VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY

(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)

Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

For

Master of Engineering Programmes

(M.TECH-Biotechnology)

(For admission in 2022-23 and onwards)

PROPOSED SCHEME OF EXAMINATION OF M. TECH. 2 YEAR PROGRAMME FOR BIOTECHNOLOGY

SEMESTER I

Sr. No.	Course type/code	Course name	Teaching scheme			Credits	Internal marks	External marks	Total marks
			L	T	P				
1.	BTT-301	ADVANCED BIOSTATISTICS	3	1	0	4	50	100	150
2.	BTT-302	APPLIED BIOCHEMISTRY	3	1	0	4	50	100	150
3.	BTT-303	MICROBIAL BIOTECHNOLOGY	3	1	0	4	50	100	150
4.	PROFESSIONAL ELECTIVE-1	*	3	0	0	3	50	100	150
5.	PROFESSIONAL ELECTIVE-2	**	3	0	0	3	50	100	150
6.	BTP-301	LAB-I (BIOCHEMISTRY AND BIOANALYTICAL TECHNIQUES)	0	0	3	1	25	25	50
7.	BTP-302	LAB-II (MICROBIAL BIOTECHNOLOGY/ BIOPROCESS ENGG.)	0	0	3	1	25	25	50
8.	MANDATORY COURSE	RESEARCH METHODOLOGY AND IPR	2	0	0	2	50	50	100
9.	AHT-303	Technical Writing and Presentation Skill	2	0	0	0	50	100	0
		TOTAL	**19**	**3**	**6**	**22**	**400**	**700**	**950**
10.	*OPEN ELECTIVE-1 (OPTIONAL)		3	0	0	3	50	100	150

***PROFESSIONAL ELECTIVE-I**

1. **BTT-304:**BIOANALYTICAL TECHNIQUES
2. **BTT-305:**BIOSEPERATION TECHNOLOGY
3. **BBT-306:**BIOPROCESS ENGINEERING
4. **BTT-307:**BIOFUELS

**** PROFESSIONAL ELECTIVE-II**

1. **BTT-308:**BIOTECHNOLOGY FOR HUMANHEALTH
2. **BTT-309:**NATURAL RESOURCE MANAGEMENT
3. **BTT-310:**FOOD BIOTECHNOLOGY
4. **BTT-311:**HERBAL BIOTECHNOLOGY

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SEMESTER II

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits	Internal Marks	External marks	Total Marks
			L	T	P				
1.	BTT-312	BIOINFORMATICS & SYSTEM BIOLOGY	3	1	0	4	50	100	150
2.	BTT-313	RECOMBINANT DNA TECHNOLOGY	3	1	0	4	50	100	150
3.	Professional Elective-3	*	3	1	0	4	50	100	150
4.	Professional Elective-4	**	3	0	0	3	50	100	150
5.	Open Elective-1		3	0	0	3	50	100	150
6.	BTP-303	Lab-III (MOLECULAR BIOTECHNOLOGY ANDBIOINFORMATICS)	0	0	3	1	25	25	50
7.	BTP-304	Lab-IV (IMMUNOTECHNOLOGY / Enzyme technology)	0	0	3	1	25	25	50
		Total	**15**	**3**	**6**	**20**	**300**	**550**	950
8.	*Open Elective-2 (Optional)		3	0	0	3	50	100	150

PROFESSIONAL ELECTIVE-III

1. **BTT-314:**MEDICAL-NANOTECHNOLOGY
2. **BTT-315:** ENZYME TECHNOLOGY & PROTEIN ENGINEERING
3. **BTT-316:**GENOMICS & PROTEOMICS
4. **BTT-317:**BIOREACYTOR ENGINEERING

PROFESSIONAL ELECTIVE-IV

1. **BTT-318**:VACCINE BIOTECHNOLOGY
2. **BTT-319:**ANIMAL BIOTECHNOLOGY
3. **BTT-320**:IMMUNOTECHNOLOGY
4. **BTT-321**:PHARMACEUTICAL BIOTECHNOLOGY

APPLIED BIOSTATISTICS (BTT-301)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. The students will earn statistical concepts and terminology and basic analytic techniques.
2. The students will understand and interpret results obtained from mathematical and statistical methods to compare between two or more than two independent populations.
3. The students will encompass the methodology and theory of statistics as applied to problems in the life and health sciences.

COURSE OUTCOMES

On successful completion of this course, students will be able to:

1. Apply basic statistical concepts commonly used in Health and Medical Sciences.
2. Able to explain the basic concepts of probability and to apply probability distributions in their field.
3. Interpret results of commonly used statistical analyses in written summaries.
4. Able to use statistical techniques for analyzing biological data.
5. Use basic and modern statistical software to analyze the biological and clinical data.

Syllabus:

UNIT-I **(8 hours)**

Introduction to Bio-Statistics: Types of biological data (data on ratio scale, interval scale, ordinal scale, nominal scale, continuous and discrete data), frequency distribution and graphical representations (bar graph, histogram and frequency polygon), Measures of central tendency, Measures of dispersion– Skewness and Kurtosis– Correlation and Regression.

UNIT-II **(8 hours)** Probability and Theoretical Distributions: Probability concepts – conditional probability – Baye's theorem addition and multiplication theorem of probabilities, Theoretical distributions: Binomial, Poisson, Normal (Problems only).

UNIT-III **(8 hours)**

Testing of Hypothesis: Introduction–Large sample tests based on normal distribution-Test for single mean, difference between means, proportion, and difference between proportions, standard deviation, and difference between standard deviation. Chi-square test for goodness of fit, independence of attributes-testing linkage, segregation ratio

UNIT-IV **(8 hours)**

Analysis of Variance: Small sample tests based on t- and F-distribution Test for single mean, difference between means, Paired t-test, test for equality of variances. ANOVA– one-way classification, Two-way classification.

UNIT-V **(8 hours)**

Introduction to Mini Tab and MATLAB. Bio statistical consideration at the design, analysis and reporting stage, Experimental Designs: Principles of experimental designs, completely randomized, Randomized block and Latin square designs, Tag Suchi experimental design, Fractional factorial design, Preparation of a successful clinical study, Study management, Project management Documentation, Monitoring, Audits and

APPLIED BIOSTATISTICS (BTT-301)

L:T:P::3:1:0 **Credits-4**

Inspections Pharma-covigilance, Importance of statistics in clinical research.

TEXT/REFERENCEBOOKS:

1. Statistical methods in biology (3rded) By Normant. J. Bailey, Cambridge University Press1995.
2. Fundamentals of mathematical statistics (10thed) Bys. C. Gupta and V.K. Kapoor, Sultan chand and sons educational publishers, New Delhi,2003.
3. Statistical methods in biology (3rded) Byn. T.J.Bailey., Cambridge university press, 2012.
4. A Text Book of Agricultural Statistics By R. Rangaswami, New Age Intl. Pub. ,1985.
5. Biostatistics (7thed) By way new. Daniel, Wiley India, 2005.

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APPLIED BIOCHEMISTRY (BTT-302)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To gain the knowledge of biomolecules and metabolism.
2. To acquire knowledge about the tools of bioinformatics used in the analysis of bio pathways and metabolic engineering.
3. To understand the application of biomolecules and their characterization.

COURSE OUTCOMES

On successful completion of this course, the students will be able to:

1. Understand Biomolecules, energetic and signal transduction in biological system.
2. Understand basic concept of metabolism and metabolic engineering.
3. Select and apply bioinformatics tools for metabolic analysis and Metabolic Engineering.
4. Appreciate the therapeutic and diagnostic applications of biomolecules.
5. Develop an understanding of various techniques for biomolecule characterization

Syllabus:

UNIT-I **(8 hours)**

Bimolecular structures, Molecular dynamics simulations of biomolecules. Concept of energy and thermodynamics principles in biological system, Signal transduction, and the mediation of information.

UNIT-II **(8 hours)**

Overview of Metabolism; Glycolysis and Gluconeogenesis, Glycogen Metabolism, Lipid biosynthesis, Fatty acid catabolism, amino acid metabolism, Respiration and Electron Transport.

UNIT-III **(8 hours)**

Cellular metabolites and interconnectivity in biochemical pathways; Basic concepts Of Metabolic Engineering, Metabolic Databases, *In-Silico*Systems Analysis of Bio pathways, Some successful examples of metabolic engineering.

UNIT-IV **(8 hours**

Applications of Biomolecules; Therapeutic and diagnostic applications, Application of biomolecules in drug delivery: lipid based drug delivery system- emulsions, vesicular systems (liposomes, niosomes),lipid particle system (lip sphere, solid lipid micro particle), Carbohydrates and proteins in drug delivery.

UNIT-V **(8 hours)**

Fundamentals of CD, IR and Raman spectroscopy and their use in Spectroscopy and their use in study of biomolecule conformation, Fundamentals of X-Ray, NMR, and cryo-electron microscopy for determination of bimolecular structure. Mass Spectrometry.

TEXT/REFERENCE BOOKS:

1. Lehninger Principles of Biochemistry 7th edition by Nelson, David L. Cox, Michael .Lehninger, AlbertL. W H Freeman & Co.
2. Metabolic Engineering: Principles and Methodologies by Gregory N.Stephanopoulos, Aristos, Aristidou, and Jens Nielsen. Academic Press(1998)

3. Biochemistry by Voet, D. and Voet, J.G. John Wiley & Sons Inc.,(2010)
4. Biochemistry by Rastogi, S.C."Biochemistry" 3rdEdition. TataMcGraw-Hill (2010)
5. Biochemistry Satyanarayana, U. and U. Chakerapani, "Biochemistry" Books & Allied (P) Ltd.(2019)

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MICROBIAL BIOTECHNOLOGY (BTT-303)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To know about selection and screening of microorganisms with industrial potential and strain development
2. To provide awareness of the wide scope of applications of microorganisms in industry; the applications of fermentation technology and potentials for future development
3. To improve knowledge about production and applications of useful microbial products by fermentation techniques
4. To enrich skill about application of microorganisms in varied fields industrial biotechnology like bioremediation, Bio-fertilizer production, Biodiesel etc.

COURSE OUTCOMES

Upon completion of the course, the student will be able to:

1. Learn various methods for isolation, identification, screening and improvement of microbial strains of industrial importance
2. Select and use of microorganisms in production of organic acid, vitamin, antibiotics, vaccines, proteins, primary and secondary metabolites, as well as food and dairy products.
3. Acquire, discover, and apply the theories and principles of microbial technology in practical, real-world situations and problems.
4. Explore Work opportunities for applied microbiology in emerging biotechnology industries.

Syllabus:

UNIT- I **(8 hours)**

General concept on microbial biotechnology, Industrially important microorganisms, Isolation, Screening, Primary and secondary metabolites, Databases for microbiologists, Microbial strain improvement and development, Biotechnological tools to improve the microbial strains with respect to industry, Isolation and preservation of industrially important microorganisms.

