, Secretion, and Endocytosis, exocytosis; entry of viruses and toxins into cells Membrane trafficking: Translocation of secretory proteins across the ER membrane; protein modifications, folding and quality control in the ER; export and sorting of proteins to mitochondria, chloroplast and peroxisomes.

Module-4 (8 Hours)

GENETICS:

Nature of genetic material, Mendelian Laws of inheritance, monohybrid and dihybrid inheritance, law of segregation & independent assortment, Gene interactions, supplementary genes - Comb patterns in fowls, Complementary genes - Flower color in sweet peas, Epistasis- Inhibitory and colored genes in fowls, simple problems. Identification of genetic material, classical experiments- Hershey & Chase, Avery, McLeod etc.,

Multiple alleles and groups antigens. Numericals based on concepts. Chromosome, Centrosome, telomere, Chemical composition of chromatin, structural organization of nucleosomes, heterochromatin. Polytene and lamp-brush chromosomes, human chromosomes.

Module-5 (8 Hours)

CHROMOSOMAL DISORDERS

Sex determination in plants, animals XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in animals. Chromosomal disorders. Sex linked inheritance molecular diseases, hemoglobinopathies. Disorders of coagulation, Colour blindness, hemophilia, Non-disjunction as a proof of chromosomal theory of inheritance, Linkage maps, crossing over. Chromosomal maps, interference coincidence.

POPULATION GENETICS:

Introduction, Gene frequency, and equilibrium estimation, changes in gene frequency, inbreeding and heterosis, genetic structure of population, speciation and evolution, prospects for the control of human evolution. Spontaneous and induced mutations, Eugenics. Pedigree analysis

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Co-relate cellular structure-function relationship in the context of cell growth and death.
2. Apply the concepts of cell signalling to biofilm formation.
3. Apply the principles of Mendelian Genetics to understand gene interactions, multiple alleles and sex-linked inheritance.
4. Apply principles of Chromosome structure and gene frequencies in the context of inherited disorders and population genetics.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

- The Cell – A Molecular Approach, Cooper & Hausman, ASM Press, 2004.
- Cell and molecular biology, EDPDe Robertis, EMF De Robertis, Lea &. Febiger Intl. ed.1991.
- Molecular Biology of the Cell, B. Alberts, et al., Garland Science, 4th ed. 2002.
- Molecular Cell Biology Hardcover ,James E. Darnell, Harvey Lodish, David Baltimore,1999

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=LFyjJBiltFI
- https://www.biologyonline.com/tutorials/biological-cell-introduction
- https://study.com/academy/topic/cell-biology.html
- https://www.edx.org/learn/cellular-biology
- https://onlinecourses.swayam2.ac.in/cec19_bt12/preview

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Group Discussion of Case studies
- Model Making and poster presentations

UNIT OPERATIONS + LAB		Semester	III
Course Code	**BBT302**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory/Laboratory		

Course objectives:

- To know the fundamental concepts of fluid mechanics, heat and mass transfer.
- To understand the design concepts of fluid and particulate technology.
- To solve engineering problems related to fluid flow, heat and mass transfer.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

MODULE-1 (8 HOURS)

FUNDAMENTALS OF FLUID MECHANICS:

Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids &Newton's Law of viscosity. Fluid static s-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement (problems), Basic equations of fluid flow, Continuity equation, Euler's equation and Bernoulli equation; Types off low: laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits, Hagen Poiseuille equation (no derivation). Flow through stagnant fluids, theory of Settling and Sedimentation, Equipment(cyclones, thickeners) Conceptual numericals.

MODULE-2 (8 HOURS)

FLOW MEASUREMENTS & MECHANICAL OPERATIONS:

Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements. Pumps: types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction, characteristics of comminute products, sieve analysis, Properties and handling of particulate solids: characterization of solid particles, average particle size, screen analysis, Conceptual numericals of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipment (plate and frame, rotary drum). Conceptual numericals.

MODULE-3 (8 HOURS)

CONDUCTIVE & CONVECTIVE HEAT TRANSFER:

Modes of heat transfer; Conduction: steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection: Forced and Natural convection, principles of heat transfer coefficient, log mean temperature difference, individual and overall heat transfer co-efficient, fouling factor; Condensation: film wise and dropwise (no derivation). Heat transfer equipment: double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications). Conceptual numericals.

MODULE-4 (8 HOURS)

BASICS OF MASS TRANSFER:

Diffusion: Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant/unidirectional and bidirectional). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numericals.

MODULE-5 (8 HOURS)

MASS TRANSFER OPERATIONS:

Basic concepts of Liquid-liquid extraction: equilibrium, stage type extractors (belt extraction and basket extraction). Distillation: Methods of distillation, distillation of binary mixtures using McCabe Thiele method. Drying operations, batch and continuous drying. Conceptual numericals.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Batch Sedimentation
2	Flow through circular/non-circular pipes / packed bed flow
3	Flow measurements using Venturi /Orifice meter.
4	Ball Mill and Sieve Analysis
5	Natural convection in bare tubes
6	Heat transfer in packed bed / DPHE
7	Mass transfer coefficient in Humidification and Dehumidification
8	Diffusion of organic solvent (CCL4) in air
9	Effect of temperature on the diffusion co-efficient
10	Liquid-Liquid Extraction
11	Distillation of binary mixtures
12	Tray drying characteristics

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

1. Describe the nature and properties of fluids.
2. Perform various flow measurements using different instruments.
3. Explain the Principles of various mechanical operations like size reductions, conveying equipment, sedimentation and mixing tanks.
4. Illustrate the laws governing the heat and mass transfer operations.
5. Analyse the construction details of heat and mass transfer equipment for specific requirements.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

- Unit operations in Chemical Engineering, Warren L. McCabe, Julian, C. Smith & Peter Harriot, McGraw-Hill Education (India) Edition, 2014
- Principles of Unit Operations Alan S Foust, L.A. Wenzel, C. W. Clump, L. Maus, and L. B. AndersonJohn Wiley & Sons, 2nd edition, 2008.
- Unit Operations of Chemical Engineering, Vol I&II Chattopadhyaya KhannaPublishers,Delhi-6 1996.
- Fluid Mechanics, K L Kumar S Chand & Company Ltd, 2008.
- Introduction to Chemical Engineering, Badger W.I. and Banchero, J.T., Tata McGraw Hill New York. 1997.
- Heat Transfer J P Holman Mc Graw Hill International Ed., 10th Edition, 2010.

Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://nptel.ac.in/courses/103103155
- https://nptel.ac.in/courses/103107127
- https://www.youtube.com/watch?v=ntjyr9kXuCs
- https://onlinecourses.nptel.ac.in/noc20_ch27/preview
- https://www.classcentral.com/course/swayam-mechanical-unit-operations-14193
- https://www.isa-lille.com/academics/master-programs/food-science/course-unit-operations/N

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Group Discussion of Case studies
- Model Making and poster presentations

BIOCHEMISTRY + LAB		Semester	III
Course Code	**BBT303**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory/Laboratory		

Course objectives:

- To get an overview of the main aspects of biochemistry by relating molecular interactions to their effects on the organism as a whole.
- To understand the organization of macromolecules through a discussion of their hierarchical structure and study their assembly into complexes, responsible for specific biological processes.
- To Comprehend the different metabolic pathways and their interconnections into tightly regulated networks

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

MODULE-1 (8 HOURS)

BASIC CONCEPTS:

Types of chemical reactions, pH, Henderson Hesselbalch equation, buffers and their properties, concentration of solutions. Stereo chemistry of carbon compounds. BIOMOLECULES: Classification, structure, properties and functions of Carbohydrates, Lipids, Proteins and Nucleic acids (in brief)

MODULE-2 (8 HOURS)

BIOENERGETICS:

Introduction, energy flow cycle, thermodynamic laws, Standard free energy change-equilibrium constant. High energy compounds, structure and properties of ATP, biological oxidation - Electron transport chain, ATP synthesis. Oxidative phosphorylation. Energetics, energy balance sheet, oxidative stress. Photosystems and photophosphorylation (synthesis of ATP and NADPH), Inhibitors of oxidative phosphorylation,

MODULE-3 (8 HOURS)

METABOLISM OF CARBOHYDRATE:

Glycolysis –metabolism. Aerobic and anaerobic pathway and regulation, TCA cycle, NADPH Cycle, Calvin Cycle, Glyoxylate cycle, Pentose Phosphate Pathway. Gluconeogenesis – regulation of gluconeogenesis. Glycogenesis and glycogenolysis, their regulation. Disorders of carbohydrate (lactose intolerance, galactosemia, diabetes)

MODULE-4 (8 HOURS)

METABOLISM OF LIPID:

Digestion, Mobilization and transport of fats, Biosynthesis of palmitic acid, and biodegradation of triglycerides and fatty acids (beta oxidation). Physiology of lipids/lipoproteins and apolipoproteins. Disorders of Lipid metabolism (atherosclerosis, ketone bodies (acidosis-kesosis), Gaucher disease and LDL-hypercholesterolemia)

MODULE-5 (8 HOURS)

METABOLISM OF AMINO ACIDS & NUCLEIC ACIDS:

Biosynthesis of essential amino acids: Lysine, Phenylalaninine and Glutamine. Biodegradation of amino acids, deamination, transamination and urea cycle. Disorders of amino acid metabolism (phenylketonuria, alkaptonuriea, tyrosinemia and maple syrup urine disease). Biosynthesis, biodegradation, and regulation of Purines, pyrimidines,

Disorders of nucleic acid metabolism (Gout, leshnyhn syndrome, hyper and hypo uricemia, adenosine deaminase deficiency).

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	pH measurements, volume / weight measurements, concentration units, sensitivity Specificity, precision, accuracy, preparation of buffers of constant strength.
2	Titration of amino acids with acids & bases.
3	Qualitative tests for carbohydrate and lipids.
4	Qualitative tests for amino acids and proteins.
5	Estimation of blood sugar by Folin method/ O-Toluidine method
6	Estimation of amino acid by ninhydrin method.
7	Estimation of DNA by DPA method
8	Determination of Saponification value and iodine value of lipids with error analysis.
9	Estimation of proteins by Lowry's method
10	Estimation of urea by DAMO method
11	Estimation of iron from haemoglobin with error analysis.
12	Separation of Chlorophyll and Chloroplast.

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

1. Explain the fundamentals of biologically important molecules such as structures, functions and interactions
2. Understand complex biochemical pathways within living cells and the associated metabolic disorders
3. Comprehend biochemical principles and apply them to biological systems/samples
4. Perform basic biochemical experiments, analyse, interpret and present the data

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.

- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

- Principles of Biochemistry, Donald Voet, Judith G. Voet, Charlotte W. Pratt, 4th Edition, John Wiley & Sons, 2012.
- Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, 67h Edition, W.H. Freeman, 2017.
- Biochemistry, U Satyanarayana, 5th Edition Books & Allied Ltd., 2017.
- Biochemistry, Denise Ferrier, Lippincott, Williams & Wilkins, 2017.
- Harper's Illustrated Biochemistry by Victor W. Rodwell, David Bender, Kathleen M. Botham, Peter J. Kennelly,P. Anthony Weil, Thirty-First Edition (A & L LANGE SERIES), 2018.

Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://ocw.mit.edu/courses/7-012-introduction-to-biology-fall-2004/resources/lecture-2-biochemistry-1/
- https://onlinecourses.nptel.ac.in/noc22_cy06/preview
- https://ocw.mit.edu/courses/5-111-principles-of-chemical-science-fall-2008/resources/lecture-36/
- https://cosmolearning.org/courses/biochemistry-i/video-lectures
- https://ocw.mit.edu/courses/7-012-introduction-to-biology-fall-2004/resources/lecture-2-biochemistry-1/
- https://onlinecourses.nptel.ac.in/noc22_cy06/preview
- https://www.udemy.com/course/introduction-to-biochemistry/
- https://www.edx.org/learn/biochemistry

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Beer lamberts law and Determination of lambdamax of colored solutions/molecules.
- Importance of Biochemistry in drug discovery (with case studies)
- Regulation of metabolic pathways (with examples)
- Group Discussion of Case studies

MICROBIOLOGY		Semester	III
Course Code	**BBT304**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To understand the details of classification, structural features and functional aspects of prokaryotic and eukaryoticmicroorganisms.
- To learn different techniques of microscopy and be able to describe microbial techniques for growth, cultivation and characterization of microorganisms.
- To explain microbial metabolism, growth and control of microorganisms.
- To describe and relate the occurrence of microbes caused diseases.
- To be able to study occurrence and role of general microflora of air, water and soil.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflectiveand questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 hours)

OVERVIEW OF MICROBIOLOGY AND MICROORGANISMS:

Scope and History of Microbiology (Major milestones). Prokaryotes, Archaea and Eukaryotes. Microbial diversity and Taxonomy. Classification, characteristics and reproduction of Bacteria, Viruses, Fungi, Protozoa, Algae. General features of true bacteria (Rickettsia, Mycoplasma and Chlamydia), Prions, Spirochetes, Actinomycetes.

Module-2 (8 hours)

METHODS AND TECHNIQUES IN MICROBIOLOGY:

Microscopy: Bright-Field, Dark-Field, Phase-Contrast, Acoustic, Fluorescence, Electron Microscopy (SEM, TEM). Micrometry. Media: types and preparation. Pure culture Techniques (streak-plate, spread plate, pour plate). Staining techniques (Simple and differential).

Module-3 (8 hours)

MICROBIAL GROWTH, METABOLISM AND CONTROL:

Microbial growth Phases, Factors affecting the growth, growth measurement and enumeration. Metabolism; Primary and Secondary metabolites with examples, metabolic pathways important in microorganisms- Respiration and Fermentation (EMP, HMP, ED, Phospho ketolase, Mixed acid, TCA). Control of growth (Sterilization and disinfection techniques).

Module-4 (8 hours)

MICROBIOLOGY AND DISEASES:

Common diseases caused by microbes: viruses (Polio, H1N1, SARS, Covid-19, HIV, Hepatis), bacteria (TB, Cholera, Typhoid, Pneumonia, Plague, Diphtheria, *E. coli* infections), Protozoans (Malaria, Leishmaniasis and Amebiasis). Common types of fungal infections (ringworm, yeast infection). Microbiome and gut health.

Module-5 (8 hours)

MICROBIOLOGY OF AIR, WATER & SOIL

Aerobiology, Air sampling techniques. and commonly found atmospheric microbe profile. Water sampling techniques, Microbiology of potable water and wastewater treatment. Microbiology of soil: Soil fertility, Biofertilizers: VAM, Rhizobium and Azotobacter. Biogeochemical cycles. Case studies.

Course outcome (Course Skill Set)

1. Be able to classify microorganism along with their structural and functional roles
2. Apply learning of microscopy and microbial techniques in identification and enumeration
3. Identify microbes through use of appropriate culture, characterize them under given conditions and study the microbial growth along with its control
4. Describe and relate the occurrence of microbes caused diseases.
5. Explain the occurrence and role of general microflora of air, water and soil.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

- Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**
- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

- General Microbiology: Roger Y Stanier, John L Ingraham, and Mark L Wheels Macmillan Press Ltd, V Edition(International Edition). 1999.
- Ananthanarayan and Paniker, Textbook of Microbiology. Orient Blackswan, 2006.
- Microbiology Michael J Pelczar, J R Chan ECS, Noel R Krieg Tata McGraw-Hill Education Pvt. 2013.
- Harley, Klein. Microbiology Prescott, McGraw Hill Seventh Edition.1996.
- Industrial Microbiology, Prescott and Dunn, CBS Pub. 4th Edition, 2004.
- Black J, Microbiology: Principles and Explorations, 7th Edn. John Wiley and Sons, USA. 2010.

Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://www.udemy.com/course/basics-of-medical-microbiology/
- https://www.edx.org/learn/microbiology
- https://www.coursera.org/courses?query=microbiology
- https://www.futurelearn.com/courses/introduction-to-microbiology
- https://alison.com/course/introduction-to-microbiology
- https://www.hsph.harvard.edu/nutritionsource/microbiome/
- e- books:
  http://books.pakchem.net/microbiology-books.html
  http://www.austincc.edu/rohde/noteref.htm

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Group Discussion of Case studies
- Model Making and poster presentations

MICROBIOLOGY LAB		Semester	III
Course Code	BBTL305	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total hours	15	Total marks	100
Credits	01	Exam Hours	3
Examination type (SEE)	Practical		

Course objectives:

- To develop ability to use basic instruments in the microbiology lab
- To prepare required media and sterile the glassware for culturing microbes
- To be able to characterize and enumerate different microorganisms
- To analyse the bacterial growth curves and phases of growth

Sl.NO	Experiments
1	Study of major laboratory instruments: Compound microscope, Autoclave, Hot air oven, Incubator, biosafety cabinet and centrifuge.
2	Aseptic techniques in laboratory preparations and analysis: Sterilisation, disinfection and sanitisation.
3	Culture techniques: Types of culture media, inoculation, incubation and isolation of pure colonies.
4	Cultural characterisation: Study of strain colony morphology (homogeneity, size, shape, colour, opacity and texture of colonies)
5	Microscopic characteristics: Microscopic observation of shape and cell size, mobility.
6	Enumeration techniques: Enumeration of microbes (Plate count, haemocytometer), and size determination using micrometry.
7	Fixation and staining: Isolation of microbes using staining techniques (Simple, Gram staining, and spore staining).
8	Staining techniques: Acid Fast Staining, Negative staining and Fungal staining.
9	Biochemical Characterization of bacteria: IMViC, Starch hydrolysis, carbohydrate assimilation.
10	Biochemical Characterization of bacteria: Catalase, Urease, hydrogen sulphide, Gelatine Liquefaction tests.
11	Bacterial Growth curve studies.
12	Antibiotic susceptibility test of a selected bacterium.
13	DIY experiment (To be designed and executed by students themselves).

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. Learn the basic techniques in Microbiology.
2. Apply the knowledge and execute experiments on methods of sterilization, identification, and characterization of microbes.
3. Observe and deduce conclusion of bacterial growth studies.
4. Design and execute an experiment in basic microbiology.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics

shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- Experiments in Microbiology, Plant Pathology and Biotechnology by K. R. Aneja, New Age International, 2003
- Microbiology: A Lab Manual by Cappuccino, Pearson Education, 2007
- Manual of Microbiology: Tools & Techniques by Kanika Sharma, Ane Books Private Limited, New Delhi, II Edition 2011, Reprinted 2020
- Lab Ref Jane Roskams, Linda Rodgers, Cold Spring Harbor, N.Y., 2002

Web links and Video Lectures (e-Resources):

- https://www.labster.com/microbiology-virtual-labs
- https://www.mheducation.com/highered/microbiology.html
- https://asm.org/Articles/2020/December/Virtual-Resources-to-Teach-Microbiology-Techniques
- https://www.cnm.edu/programs-of-study/math-science-engineering/microbiology-lab-manual
- http://faculty.collin.edu/dcain/CCCCD%20Micro/tutorial.htm
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4844744

PYTHON PROGRAMMING		Semester	III
Course Code	**BBT306A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To read and write simple Python programs.
- To develop Python programs with conditional sandloops.
- To define Python functions and call them.
- To use Python data structures–lists, tuples, dictionaries

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 Hours)

ALGORITHMIC PROBLEM SOLVING

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, and guess an integer number in a range, Towers of Hanoi.

Module-2(8 Hours)

DATA EXPRESSION

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments

Module-3(8 Hours)

STATEMENTS, CONTROL FLOW

Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points. Conditionals: Boolean values and operators, conditional(if), alternative(if-else), chained conditional (if- elif-else); Iteration: state, while, for, break, continue, pass; Strings: string slices, immutability, string functions and methods, string module.

Module-4 (8 Hours)

FUNCTIONS, LISTS

Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters.

Module-5 (8 Hours)

TUPLES, DICTIONARIES:

Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Develop algorithmic solutions to simple computational problems.
2. Read, write, debug, and execute simple Python programs.
3. Structure simple Python programs for solving problems.
4. Decompose a Python program into functions

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

- Think Python: How to Think Like a Computer Scientist Allen B. Downey. Shroff O'Reilly Publishers 2ndedition,2016.
- An Introduction to Python –Revised and updated for Python 3.2 Guido van Rossumand Fred L. Drake Jr Network Theory Ltd., 2011.
- Introduction to Computer Science using Python :A Computational Problem-Solving Focus Charles Dierbach Wiley India Edition, 2013.
- Introduction to Programming in Python: An Inter-disciplinary Approach Robert Sedgewick, Kevin Wayne, Robert Dondero Pearson India Education Services Pvt. Ltd, 2016.
- Fundamentals of Python: First Programs Kenneth A. Lambert CENGAGE Learning, 2012.

Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://nptel.ac.in/courses/106106182
- https://www.youtube.com/watch?v=_uQrJ0TkZlc
- https://www.udemy.com/course/pythonforbeginners/
- https://www.udemy.com/topic/python/
- https://www.coursera.org/courses?query=python
- https://www.freecodecamp.org/news/best-python-courses/
- https://www.codecademy.com/catalog/language/python
- https://www.edx.org/learn/python

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Installation and running of latest version of python from website.
- Introduction of console
- Check data types.
- Write a program to demonstrate different number datatypes in python.
- Write a program to perform different arithmetic operations on numbers in python.
- Write a program to create, concatenate and print a string and accessing substring from a given string.
- Write a python script to print the current date in following format “Sun May 29 02:26:23 IST 2017”
- Write a python program to find largest of three numbers.
- Write a python program to convert temperature to and from Celsius to Fahrenheit.
- Write a python program to print prime numbers less than 20.
- Write a python program to find factorial of a number using recursion.
- Create a function calculator to do basic mathematical operations.
- Write a python program to define a function to find Fibonacci Numbers
- Construct a module and reuse the module in a program to create a personalized birthday song.
- Write a program to enrol students to multiple games using list (maximum team size is 11)
- Write a Python program to create a tuple with different data types.
- Write a Python program to check whether an element exists within a tuple.
- Write a python program to create a dictionary and access an element from dictionary.
- Write a python program to check if a key already exists in dictionary.

HUMAN ANATOMY AND PHYSIOLOGY		Semester	III
Course Code	**BBT306B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To understand the fundamentals of Anatomy & Physiology.
- To provide an in-depth instruction in the organization, structures, and functions of the human body.
- To learn about the pathology of each body system and how they interrelate to maintain homeostasis.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 Hours)

INTRODUCTION TO HUMAN BODY:

Definition and scope of anatomy and physiology, levels of structural organization and body systems, basic life processes, homeostasis, basic anatomical terminology. Skeletal system: Divisions of skeletal system, types of bone, salient features and functions of bones of axial and appendicular skeletal system Organization of skeletal muscle. Lymphatic system: Lymphatic organs and tissues, lymphatic vessels, lymph circulation and functions of lymphatic system Peripheral nervous system: Classification of peripheral nervous system: Structure and functions of sympathetic and parasympathetic nervous system. Origin and functions of spinal and cranial nerves. Special senses: Structure and functions of eye, ear, nose and tongue and their disorders.