UNIT- II **(8 hours)**

Fermentation: Microbial fermentation, Substrate for industrial fermentation, Overview of fermenter, Upstream Processing, scaling up and downstream processing, production of useful products/bio products and the application, Process Control and monitoring and Kinetics

UNIT-III **(8 hours)**

Microbial Production Of Ethanol, Wine, Vinegar and citric acid, Amino acids (Glutamic Acid), Vitamins, Active pharmaceutical ingredients or drug substances, Antibiotics (Penicillin), High fructose Corn syrup and Cheese

UNIT- IV **(8 hours)**

Microbial Production of Bio fertilizers and Bio pesticide, Microbial Production Of Enzymes/extremozymes (Amylase), single cell proteins, fermented food, probiotics, Recombinant Vaccine (Hepatitis B vaccine) and Insulin production, Production of microbial enzymes (amylases), Single cell proteins

MICROBIAL BIOTECHNOLOGY (BTT-303)

L:T:P::3:1:0 **Credits-4**

UNIT- V **(8 hours)**

Xenobiotic, Bioremediation, Biotechnological treatment of wastewater, sewage and sludge, Microbes In Mining/metal extraction, Biotransformation, Bio-energy-fuel for biomass, production and economics of biofuels, bioethanol, butanol, Biodiesel, Biogas, Bio-refineries, Microbial Enhanced Oil Recovery(MEOR)

TEXT/REFERENCE BOOKS :

1. Industrial microbiology (4th ed) by Samuel Cate Prescott and Cecil Gordon Dunn, CBS Publishers and Distributors, 2004
2. Crueger Biotechnology: A Textbook Of Industrial Microbiology (3rd ed) by W Crueger, A Crueger and KR Aneja, Medtech Publications, 2017
3. Microbial Biotechnology: Fundamentals of applied microbiology (2nd ed) by Alexander, N; Glazer & Hiroshi, Nikaido, WH Freeman & Co,1995
4. Basic Biotechnology (3rd ed) by C. Ratiedge and B. Kristiansen, Cambridge Univ. Press, UK, 2017.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

BIOANALYTICAL TECHNIQUES (BTT-304)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To understand protein crystallization techniques and its applications.
2. To understand chromatographic techniques for protein purification.
3. To understand advanced imaging techniques, electrophoretic techniques and other advanced techniques for analysis of biological samples.

COURSE OUTCOMES

Upon completion of the course, the student will be able to:

1. Define the fundamentals of various analytical methods for solving a given problem.
2. Handle and calculate instrumental measurements uncertainties.
3. Understand the requirements for successful operations of analytical techniques
4. Apply principles of various analytical devices used in research and enhance problem-solving technique.

Syllabus:

UNIT-I **(8 hours)**

Protein Crystallography: Biological macromolecules, Principle and method of protein crystallization, Crystallography and X-ray diffraction: Introduction to x-ray and general theory and instrumentation, Bragg's Law, various techniques to determine crystal structure.

UNIT-II **(8 hours)**

Chromatographic Methods for protein and peptide purification: Gas Chromatography With Mass Spectrometric Detection (GC-MS), liquid chromatography with mass spectrometric detection (LC-MS), inductively coupled plasma with mass spectrometric detection (ICP-MS). Metal analysis by ICP-MS; Analysis of data: HPLC chromatograms, including trouble shooting – how to achieve good separation on HPLC; GC-MS data; LC-MS spectra.

UNIT-III **(8 hours)**

Advanced imaging techniques in microscopy: Live cell imaging, Confocal microscopy and sample preparation for fluorescence microscopy, High content/throughput screening: Basics of SEM and Specimen preparation for SEM, Basics of TEM and Specimen preparation for TEM, Atomic Absorption and IR Spectro-photometry: Principle, instrumentation details, and applications.

UNIT-IV **(8 hours)**

Electrophoretic Techniques: Strategies, Separation of proteins using 2D Electrophoresis, Electrophoresis method for purifying proteins, *in-situ* enzyme detection, staining method, Separation Of Peptide Mixture, Pulse field gel electrophoresis, Denaturing gradient gel electrophoresis.

UNIT-V **(8 hours)**

Flow Cytometer: Introduction to flow cytometry, Fluorochromes and fluorescence, Experimental Design And Fluorescence Quantitation. Gating, analysis of flow cytometry data, Radioisotope Techniques: Radiotracers, units of radioactivity measurement, proportional and scintillation counters, introduction to autoradiography and nuclear medicine.

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BIOANALYTICAL TECHNIQUES (BTT-304)

L:T:P::3:0:0 **Credits-3**

TEXT/REFERENCEBOOKS:

1. A biologist Guide to principles and technique of practical biochemistry- By Keith Wilson, Kenneth H. Gouldind 3rd Edition, ELBS Series
2. Williams, D. and Fleming, I."Spectroscopic Methods in Organic Chemistry", McGraw-Hill Higher Education, Maidenhead, UK.
3. Babine, R.E. and Abdel Meguid, S.S., "Protein Crystallography in Drug Discovery", Willy VCH Verla.

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BIOSEPERATION TECHNOLOGY (BTT-305)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To provide an opportunity to understand the importance of the bio separation process.
2. To learn various separation techniques related to primary cell disruption, primary isolation, purification and final polishing.
3. How to deal with problems associated with product recovery through case studies.

COURSE OUTCOME

On successful completion of this course, the students will be able to:

1. Perform different laboratory procedures related to the subject.
2. Develop skill sets to the students for the Research, chemical, pharmaceutical, biotech and Food Industry.
3. Analyze and select the appropriate scheme and separation methods for the recovery of any bio products.
4. Demonstrate critical thinking, problem solving and decision making abilities.

Syllabus:

UNIT-I

Role and importance of bioseparation process in biotechnological processes. Problems and requirements of bioproduct purification. Characteristics of biological mixtures, classification of bioproducts, process economics-capital and operating cost analysis.

UNIT-II

Cell disruption methods for intracellular products, removal of insoluble, biomass (and particulate debris) separation techniques-flocculation and sedimentation, Industrial visit for centrifugation and filtration methods- theory and equipment.

UNIT-III

Extraction – theory and practice: Aqueous two phase extraction, supercritical fluid extraction Precipitation techniques: salts, solvents, polymers (PEG). Membrane based separations techniques: micro, ultra-filtration, RO and Dialysis- theory, design and configuration of membrane separation equipment, applications.

UNIT-IV

Theory, practice and selection of media for – gel-filtration chromatography, Ion exchange chromatography, Hydrophobic interaction chromatography, reverse phase chromatography, Affinity chromatography – Metal affinity chromatography, dye affinity chromatography, immunosorbent affinity chromatography & Expanded bed chromatography. Scale-up criteria for chromatography, calculation of no. of theoretical plates and design, all electrophoresis techniques including capillary electrophoresis, hybrid separation technologies-membrane chromatography, electro-chromatography.

UNITV

Drying and crystallization- Theory and equipment. Case studies on purification of: cephalosporin, aspartic acid, Recombinant Streptokinase, Monoclonal antibodies, Tissue plasminogen activator, Taq polymerase, Insulin. Case studies of product recovery economics.

BIOSEPERATION TECHNOLOGY (BTT-305)

L:T:P::3:0:0 **Credits-3**

TEXT /REFERENCE BOOKS:

1. Bioseparation: Downstream Processing for Biotechnology, by Belter, P. A.; Cussler E. L. and Hu W. S. (2003) John Wiley & Sons. OXFORD.
2. Bioseparation : Principles and Techniques by Shivashankar, PHI, 2005.
3. Bioseparation science and engineering by Harrison et al. Oxford Univ. Press (2006)

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BIOPROCESS ENGINEERING (BTT-306)

L:T:P::3:0:0 **Credits-3**

COURSEOBJECTIVES

1. To introduce the engineering principles of bioprocess including kinetics of microbial cells in different types of fermentation process, medium requirements and optimization.
2. To study different types of bioreactor, control of bioreactors and concept of sterilization.
3. To learn the techniques used in product recovery, basic concept of scale up and role of mass transfer bioreactor
4. To identify good manufacturing and lab practices in bioprocess industries.

COURSEOUTCOMES

On successful completion of this course, students will be able to:

1. Solve problems related to microbial growth kinetics and mass transfer in bioreactor
2. Apply the acquired knowledge to design of fermenters and various processes in any bioprocess industries.
3. Decide and select appropriate techniques for bio separation of products.
4. Develop knowledge of bioprocess modeling and optimization of processes in bioprocess.
5. Apply engineering principles to systems containing biological catalysts to meet the needs of the society.

Syllabus:

UNIT-I **(8 hours)**

Introduction to bioprocess engineering, biological systems in bioprocess, isolation, preservation and maintenance of industrial microorganisms; medium formulation and optimization; Medium design of commercial media for industrial fermentations-plackett-Burman design, response surface methodology, simplex design., kinetics of microbial growth, substrate utilization and product formation in batch, fed-batch and continuous culture. Models for microbial growth.

UNIT-II **(8 hours)**

Bioreactor: components and control of major process parameters. Control Systems in bioreactors and methodologies. Different Types Of Bioreactor: CSTR, airlift, fluidized, plug flow, packed bed, specialized bioreactor: photo-bioreactor, Membrane bioreactor. Sterilization of reactor and medium: concept and method.

UNIT-III **(8 hours)**

Downstream Processing: introduction, removal of microbial cells and solid matter: Foam Separation, precipitation, filtration, and centrifugation, Cell disruption techniques, liquid-liquid extraction and chromatography, Membrane Separation Process, drying and crystallization, effluent treatment of bioprocess waste.

UNIT-IV **(8 hours)**

Mass Transfer and Diffusion and in Bioreactors: The Oxygen Requirement of Industrial Fermentation. Oxygen transfer phenomenon. Determination of Kla, factors affecting oxygen transfer rate, Concept Scaleup: scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed, Fluid rheology and factors affecting bioreactor processes. Flow Patterns in agitated tanks.

BIOPROCESS ENGINEERING (BTT-306)

L:T:P::3:0:0 **Credits-3**

UNIT-V **(8 hours)**

Safety Practices In Bioprocess, Quality Control OfBio products, Concept of GMP and GLP in bioprocessing, Utilizing Genetically Engineered Organism In Bioreactors, Basic Concepts Of Computer modeling and optimization in bioprocess applications.

TEXT/REFERENCEBOOKS:

1. Michael L. Shuler, FikretKargi, Matthew DeLisa . Bioprocess Engineering, 3rdEdition, Prentice Hall International Series.(2017).
2. Peter Stanbury, Principles of Fermentation technology, third edition, Butterworth Heinemann. (2015)
3. Pauline M Doran Bioprocess Engineering Principles, 2ndEdition, Academic Press, USA.(2013)
4. James E Bailey& David FOllis. Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill Book Co.-Singapore.(1986)
5. Keith Wilson and John Walker, “Principles and Techniques of Practical Biochemistry”, Cambridge University Press.
6. Kwon, Young Min, Ricke, Steven C. (Eds), “High-Throughput Next Generation Sequencing Methods and Applications” Humana Press.
7. Bhowmik, G. and Bose, S., “Analytical Techniques in Biotechnology”, Tata McGraw-Hill Publishers.
8. Chandler, D. and Roberso, R.W., “Bioimaging: Current Techniques in Light & Electron Microscopy”, Jones and Bartlett Publishers.

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BIOFUELS (BTT-307)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To build a solid foundation of knowledge about liquid /gaseous biofuels and biofuel production technologies.
2. To be familiar with the role of biotechnology in bioenergy generation.
3. To understand the Life cycle assessment and impacts of biofuels.
4. To know the status of Biofuel production and policies.

COURSE OUTCOMES

On successful completion of this course, students will be able to:

1. Select the suitable biomass feedstocks and conversion technologies for biofuel production.
2. Understand the production process of various biofuels.
3. Appreciate the role of microorganisms and metabolic engineering in biofuel development and production.
4. Develop an understanding of Bioenergy commercialization and impacts of Biofuels.

Syllabus:

UNIT-I **(8 hours)**

Overview of Energy Sources and Utilization, Fossil fuels versus renewable energy resources. Introduction of biofuels: history of biofuels, Different generations of biofuels. Bioenergy Feedstocks: Biomass types, characterization and chemistry, bioenergy feedstock cultivation and harvesting, Energy efficiency of biofuels, National Biofuel Policy.

UNIT-II **(8 hours)**

Bioethanol production from sugar, starch and lignocellulosic feedstock, biomass pretreatment and fermentation process. BioButanol: Butanol and its properties, butanol as fuel, method of its production, industrial application.

UNIT-III **(8 hours)**

Bio hydrogen production: types of substrates, different production process for biohydrogen, photobiological hydrogen production using algae. Biodiesel production**:** Chemistry of biodiesel production, Sources and production by plants and other sources, methods of biodiesel production. Biodiesel Industrial Plants.

UNIT-IV **(8 hours)**

Microbiology of methane production, biomass sources for methane production, biogas composition and use, biogas design. Algal Biofuel: Harvesting, drying, biomass pretreatment (physical, chemical and biological) and bioenergy production. Fuel Cell: concept, working and principle, Biochemical basis of fuel cell design

UNIT-V **(8 hours)**

Fuel Biotechnology: Biofuels, bioenergy commercialization and case studies, life cycle assessments, recent advances in bioenergy research, Current status of Biofuel production and utilization in India and World, Future trends of biofuel development, challenges and hurdles in biofuel production, Role of Genetic and metabolic engineering in biofuel production. Economic and environmental impact of biofuels.

BIOFUELS (BTT-307)

L:T:P::3:0:0 **Credits-3**

TEXT/REFERENCEBOOKS:

1. Biofuels and Bioenergy by John Love and John A. Bryant. Wiley-Blackwell (2017)
2. Introduction to Biofuels by David M. Mousdale. CRC Press (2010)
3. Biofuels production by Babu, V., Thapliyal, A., & Patel, G. K. John Wiley & Sons(2013)
4. Biofuel**s:** Securing the Planet's Future Energy Needs by AyhanDemirbas. Springer-Verlag London (2009)

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

BIOTECHNOLOGY FOR HUMAN HEALTH (BTT-308)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To Identify Benefits of Biotechnology for human health.
2. To Acquire Knowledge of tools and techniques of biotechnology helping human life improvement.
3. To deal with easily available diagnostic techniques for curing human ailments and disease

COURSE OUTCOMES

On successful completion of this course, students will be able to:

1. Acquire the knowledge about common diseases which can easily be cured using biotechnological tools.
2. Apply the knowledge of biotechnology for counseling and curing of complex genetic diseases/disorders.
3. Develop new strategies for the biopharmaceutical industry.

Syllabus:

UNIT-I

An Introduction and Scope of Medical Biotechnology, pharmaceutical applications of plants, animal and microbes for human health, classification of genetic diseases and their possible cure through biotechnology, Chromosomal disorders, mitochondrial disorders.

UNIT-II

Molecular Basis of Human Diseases, Pathogenic Mutations, oncogenes, Huntington's diseases, Pittsburgh Variant Of alpha-1 Antitrypsin, loss of function-Tumor suppressor, Genomic Dynamic Mutations-Fragile–X Syndrome, Myotonic Dystrophy.

UNIT-III

Prenatal diagnosis-Invasive Techniques-Amniocentesis, Fetoscopy, Chronic Villi Sampling (CVS), nNon – invasive techniques-Ultrasonography, X-ray, TIFA, maternal serum and foetal cells in maternal blood, Diagnosis using protein and enzyme markers.

UNIT-IV

Mechanism Action of Antibiotics and Drug Resistance, Monoclonal antibodies, Hybridoma Technology and Concept of Antibody Engineering, DNA/RNA based diagnosis, Microarray technology, Clinical Management and Metabolic manipulation- PKU, Familial Hyper-cholestrolemia, Rickets, ADA, Congenital Hypothyroidism. Metacyc, Biocyc, KEGG.

UNIT-V

Strategies of Gene Therapy, vectors used in gene therapy, biological vectors retrovirus, adenoviruses, Herpes Synthetic vectors- liposomes, receptor mediated gene transfer, Cell and Tissue Engineering, Stem Cell: Potential use of Stem Cells- Cells Based Therapies.

TEXT/REFERENCEBOOKS:

1. Mackie & McCartney Practical Medical Microbiology (14thEdition) by Gerald Collee J, Andrew G Fraser, Barrie P Marmion, Mackie, Elsevier. 1996.
2. Text Book of Microbiology (10th edition) by Annanthnarayan and Panicer, The Orient Blackswan, 2017.
3. Essentials of Medical Microbiology (2nd edition) by ApurbaSankarSastry, SandhyaBhat K, Jaypee Brothers Medical Publishers (2018)

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NATURAL RESOURCE MANAGEMENT (BTT-309)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To acquaint the students the knowledge of Natural Resources and their Importance
2. To acquire Knowledge of Different resource management strategies
3. To get knowledge about Conservation of natural resources for sustainable development

COURSE OUTCOMES

On successful completion of the course, students will be able to:

1. Apply the knowledge of natural resource management to live a healthy life.
2. Develop the approaches with incorporation of new technology for the sustainable development
3. Create awareness among masses to conserve all natural resources to save mother earth

Syllabus:

UNIT-I **(8 hours)**

Introduction to Natural Resources Bases, concept of resource, classification of natural resources, factors influencing resource availability, distribution and uses, interrelationship among different types of natural resources Viz Animal, Plant Microbes etc, concern on productivity issues, ecological, social and economic dimension of resource management and their subsequent conservation

UNIT-II **(8 hours)**

Forest resources, forest vegetation, status and distribution, major forest types, mining, dams and their effects on forest and tribal people, forest management, developing and developed world strategies for forestry, land resources, soil erosion, wet land ecology and management, use and over utilization of water resources, water ecology and management

UNIT-III **(8 hours)**

Main energy resources, energy needs, renewable and non-renewable energy resources, use of alternative energy sources and their management, world food problems and importance of food resources, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer pesticide problems, water logging,

UNIT-IV **(8 hours)**

Fish and other Marine Resources, their production, status, unsustainable harvesting, issues and challenges for resource supply, new prospects in fish farming, use and exploitation of mineral resources, environmental effects of extracting and using mineral resources.

UNIT-V **(8 hours)**

The Evolution and History of resource management paradigms, resources conflicts, resource extraction, access and control system, ecological, economic and ethnological approach of natural resource management and conservation, implications of different approaches, integrated resource management strategies, causes and link with resources scarcity and poverty. Biotechnological approaches, tools and techniques for natural resources management and conservation

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

NATURAL RESOURCE MANAGEMENT (BTT-309)

L:T:P::3:0:0 **Credits-3**

TEXT/REFERENCEBOOKS:

1. Francois Ramade, 1984. Ecology of Natural Resources. John Wiley & Sons Ltd
2. Global Change and Natural Resource Managemnt, Vitousek, P.M.1994. Beyond global warming: Ecology and GlobalChange, Ecology 75,1861-1876
3. Agarwal, K.C. 2001. Environmental Biology, Nidhi Publications Ltd, Bikaner
4. Singh H.R. 2014 Environmental Biology S. Chand & Company PVT. LTD
5. Saha T.K. 2007. Ecology and Environmental Biology. Books and Allied (P) Ltd.
6. Sharma P.D. 2007. Ecology and Environment. Rastogi Publications (P) Ltd.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

FOOD BIOTECHNOLOGY (BTT-310)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To learn the principles involved in food preservation.
2. To understand the principles that makes a food product safe for consumption
3. To be aware about the principles and current practices of processing techniques and the effects of processing parameters on product quality.

COURSE OUTCOMES

On successful completion of this course, students will be able to:

1. Handle the basic food safety issues in the food market.
2. Develop and evaluate the quality of new food products using objective and subjective methodologies.
3. Apply basic concepts in biochemistry and food analysis.
4. Identify the conditions under which the important pathogens are commonly inactivated, killed or made harmless in foods.
5. Understand the relevance and significance of food safety, food quality and food-plant sanitation laws and regulations.

Syllabus:

UNIT-I **(8 hours)**

Introduction to Food Biotechnology: Scope of Food Biotechnology, Types of Food and their Nutritional Properties, Growth of Microorganisms in Food: Intrinsic & Extrinsic Factors, Indian and International Food Laws, Introduction to nutraceuticals and pharmaceuticals and their role and applications in food processing, Major food processing industry in India.

UNIT-II **(8 hours)**

Principles of Food Preservation, Processing and Packaging: Definition of Food Preservation, Type of food, Principles of Food Preservation, Food Preservation methods, Food processing, Classification of food processing: Primary, Secondary and Tertiary, aims of food processing, Benefits and Drawbacks of food processing, Food Packaging methods, Roles of Food Packaging, Materials used in Food Packaging, improved food packaging (Biodegradable) .

UNIT-III **(8 hours)**

Principles and Basics of Food Chemistry and their role in Human Nutrition: Structure and functions of macro and micro nutrients, Role of macro and micronutrients in human nutrition, Overview of food additives with respect to their technological functions, Overview of anti-nutritional factors and their removal from food, Overview of enzymes as food processing aids, Overview of nutraceuticals and functions foods, Food contamination and adulterants and their effect on human health, Food allergen and allergenicity, Importance of diet in alleviating health risks, especially non communicable disease.

UNIT-IV **(8 hours)**

Food Microbiology and General principles of Food Hygiene: General principles of food microbiology and overview of food borne pathogens, Overview of sources of microorganism in food chain (raw material, water, air, equipment etc.), Microbiological quality of foods, Microbial food spoilage and food borne disease, General principles and techniques in microbiological examination of foods, Overview of beneficial microorganism and their role in food processing and human nutrition.

FOOD BIOTECHNOLOGY (BTT-310)

L:T:P::3:0:0 **Credits-3**

Food Safety management system: General principles of food safety management system including traceability and recall – sanitation, HACCP, Good production and processing practices (GMP, GAP, GHP, GLP, BAP etc.)

UNIT-V **(8 hours)**

FSSAI– Role, Functions, Initiatives: Genesis and evolution of FSSAI,Structure and Functions of FSSAI, Overview of systems and processes in standards, Factors affecting food safety, Food safety and standard act, 2006, Role of state food authority, Food regulations, grades and standards (AgMark, and BIS Standards)

General concepts of Food Analysis and Testing: Fundamentals of field level and laboratory sampling with reference to importance of statistical tools, Overview of basic/classical methods of food analysis, Overview of modern analytical techniques including mass spectrometry and molecular techniques, Principles of Quality assurance and Quality control with reference to food analysis and testing.

TEXT/REFERENCEBOOKS:

1. Food Microbiology: A Laboratory Manual by Ahmed E. Yousef, Carolyn Carlstrom, JohnWiley& Sons, 2003.
2. Biotechnology in Food Production and Processing by Dietrich Knorr and Anthony J.Sinskey,Science,1985
3. Food Microbiology Fundamentals and Frontiers by Michael P. Doyle, Larry R. Beuchat and Thomas J. Montville, by Michael P. Doyle, Larry R. Beuchat and Thomas J. Montville, ASM Press, 2001.
4. Food Preservation & Safety: Principles & Practice (1st Ed) by Shirley J. Vangrade, Margy Woodburn, Lowa State University, 2001.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

HERBAL BIOTECHNOLOGY (BTT-311)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To acquire knowledge of medicinal plant wealth of the Himalaya region.
2. To enrich knowledge about Indian drug system since ancient times
3. To know different techniques for harnessing the potential of medicinal plant wealth solves the medical problems of the masses.

COURSE OUTCOMES

On successful completion of this course, students will be able to:

1. Recognize the medicinal plants of Himalaya region.
2. Understand the techniques/methods used for cultivation of medicinal plants.
3. Conduct research on medicinal herbs and acquire skills required for biopharmaceutical industry
4. Prepare herbal extract and choose techniques to isolate and identify secondary metabolites.
5. Identify the medicinal plants to prepare herbal remedies against various parasitic and lifestyle-associated ailments.

Syllabus:

UNIT-I **(8 hours)**

Introduction to medicinal plant of North Himalaya, Important medicinal plants of Garhwal Range & their medicinal value, Importance and relevance of herbal drugs in traditional Indian system of medicine (Ayurveda, Unani, Sidha, Homeopathy etc).

UNIT-II **(8 hours)**

Pharmacognosy- Aim and Scope; branches of Pharmacognosy and Phytochemicals– Reserve materials; Secretory materials; excretory materials, Principles and techniques in medicinal plant cell and tissue cultures, RFLP RAPD, AFLP mapping used for authentication of diversity in medicinal plants.