Module-2 (8 Hours)

TISSUES, SKELETAL & MUSCULAR SYSTEM:

Epithelial tissue, Connective tissues (Blood, Bones, cartilages), Muscular tissues, Nervous tissue, Cartilage and bone; Comparison between cartilage and bone; Functions of skeletal system; Joints; Muscles of limb movement. Principal types of muscles; General properties of muscles; Mechanism of muscle contraction and relaxation, Red and white muscle fibers.

Module-3 (8 Hours)

DIGESTIVE SYSTEM:

Overview of digestive system, functional anatomy of digestive system: mouth, pharynx, oesophagus, the stomach the small and large intestine. Digestive glands, Enzymes; Physiology of Digestion and Absorption.

EXCRETORY SYSTEM:

Methods of excretion; Physiological processes involved in excretion; Kidneys; Anatomy and physiology, Nephron and its structure. Functions of nephron; Nephron physiology and mechanism of urine formation; Regulation of urine formation; Osmoregulation by kidney.

Module-4 (8 Hours)

RESPIRATORY & CIRCULATORY SYSTEM:

Structure of respiratory organs; Mechanism of breathing; pulmonary air volumes, Gas exchange in the lungs. Kinds of respiration; Transport of respiratory gases in the blood Structure, Composition and functions of blood. Blood Groups and Rh factor. Blood clotting mechanism, Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle, electrocardiogram. Blood pressure and its regulation. Brief outline of cardiovascular disorder like hypertension, hypotension, arteriosclerosis, angina, myocardial infarction, congestive heart failure and cardiac arrhythmias.

Module-5 (8 Hours)

NERVOUS AND ENDOCRINE SYSTEM:

Role of nervous system; Types of neurons. Types of glial cells and its function. Main properties of nervous tissue Mode of action of nerves; Conduction of nerve impulses; Central nervous system; The brain; The spinal cord; Peripheral nervous system Endocrine systems of vertebrates; Pituitary gland; Thyroid gland; Parathyroid gland; Pancreas; Adrenal or suprarenal glands; Sex glands; Gastrointestinal mucosa; Thymus gland; Pineal gland; Summary of different endocrine glands; their hormones and influence; Summary of the effect of hyper secretion and hyposecretion of some important endocrine glands.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Apply the basic knowledge of physiology as a process of various human anatonomical systems.
2. Co-relate functioning of different tissue and organ systems in the context of health and disease.
3. Analyze the interface between different organ systems essential for maintenance of health & well-being.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

- Human Physiology by Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022.
- Ross and Wilson Anatomy and Physiology in Health and Illness by Anne Waugh, Allison Grant. Churchill Livingstone 11th Edition, 2010.
- Fundamentals of Human Physiology by Lauralee Sherwood Brooks/Cole, Belmont 4thEdn, 2012.
- Anatomy and Physiology for nurses (including notes on their clinical application) by Evelyn Pearce. JAYPEE Publishers, 1993.
- Essentials of human physiology for pharmacy by Laurie Kelly Mccorry. CRC Press 2nd Edn, 2008.
- Concise Medical Physiology by Sujit K Chaudhari, New Central Book Agency Pvt. Ltd 5th Edn, 2003.

Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://www.udemy.com/course/anatomy-and-physiology-1-the-foundations/
- https://www.mindluster.com/certificate/123?
- https://www.edx.org/learn/human-anatomy
- https://oli.cmu.edu/courses/anatomy-physiology-i-ii-v2-academic/
- https://www.coursera.org/courses?query=anatomy

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- AV presentation by students (on topics as per choice of the teacher)
- Online tools for surprise quizzes
- Collection of case studies based on research findings
- Poster presentations on specific case studies.

R PROGRAMMING FOR BIOLOGISTS		Semester	III
Course Code	**BBT306C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To master the use of the R and RStudio interactive environment.
- To expand R by installing R packages.
- To explore and understand how to use the R documentation.
- To read Structured Data into R from various sources.
- To understand the different data types in R.
- To understand the different data structures in R.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 Hours)

INTRODUCTION:

Fundamentals, installation and use of software, data editing, Downloading and installation of R from CRAN on windows and Linux OS. Getting help from CRAN website and the internet and the help commands. Command packages: standard command packages, running and manipulating the commands, Establishment of R programming.

Module-2 (8 Hours)

DATA TYPES:

R & R Studio Installation, Scalar, Vectors, Matrix, List, Data frames, Factors, Handling date in R, Conversion of data types, Operators in R, importing data and manipulating data in R.

Module-3 (8 Hours)

CONDITIONAL STATEMENTS AND FUNCTIONS:

If …else, For loop, While loop, Repeat loop, Apply(), sApply(), rApply(), tApply. conditional executions and loops, data management with sequences. Data management with repeats, sorting, ordering, and lists.

Module-4 (8 Hours)

DATA MANAGEMENT:

Vector indexing, factors, Data management with strings, display and formatting. data management with display paste, split, find and replacement, manipulations with alphabets, evaluation of strings, Data frames, import of external data in various file formats

Module-5 (8 Hours)

STATISTICS:

Basics of statistics, statistical functions, compilation of data. Data Visualization in R using GG Plot: Box Plot, Histograms, Scatter Plotter, Line chart, Bar Chart, Heat maps Misc. functions and Data Visualization using Plotly:3Dview, Geo Maps, Null Handling, Merge, Grep, Scan.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Download and install R and RStudio.
2. Use of operators and functions in R.
3. Solve fundamental problems.
4. Apply R in data management and visualization.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

- R For Dummies 2nd Edition by Andrie de Vries and Joris Meys, 2015.
- R in a Nutshell 2e: A Desktop Quick Reference Paperback by Joseph Adler, 2012.
- Learning R: A Step-By-Step Function Guide to Data Analysis Paperback by Richard Cotton, 2013.
- R Programming for Beginners: Fast and Easy Learning Rby Steven Keller, 2016.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/111104100
- https://www.youtube.com/watch?v=fDRa82lxzaU
- https://www.udemy.com/topic/r-programming-language
- https://www.udemy.com/course/r-programming/
- https://www.mygreatlearning.com/great-lakes-pgpdsba?
- https://www.coursera.org/learn/r-programming
- https://www.edx.org/learn/r-programming
- https://www.udemy.com/topic/r-programming-language/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Installation and working with R
- Executing simple programs in R
- Using graphical data visualization
- Problem solving using R

PLANT PHYSIOLOGY AND PHYTOHORMONES		Semester	III
Course Code	**BBT306D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To learn the fundamental so plant physiology
- To explore the roles of various phytohormones and their action mechanisms
- To study the plant environment interactions

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 Hours)

Introduction to Plant Physiology: Definition and scope of plant physiology, Plant anatomy and morphology, Plant growth and development, Water Relations and Mineral Nutrition, Water potential and its measurement, Water uptake and transport in plants, Mineral nutrients and their roles in plant growth, Nutrient uptake and transport mechanisms.

Module-2 (8 Hours)

Photosynthesis, Respiration and Energy Metabolism: Light absorption and chlorophyll pigments, Photosynthetic pigments and their functions, Calvin cycle and carbon fixation, Factors affecting photosynthesis, Respiration and Energy Metabolism - Cellular respiration and ATP production, Glycolysis, Krebs cycle, and electron transport chain, Aerobic and anaerobic respiration.

Module-3 (8 Hours)

Plant Hormones: Introduction to phytohormones, Auxins: functions and physiological effects, Gibberellins: functions and physiological effects, cytokinins: functions and physiological effects, Abscisic acid: functions and physiological effects, Ethylene: functions and physiological effects.

Module-4 (8 Hours)

Plant Growth, Development & plant movements: Seed germination and dormancy, Photomorphogenesis and photoperiodism, Flowering and reproduction, Senescence and aging, Tropisms: phototropism, gravitropism, thigmotropism, Nastic movements: nyctinasty, eismonasty, Movements in response to environmental cues.

Module-5 (8 Hours)

Plant-Environment Interactions and Stress Physiology: Plant responses to abiotic stress (e.g., temperature, light, drought), Plant responses to biotic stress (e.g., pathogens, herbivores), Plant defence mechanisms, Signal transduction pathways in stress responses, Plant responses to light and photomorphogenesis, Plant responses to temperature, Water, and nutrients

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. comprehend the fundamental principles of plant physiology.
2. Examining the mechanisms of plant hormone action.
3. Analysing the interaction between phytohormones and the environment.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

- Plant Hormones: Physiology, Biochemistry and Molecular Biology" by P.J. Davies and H.G. Davies
- A Textbook of Plant Physiology by S. K. Sinha
- Plant Physiology and Biochemistry" by S. Mohan Jain and A. K. Gupta
- Principles of Plant Physiology by K. V. Madhava Rao:

Web links and Video Lectures (e-Resources):

- https://onlinecourses.swayam2.ac.in/cec20_bt01/preview
- https://nph.onlinelibrary.wiley.com/doi/full/10.1046/j.0028-646X.2001.00281.x
- https://www.intechopen.com/chapters/81026
- https://www.cambridge.org/core/books/abs/plant-physiology/plant-hormones-and-signal-transduction/9A8F77D94D53C30A70F3B6A406CFB187

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning.

- AV presentation by students (on topics as per choice of the teacher)
- Online tools for surprise quizzes.
- Collection of case studies based on research findings.
  Poster presentations on specific case studies.

BIO-LAB MANAGEMENT AND RISK ASSESSMENT		Semester	III
Course Code	**BBT358A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

- To enable the students to develop an understanding biolab management and risk and its assessment.
- To enable the students to learn the methods to minimize and mitigate the risks at various steps of lab processes.
- To enable the students to perform the risk-benefit analysis in biotechnological processes.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (3 Hours)

BIO LABORATORY MANAGEMENT:

Essentials of lab management- Designing the lab, spacing, inventory organization and its management, automation via use of technology, documentation, safety requirements, biosafety levels, planning experiments, storage space, waste generation and its disposal. Case studies.

Module-2 (3 Hours)

INTRODUCTION TO RISK ASSESSMENT:

Definition and meaning of Risk. Difference between risk and hazard. Probability of occurrence of risk. Risk assessment, risk control, risk review, risk management tools, HACCP, risk ranking and filtering. Case studies.

Module-3 (3 Hours)

BASICS OF BIOSAFETY:

Biosafety- meaning, levels of biosafety- BSL 1, BSL2, BSL 3 and BSL 4, examples, applications of each and hazards involved there in for products derived out of biotechnology. International protocols and Case studies.

Module-4 (3 Hours)

BIOSAFETY AND RISK ASSESSMENT:

Principles of safety assessment (for infectious organisms, agents, microbes- genetically altered/ metabolically engineered, transgenic plants, GMOs /LMOs used in food, pharma, bioremediation etc., Sequential steps in risk assessment; concepts of familiarity and substantial equivalence; environmental risk assessment and food and feed safety assessment. Case studies.