UNIT-III **(8 hours)**

Plant disease of medicinal plants like Blast, blight, tikka, smut, wilt, their control measures, and plant based herbicides, Use of biotechnology in crop improvement of medicinal, Plant symbiont interaction, nitrogen fixation disease, stress and salt resistance, Gene isolation, cloning and transfer in medicinal plants

UNIT-IV **(8 hours)**

Herbal extraction methods, steps involved, solvents used, and equipment required. Types of herbal extract preparation and storage methods. Isolation and quantification of secondary metabolite used in drug production from medicinal plants (viz., alkaloids, terpenoids, steroids, essential oils, essential perfumes etc.)

UNIT-V **(8 hours)**

Application of herbs in diseases like Parasitic diseases like Malaria, Filaria their herbal remedies and cure, Control of malaria parasite and vector through medicinal plants, Herbs for human diseases like Diabetes (*Steviaspp*), Cancer (*Gingkobiloba*), Diarrhea (*Cinnamomumzeylanicum*) etc as case studies. Future prospects of herbal medicines in drug discovery. Naturopathy, Industrial Visit to any Ayurvedic manufacturing plants to study the processing of medicinal products.

HERBAL BIOTECHNOLOGY (BTT-311)

L:T:P::3:0:0 **Credits-3**

TEXT/REFERENCEBOOKS:

1. Advances in medicinal Plants by K.J anardhan Reddy, University Press, (2007).
2. Handbook of Medicinal Plants (4th reviseded) by Bhattacharjee, Aavishkar Publication, (2004).
3. Medicinal herbs & flowers by Bhattacharjee, Aavishkar Publication, (2005).
4. Medicinal plants: applied biology of domestication & export by Singh, K., Aavishkar Publication. (2004)
5. Medicinal Plants: Utilization & conservation by Thrived, P.C., Aavishkar Publication (2004)
6. Plant Pathology by Sharma, P.D, Alpha Science International (2006)
7. Textbook of PharmacognosyAndPhytochemistry by Shah and Seth, Elsevier publications, (2010).

Technical Writing and Presentation Skills (AHT-303)

L:T:P::2:0:0 **credit : 00**

Course Objectives:

- To develop effective writing and presentation skills in students.
- To develop textual, linguistic and presentation competencies instudents appropriate for their professional careers.

Course Outcomes:

After the successful completion of course, the students will be able to:

CO1: Write clearly and fluently to produce effective technical documents.

CO2: Demonstrate an appropriate communication style to different types of audiences both orally and written as per demand of their professional careers.

CO3: Communicate in an ethically responsible manner.

Course Contents:

WRITING SKILLS

Unit-I **(4 hours)**

Technical Writing-Basic Principles: Words-Phrases-Sentences, Construction of Cohesive Paragraphs, Elements of Style.

Unit-II **(4 hours)**

Principles of Summarizing: Abstract, Summary, Synopsis

Unit-III **(6 hours)**

Technical Reports: Salient Features, Types of Reports, Structure of Reports, Data Collection, Use of Graphic Aids, Drafting and Writing

PRESENTATION SKILLS

Unit-IV **(6 hours)**

Speaking Skills: Accuracy vs. Fluency, The Audience, Pronunciation Guidelines, Voice Control.

Unit-V **(8 hours)**

Professional Presentations: Planning, Preparing, Presentation Strategies, Overcoming, Communication Barriers, Using Technology, Effective Presentations.

References:

1. Kumar, Sanjay &PushpLata, “Communication Skills”, Oxford UniversityPress,2011.
2. Quirk & Randolph, “A University Grammar of English”, Pearson,2006.
3. Rutherford, Andrea J., “Basic Communication Skills for Technology”, Pearson 2007.
4. Rizvi, M Ashraf, “Effective Technical Communication”, McGraw Hill,2009.
5. Leigh, Andrew & Maynard, Michael, “The Perfect Presentation”, Random House.
6. Barker, Larry L., “Communication”, Prentice-Hall.
7. Lesikar&Flatley, “Basic Business Communication-Skills for Empowering the Internet Generation”, Tata McGraw-Hill.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

BIOCHEMISTRY & BIOANALYTICAL TECHNIQUES (BTP-301)

L:T:P:: 0:0:2 **Credit-01**

COURSE OBJECTIVES:

To introduce the hands-on descriptions of various types of biomolecules, enzyme kinetics, physical concepts of analytical techniques, working of bioanalytical tool etc with the help of related instruments and devices.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

1. Formulate, analyze and solve a multilevel laboratory problems using analytical instruments and devices.
2. Demonstrate experimental comprehension of biomolecules and their properties.
3. Analyze the concept of enzyme inhibition and biomolecule extraction.
4. Handle various analytical equipments to conduct experiments related to Microscopy, Spectrometry, chromatography and electrophoresis.
5. Think innovatively and improve the creative skills those are essential to solve biochemistry problems.

Syllabus:-

BIOCHEMISTRY

1. Titration curve of amino acids.
2. Isoelectric precipitation of protein: Casein from milk.
3. To test for activity and determination of salivary amylase.
4. Study of enzyme kinetics.
5. Study of enzyme inhibition kinetics.
6. Immobilization of an enzyme and study of immobilized enzyme kinetics.
7. Separation of amino acids and chlorophyll pigments by TLC.

BIOANALYTICAL TECHNIQUES

1. Protein precipitation by organic solvents, Ammonium sulfate
2. Isolectric precipitation of protein
3. Thin layer chromatography of given plant extract.
4. Visualization of migration of various forms of plasmid using gel electrophoresis.
5. SDS-PAGE and Native PAGE analysis of given protein sample
6. Fluorescence imaging for the study of bacterial cell biology.
7. FTIR: Sample Preparation Techniques and Interpretation of Spectra of an Unknown.
8. Analysis of plant extracts by High Performance Liquid Chromatography (HPLC).
9. Gas Chromatography: Separation and Identification of Organic Unknowns
10. Characterization of nanoparticles by SEM and TEM.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

MICROBIAL BIOTECHNOLOGY AND BIOPROCESS ENGINEERING (BTP-302)

L:T:P:: 0:0:3 **Credit-01**

COURSE OBJECTIVES:

To introduce the hands-on descriptions of various types of microbes, concept of microbial biotech, bioreactor and its processing, monitoring etc with the help of related experiments, instruments and devices.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

1. Formulate, analyze and solve a multilevel laboratory problems in microbiology and bioprocess engineering.
2. Demonstrate experimental comprehension of isolation and preservation of microbes.
3. Analyze the concept of mutagenesis, bioreactor processing and monitoring in lab.
4. Handle various experiments in the area of microbiology, cell growth and production kinetics.
5. Think innovatively and improve data interpretation skills those are essential for bio-engineers.

Syllabus:-

1. Bacteriological examination of food samples
2. Isolation and preservation of industrially important microorganism
3. Development of streptomycin resistant mutant by gradient plate method
4. Development of streptomycin resistant mutant by selective enrichment method
5. To perform UV mutagenesis
6. Microbial production of citric acid
7. Production of ethanol by yeast
8. Enzyme assay for various microorganism
9. Production of secondary metabolites by microbes
10. Production of antibiotics by microbes
11. To perform enzyme immobilization
12. To perform Sterilization of fermenter
13. Effect of pH, salt & temperature on bacterial growth
14. Batch growth kinetics of bacteria
15. Enzyme immobilization kinetics

Calculation of oxygen transfer coefficient – dynamic gassing-out method and sulphite oxidation

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

BIOINFORMATICS & SYSTEM BIOLOGY (BTT-312)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To acquire knowledge the interdisciplinary nature advances in bioinformatics and systems biology.
2. The basic understanding of how biological data is stored and retrieved from various biological databases.
3. To develop an understanding of algorithms of sequence alignment (pairwise and multiple) and scoring algorithms.
4. To solve problems through understanding various tools and software.
5. To develop an *In-silico* understanding of various systems in living organisms.

COURSE OUTCOMES

After successfully completing this course, students will be able to:

1. Explain the basic principles that underpin Bioinformatics analyses, and apply these principles when analyzing biological data;
2. Survey a selected field within Bioinformatics, synthesize information from primary literature, and coherently report the findings in a written document;
3. Analyze biological data using a variety of Bioinformatics Tools; and enrich themselves with system-level understanding for biological systems.
4. Develop and analyze the properties of *in-silico* models of gene-gene interactions and protein-protein interactions

Syllabus:

UNIT-I **(8 hours)** Introduction, Evolution, History, Scope and Application of Bioinformatics. Biological databases; primary, secondary and tertiary databases, Introduction to sequence Alignment (Pairwise and Multiple), Optimal Alignment Methods, and substitution Scores and Gap Penalties, Database :FASTA, BLAST algorithms.

UNIT-II **(8 hours)**

Protein structure, domains and motifs prediction method, visualization,model validation and Prediction, Structure classification (SCOP,CATH): Visualization software (Pymol, Rasmoletc.)

UNIT-III **(8 hours)**

Energy minimization; Molecular dynamics; Rosetta; Structure comparison (DALI, VAST etc.) CASP; Protein Ligand Docking; Computer Aided Drug Design (pharmacophore identification) QSAR.

UNIT-IV **(8 hours)**

Introduction to Systems Biology: Scope, Applications. Concepts, implementation and application. Databases and software for Systems Biology: Introduction-databases: KEGG, EMP, MetaCyc. Expression databases and other databases related to systems biology. Cystoscape, viz ANT & Cell Designer.

UNIT-V **(8 hours)**

Biological Networks: Protein-protein interaction network, gene regulatory network, metabolic network, signal transduction network.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

BIOINFORMATICS & SYSTEM BIOLOGY (BTT-312)

L:T:P::3:1:0 **Credits-4**

TEXT/REFERENCEBOOKS:

1. Dictionary of Bioinformatics & computational biology (1st edition) by Hancock, Wiley, (2004).
2. Bioinformatics-Sequence &GenomeAnalysis(4thEd) by T.W. Mount, Cold Spring Harbor, N.Y(2014).
3. Bioinformatics & functional genomics (3rd edition) by Pevsner, Wiley, (2015).
4. Introduction to Systems Biology: Design Principles of Biological Circuits (2nd edition) by UriAlon, Chapman & Hall/CRC, (2019).
5. Synthetic Biology: A Primer (revised edition) by P.S. Freemont &R.I.Kitney, Imperial College Press,(2012)

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

RECOMBINANT DNA TECHNOLOGY (BTT-313)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. This course aims to expose students to the principles, methods and applications of recombinant DNA technology in biotechnological research.
2. To train students in strategizing research methodology for employing genetic engineering techniques.

COURSE OUTCOMES

On successful completion of this course, students will be able to:

1. Summarize the basics of molecular biology and handle RDT experiments according to safety guidelines.
2. Identify suitable vectors for RDT experiments and methods
3. Select suitable Expression vectors and demonstrate cloning and expression strategies of foreign genes in host.
4. Demonstrate and apply various advanced techniques of RDT including, PCR, antisense, CRISPR/Cas9 technology etc. Use RDT ethically for welfare of living organisms and protection of environment

Syllabus:

UNIT-I **(8 hours)**

Introduction to Gene Manipulation: History: Early experiments in Recombinant DNA Technology, Tools of RDT, Processes of Recombinant DNA Technology, Safety guidelines for recombinant DNA research, Control of spills and mechanism of implementation of biosafety guidelines.

UNIT-II **(8 hours)**

Enzymes used in manipulation of DNA: Restriction nucleases: exo- and endo-nucleases, Enzymes in modification- Polynucleotide phosphorylase, DNase and their mechanism of action, Enzymes in Modification- Methylases and phosphatases and their mechanism of action, Enzymes in modification- Polynucleotide kinase, Ligases, RNase, Reverse Transcriptase and their mechanism of action.

Salient features of vectors of recombinant DNA Technology, Plasmid based cloning vector, Bacteriophage vectors, Cosmid vector, Specialist vectors.

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UNIT-III **(8 hours)**

Cloning strategies: Plants, microbes, Animals, Insertion of Foreign DNA into Host Cells, Transformation, Expression of cloned genes in prokaryotes, eukaryotes. Gene regulation study. Gel electrophoresis; Hybridization Techniques: Northern, Southern, and Fluorescence *in-situ* hybridization (FISH), expression in bacteria, expression in yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants

His-tag, GST-tag, MBP-tag etc. Restriction proteases, intein-based vectors. Inclusion bodies, methodologies to reduce formation of inclusion bodies

UNIT-IV **(8 hours)**

Restriction mapping DNA fragments and map construction, DNA labelling. Nucleic acid Sequencing. Genetic markers. Gene therapy: Strategies of gene delivery**,** Genomic and cDNA libraries, screening of libraries by nucleic acid hybridization**,** gene regulation and silencing

Principle and application of PCR, types of PCR. Primer designing and design tools (Primer BLAST, primer3 etc.), Antisense molecules, Introduction to siRNA; Si-RNA technology; Gene knockout analysis, RNA interference, CRISPR, CRISPR/Cas9 technology, Site-directed mutagenesis and protein engineering.

RECOMBINANT DNA TECHNOLOGY (BTT-313)

L:T:P::3:1:0 **Credits-4**

UNIT-V **(8 hours)**

Molecular approaches to generate transgenic organisms and their applications: BT cotton, Golden rice, Cloned animals, Recombinant Insulin, Growth Hormone, Edible vaccine; Creation of knockout mice, disease model, somatic and germ-line therapy in vivo and ex-vivo, Application of antisense & ribozyme technologies, Microarray technique. DNA chips, Quantum Dots, DNA foot printings, Ethics in rDNA Technology and Case studies

TEXT/REFERENCEBOOKS:

1. Molecular Cloning: A Laboratory Manual, J. Sambrook, E. F. Fritsch and T. Maniatis. Cold Spring Harbor Laboratory Press, New York, 2000.
2. Brown, Terence A. *Gene cloning and DNA analysis: an introduction*. John Wiley & Sons, 2020.
3. Primrose, Sandy B., and Richard Twyman. *Principles of gene manipulation and genomics*. John Wiley & Sons, 2013.
4. Albertset.al.: Molecular Biology of the cell(3rdand4theditions).
5. Cseke, L.J., Kirakosyan, A., Kaufman, P.B., & Westfall, M.V. (Eds.). (2011). Handbook of Molecular and Cellular Methods in Biology and Medicine (3rd ed.). CRC Press. .
6. DNA Science: A First Course in Recombinant Technology, D.A. Mickloss and G_A.Freyer, Cold Spring Harbor Laboratory Press, NewYork,1990.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

MEDICAL-NANOTECHNOLOGY (BTT-314)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. The purpose of this course is to provide an insight into the fundamentals of nanotechnology in biological and biomedical research.
2. It will also guide the students to understand how nanobiomaterials can be used for a diversity of analytical and medicinal rationales.

COURSE OUTCOMES

All the end of the course, students will be able-

1. To understand the essential features of biology and nanotechnology that are converging to create the new area of nano-biotechnology.
2. To recognize the structural and functional principles of bio-nanotechnology
3. To employ Nanobiomaterials for analysis and sensing techniques
4. To apprehend and explain the biomedical application of nanotechnology

Syllabus:

UNIT-I **(8 hours)**

Nano biomaterials and biocompatibility: surface and bulk properties of bio materials- nanobiomaterials– nanoceramics, nanopolymers, nanosilica, hydroxyl apatite, carbon-based nanomaterials; surface modification- textured and porous materials; surface immobilized biomolecules– cell-biomaterial interactions; immune response- *in-vitro* and *in-vivo* assessment of tissue compatibility.

UNIT-II **(8 hours)**

Structural & functional principles of bio nanotechnology-: Lipid bilayers- liosomes, neosomes polysaccharides, peptides, nucleic acids– DNA scaffolds, Enzymes– Biomolecular motors: linear, rotary mortors, immunotoxins; membrane transporters and pumps, antibodies– monoclonal Antibodies, immunoconjugates, limitations of natural biomolecules.

UNIT-III **(8 hours)**

Protein and DNA based nanostructures: nanocircuitry**,** S-layer proteins: structure, chemistry and assembly; lipid chips-S, layers as templates, engineered nanopores, DNA– protein nanostructures– DNA template, Electronics– DNA-based metallic nanowires and networks, DNA–gold nanoparticle conjugates, DNA– template electronics – DNA nanostructures for mechanics and computing.

UNIT-IV **(8 hours)**

Nanobio-Analytics: Luminescent quantum dots for biological labeling- nanoparticle molecular labels- surface biology: analysis of biomolecular structure by atomic force microscopy and molecular pulling – force spectroscopy – biofunctionalized nanoparticles for surface –enhanced Raman scattering and surface Plasmon Resonance –Bioconjugated Silica Nanoparticles for Bioanalytical Applications.

UNIT-V **(8 hours)**

Nanotechnology in food, Medicine and health science-: Nano particle based drug delivery systems – ultra sound triggered nano/microbubbles – regenerative medicine – Nanoimmuno conjugates- Biosensors – optical biosensors based on Nanoplasmonics – Nanobiosesors – Nano – Biosensors for mimicking gustarory and olfactory senses – cyclodextrin in nanomedicinal foods and cosmetics – bioavailability and delivery of nutraceuticals and functional foods using nanotechnology – polymer-based nanocomposites for food packaging – toxicity and environmental risks of nanomaterials.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

MEDICAL-NANOTECHNOLOGY (BTT-314)

L:T:P::3:1:0 **Credits-4**

TEXT/REFERENCEBOOKS:

1. Niemeyer C.M "Nano biotechnology : concepts, applications and perspectives", Wiley – VCH, 2006.
2. David S Goodsell, "Bio nanotechnology", John Wiley & Sons, 2004.
3. DebasisBagchi, ManashiBagchi, Hiroyoshi Moriyama, Fereidoonshahidi, "bio-Nanotechnology: A revolution in food, biomedical and health sciences "Wiley-Blackwell, 2013.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

ENZYME TECHNOLOGY & PROTEIN ENGINEERING(BTT-315)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. This course aims to provide deeper insight into the fundamentals of enzyme structure, function and kinetics of soluble and immobilized enzymes and protein engineering.
2. To acquire knowledge about isolation and purification of enzymes.
3. To understand the protein structure, stability, and folding and to analyze the effect of mutations on the characteristics of proteins.
4. To gain knowledge about enzyme immobilization and their application in Industry.
5. To study various aspects of enzyme and protein engineering

COURSE OUTCOME

On successful completion of this course, students will be able to:

1. Develop understanding of various methods of incorporating mutations in proteins and pros and cons of each method.
2. Review the factors of significant for protein folding processes and stability.
3. Understand the advanced biophysical techniques for protein analysis, including the capacity to discuss their relative merits and interpret data from those techniques

Syllabus:

UNIT-I **(8 hours)**

- History and scope of enzyme technology and protein engineering.
- Classification, nomenclature, activity units of enzymes.
- Energetics of enzyme catalyzed reactions, transition state.
- Concept of active sites and enzyme-substrate complex, active site mapping

UNIT-II **(8 hours)**

- Enzyme kinetics: Michaelis-Menton equation, secondary plots, Arrhenius equation, determination of energy of activation.
- Bi-substrate reaction kinetics including Random, ordered and Ping-Pong mechanism.
- Enzyme Inhibition, types: reversible (competitive and non -competitive), irreversible enzyme inhibition.

UNIT-III **(8 hours)**

- Allosteric enzymes and regulation of enzyme activity.
- Isoenzymes, Ribozymes and Catalytic antibodies.
- Multienzyme systems: Occurrence, poly-genic nature of multienzyme systems.
- Enzyme Purification: Isolation and purification of enzymes, criteria of homogeneity of enzymes and characterization of enzymes including determination of the molecular weight

UNIT-IV **(8 hours)**

- Methods of immobilization of enzymes, physical adsorption, covalent binding, entrapment and micro-encapsulation
- Kinetics of immobilized enzymes, effect of solute partition and diffusion on the kinetics of immobilized enzymes. biosensors-calorimetric, Potentiometric, optical piezoelectric biosensors and immune sensors.

ENZYME TECHNOLOGY & PROTEIN ENGINEERING(BTT-315)

L:T:P::3:1:0 **Credits-4**

UNIT-V **(8 hours)**

Different approaches of protein engineering Random mutagenesis, Mutagenesis by rational design, Protein sequencing Effect of mutation on protein structure, stability and folding phi value analysis Applications of protein engineering. Examples of commercially used engineered proteins, Strategies for Protein identification Protein structural and biochemical characterization using fluorescence spectroscopy, circular dichroism, X-ray crystallography, NMR, FTIR, mass-spectrometry etc. **Enzyme database:** BRENDA, KEGG, MEROPS, Meta-Cyc, Kin-Base, **Structure prediction tools:** Raptor, Biskit, Modeller, Swiss Model, Yasara: **Function Prediction Tool:** Ec Pred.

TEXT/REFERENCEBOOKS:

1. Fundamentals of Enzymology: Nicoles C Price and Lewis Stevens. Oxford Univ. Press.2005..
2. The chemical kinetics of enzyme action by K.J. Laidler and P.S. Bunting, Oxford University Press, London.
3. Enzymes by M. Dixon, E.C. Webb, CJR Thorne and K.F.Tipton, Longmans, London.
4. Enzyme structure and mechanism (1977) by Alan Fersht, Reading, USA.
5. Enzymatic reaction mechanism (1979) by Christopher Walsh, Freeman Publishers, San Francisco.
6. Immobilized enzymes (1978) by InhiroChibata, Halsted PressBook.
7. Introduction to Protein Structure, C. Branden and J. Tooze, Garland Publishing, New York.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

GENOMICS AND PROTEOMICS (BTT-316)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To acquire the fundamentals and high throughput techniques in Genomics and Proteomics and their applications.
2. Developing a detailed understanding of eukaryotic genome complexity and organization.
3. To develop detailed understanding of techniques of gene diagnostics and DNA profile.

COURSE OUTCOMES

On successful completion of this course, students will be able to:

1. Acquire the knowledge and practical skills associated with genomics and proteomics.
2. Understand functional and structural genomics.
3. Identify and discuss the techniques used in functional genomics such as microarrays.
4. Understand tools for proteome analysis.

Syllabus:

UNIT-I **(8 hours)**

Introduction to Genomics, Gene and Genome, Structural, Functional and Comparative Genomics, DNA Fingerprinting and its applications, DNA Fingerprinting Case Study, Human Genome Project.

UNIT-II **(8 hours)**

DNA sequencing–chemical and enzymatic methods, Strategy of Genome Sequencing, De-novo sequencing, Next-generation sequencing, Genome sequencing projects: Genome Assembly: Velvet, ABySS, Assembly validation using short read aligners: BWA, Viewing the Genome assembly: Tablet,

UNIT-III **(8 hours)**

Phylogenetic Analysis, MEGA (MolecularEvolutionaryGeneticAnalysis), COGS[Cluster of orthologous genes], Microarray Technique, Genomics databases and tools,Comparative genomic visualization tools, Genome Annotation Techniques: RAST, KAAS, Construction of circular map.

UNIT-IV **(8 hours)**

Introduction to Proteomics: Basics of Proteins and Proteomics, Basic Proteomics Workflow, How to analyze a Proteome – 2D-gelelectrophoresis, high-throughput proteome analysis with 2D-IEF, MALDI-TOF, Basics of mass spectrometry.