Module-5 (3 Hours)

RISK MINIMIZATION AND/OR RISK MITIGATION:

Risk assessment through omics approach. Ethical, legal, and social implications of health privacy and policy

laws for mitigation/minimization (Indian and Global contexts). Risk characterization and development of analysis plan. Case studies.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Apply principles of biology to understand risk and its assessment.
2. Deduce methods to minimize and mitigate the risks.
3. Evaluate risk-benefit analysis of different genetic engineering interventions based upon case studies.
4. Correlate laws pertaining to biological risk to the sustainable use of GMOs in different applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

- Biotechnology risk: Complete Self-Assessment Guide, by Gerardus Blokdyk, 2018
- Laboratory Biorisk Management Biosafety and Biosecurity, Reynolds M. Salerno, Jennifer Gaudioso,2015

Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource Features of Risk

- Assessments of Genetically Modified Crops. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. Euphytica, 2008
- An Overview of General divisions/csurv/geac/annex-5.pdf F. Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants. Transgenic Research, 19(3), 425-436, 2009
- https://www.who.int/publications/i/item/9789240011458
- https://www.youtube.com/watch?v=yKsGC_XFwKU
- https://www.youtube.com/watch?v=0QwJB1sH3Oc
- https://www.labmanager.com/business-management/lab-management-fundamentals-2641
- https://www.altexsoft.com/blog/lims-systems/
- https://www.who.int/publications/i/item/9789240011458

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Assessment of surface contaminants in labs
- Collect and present all biosafety level logos.
- Group Discussion of Case studies
- Model Making and poster presentations

DATA PRESENTATION, ERROR ANALYSIS AND INFERENCES		Semester	III
Course Code	**BBT358B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

- To enable the students to develop an understanding of data, its occurrence and usefulness.
- To enable the students to learn the means to analyse errors in data for various purposes.
- To enable the students to learn to infer and present the data in various formats for various sectors that generate or use data.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (3 Hours)

INTRODUCTION TO DATA:

Definition. Representation of data in mathematical (quantitative) terms. Characteristics of data, its types. Occurrence of data across BT sectors and disciplines. Practical applications and discussion of case studies based upon real-time data.

Module-2 (3 Hours)

DATA PRESENTATION:

Techniques to present data in textual, tabular, and graphical forms. Purposes and Key methods to present the data. Use of MS Excel and Google sheets. Practical applications and discussion of case studies based upon real-time data gathered from lab sessions.

Module-3 (3 Hours)

DATA ANALYSIS:

Meaning and processing data for analysis by using statistical or logical techniques in BT. Methods of data analysis: descriptive, diagnostic, inferential, predictive and prescriptive. Practical applications and discussion of case studies based upon real-time data gathered from lab sessions.

Module-4 (3 Hours)

ERROR ANALYSIS:

Sources of errors. Types of errors (massive, specific and incidental) in Biotechnology labs, research and industrial scales. Meaning of error analysis and its stages. Methods and means to minimize errors. Practical applications and discussion of case studies based upon real-time data gathered from lab sessions

Module-5 (3 Hours)

DATA INFERENCE:

Need to identify trends and key points in data presentation (highlighting the inference, using relevant images for enhancing impact of presentation, visually presentation the numbers, stepwise or stage wise presentation of information). Practical applications and discussion of case studies based upon real-time data gathered from lab sessions

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Understand the sources of data, present the data for specific purposes/application.
2. Gain ability to analyse the occurrence of errors in data sets.
3. Demonstrate the ways to draw inferences from data.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

- Introduction to data and data analysis, Deepak Shrivastava, 2020
- A General Introduction to Data Analytics, Moreira Joao. John Wiley and Sons Ltd. Anonym, 2018
- Does presentation format matter? The impact of data presentation on decision making, By Anonym, Grin Verlag Gmbh. 2015

Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource • https://nptel.ac.in/courses/110104094 • https://www.simplilearn.com/learn-data-analytics-for-beginners-skillup • https://www.coursera.org/professional-certificates/google-data-analytics • https://upgradcampus.com/data-analytics-ads-lp/ • https://www.simplilearn.com/big-data-and-analytics/senior-data-scientist-masters-program-training • https://intellipaat.com/data-scientist-course-training/ • https://www.edx.org/learn/data-science • https://www.udemy.com/topic/data-science/free/
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Group Discussion of Case studies • Model Making and poster presentations

ANALYSIS OF DAIRY PRODUCTS LAB		Semester	III
Course Code	BBTL358C	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours	15	Total Marks	100
Credits	01	Exam Hours	2
Examination type (SEE)	PRACTICAL		

Course objectives:

- To learn preparation of sample of various dairy products for analysis
- To lean the detection of ingredients and adulterants in milk and milk products

Sl.NO	Experiments
1	Preparation of sample for milks
2	Detection of adulterants in milk
3	Detection and quantification of starch in milk
4	Detection of cellulose in milk
5	Detection of added urea in milk
6	Detection of foreign fat in milk
7	Detection of gelatine in milk
8	Determination of pH in Whey powder.
	Demonstration Experiments
9	Preparation sample of curd and determination of total solids, moisture and fats
10	Preparation sample of curd condensed/falvoured milk and determination of tradable acidity.
11	Preparation sample of dried milk and determination of carbohydrates, protein and ash
12	Preparation sample of butter and determination of free fatty acids and moisture

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. Prepare various milk and milk products for analysis.
2. Learn to detect ingredients present and adulterants added to milk and milk product.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are

made known to students at the beginning of the practical session.

- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- FSSAI, Manual of Methods Of Analysis Of Foods: Milk And Milk Products, Food Safety And Standards Authority Of India, Ministry Of Health And Family Welfare, Government Of India, New Delhi, 2015.
- Handbook of Dairy Foods Analysis, Fidel Toldra, Leo M.L. Nollet, Routledge Tyler and Francis, 2021

e-resources

- https://archive.nptel.ac.in/courses/126/105/126105013/
- https://onlinecourses.nptel.ac.in/noc19_ag05/preview
- https://www.youtube.com/watch?v=qbVyZ2QxRAA

BIODIVERSITY AND CONSERVATION LAW		Semester	III
Course Code	**BBT358D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

- To give an insight into Biodiversity and species evolution.
- To acquire knowledge of ecological threats, habitat destruction and extinction of species.
- To enable an understanding of Environmental law and IP issues

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1

BIODIVERSITY:

Concept and definition Scope and Constraints of Biodiversity Science, Composition and Scales of Biodiversity: Genetic Diversity, Species/Organismal Diversity, Ecological/Ecosystem Diversity, Landscape/Pattern Diversity, Agrobiodiversity, Biocultural Diversity and Urban Biodiversity. Case studies.

Module-2

CAUSES OF BIODIVERSITY ORIGIN OF SPECIES /SPECIATION:

History of the Earth and Biodiversity patterns through Geological times; Current Centers of Biodiversity. Values of Biodiversity Instrumental/Utilitarian value and their categories, Direct use value; Indirect/ Non-consumptive use value. Case studies.

Module-3

ECOLOGICAL ECONOMICS:

Monetizing the value of Biodiversity; Intrinsic Value; Ethical and aesthetic values, Anthropocentrism, Biocentrism, Ecocentrism and Religions. Threats to Biodiversity Habitat Destruction, Fragmentation, Transformation, Degradation and Loss: Causes, Patterns and consequences on the Biodiversity of Major Land and Aquatic Systems, Case studies.

Module-4

INVASIVE SPECIES:

Biological impacts of invasive species on terrestrial and aquatic systems. Pollution: Impacts of Pesticide pollution, Water pollution and Air Pollution on biodiversity, Overexploitation: Impacts of Exploitation on Target and Non-target Terrestrial and Aquatic species and Ecosystems Extinction, Types of Extinctions, Processes responsible for Species Extinction. Case studies.

Module-5

ENVIRONMENT AND LAWS:

Traditional Knowledge and Environment, International Convention for the Protection of New Varieties of

Plants (UPOV Convention), Emergence of International Environmental Law, Fundamental Principles, Application of International Environmental Law, Introduction to Trade & Environment, UNFCCC - 1992 & Kyoto Protocol - 1997, Treaty on Antarctic & Polar Regions – 1961, UN Convention of Law of the Sea - 1982 and Regional Seas Convention, Convention on Biodiversity (CBD) and its key elements.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Understand ecological systems and apply the same to Biodiversity and evolution of species.
2. Comprehend Ecological economics and analyse the values of biodiversity.
3. Analyse the impacts of species, terrestrial and aquatic ecosystems towards extinction of fauna.
4. Apply Environmental law and ethical guidelines towards conservation of species.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

- Principles of Conservation Biology. Groom, M. J., Meffe, G. R. and C. R. Carroll. Sinauer Associates, Inc.2006.
- Textbook of Biodiversity. Krishnamurthy, K. V. Science Publication. 2003.
- Essentials of Conservation Biology. Primack, R. Sinauer Associates, Inc., USA,2006.
- Conservation, 2nd Edition, Clive Hambler, University of Oxford, Susan M. Canney, 2013.
- Conservation Biology: Foundations, Concepts, Applications by Fred Van Dyke, Springer. 2010

Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://www.youtube.com/watch?v=OrY1cr0m97M
- https://www.tutorialspoint.com/environmental_studies/environmental_studies_conversation_of_biodiversity.htm
- https://www.tutorialspoint.com/environmental_studies/environmental_studies_biodiversity.htm
- https://portals.iucn.org/library/sites/library/files/documents/EPLP-029.pdf
- https://programsandcourses.anu.edu.au/2017/course/LAWS8280 .

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Group Discussion of Case studies
- Model Making and poster presentations

MOLECULAR BIOLOGY & GENETIC ENGINEERING		Semester	IV
Course Code	**BBT401**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To acquire the fundamentals of molecular biology and genetic engineering principles.
- To understand the protocols of isolation of Nucleic acids and their analysis.
- To develop a conceptual application of gene libraries and various interactions.
- To learn the strategies for gene manipulation, editing technologies and its applications.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 Hours)

CENTRAL DOGMA OF MOLECULAR BIOLOGY:

Replication of DNA in Prokaryotic cell and Eukaryotic cell. Mechanism of action of telomerase, DNA damage, and repair: Base excision repair, mismatch excision repair, photo-reactivation, nucleotide excision, and SoS repair. Transcription in the prokaryotic and eukaryotic cell: Initiation, elongation, and termination. Processing of mRNA. Translation in the prokaryotic and eukaryotic cell: Initiation, elongation, and termination. Wobble Hypothesis Post-translational modification of proteins. Protein targeting

Module-2 (8 Hours)

GENE REGULATION:

Regulation of gene expression in prokaryotes (lac-operon and trp-operon). Positive and negative gene regulation, riboswitches. Regulation of gene expression in eukaryotes: Transcriptional control, RNA processing control, Translational control, and post-translational level control. Hormonal control of gene expression in eukaryotes (steroid hormone, auxin, and gibberellic acid). Gene silencing: antisense technique, RNA interference, Ribozymes.