UNIT-V **(8 hours)**

Interactomics, Genomic browsers and databases, Proteomics applications, Aspects of Clinical Proteomics, Protein-Protein Interaction Mapping: Experimental and Computational. Its application in health and disease. Proteomics Tools and Databases, Pharmacogenomics :Ethical considerations of genetic testing; Genomics in drug discovery.

TEXT/REFERENCEBOOKS:

1. Gene Cloning & DNA Analysis: An Introduction, (VII Edition) by T.A.Brown, Wiley Blackwell (2016)
2. A Primer of Genome Science, (3rd Edition) by Greg Gibson and Spencer V. Muse,
3. Essential of Genomics and Bioinformatics by C.W. Sensen, John Wiley and Sons Inc. 2002
4. Advances in Biotechnology (1sted) by Indu Ravi, MamtaBaunthiyal and JyotiSaxena, Springer, 2014.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

BIOREACTOR ENGINEERING (BTT-317)

L:T:P::3:1:0 **Credits-4**

COURSE OBJECTIVES

1. To introduce the concepts of bioreactor design and different types of bioreactors.
2. To learn about the concept of ideal, non-ideal reactors their models
3. To study bioreactor consideration in enzyme system and multiphase bioreactor system
4. To know about unconventional bioreactors and their application
5. To learn various bioreactor operation and control strategies used in bioreactor.

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

1. Perform different laboratory experiments related to the subject.
2. Understand how to fully specify bioreactor design characteristics of free and immobilized systems.
3. Evaluate and solve problems related to reactor data.
4. Relate the fundamental knowledge of bioreactor engineering to industrial practice.

Syllabus:

UNIT-I **(8 hours)**

Bioreactor: Mechanical design of bioreactors. Types of reactor**:** Batch, plug flow reactor (PFR), continuous stirred tank reactor (CSTR), Fluidized bed reactor, bubble column, airlift fermenter. Design criteria for airlift, bubble column, and chemostat bioreactor.

UNIT-II **(8 hours)**

Concept of ideal and non-ideal reactors, models of non-ideal reactors–plug flow with axial dispersion, tanks-in-series model, chemostat model with cell growth kinetics. Reactors in series with and without recycling.

UNIT-III **(8 hours)**

Bioreactor consideration in enzyme system: Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factor. Design of immobilized reactors: Packed bed, fluidized bed and membrane reactors.

UNIT-IV **(8 hours)**

Unconventional bioreactors**:** Gas liquid reactors, hollow fiber reactor, and perfusion reactor for animal and plant cell culture, bioreactor design consideration for animal/mammalian and plant cell culture, Reactors for Solid-state fermentation.

UNIT-V **(8 hours)**

Bioreactor Operations: Sterilization of bioreactor, mixing and aeration, process monitoring and control, Advanced control strategies viz. PID controllers, Fuzzy logic based controllers and Artificial Neural Network (ANN) based controllers, Heat and mass transfer in bioreactor.

TEXT/REFERENCEBOOKS:

1. Michael L. Shuler, FikretKargi, Matthew DeLisa. Bioprocess Engineering, 3rd Edition, Prentice Hall International Series. 2017.
2. Peter Stanbury, Principles of Fermentation technology, third edition, Butterworth-Heinemann. 2015
3. Pauline M Doran. Bioprocess Engineering Principles, 2nd Edition, Academic Press,USA. 2013

4. James E Bailey & David F Ollis. Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill Book Co., Singapore. 1986
5. Bioreaction Engineering: Modeling &Control.vol. I & II. SchugerlKandBellgardt K.H, Springer Verlag Publications. 2000
6. Multiphase Bioreactor Design. Edited by: JoaquimM.S.Cabral, Manuel Mota, Johannes Tramp, CRC Press. 2001
7. Bioreactor analysis and design by T Panda, MacGraw Hill, New Delhi.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

VACCINE TECHNOLOGY (BTT-318)

L:T:P::3:0:0 **Credits-3**

COURSEOBJECTIVES

1. To understand the concept of Immune system, immunization and vaccine importance
2. To study various factors that influence vaccine design and development.
3. To enrich knowledge about different kinds ofVaccines and Vaccine delivery system
4. To be familiar with role of bioinformatics for vaccine development
5. To understand the process and technologies for vaccine development and production

COURSEOUTCOMES

On successful completion of this course, students will be able to:

1. Understand the concept of immunization and vaccines.
2. Understand vaccine types and vaccine delivery systems.
3. Select and use *in-silico* tools to develop new vaccines for different diseases.
4. Demonstrate an understanding of the development and manufacturing of vaccines and regulations in the vaccines production process.

Syllabus:

UNIT-I

Overview of immune system, Components of innate and acquired immunity, Humoral and Cellmediated immunity, Antigens, Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, General immunization practices, Age of commencement of immunization, Dosage And Dosage Spacing, Vaccine Schedule, Hazard of immunization.

UNIT-II

Vaccines: Introduction and types; Inactivated, attenuated, Toxoid, Subunit and multivalent vaccine, Purified macromolecules, Conjugate vaccine. New generation vaccines; Synthetic peptide vaccines, Recombinant antigen vaccines, DNA vaccines, Edible vaccines Immune stimulants, Adjuvants,

UNIT-III

A short history of vaccination, Pathogen–Host Interactions: Implications for vaccine design, Immunodeficiency, Vaccination of immunocompromised hosts, Antibody genes and antibody engineering-chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

UNIT-IV

Licensed vaccines, Viral Vaccine, Bacterial Vaccine, Parasitic vaccine, Novel vaccine delivery systems, Role of Bioinformatics on Vaccine design and development, *In-silico* Vaccine Design tools.

UNIT-V

Conventional methods of vaccine production; Recombinant approaches to vaccine production, Different stages in development of new vaccines and clinical trials- Case studies. The vaccine industry, Vaccine manufacturing, Vaccine additives and manufacturing residuals, Regulation and testing of vaccines, Vaccine safety and Legal issues.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

VACCINE TECHNOLOGY (BTT-318)

L:T:P::3:0:0 **Credits-3**

TEXT/REFERENCE BOOKS:

1. New Vaccine Technologies by Ronald by W.Ellis, Landes Bioscience, 2001
2. Advances in Vaccine Technology and Delivery by Cheryl Barton, Espicom Business Intelligence, 2009
3. Immunology, 7th Edition, by Male, David Mosby Publication
4. Vaccines, (6thEd) by Stanley A .Plotkin& Walter Orenstein &PaulA.Offit, Elsevier Publication, 2013

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

ANIMAL BIOTECHNOLOGY (BTT-319)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To understand the importance and types of different kinds of media and cell cultures that are commonly used in Animal Biotechnology.
2. To be familiar with the latest techniques and methods that are used in Animal biotechnology.
3. To Enrich the knowledge about applications of cell cultures in pharmaceutical and medical industry.

COURSE OUTCOMES

On completion of this course, students shall be able to:

1. To acquire basic understanding of laboratory practices in Animal cell cultures.
2. Select the appropriate medium composition and culture systems to establish cell cultures.
3. Understand the techniques and methods used in Animal Cloning, transplantation, transgenic animals and production of pharmaceuticals.
4. Appreciate the role of Animal Biotechnology in improving health and welfare of human and animals.

Syllabus:

UNIT-I **(8 hours)**

Introduction to Animal Biotechnology, Historical perspectives, Scope and Importance, Structure and organization of animal cell, Laboratory facilities for animal tissue culture, Bioethical issues related to animal biotechnology.

UNIT-II **(8 hours)**

Initiation of animal cell cultures, Primary culture, secondary culture, sub-culturing, Established celllines, Cultural media, Nutrient requirements of mammalian cells, natural and artificial media, Serumfreemedia,Preparationandsterilizationofsubstrateandmedium,Trypsinization,Cryopreservationofcellli nes,revivalandmaintenanceofanimalcelllines, Cell death, measurement of cell death.

UNIT-III **(8 hours)**

Large scale culturing in biotechnology, Monolayer (in Roux Bottle, Roller bottle, Plastic film, Opticalculturesystem,BreadBedreactors,Heterogenousreactors),Suspensions(stirredbioreactors,continuous flow cultures, air lift fermenter) and immobilized cell cultures, Methods of scaling up ofanimalcellculture,Hybridomatechnology,monoclonalantibodyandtheirapplicationinanimalhealthandprodu ction.

UNIT-IV **(8 hours)**

Induction of super ovulation, In vitro fertilization and embryo culture in human and farm animals, Requirement and Application of embryo transfer technology, Somatic cell fusion, Embryo collection and evaluation. Embryo splitting. Embryo sexing. Embryo transfer. Embryo Cloning. Nuclear Transplantation. Identification and transfer of gene influencing production and disease resistance

UNIT-V **(8 hours)**

Application of animal cell culture for in vitro testing of drugs, Testing of toxicity of environmental pollutants in cell culture, Application of cell culture technology in production of viral vaccines, pharmaceutical proteins: Stem cell culture, their application, Development of transgenic animal, detection of transgenic and transgene function, Animal cloning, Tissue and organ transplant, Case Studies on Animal Cloning and Organ transplants. Engineering human interferons and human growth hormones.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

ANIMAL BIOTECHNOLOGY (BTT-319)

L:T:P::3:0:0 **Credits-3**

TEXT/REFERENCE BOOKS:

1. Culture of Animals Cells(7th Edition) by R Ian Freshney, Wiley-Blackwell (2015).
2. Cell Growth and Division:A Practical Approach, edited by R Basega, IRL Press(1989).
3. Textbook of Animal Biotechnology. B. Singh , S.K. Gautam .Oxford & IBH Publishing Co Pvt.Ltd (2013).
4. Animal Cell Culture– Practical Approach (3rdedition) by John R. W. Masters, Oxford Press,(2000).
5. Animal Biotechnology. M.M. Ranga 3rd Ed. Agrobios India, (2007).

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

IMMUNOTECHNOLOGY (BTT-320)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To learn about immune system and immunization of host
2. To acquire knowledge about Immunodiagnostic Techniques and its role in disease diagnosis
3. To enrich knowledge about vaccine technology and its role in human health
4. To know about monoclonal and polyclonal antibodies- their production, characterization and its application in immunodiagnosis in clinical purpose.
5. To learn the concept of transplantation and cancer biology.

COURSE OUTCOMES

On successful completion of this course, students will be able to:

1. Understand immunization/vaccination, immunological disease and immunotherapy
2. Perform techniques like immunodiagnostic tests, western blot analysis, immuno-electrophoresis, ELISA-principle and applications, radioimmunoassay chemiluminescence assay
3. Understand reaction mechanism of vaccine and methods of preparation vaccines Account for polyclonal, monoclonal and humanized antibodies production and industrial applications
4. Evaluate and assess current and evolving concepts in immunological developments including immunotechnology, immunotherapy (cancer stem cell) and immunoprophylaxis

UNIT-I **(8 hours)**

Basic Concept of Immunotechnology: antigens for raising antibodies: peptide antigens and their preparation; handling of animals; viral coat proteins as recombinant, adjuvants and their mode of action..

UNIT-II **(8 hours)**

Immunodiagnostic Techniques- Agglutination, Precipitation, Neutralisation test, immunofluorescence, immuno-electrophoresis, ELISA (Indirect, Sandwich, Competitive) ELISPOT assay, radioimmunoassay, western blotting, flow cytometry, Complement System-components and functions of complement

UNIT-III **(8 hours)**

Vaccine Technology,Immunization ,types of immunization, Active and passive immunization, Rationale of immunization, role of adjuvant immunization; Live, killed, attenuated, subunit vaccines; recombinant DNA and protein based vaccines, DNA vaccine, plant-based, vaccines, reverse vaccinology, Peptide vaccines, conjugate, Immunotoxin: mechanism of immunotoxin and their role in medical science

UNIT-IV **(8 hours)**

Antibody engineering, Monoclonal and polyclonal antibody, Hybridoma technology, Production of monoclonal antibodies and their applications-in biomedical research, in clinical diagnosis and treatment, Human recombinant antibodies-antibody humanisation and applications of humanized antibodies, Application of human recombinant antibodies and antibody fragments in medicine and industry.