Module-3 (8 Hours)

INTRODUCTION TO GENETIC ENGINEERING:

Basics of Genetic Engineering, Vectors for gene cloning: Cloning and Expression vectors. Plasmids, Phages, Cosmids, Fosmids, Phagemids, and Artificial chromosomes. Viral vectors. Molecular tools for gene cloning: Restriction and Modification systems: Restriction Endonucleases, Methylases, Ligases. Polynucleotide kinases, Phosphatases, DNA and RNA polymerases, Reverse transcriptase, Terminal transferase, DNAses (Extremophiles), Nuclease. RNases, Topoisomerase. Cloning Techniques: Restriction digestion based cloning. Linkers and adapters, Strategies for cloning TA cloning. Ligase free cloning

Module-4 (8 Hours)

GENE TRANSFER TECHNIQUES:

Physical, chemical and biological methods, Competent cells: Chemical and Electro-competent. Transformation/ transfection in plants and animals. Construction of genomic and cDNA libraries: Screening of DNA libraries for clone identification. Characterization of clones. Methods of nucleic acid detection;

Polymerase chain reaction (PCR) - techniques and requirements, types of PCR, applications. Blotting techniques (Southern, Northern and Western), Radioactive and non-radioactive labelling of nucleic acids

Module-5 (8 Hours)

APPLICATIONS OF GENETIC ENGINEERING:

Engineering microbes for the production of antibiotics, enzymes, insulin and monoclonal antibodies. Transgenic technology for plant and animal improvement, Over expression and Knock out/ knock down studies, RNAi. Bio pharming- Animals and plants as bioreactors for recombinant proteins. Genome-Editing Technologies: Types, Principles and Applications; CRISPR- associated protein – Cas 9.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Understand the basic concepts of genetic engineering for augmentation of traits.
2. Apply and comprehend the principles of gene manipulation, expression and interaction of genes and proteins.
3. Evaluate the screening and interaction studies using classical/conventional and high through put methods.
4. Design the strategies for gene cloning and gene editing.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

- Gene Cloning and DNA Analysis – An Introduction, T.A. Brown, Wiley-Blackwell Science, 7th edition, 2018.
- From Genes to Genomes, Concepts and applications of DNA Technology. Jeremy W. Dale and MV Schantz. 2nd edition, 2018.
- Lewin's genes XII Burlington, Massachusetts: Krebs, Jocelyn E., Goldstein, Elliott S., Kilpatrick, Stephen T., Jones & Bartlett Learning, 2018.
- Molecular Biotechnology – Principles and applications of recombinant DNA, B.R. Glick, J.J. Pasternak and C.L Patten; ASM Press; 6th edn; 2017.

Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://www.coursera.org/courses?query=molecular%20biology
- https://www.edx.org/learn/molecular-biology
- https://www.classcentral.com/tag/molecular-biology
- https://www.cdc.gov/labtraining/training-courses/basic-molecular-biology/index.html
- https://pll.harvard.edu/subject/molecular-biology
- https://onlinecourses.swayam2.ac.in/cec19_bt02/preview
- https://nptel.ac.in/courses/102103013
- https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/7%3A_Microbial_Genetics/7.23%3A_Genetic_Engineering_Products/7.23B%3A__Applications_of_Genetic_Engineering

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Group Discussion of Case studies
- Model Making and poster presentations

BIOSTATISTICS AND TOOLS + LAB		Semester	IV
Course Code	**BBT402**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory/practical		

Course objectives:

- Understand different types of data and variables.
- Usage of descriptive tools to summarize and display data from public health or medical studies.
- To appropriately choose, define probability distributions such as the Binomial, Poisson and normal distribution to solve engineering problems.
- To calculate and articulate the associate between two variables.
- Understand the principles of various study designs used in epidemiological studies and explain their advantages and limitations.
- Practical application of design of experiments in agricultural and laboratory experiments.
- Understand the importance and basic principles of estimation in clinical and translational research.
- To learn how to formulate hypothesis, perform hypothesis testing and to work with sample data to make inferences about a population.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflectiveand questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

MODULE-1 (8 hours)

REPRESENTATION OF DATA AND DESCRIPTIVE STATISTICS:

Introduction to Biostatistics, classification of variables, types of data, data collection and sampling methods, data representation- diagrammatic methods (line diagram, bar diagram, pie chart), graphical methods (Histogram, frequency polygon, frequency curve, ogive). Measure of central tendency- mean, median, mode, quartiles, harmonic mean and geometric mean. Measure of dispersion- mean deviation, quartile deviation, standard deviation and coefficient of variation.

MODULE-2 (8 hours)

BIVARIATE ANALYSIS AND PROBABILITY DISTRIBUTION

Correlation- types, reasons and methods of estimating correlation Spearman's Rank correlation coefficient. and Karl Pearson's coefficient of correlation. Linear Regression analysis, Curve fitting. Probability distribution-Binominal distribution, Poisson distribution and. Normal distribution.

MODULE-3 (8 hours)

EPIDEMIOLOGICAL STUDY DESIGNS:

Observational studies and experimental studies-case reports and case series, ecological study, cross-sectional, case-control, cohort study and nested design. historically controlled studies, cross over studies, randomized controlled design, Selection of Cases and Controls, Types of Controls, Matching in a Case-Control Study. Measures of Association-Relative Risk & Odds Ratio, Risk difference, attributable risk, excessive risk incidence, prevalence and incidence rate, prospective and retrospective studies, Selectivity, specificity and sensitivity, Bias, and Confounding, multiple sources of variation, Ethical considerations. Replication and repetition, randomisation and blocking, single- and double-blind experiments.

MODULE-4 (8 hours)

DESIGN AND ANALYSIS OF EXPERIMENTS

Randomized complete block design (RCBD) and CRD analysis, Variants of RCBD such as Latin Square, central composite design, etc., Full factorial experiments, Blocking and Confounding in 2k, Fractional factorial experiments, Plackett-Burman Designs, Response surface methodology (RSM)

MODULE-5 (8 hours)

INFERENTIAL STATISTICS FOR CLINICAL RESEARCHERS

Point estimation, interval estimation- mean and proportion, sample size estimation, sampling distributions of mean and its properties, testing of hypothesis, type 1 error and type II error, power of study, test statistics (two tailed only)- Z-test, t-test (Paired and unpaired), chi-squared test. Wilcoxon Signed Rank Test, Wilcoxon-Mann-Whitney Test, ANOVA- One-way and Two way,

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Measurement and Sampling: To select a simple random sample from the population and enter these data into SPSS/Minitab/or any other statistical software.
2	Diagrammatic & Graphical representation: To plot line diagrams, bar diagram. Pie chart, Histogram and frequency distribution of the collected data.
3	Summary Statistics: To calculate and interpret summary statistics for the data in your sample.
4	Correlation: Calculation & interpretation of correlation and regression between variables
5	Randomization: Use of open-source randomization tools and sample size estimation.
6	Hypothesis testing: To test a hypothesis by determining a significance difference for mean and proportion.
7	t – test: To use t- test for determining a significance difference between two groups.
8	Chi – Square test: Use of Chi – Square test of independent of Attributes for 2 X 2 contingency table.
9	Experimental Design: Design and analysis of experiments based on factorial design and calculate main effect, interaction effect.
10	Experimental Design: Design and analysis of mixture experiments using different factors.
11	Experimental Design: Design and analysis of screening experiments using Plackett–Burman designs
12	Experimental Design: Design and analysis of experiments based on response surface methodology (RSM).

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

1. Gather data, present appropriately and perform uni-variate, bi-variate analysis of data.
2. Analyze the statistically designed biological experiments,
3. Draw inferences about the characteristics of population from the samples using parametric and non-parametric tests.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

- Fundamentals Of Statistics (Paperback, SC GUPTA) Edition, 6; Publisher, Himalaya, 1984.
- Design of Experiments 1st Edition Bradley Jones, Douglas C. Montgomery/
- Fundamentals of Biostatistics Paperback – 1 December 2009 by V.B. Rastogi (Author).

Web links and Video Lectures (e-Resources):

- VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource
- https://archive.nptel.ac.in/courses/102/106/102106051/
- https://onlinecourses.nptel.ac.in/noc21_mg48/preview
- https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-mg01/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstration of sampling
- Two group studies in clinical trials, randomisation and case control experiments.
- https://bolt.mph.ufl.edu/category/important-concepts/activity-learn-by-doing/

IMMUNOTECHNOLOGY+ LAB		Semester	IV
Course Code	**BBT403**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory/Laboratory		

Course objectives:

- To learn the underlying concepts of molecular and cellular mechanisms involved in the development and regulation of the immune response.
- To describe the cause for Immune System Disorders.
- To learn the techniques of Immunodiagnostics.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

MODULE-1 (8 HOURS)

IMMUNE SYSTEM:

Introduction; Immunity-innate and acquired immunity; Haematopoiesis; Cells of immune system – lymphoid cells, mononuclear cells, granulocytes, dendritic cells & mast cells; organs of immune system - primary and secondary lymphoid organs; Humoral and Cell mediated immunity; Antigens: Chemical and biological Factors affecting antigenicity/Immunogenicity and molecular nature, Haptens, adjuvants; Antibodies: structure and function, Immunoglobulin classes and subclasses (isotypic, allotypes, idiotypes and anti-idiotytopic antibodies).

MODULE-2 (8 HOURS)

HUMORAL AND CELL MEDIATED IMMUNITY:

B-lymphocytes and their activation, development and maturation. antibody genes and generation of diversity, Class Switching mechanism; production of monoclonal antibodies, polyclonal antibodies and applications; Thymus derived lymphocytes (T cells): activation, development and maturation, their ontogeny and types. Major histocompatibility Complex (MHC) Complex, MHC Class I and II molecules. Antigen processing and presentation process.

MODULE-3 (8 HOURS)

IMMUNE SYSTEM IN HEALTH AND DISEASE:

Complement system, pathways of complement activation and its functions, Hypersensitivity: Gell and Coombs classification of Hypersensitivity, Autoimmune disorders-types, animal model and treatment; Immune response to infections: immunity to viruses, bacteria, fungi and parasites; Immunodeficiency disorders: Primary and secondary immunodeficiencies (AIDS); Injury and inflammation, Vaccines and their types, production of recombinant vaccine, Vaccine for hepatitis B surface antigen.

MODULE-4 (8 HOURS)

TRANSPLANTATION AND TUMOR IMMUNOLOGY:

Transplantation and its classification, Immunologic basis of graft rejection and its mechanism, transplantation antigens, tissue typing, role of MHC molecules in allograft rejection, Clinical transplantations, bone marrow, HSC transplantation and immunosuppressive therapy; Tumours of the immune system-tumour antigens and immune response to tumours, tumour immune-therapy.

MODULE-5 (8 HOURS)

MOLECULAR IMMUNOLOGY & IMMUNODIAGNOSIS:

Antigen antibody interaction – Precipitation reactions, Agglutination reactions; ABO Blood typing principles; Principles and applications of ELISA, Radio Immuno Assay (RIA), western blot analysis, immunoelectrophoresis, Immunofluorescence, Fluorescence Activated Cell Sorting (FACS) analysis. Role of stem cells technology in immunology, Production of humanized monoclonal antibodies (Single chain fragment variable).

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Agglutination Technique: ABO typing
2	Isolation of lymphocytes from peripheral blood
3	Differential counting of WBC
4	Bacterial Agglutination reaction-Widal test (Tube)
5	Bacterial Agglutination reaction-Widal test (slide agglutination)
6	Ouchterlony Double Diffusion (ODD)
7	Rocket immune-electrophoresis (RIEP)
8	Counter-current immune-electrophoresis (CCIEP)
9	Enzyme-linked immunosorbent assay (ELISA)
10	Western blotting
11	Complement fixation test
12	Radial Immunodiffusion (RID)

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

1. Outline the molecular and cellular mechanisms involved in the development and regulation of the immune response,
2. Detail the cause, challenges and treatment for Immune System Pathologies and Dysfunctions.
3. Apply the major immunological laboratory techniques and their application to both clinical analysis and experimental research.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

- Kuby Immunology by by Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen, WH Freeman; 8th ed. 2018.
- Immunology – an Introduction by Tizard Thomson. Saunders College Publising, 1984
- Immunology &Immunotechnology, Ashim K Chakravarthy, Oxford University Press. 2006.
- Immundiagnostics by S C Rastogi, New Age International. 1996.
- Essential Immunology by Roitt I. Blackwell Scientific Publications, 13th Edition, 2017.
- Immunology: A Short Course Richard Coico, Geoffrey Sunshine Wiley-Blackwell 7th Edition, 2015.
- Understanding Immunology by Peter Wood, Pearson Education, 2001.

Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://www.coursera.org/courses?query=immunology
- https://www.edx.org/learn/immunology
- https://www.tangolearn.com/best-immunology-courses-classes-online/
- https://www.classcentral.com/course/swayam-immunology-14117
- https://onlinecourses.nptel.ac.in/noc20_bt43/preview
- https://pll.harvard.edu/course/hmx-immunology?delta=1

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- AV presentation by students (on specific topics).
- Online surprise quizzes.
- Discussion of case studies based on research findings.
- Model making and Poster presentations.

MOLECULAR BIOLOGY & GENETIC ENGINEERING LAB		Semester	IV
Course Code	**BBTL404**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total hours	15	Total marks	100
Credits	01	Exam Hours	3
Examination type (SEE)	Practical		

Course objectives:

- To understand the methods related to isolation, quantification, characterization and amplification of nucleic acids.
- To perform experiments related to Genetic transformation and recombinants.
- To learn protocols related to separation of Proteins and DNA.

Sl.NO	Experiments
1	Preparations of common molecular biology lab buffers (TAE, TBE, TE, Tris-Hcl etc.)
2	Isolation of genomic DNA plant sources
3	Isolation of genomic DNA microbial or animal sources
4	Agarose gel electrophoresis and quantification of nucleic acids
5	Isolation of total RNA from bacteria/plant/animal samples
6	Estimation of RNA Using Orcinol Method
7	Characterization of DNA by Spectrophotometric Assay and Melting Temperature (Tm)
8	Isolation of plasmid DNA from bacteria
9	Restriction Digestion of plasmid pUC18
10	Amplification of DNA by PCR
11	Separation of Proteins - SDS-PAGE
12	Genetic transformation of E.coli and blue-white screening
13	DIY experiment (To be designed and executed by students themselves)

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. Apply the principles of molecular biology and genetic engineering.
2. Conduct experiments related to isolation, separation, quantification, digestion and amplification of nucleic acids.
3. Interpret and discuss the outcome of the experiments formally through written reports.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- Gene Cloning and DNA Analysis – An Introduction; T.A. Brown; Wiley-Blackwell Science; 7th edn;2018.
- Laboratory manual for genetic engineering, Vennison S John. Phi learning publishers. 2009.
- Basic techniques in molecular biology by Surzycki, Stefan. Springer Science & Business Media, 2012.
- Basic Techniques in Biochemistry, Microbiology and Molecular Biology: Principles and Techniques by Aakanchha Jain et al., Springer Protocols Handbooks, 2020.

Web links and Video Lectures (e-Resources):
VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://onlinecourses.nptel.ac.in/noc21_bt35/preview
- https://www.mitconbiopharma.com/training/bio-tech-training/certificate-course-in-genetic-engineering/
- https://alison.com/course/understanding-molecular-biology
- https://stores.biotecnika.org/products/molecular-biology-techniques-certification-course

BIOCHEMICAL THERMODYNAMICS		Semester	IV
Course Code	**BBT405A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To know the basic concepts of thermodynamics in process industry.
- To understand the significance of zeroth, I, II & III laws of thermodynamics.
- To understand the thermodynamic properties of fluids, their equations of state and applications.
- To realize the importance of Biochemical Energetics.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 Hours)

BASIC CONCEPTS & LAWS OF THERMODYNAMICS:

System, Surrounding &Processes, Closed and Open systems, State Properties, Intensive & Extensive Properties State and Path functions, Equilibrium state, enthalpy, specific heat, Reversible and Irreversible processes. Zeroth law of Thermodynamics, General statement of First law of Thermodynamics, First law for Cyclic Process, Non- Flow Process, Flow process, Heat capacity. Heat reservoir and Heat engines. General statements of the second law, Concept of entropy, Carnot principle, Calculation of entropy changes, Third law of Thermodynamics. Numericals.

Module-2 (8 Hours)

PVT BEHAVIOUR AND COMPRESSIBILITY CHARTS:

PVT Behavior of pure fluids, equations of state & ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic & polytrophic processes, Equations of state for real gases: Vander Waals equation, Redlich-Kwong equation, Peng-Robinson equation, virial equation.Numericals.Principlesofcorrespondingstates,generalizedcompressibilitycharts,Heateffectsaccompanyingchemical reactions, Standard heat of reaction, formation, combustion, Hess's law of constant heat summation, effect of temperature on standard heat of reaction. Numericals.

Module-3 (8 Hours)

PROPERTIES OF PURE FLUIDS:

Reference properties, energy properties, derived properties, work function, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, modified equations for internal energy (U) & enthalpy(H), Effect of temperature on U, H &Entropy(S). Gibbs-Helmholtz equation. Concept of Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, solids and liquids, Activity: Effect of temperature and pressure on activity. Numericals.

Module-4 (8 Hours)

PROPERTIES OF SOLUTIONS & PHASE EQUILIBRIA:

Partial molar properties of solution and its determination, chemical potential –effect of temperature and pressure, Lewis – Randall rule, Raoults law for ideal solutions, fugacity in solutions, Henry's law and dilute solutions, ideal behavior of real solutions and Henry's law, Activity in solutions, Activity coefficients: effect of temperature and pressure, Gibbs -Duhem equation, calculation of activity coefficients using Gibbs-Duhem equation. Numericals. Criteria of phase Equilibria, criterion of stability, Duhem's theorem, Vapour-Liquid Equilibra in ideal and non-Ideal solutions. Numericals.

Module-5 (8 Hours)

BIOCHEMICAL ENERGETICS:

Bioenergetics and Energy Flow, Coupled reactions and energy rich compounds, Reaction Stoichiometry, criteria of biochemical reaction equilibrium, equilibrium constant and standard free energy change, effect of temperature, pressure on equilibrium constants and other- factors affecting equilibrium conversion – Le – Chatelier's principle, liquid phase reactions, heterogeneous bioreaction equilibria, phase rule for reacting systems, Liquid- Liquid Equilibrium diagrams. Numericals.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Describe the concepts of system, surrounding, process, entropy and laws of thermodynamics.
2. Explain the PVT behaviour of pure fluids &gases and derive equations of state for real gases.
3. Determine the partial molar properties and activity coefficients of the solution.
4. Illustrate the phase rule for reacting systems and effect of temperature, pressure one equilibrium constants.
5. Correlate these aspects to biochemical reactions and energetics.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

- Introduction to Chemical Engineering thermodynamics by J. M. Smith, H.C. Van Ness& M.M. Abbott. MGH Publication, 6th Edition. 2003.
- Biochemical Calculations by Irwin H. Segel. John Wiley & Sons 2nd Edition.1976.
- Engineering Thermodynamics by RK Singal and Mridual Singal. IKIntl.2010.
- Chemical Engineering Thermodynamics by Y.V.C. Rao, New Age International. 1997.
- A Textbook of Chemical Engineering Thermodynamics by K. V. Narayanan. PHI 1st Edition, 2001

Web links and Video Lectures (e-Resources):

- https://www.classcentral.com/subject/thermodynamics
- https://learncheme.com/screencasts/kinetics-reactor-design/
- https://www.udemy.com/course/an-introduction-to-mechanical-engineering-thermodynamics/?
- VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning.

- AV presentation by students (on topics as per choice of the teacher)
- Online tools for surprise quizzes.
- Collection of case studies based on research findings.
  Poster presentations on specific case studies.

MARINE BIORESOURCES AND APPLICATIONS		Semester	IV
Course Code	**BBT405B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To enable the students to understand the ocean environment
- To enable students to comprehend concepts of marine pharmacology.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 Hours)

THE OCEANIC ENVIRONMENT:

Classification of the marine environment – Geography of the Global Ocean, biotic and abiotic divisions, Marine life: Marine microbes, Marine algae and plants (seaweeds, sea grasses, mangrove plants), Invertebrates: sponges, cnidarians, polychaetes, crustaceans, molluscs, echinoderms, arthropods, Non-craniate (non-vertebrate) chordates, Vertebrates, Marine fishes (bony, cartilaginous, jawless fishes) Marine tetrapods, Marine zoogeography with reference to Indian, Artic and Antartic oceans, Adaptations of organisms to different habitats. Wealth of the sea-Economically important marine animals-fin fishes, shrimp, crab, edible oysters and pearl oysters.

Module-2 (8 Hours)

BIOACTIVE COMPOUNDS FROM THE OCEAN:

Important products isolated from marine organisms and their uses, Seaweed: Nutritional Value, Bioactive Properties, and Uses. Seafood Processing Wastes: Chitin, Chitosan, and other compounds, Seaweed Hydrocolloids; agarose, agar, alginates, carrageenans, chitin, chitosons and glucosamines- Biological Activities, uses and importance, Marine enzymes; Isolation and applications, Marine Enzymes in Cancer, Biotechnological Applications of Marine Enzymes from Algae, Bacteria, Fungi, and Sponges, Antifreeze Proteins, Cold-Adapted Enzymes, applications. marine flavourants, lectins, heparin and carotene. Microbial Enzymes in Biotechnology. Probiotics for Animal Health, Production and Applications for Human Health, Biomedical Applications of Enzymes from Marine Actinobacteria.

Module-3 (8 Hours)

PHARMACEUTICALLY IMPORTANT PRODUCTS: Need, importance and potentialities of marine drugs and sources. Drugs and Pharmaceuticals from Marine Sources, Development and problems in Marine Drug Development, Global Interests and Commercial Status. Marine Microalgae, Bioactive compounds from Microalgae, Bioactive natural products – anti-bacterial, anti-fungal, anti-viral, anti-inflammatory, anti-tumour, antiparasitic and antihelminthic, nutraceuticals. Marine Sources of Carotenoids, Isolation, Characterization, Antioxidant Activities of carotenoids. Marine Products; B-carotene, vitamins, immunomodulators, anticancer and cytotoxic compounds from marine sources- their extraction process and characterization. Marine Lipids, PUFA, Omega-3 PUFA-Rich Oils from Marine Fish, Health Benefits. Seafood Proteins as Dietary Component, Bioactive Peptides from Seafood, Isolation of Seafood Peptides, Functional Roles of Marine Peptides in Foods. Marine Sources of Vitamins and Minerals with examples. Marine

Nutraceuticals for Food Fortification and Enrichment, examples. Marine Sponge Compounds with Anti-Inflammatory Activity. Safety Hazards with Marine Products and Their Control.

Module-4 (8 Hours)

MARINE TOXINS AND TOXICOLOGY:

Classifications of Marine Based-Toxins. Seafood Poisoning, Toxicity related to seafood, Different Routes of Exposure of Marine Toxins. Puffer Fish Poisoning (PEP), Scombroid Fish Poisoning, Saxitoxin, *Brevetoxins,* Ciguatera Fish Poisoning, Paralytic Shellfish Poisoning, Neurotoxic Shellfish Poisoning., Marine Invertebrate Toxins, Limu-Make-o-Hana (the Deadly Seaweed of Hana). Diarrhoeic Shellfish Poisoning (DSP). The Cone Shells. Sea Snakes, Venomous Fish. Tetrodotoxin, Amnesic Shellfish poisoning, Azaspiracid, Palytoxin Poisoning, Other Marine Biotoxin; Conotoxins, nodularin, cylindrospermopsin, microcystins, anatoxins, yessotoxin, and palytoxin (PTX) and their effects on human health. Treatments of Marine-Based Food Poisoning, Prevention Aspects of Marine Toxin for Humans. Safety Hazards with Marine Products and Their Control, Food-Borne Hazards, Types, Algal Toxins Influenza Viruses: A Threat to Marine Mammals Populations.