UNIT-V **(8 hours)**

Transplantation Immunology, Transplantation antigen, Graft rejection, Case studies- Transplantation and Graft rejection, Computational and Identification of biomarkers, Cancer biology, Tumors of immune system, MTT assay, Immunomodulators, Autoimmunity and autoimmune disease, criteria and causes of autoimmune diseases, Immunotherapy, Immunoinformatics and its applications.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

IMMUNOTECHNOLOGY (BTT-320)

L:T:P::3:0:0 **Credits-3**

TEXT/REFERENCE BOOKS:

1. *Kuby immunology*, Owen, J. A., Punt, J., &Stranford, S. A. New York: W H Freeman. (2013).
2. Roitt'sEssentialimmunology(7th eds) byPeterJ.Delves, SeamusJ.Martin, DennisR.Burton, Ivan M, Wiley-Black. 2017
3. The elements of Immunology(1st Eds)by Fahim Halim Khan, Pearson Education, 2009

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

IMMUNOTECHNOLOGY (BTT-321)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To acquire knowledge of new drug discovery and novel drug delivery systems.
2. To enrich minds with development and approval process regarding manufacturing of drug
3. To develop the skill of quality control pharmaceutical industry through biotechnology tools.
4. To be aware of laws and regulations of pharmaceutical sector India.
5. Discuss, dissect, interpret and build an awareness on biotechnology based pharmaceutical products

COURSE OUTCOMES

On successful completion of course, students will be able to:

1. Apply the concepts of biopharmaceuticals in pharmaceutical industry
2. Apply the knowledge of Pharmaceutical manufacturing in the production of biopharmaceuticals
3. Develop the strategies of new drug discovery.
4. Explain pharmacology research career to develop new products as well as have a solid foundation to critically evaluate the cutting edge issues in PharmaceuticalBiotechnology.
5. Evaluate and apply the fundamental knowledge in biotechnology- based applications in pharmaceutical and sectors related drug development use

UNIT-I **(8 hours)**

Introduction to biopharmaceuticals, current and future prospects .Development of drugs and pharmaceutical industry-organic therapeutic agents, uses and economics, strategies for new drug discovery using biotechnological tools. General Concept of drug pharma kinetics Pharmacodynamics.

UNIT-II **(8 hours)**

Properties of biotechnology derived therapeutic products. Production of biotechnologically derived therapeutic proteins like Human insulin, Interferons, somatotropin, human growth hormone, somatostatin. DNA vaccines, Monoclonal Antibody Based Pharmaceuticals, Nucleic acid based biotherapeutic, Recombinant Human Deoxyribonuclease,

UNIT-III **(8 hours)**

Role of proteomics in disease detection and diagnostic kit development, drug registration and regulatory affairs, cGMP guidelines for Biopharmaceuticals. Gene therapy and toxicogenomics, Pharmacogenomics, Genetic diseases and DNA based diagnosis of genetic disease. Nanomedicines.

UNIT-IV **(8 hours)**

Introduction to drug discovery, lead compound isolation and targeting, combinatorial chemistry, SAR and rational drug design- phases of preclinical and clinical trials, role of regulatory authorities. ICH,FDA, EMEA and Indian drug regulations. Production of pharmaceuticals by genetically engineered cells, microbial transformation for the production of steroids and semisynthetic antibiotic and therapeutic enzymelike Streptokinase and Staphylokinase.

UNIT-V **(8 hours)**

Drug formulation and their classification, Drug delivery system –Basic concepts and Novel advances.Cell specific drug delivery, Brain specific drug targeting strategies and Pulmonary delivery systems. Pharmaceutical Testing, Analysis and Control. Quality control and testing as per Indian/US Pharmacopeia. Industrial visit to nearby MANUFACTURING Plants to study the manufacturing of herbal products.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

IMMUNOTECHNOLOGY (BTT-321)

L:T:P::3:0:0 **Credits-3**

TEXT/REFERENCEBOOKS:

1. Loyd V Allen, Howard C, Ansel. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Wolters Kluwer Health.2013
2. Satoskar RS, Bhandarkar SD, NirmalaNRege, Satoskar RR. Pharmacology and Pharmaco-therapeutics, 20th Edition, Popular Prakashan (P) Ltd.2008.
3. Leon Sharge, Andrew Yu, Susanna Wu-Pong. Applied Biopharmaceutics& Pharmacokinetics, 6th Edition, McGraw-Hill Education/Medical.2012
4. Gary Walsh. "Pharmaceutical Biotechnology-Concepts and Applications," Wiley Publication.2007

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

MOLECULAR BIOTECHNOLOGY & BIOINFORMATICS (BTP-303)

L:T:P:: 0:0:3 **Credit-01**

COURSE OBJECTIVES:

To introduce the hands-on descriptions of important and advanced tools and techniques in molecular biology and bioinformatics in order to solve biotechnological problems using recombinant DNA technology, Database search, Biological data retrieval tools and sequence analysis etc. in laboratory.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

1. Formulate, analyze and solve a multilevel laboratory problem in molecular biotechnology and Bioinformatics lab.
2. Demonstrate experimental comprehension of DNA transformation techniques and recombinant cell preparation.
3. Visualize and analyze the protein structure using computational biology tools.
4. Give innovations in their thoughts and incorporate creative skills those are essential for molecular and computational biologists.

Syllabus:

MOLECULAR BIOTECHNOLOGY

1. To perform agarose electrophoresis of DNA.
2. Extraction and estimation of chromosomal/genomic DNA from plant microbes.
3. Isolation of plasmid DNA from *E. coli*.
4. To determine the melting curve of DNA.
5. To perform restriction enzyme digestion.
6. DNA ligation and recombinant DNA preparation.
7. Transformation of *E. Coli*with a recombinant plasmid.
8. PCR amplification of a DNA fragment from plant genomic DNA.
9. Preparation of competent cells of *E.coli*and transformation of competent cells with plant transformation vectors.
10. Direct DNA delivery to plant cell by Particle Bombardment.
11. Development of drought tolerant transgenic plants.
12. Development of genetically modified corn.
13. Animal cell culture: Preparation of Primary Culture
14. To passage the primary culture of chick embryo fibroblast and to check cell viability and cell proliferation by MTT assay.
15. To check cell viability using the trypan blue method.

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MOLECULAR BIOTECHNOLOGY & BIOINFORMATICS (BTP-303)

L:T:P:: 0:0:3 **Credit-01**

BIOINFORMATICS-

1. Exploration of the resources available in NCBI and PUBMED
2. Retrieval of a Genbank Entry using an accession number
3. Retrieval and analysis of a gene sequence “AF375082” in FASTA format
4. Finding the official Symbol, alias name, chromosome number and ID for gene using NCBI
5. Retrieval and analysis of a protein sequence from protein database
6. Primary structure analysis of a protein 19 07 Secondary structure analysis of a protein
7. Tertiary protein structure analysis using RASMOL
8. Pair-wise and multiple sequence alignment using ClustalW
9. Pair-wise and multiple sequence alignment using BLAST
10. Alignment of two Sequences and determination of PAM Scoring Matrix
11. Alignment of two Sequences and determination of BLOSUM Scoring Matrix
12. Similarity Search using BLAST and Interpretation of Results
13. Conversion of Gene Sequence into its Corresponding Amino Acid Sequence

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

IMMUNOTECHNOLOGY & ENZYME TECHNOLOGY (BTP-304)

L:T:P:: 0:0:3 **Credit-01**

COURSE OBJECTIVES:

To introduce the hands-on descriptions of various types of clinical immunological test, serological test, Pathological diagnosis.

To provide hands-on training on enzyme assays and inhibition kinetics etc with the help of related instruments and devices.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

1. Design, analyze and solve a multilevel laboratory problem in immunology and enzyme technology lab.
2. Demonstrate experimental setup of clinical diagnosis of disease and enzyme activity.
3. Handle various experiments related to clinical diagnostic and enzyme kinetics and inhibition.
4. Think creatively and improve data interpretation skills, which will help then to develop skill sets required in biotech industry.

Syllabus:

. **IMMUNOTECHNOLOGY**

1. Determination of ABO blood group
2. To isolate serum and plasma of given blood sample
3. To perform Haemoglobin test of own blood
4. To determine total leucocyte count (TLC) of the given blood sample
5. To determine the differential leucocyte count (DLC) of the given blood sample.
6. To perform separation of Lymphocytes from given blood sample
7. To Perform Widal test by slide agglutination for detection of typhoid fever
8. To perform Immune chromatographic test for detection of Hepatitis B surface Antigen in
9. To perform ASO latex agglutination test for diagnosis of Arthritis
10. To perform single radial immunodiffusion for detecting antibody against surface antigen by
11. Mancini's technique.
12. To perform double immunodiffusion (DID) for detecting antibody against surface antigen by
13. Ouchterlony's method
14. To perform Immuno electrophoresis to detection antigen –antibody complex
15. To perform Rocket Immunoelectrophoresis to detection antigen –antibody complex
16. To perform western blotting assay
17. To perform enzyme-linked immunosorbent assay (ELISA) to detect antigen or antibody
18. To perform Immunoprecipitation Techniques to detect antigen – antibody interaction

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

IMMUNOTECHNOLOGY & ENZYME TECHNOLOGY (BTP-304)

L:T:P:: 0:0:3 **Credit-01**

ENZYME TECHNOLOGY

1. Identification of enzymes in different sources.
2. Assay of Enzyme activity and Specific activity.
3. Determination of kinetic properties (Km and Vmax values) of an enzyme.
4. To asses effect of pH on enzyme activity
5. To asses temperature stability of the enzyme
6. To asses effect of activator on enzyme activity
7. To asses effect of inhibitor on enzyme activity
8. Preparation of immobilized enzymes and Effect of enzyme immobilization on its activity
9. Detection of Active site of enzyme using computational tool
10. Production of industrially useful enzyme using microbes

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0 **Credits-2**

Course Objectives: Students will be able to:

1. To understand the fundaments of research in today's world controlled by technology, ideas, concept, and creativity.
2. To understand different methods of research designing and data collections.
3. To understand the methods of report writing and its different methods of interpretations.
4. To understand research ethics and methods of research publications
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and inturn brings about, economic growth and social benefits.

Course Outcomes:

1. To understand research problem formulation.
2. To study research design and method of data collections.
3. To study methods of report writing.
4. To follow research ethics.
5. To enhance student's competence to discover new inventions.

Syllabus Contents:

UNIT I: FUNDAMENTAL OF RESEARCH (8 hours)

Meaning of research; objectives of research; basic steps of research; criteria of good research;

Research methods vs. Methodology. Types of research –criteria of good research; Meaning ofresearch problem; selection of research problem; Approaches of investigation of solutions for researchproblem, Errors in selecting a research problem, Scope and objectives of research problem, Review ofrelated literature- Meaning, necessity and sources.

Unit 2: RESEARCH DESIGN AND DATA COLLECTION (8 hours)

Research design: Types of research design- exploratory, descriptive, diagnostic and

experimental;Variables- Meaning and types; Hypothesis- Meaning, function and types of hypothesis;

Null/Alternative hypothesis; Sampling- Meaning and types of sampling; Probability and Non-

Probability; Tools and techniques of data collection- questionnaire, schedule, interview, observation,case study, survey etc.

Unit 3:REPORT WRITING AND ITS INTERPRETATION (8 hours)

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of

Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports,

Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research

Reports, Conclusions.

Unit 4:RESEARCH ETHICS AND SCHOLARY PUBLISHING (8 hours)

Ethics-ethical issues, ethical committees (human & animal); scholarly publishing- IMRAD conceptand design of research paper, citation and acknowledgement, plagiarism and its concept andimportance for scholar.