Module-5 (8 Hours)

MARINE POLLUTION:

Sources of marine pollution, its dynamics, transport paths and agents. Composition of domestic, industrial and agricultural discharges. Their fate in the marine environment. Toxicity and treatment methods. Oil pollution: Sources, composition, and its fate in marine habitats. Toxicity and treatment methods. Thermal and radioactive pollution: sources, effects, and remedial measures. Solid dumping, mining and dredging operations: their effects on marine ecosystem. Role of biotechnology in marine pollution control. Biofouling and biodeterioration: Agents and protection methods. Global environmental monitoring methods: status, objectives and limitations. Bioinformatics Techniques on Marine Genomics, Omics Approaches in Marine Biotechnology: genomics, proteomics, transcriptomics, nutrigenomics, and metabolomics. Applications of Omics Tools in Blue Biotechnology.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Apply the basics of ecology to understand ocean ecosystems with reference to their sustainable use
2. Evaluate the role of marine ecosystems as a source of bioactive compounds
3. Apply principles of toxicology in ecological integrity fauna
4. Analyze the role of bioremediation in the context of safeguarding marine resources.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

- Marine Products for Healthcare: Functional and Bioactive Nutraceutical Compounds from the Ocean (Functional Foods and Nutraceuticals Book 13) 1st Edition, Kindle Edition by Vazhiyil Venugopal (Author)
- Marine Biology-A Functional Approach to the Oceans and their Organisms, Edited By Jerónimo Pan, Paula Pratolongo, Published March 3, 2022 by CRC Press.
- Advances in Food and Nutrition Research-Marine Enzymes Biotechnology: Production and Industrial Applications Part III – Volume 80, Application of Marine Enzymes, Se-Kwon Kim and Fidel Toldrá (Eds.), Academic Press, First edition 2017, Part I,II,and III
- Marine Biology: A Very Short Introduction (2nd edn), Philip V. Mladenov Online,ISBN: 9780198841715, Oxford University Press
- Springer Handbook of Marine Biotechnology, Se-Kwon Kim (Ed.), ISBN: 978-3-642-53970-1, Springer Handbooks.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/114/105/114105047/
- https://archive.nptel.ac.in/courses/114/105/114105005/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- AV presentation by students (on topics as per choice of the teacher)
- Online tools for surprise quizzes.
- Collection of case studies based on research findings.
- Poster presentations on specific case studies.

BIOPROCESS PRINCIPLES & STOICHIOMETRY		Semester	IV
Course Code	**BBT405C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- Learn fundamentals of chemical calculations and material and energy balance.
- Discuss the material balance aspects involving chemical reactions and without chemical reactions.
- Highlight the energy balance and material balance for the development of bioprocess technology.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 Hours)

BASIC CHEMICAL CALCULATIONS AND MATERIAL BALANCE:

Concept of atom and mole, expressing composition of mixtures in Solids, liquids and gases. Expressing composition of mixtures and solutions - Percentage by weight percentage, mole percentage and Volume percentage; Normality, Morality, Molality. Generalized material balance equations for distillation, absorption, extraction, crystallization, mixing, drying & evaporation.

Module-2 (8 Hours)

MATERIAL BALANCE WITHOUT CHEMICAL REACTIONS AND FUELS

Material balances calculation in Distillation, Absorption, Extraction, Crystallization, Drying, Mixing and Evaporation Operations, Fuels – types of fuels, (solid, liquid and gaseous fuel), relevance to biofuels, characteristics of fuels, Ultimate and proximate analyses of fuels.

Module-3 (8 Hours)

MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS:

Material balances calculation involving bypass, recycle and operations. Generalized material balance equations, Principles of stoichiometry, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, Selectivity, unit process – neutralization, oxidation, nitration, hydrolysis, and problems relating to these unit processes.

Module-4 (8 Hours)

ENERGY BALANCE:

General energy balance equation for steady state. Heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Enthalpy, Standard Heat of formation, standard heat of reaction, Standard heat of combustion and calorific value, Calculation of heat of reaction at elevated temperature

Module-5 (8 Hours)

BIOPROCESS PRINCIPLES & STOICHIOMETRY OF BIOPROCESS:

Historical development of bioprocess technology; Bioprocess principles and operations, generalized process flow sheets. General material balance equation for steady state (for manufacture of penicillin and ethanol) - outline of a bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses. Stoichiometry of microbial growth and product formation.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Discuss the significance of material and energy balance for bioprocess technology.
2. Solve problems related to material and energy balance to give solutions for bioprocess development.
3. Develop the flowsheet for general processes operating in bioprocess industry.
4. Appreciate the stoichiometry of microbial growth and product formation involved in bioprocess technology.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

- Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI
- Bioprocess Engineering by Shuler and Kargi, Prentice Hall.
- Stoichiometry by Bhatt and Vora, Tata McGraw Hill, 2004.
- Chemical Process Calculations by R. Asokan, University Press, 2011
- Principles of Biochemistry by David L. Nelson (Editors), W.H. freeman and company.
- Bioprocess Engineering Principles by Pauline Doran, Academic Press.
- Biochemical Engineering Fundamentals by J E Bailey & D. F. Ollis, McGraw Hill.
- Calculations by I. H. Segel, John Wiley & Sons

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/102105064
- https://nptel.ac.in/courses/102106053
- https://onlinecourses.nptel.ac.in/noc21_bt17/preview
- https://www.youtube.com/watch?v=-Zrvfgfi0Zs
- https://archive.nptel.ac.in/courses/103/103/103103153/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- AV presentation by students (on topics as per choice of the teacher).
- Online tools for surprise quizzes.
- Collection of case studies based on research findings
- Poster presentations on specific case studies.

STRUCTURAL BIOLOGY AND BIOPHYSICAL TECHNIQUES		Semester	IV
Course Code	**BBT405D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To learn the fundamentals of biomolecular structure-function hypothesis.
- To gather knowledge of various biophysical, spectroscopic, chromatographic techniques and their applications.
- To be able to understand and select the specific analytical technique for required case study

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 Hours)

STRUCTURE AND CONFORMATION OF PROTEINS:

Composition and primary structures of proteins, peptide geometries, phi, psi, omega angles, Ramachandran or steric contour diagram, allowed chi angles of side chains in proteins, Conformational analysis and forces that determine protein structures, hydrogen bonding, disulphide bonds, hydrophobic interactions, Van der Waals forces, potential energy calculations. Secondary structures: alpha helices, beta sheets, turns. Thermodynamic aspects of protein folding. Relationship between the primary, secondary, and tertiary structure of proteins. Structure of IgG, fibrous proteins (structure of collagen, keratin). Quaternary structures – dimers (homo & heterodimers), trimers, tetramers; Popular Protein folds, structural families and classes, multifunctional domains (qualitative examples).

Module-2 (8 Hours)

STRUCTURE AND CONFORMATION OF NUCLEIC ACIDS AND BIOMEMBRANES:

General characteristics of nucleic acid structures (A, T, G, C, U), forces and stabilizing geometries, glycosidic bond, rotational isomers. Stabilizing ordered forms of DNA (A, B and Z), base pairing types, base stacking, tertiary structure of DNA (Supercoiled DNA), Melting of the DNA double helix (Hyperchromicity), Interaction with small ions and small molecules. Ribose puckering and Tertiary structure of tRNA. Structure and conformational properties of cell membranes, Singer and Nicholson model, integral proteins in membranes, conformational variations during ion transport, Signal transduction and molecular reception (qualitative).

Module-3 (8 Hours)

BIOPHYSICAL TECHNIQUES:

Rayleigh scattering, ultra-centrifugation, viscometry. Electronmicroscopy (SEM, TEM, AFM), luminescence (fluorescence & phosphorescence), Calorimetry, DSC, DTA/TGA, Mass spectrometry, MALDI-TOF, Voltage Clamp and Patch Clamp (measurements of membrane potentials). Flow cytometry.

Module-4 (8 Hours)

SPECTROSCOPIC TECHNIQUES:

X-ray diffraction: structure determination via single crystal diffraction, fibre diffraction; Neutron diffraction. XPS, XAFS. NMR spectroscopy (structure determination). ORD/CD, UV, IR, Laser Raman, ESR/EPR.

Module-5 (8 Hours)

ELECTROPHORETIC TECHNIQUES:

Agarose gel electrophoresis, gradient electrophoresis, horizontal and vertical gel electrophoresis, isoelectric focusing, immune electrophoresis. Capillary electrophoresis and applications. Chromatographic Techniques: Normal phase, adsorption, reverse phase, ion exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudoaffinity techniques. GC, Paper chromatography, TLC and HPLC and their applications.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Describe the structural aspects of macormoleucles like proteins, nucleic acids and biomembranes.
2. Demonstrate their structure function hypothesis via suitable techniques.
3. Apply the specific biophysical, spectroscopic, chromatographic techniques for various case studies.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

- Biophysical Chemistry by Cantor R. and Schimmel P.R, W. H. Freeman.
- Physical Biochemistry by David Freifelder, W H Freeman and Company.
- Biophysical Principles of Structure & Function by Fred M. Snell & Sidney Shulman
- Introduction to Protein Structure by Carl Branden and John Tooze, Garland Publishing.
- Proteins Structure – A Practical Approach by Creighton, Oxford University Press.
- Physical Chemistry: Principles and Applications in Biological Sciences by Tinoco and others, Prentice Hall
- Biophysics – An Introduction by Cotterill, Wiley Student Edition.
- Foundations of Biophysics by A.L. Stanford, Academic Press.
- Principles of protein structure by G Schulz and R H Schrimer, Springer Verlag.
- Principles of nucleic acid structure by Sanger, Springer Verlag.
- Introduction to Protein Science by Arthur M Lesk, Oxford University Press.
- Biological Spectroscopy by J. D. Campbell and R. A.Dwek, Plenum Press

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_bt14/preview
- https://www.digimat.in/nptel/courses/video/102107086/L11.html
- https://www.digimat.in/nptel/courses/video/102107028/L01.html
- https://nptel.ac.in/courses/102106065
- https://nptel.ac.in/courses/102106068
- https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-bt01/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- AV presentation by students (on topics as per choice of the teacher)
- Online tools for surprise quizzes
- Collection of case studies based on research findings
- Poster presentations on specific case studies.

HYDROPONICS, AQUAPONICS AND AEROPONICS		Semester	IV
Course Code	**BBT456A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

- To understand the principles and basic concepts Hydroponics, Aquaponics, and Aeroponics.
- To Learn different system designs and nutrient management.
- To study the water and resource management for sustainable practices.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (3 Hours)

HYDROPONICS:

History of hydroponics, General hydroponics, benefits, food production, organic foods versus hydroponics foods, Systems of Hydroponic/Soilless Culture.

Module-2 (3 Hours)

MEDIA FOR HYDROPONICS:

Build your own system, Media and supplies, Minerals, macro and micro Nutrients, mixing, Advanced nutrients, super nutrients, Mineral deficiencies, case studies of foods grown via hydroponics, Hydroponic Cropping.

Module-3 (3 Hours)

APPLICATION OF HYDROPONICS:

CO_2 utilization, Problems in hydroponics, Pest Control, post-harvest handling, hydroponic terminologies, Diagnostic Testing Procedures, The Hydroponic Greenhouse, Educational Role for Hydroponics

Module-4(3 Hours)

AQUAPONICS:

History of Aquaponics, System design and management, Establishing and Maintaining the Fish Tank, Seed Germination and Planting, Plant Selection and Care, Plant Nutrient Requirements, Photosynthesis, Transpiration and Light, Plant Physiology & Light

Module-5 (3 Hours)

AEROPONICS:

History of Aeroponics, The Aeroponic Value Proposition, Aeroponic Science. Aeroponics Innovations, Aeroponic Business, Practice of Aeroponics. Current research. Case studies.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Comprehend the principles of basic concepts Hydroponics, Aquaponics, and Aeroponics for sustainable agriculture.
2. Apply the knowledge of plant physiology to optimize the nutrient requirements in Hydroponics, Aquaponics, and Aeroponics
3. Evaluate the environmental factors and innovative applications in Hydroponics, Aquaponics, and Aeroponics.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered.
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

- Hydroponics and aquaponics for beginners, by Viktor Garden, Independent Publishing, 2021.
- DIY Hydroponic Gardens: How to Design and Build an Inexpensive System for Growing Plants in Water by Tyler Baras - Cool Springs Press, 2018.
- Aquaponic Gardening: A Step-By-Step Guide to Raising Vegetables and Fish Together by Sylvia Bernstein - New Society Publishers, 2011.
- Hydroponic Food Production: A Definitive Guidebook of Soilless Food-growing Methods by Howard M. Resh -Woodbridge Press Publishing Co, U.S. 1980.
- Hydroponics: Hydroponics Essential Guide: by Andy Jacobson, Createspace Independent Publishing Platform, 2016.
- Hydroponics by Kevin Espiritu, Cool Springs Press, 2019.
- Aeroponics, by Thomas W. Gurley CRC Press, 2020.

Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource Features of Risk • https://rocketskills.in/course/best-hydroponics-course? • https://www.udemy.com/topic/hydroponics/ • https://www.edx.org/course/aquaponics-the-circular-food-production-system • https://www.acseduonline.com/courses/horticultural-crops-20/aquaponic-production-bht319-569.aspx • https://mycourseguru.in/hydroponic-courses/
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Group Discussion of Case studies • Model Making and poster presentations

WATER ANALYSIS LAB		Semester	IV
Course Code	**BBTL456B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total hours	15	Total marks	100
Credits	01	Exam Hours	2
Examination type (SEE)	Practical		

Course objectives:

- This course is designed to familiarize students with the methods of water analysis and the analytical instruments used to measure the quality of drinking water.

Sl.NO	Experiments
1	To determine colour, odour, pH, taste, turbidity and total dissolved solids of given sample of water
2	To determine total hardness, alkalinity, acidity, total solids of given sample of water.
3	To determine chloride content and residual chlorine of given sample of water
4	Aerobic Microbial count of given sample of water
5	Detection of *Esh. coli*. of given sample of water
6	Detection of *Staphylococcus aureus* of given sample of water
7	Detection of *Salmonella* and *Shigella* of given sample of water
8	Detection of *Pseudomonas aeruginosa* of given sample of water
	Demonstration lab
9	Proteolytic Plate count and Lipolytic Plate count of water for processed food industry.
10	Test for Coliforms
11	Thermolytic bacterial count and Slim forming Bacteria
12	DO, COD and BOD of given sample of water

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. Describe the physical, chemical and microbial compositions of natural waters, and explain how and why these compositions vary describe the main sources of water pollution.
2. Identify the criteria for drinking water acceptability in India.

E-resources:

1. https://fssai.gov.in/upload/uploadfiles/files/Manual_Water_Analysis_09_01_2017(1).pdf
2. https://fostac.fssai.gov.in/doc/Water%20&%20Water%20Based%20Beverages.pdf
3. https://www.fssai.gov.in/upload/uploadfiles/files/WATER.pdf

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero. The minimum duration of SEE is 02 hours
Suggested Learning Resources: • Manual of Methods of Analysis of Foods: Water, Food Safety and Standards Authority of India, Ministry of Health and Family Welfare, Government of India, 2016 • Handbook of Water Analysis, Leo M.L. Nollet, Leen S. P. De Gelder, CRC Books, 2000. • Water Analysis A Practical Guide to Physico-Chemical, Chemical and Microbiological Water Examination and Quality Assurance, SpringerLink, 1988

EXTRACTION METHODS AND HERBAL PRODUCTS LAB		Semester	IV
Course Code	BBTL456C	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total hours	15	Total marks	100
Credits	01	Exam Hours	2
Examination type (SEE)	Practical		

Course objectives:

- To learn the isolation and extraction techniques of natural herbal.
- To learn to characterise phytoconstituents of the herbal products.

Sl.NO	Experiments
1	Maceration of natural herbal.
2	Extraction of phytoconstituents from herbal resources using water (Reflux).
3	Extraction of phytoconstituents from herbal resources using alcohol (Soxhlet).
4	Determination of alkaloid content in herbal extract
5	Determination of tannin content in herbal extract
6	Determination of aldehyde content in herbal extract
7	Determination of phenolic compounds in herbal extract
8	Determination of flavonoid content in herbal extract
	Demonstration Experiments (For CIE)
9	Preparation and evaluation of turmeric cream
10	Preliminary phytochemical analysis aqueous extract of neem
11	Evaluation of excipient of natural origins such as acacia, starch, honey, tragacanth, jackfruit
12	Antimicrobial activity of the herbal extract

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. Isolate and extract products from natural materials using recovery techniques.
2. Prepared and characterise phytoconstituents using herbal resources.

E-resources:

- https://www.youtube.com/watch?v=1YbDwKSPTKA
- https://www.youtube.com/watch?v=f667gI4IVMM
- https://www.youtube.com/watch?v=_7RHYEZ5x9c

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks

and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners) Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero. The minimum duration of SEE is 02 hours
Suggested Learning Resources: • Isolation and Analysis of Characteristic Compounds from Herbal and Plant Extracts, Jong Seong Kang and Narendra Singh Yadav, MDPI books, 2022 • Herbal Drug Delivery Systems: Extraction, Formulation, and Characterization, Terje Oestigaard and Gedef Abawa Fire, CSP, 2022. • Phytochemical Methods A Guide to Modern Techniques of Plant Analysis, A.J. Harborne, 1Chapman and Hall, 1998

BIOPESTICIDES AND BIOFERTILIZERS		Semester	IV
Course Code	**BBT456D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

- To familiarize the students on biopesticides and biofertilizers that are free from harmful chemicals and are more environment friendly for the purposes of achieving better crop production

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (3 Hours)

PATHOGENS AND PESTS MANAGEMENT:

Pathogens and Pests Management, Natural Enemies, Reduviids and Their Merits in Biological Control, Weaver Ants and Biocontrol of the Nuisance Pest Luprops tristis (Coleoptera: Tenebrionidae), Ground Beetles (Coleoptera: Carabidae): Their Potential as Bio-agents in Agroecosystems, Eco-friendly Control of Three Common Mosquito Larvae Species by Odonata Nymphs, Spiders as Potential Eco-friendly Predators Against Pests.

Module-2 (3 Hours)

BIOFERTILIZERS:

Types and importance of biofertilizers, Biopesticides and bioagents in agriculture and organic farming system, History of biofertilizers production Classification of biofertilizers microorganisms used in biofertilizers production

Module-3 (3 Hours)

NITROGEN FIXATION:

Concept of Nitrogen fixation. Structure and characteristic features of bacterial biofertilizers - *Azotobacter, Bacillus, Rhizobium; Cynobacterial* biofertilizers - Anabaena, and fungal biofertilizers - VAM.

Module-4 (3 Hours)

BIOPESTICIDES :

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, Mechanism of phosphate solubilization and phosphate mobilization, K solubilization. Botanicals: botanical pesticides, and biorationales. Botanicals and their uses. Plant Essential Oils and Pest Management

Module-5 (3 Hours)

PRODUCTION AND QUALITY CONTROL :

Strain selection, sterilization, growth and fermentation, mass production of biofertiizers. Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers/Biopesticides, FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, etc.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Correlate the principles of Microbiology towards Biofertilizers and Bioinsecticides.
2. Comprehend Pest-Plant interactions and apply the same in Agriculture.
3. Understand strain selection and apply the same to scale up production of Biofertilizers and Bioinsecticides.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

- Biofertilizer Technology, Marketing and Usage, Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995.
- Biofertilizers in Agriculture and Forestry, Subba Rao, N.S. Oxford and IBH. Publ. Co., New Delhi. 1993.
- Formulation of Microbial Biopesticides: Beneficial microorganisms, nematodes and seed treatments, H. D. Burges, Spingerlink, 1998.
- Biofertilizer and Biopesticide by Shalini Suri (Author)Aph Publishing Corporation 2011.
- Biological control of insect pest suppression. Coppel H.C. and J.W. Martin. Springer. 1977.
- Biofertilizers and Biopesticides by Krishnendu Acharya, Surjit Sen, Techno World; 2019.

Web links and Video Lectures (e-Resources):
VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource Features of Risk • http://courseware.cutm.ac.in/courses/certificate-course-bio-fertilizer-preparation/ • https://onlinecourses.swayam2.ac.in/cec21_ag03/preview • https://www.udemy.com/course/basics-of-fertilizers/ • https://www.youtube.com/watch?v=Qxv-IEGucFs • https://knowledge.unccd.int/e-learning-course-organic-fertilizer-sustainable-agriculture • http://www.digimat.in/nptel/courses/video/102105058/L55.html
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning. • Study of biological agents like anabena, nostoc, VAM and Rhizobium • Group Discussion of Case studies • Model Making and poster presentations

BIOLOGY FOR ENGINEERS		Semester	IV
Course Code	**BBOK407**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To familiarize the students with the basic biological concepts and their engineering applications.
- To enable the students with an understanding of biodesign principles to create novel devices and structures.
- To provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems.
- To motivate the students to develop interdisciplinary vision of biological engineering.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
- Instructions with interactions in classroom lectures (physical/hybrid).
- Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- Flipped classroom sessions (~10% of the classes).
- Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- Students' participation through audio-video based content creation for the syllabus (as assignments).
- Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
- Students' seminars (in solo or group) /oral presentations.

Module-1 (8 Hours)

INTRODUCTION TO BIOLOGY:

The cell: the basic unit of life, Structure and functions of a cell. The Plant Cell and animal cell, Prokaryotic and Eukaryotic cell, Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules; Enzymes (Classification (with one example each), Properties and functions), vitamins and hormones.

Module-2 (8 Hours)

BIOMOLECULES AND THEIR APPLICATIONS (QUALITATIVE):

Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching).

Module-3 (8 Hours)

HUMAN ORGAN SYSTEMS AND BIO DESIGNS (QUALITATIVE):

Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease). Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye). Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators). Lungs as purification system (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine). Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems).

Module-4 (8 Hours)

NATURE-BIOINSPIRED MATERIALS AND MECHANISMS (QUALITATIVE):

Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs).

Module-5 (8 Hours)

TRENDS IN BIOENGINEERING (QUALITATIVE):

Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis), scaffolds and tissue engineering, Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Self-healing Bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic).

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Elucidate the basic biological concepts via relevant industrial applications and case studies.
2. Evaluate the principles of design and development, for exploring novel bioengineering projects.
3. Corroborate the concepts of biomimetics for specific requirements.
4. Think critically towards exploring innovative biobased solutions for socially relevant problems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

- Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.
- Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
- Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
- Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
- Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
- Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
- Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
- Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.
- Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N Geetha A C Udayashankar Lambert Academic Publishing, 2019.
- 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016.
- Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/121106008
- https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists
- https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009
- https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006
- https://www.coursera.org/courses?query=biology
- https://onlinecourses.nptel.ac.in/noc19_ge31/preview
- https://www.classcentral.com/subject/biology
- https://www.futurelearn.com/courses/biology-basic-concepts

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Group Discussion of Case studies.
- Model Making and seminar/poster presentations.
- Design of novel device/equipment like Cellulose-based water filters, Filtration system.