Unit 5: INTELLECTUAL PROPERTY RIGHT (IPR) (8 hours)

IPR- intellectual property rights and patent law, commercialization, New developments in IPR; copy

right, royalty, trade related aspects of intellectual property rights (TRIPS); Process of Patenting and

Development; Procedure for grants of patents, Patenting under PCT;Patent Rights: Scope of Patent

Rights. Licensing and transfer of technology. Patent information and databases.

Reference Books:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science

&engineeringstudents’”

2. WayneGoddardandStuartMelville,“ResearchMethodology:AnIntroduction”

3. RanjitKumar,2ndEdition,“ResearchMethodology:AStepbyStepGuideforbeginners”

4. Halbert,“ResistingIntellectualProperty”,Taylor&FrancisLtd,2007.

5. Mayall,“IndustrialDesign”,McGrawHill,1992.

6. Niebel,“ProductDesign”,McGrawHill,1974.

7. Asimov,“IntroductiontoDesign”,PrenticeHall,1962.

8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New

Technological Age”,2016.

9. T.Ramappa,“IntellectualPropertyRightsUnderWTO”,S.Chand,2008

LIST OF OPEN ELECTIVES:

BTT-331: BIOINFORMATICS & SYSTEM BIOLOGY

BTT-332: BIOMEDICAL IMPLANTS AND TISSUE ENGINEERING.

BTT-333: ENVIRONMENTAL SYSTEM ENGINEERING AND ECOLOGY.

BTT-334: MEDICAL DIAGNOSTICS TECHNIQUES.

BTT-335: ADVANCED ANALYTICAL TECHNIQUES

BTT-336: WASTE MANAGEMENT TECHNOLOGIES.

BIOMEDICAL IMPLANTS AND TISSUE ENGINEERING (BTT-332)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. Strategies to modify and/or design materials that are biocompatible.
2. Explain what biocompatibility is and how it affects biomaterial design
3. Understand material selection and structure-function relationships
4. Identify methods to characterize biomedical implants and to assess the biocompatibility of biomaterials
5. Gain understanding of legal rights and moral duties of biomaterial engineers.

COURSE OUTCOMES

Upon completion of the course, the student will be able to

1. Gain fundamental knowledge of biomedical implants and acquire knowledge of the l structure, properties of biomaterials
2. Understand common use biomaterials as metals, ceramics and polymers and select biomaterial for the fabrication of biological implants
3. Learn about the properties of biological system and select biomaterial for the fabrication of scaffolds for tissue engineering
4. Illustrate the methods for the characterization and categorization of biomaterials, scaffolds and describe general methods for the assessment of biocompatibility of biomaterials.
5. Identify solutions to overcome the challenges in implantation and tissue engineering, know the legal rights of biomaterial engineers and understand the moral and ethical aspects of tissue engineering.

Syllabus:

UNIT I (8 hours)

Introduction to biomedical implants: Examples of Today's biomedical implants applications: Heart Valve Prostheses, Total Hip Replacement Prostheses, Dental Implants, etc; Biomaterials and biological materials; Characteristics of Biomaterials Science: Multidisciplinary, material diversity and Magnitude of the Field; History of Biomaterials; Bulk Properties of Biomaterials: Mechanical variables and mechanical properties, Thermal Properties, Optical Properties, Piezoelectric Properties, Electrochemical Properties, Surface Properties

UNIT II (8 hours)

Classes of materials used in biomedical implants: ***Bioactive Ceramics:*** Alumina and Zirconia Ceramics, Natural and Synthetic Hydroxyapatites: Structure, Synthesis, and Mechanical Properties; Porous Bioactive Glasses,; ***Metallic Materials:*** Titanium Alloys, Stainless Steels, CoCr Alloys, Biodegradable Metals; ***Polymeric Biomaterials:*** Naturally Occurring Polymer Biomaterials, Synthetic Polymers, Degradable and Resorbable Polymers, Hydrogels, Silicones, Carbon Biomaterials, Role of Water in Biomaterials, "Smart Polymers" as Biomaterials

UNIT III (8 hours)

Introduction to Tissue Engineering: Structure and properties of biological cells & tissues, Basic Overview of Cell Culture; Primary Culture, Cell Lines; Cryopreservation; Characteristics of Cultured Cells and surface properties;; Tissue Constituents, Organization, and Integration; Extracellular Matrix and its properties; Growth factors; Biomaterials Used for Tissue Engineering: Natural Scaffold Materials, Synthetic Biomaterial Scaffolds,

Scaffold Fabrication & Tailoring, Scaffold Applications (cell delivery, Growth factor delivery) Transport in Engineered Tissue; Organ-on-a-Chip 3D culture. 3D Bio-printing.

Applications of Tissue Engineering: Transplantation, Replacing/Regenerating Target Organs, Drug Delivery, Disease Models and Therapy

UNIT IV **(8 hours)**

Characterization of Biomaterials and Scaffolds: Importance and application of biomaterial characterization, Principles and general methods of compositional and structural characterization, techniques of X-ray, Mass spectrometry, electron microscopy, Tensile testing Compressive testing, Rheology, EDAX, Thermal methods - DTA, TGA, DSC, DMA, temperature dependent rheology.

Introduction to Biological Responses to Materials and Assessment of biocompatibility of biomaterials Biocompatibility and Implantation, The Extracellular Matrix and Cell–Biomaterial Interactions, Cell material interactions, Blood-material interactions (BMI), In-vitro biocompatibility assays (cellular adhesion, cellular viability using MTT, etc), In-vivo testing (Sensitization, Irritation, and Intracutaneous (Intradermal) Reactivity, Systemic Toxicity: Acute, Subacute, and Subchronic Toxicity), histo-compatibility assessment, Geno-toxicity assessment, Carcinogenicity.

UNIT V **(8 hours)**

Current Challenges and Opportunities: Cell Source, Vascularization, Tissue Maturation; Host Response to Implanted Biomaterials - Inflammation, Wound Healing and Foreign Body Response; Failure mechanisms of biomedical implants: Corrosion, Fracture, Degradation of Implanted Materials – Polymers, Metals, Ceramics., In-Vivo Integration.

Legal Concepts for Biomaterials Engineers: Confidentiality and Materials Use Agreements, Intellectual Property: Patents, Trade Secrets, and Freedom to Operate, Sponsored Research Agreements, License Agreements;

Moral, Ethical and Safety **Issues:** Selected Approaches to Ethical Reasoning: The Utilitarian Approach The Rights Approach The Justice Approach The Virtue Approach.

TEXT /REFERENCE BOOKS:

1. Wagner, William R., et al., eds. Biomaterials science: An introduction to materials in medicine. Academic Press, 2020.
2. B. D. Ratner, A. S. Hoffman, F. J. Schoen and J. E. Lemons, Biomaterials Science, Second Edition: Wiley Science (2004).
3. L. Hench and J. Jones, Biomaterials, Artificial Organs and Tissue Engineering (Woodhead Publishing in Materials (2002).
4. J. Breme, R. Thul and C. J. Kirkpatrick, Metallic Biomaterial Interfaces Wiley (2008).
5. Temenoff J.S. and Mikos A.G., Biomaterials: The intersection of Biology and Materials Science, Pearson, (2009).

BIOINFORMATICS & SYSTEM BIOLOGY (BTT-331)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To acquire knowledge the interdisciplinary nature advances in bioinformatics and systems biology.
2. The basic understanding of how biological data is stored and retrieved from various biological databases.
3. To develop an understanding of algorithms of sequence alignment (pairwise and multiple) and scoring algorithms.
4. To solve problems through understanding various tools and software.
5. To develop an *In-silico* understanding of various systems in living organisms.

COURSE OUTCOMES

After successfully completing this course, students will be able to:

1. Explain the basic principles that underpin Bioinformatics analyses, and apply these principles when analyzing biological data;
2. Survey a selected field within Bioinformatics, synthesize information from primary literature, and coherently report the findings in a written document;
3. Analyze biological data using a variety of Bioinformatics Tools; and enrich themselves with system-level understanding for biological systems.
4. Develop and analyze the properties of *in-silico* models of gene-gene interactions and protein-protein interactions

Syllabus:

UNIT-I **(8 hours)**

Introduction, Evolution, History, Scope and Application of Bioinformatics. Biological databases; primary, secondary and tertiary databases, Introduction to sequence Alignment (Pairwise and Multiple), Optimal Alignment Methods, and substitution Scores and Gap Penalties, Database :FASTA, BLAST algorithms.

UNIT-II **(8 hours)**

Protein structure, domains and motifs prediction method, visualization,model validation and Prediction, Structure classification (SCOP,CATH): Visualization software (Pymol, Rasmoletc.)

UNIT-III **(8 hour)**

Energy minimization; Molecular dynamics; Rosetta; Structure comparison (DALI, VAST etc.) CASP; Protein Ligand Docking; Computer Aided Drug Design (pharmacophore identification) QSAR.

UNIT-IV **(8 hours)**

Introduction to Systems Biology: Scope, Applications. Concepts, implementation and application. Databases and software for Systems Biology: Introduction-databases: KEGG, EMP, MetaCyc. Expression databases and other databases related to systems biology. Cystoscape, viz ANT & Cell Designer.

UNIT-V **(8hours)**

Biological Networks: Protein-protein interaction network, gene regulatory network, metabolic network, signal transduction network.

BIOINFORMATICS & SYSTEM BIOLOGY (BTT-312)

TEXT/REFERENCEBOOKS:

1. Dictionary of Bioinformatics & computational biology (1st edition) by Hancock, Wiley, (2004).
2. Bioinformatics-Sequence & GenomeAnalysis(4thEd) by T.W. Mount, Cold Spring Harbor, N.Y(2014).
3. Bioinformatics & functional genomics (3rd edition) by Pevsner, Wiley, (2015).
4. Introduction to Systems Biology: Design Principles of Biological Circuits (2nd edition) by UriAlon, Chapman & Hall/CRC, (2019).
5. Synthetic Biology: A Primer (revised edition) by P.S. Freemont & R.I.Kitney, Imperial College Press,(2012)

ENVIRONMENTAL SYSTEM ENGINEERING AND ECOLOGY (BTT-333)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To make student aware about environment and ecology
2. To impart basic knowledge of importance of microorganism in environment
3. To develop understanding among students about different avenues of environment sustainability through biotechnology discipline
4. to increase awareness among masses about environment protection

COURSE OUTCOMES

On successful completion of the course, students will be able to:

1. Be a proficient knowledgeable person of ecology and environment.
2. Acquire full knowledge of different components of environment.
3. Have full fledge interpretation of environmental modeling.
4. Predict environment through digital image processing.
5. Explore GIS for environmental engineering.

Syllabus:

UNIT I **(8 hours)**

Environment, Ecology and sustaining the Earth, Basics of Environmental System Engineering, Nature and Humans, Population dynamics and its impact on environment, Physical Chemical & biological components of environment.

UNIT II **(8 hours)**

Role of microorganism as vital components of environmental stability, microbial growth kinetics-waste management concerns and remedies, Natural Transport systems, Ecosystems and ecology of human population, population growth and urbanization, environmental economics ,case studies of population explosion.

UNIT III **(8 hours)**

Environmental Time domain simulation model, continuous Flow Microbiological Systems-Pesticide Concentration Model, Eutrophication, Ecological balances, material cycles in ecosphere, energy flow in different ecosystems of earth.

UNIT IV **(8 hours)**

Role of digital image processing for environment prediction and assessment, filtering, Histograms, climatic data and its interpretation through statistical and computational tools, Data products, ground control points, Advance environmental system engineering tools for checking global warming and climate change, Analysis of weather data for evaluation of climate change

UNIT V **(8 hours)**

Engineered growth models for environment protection and ecological balance, Contribution of Geographic Information System (GIS) for environmental engineering, functions of GIS ,types of data-spatial, non-spatial, database, modeling in GIS, land use planning for water ,mineral resources ,mapping of biological resources in environment, biodiversity loss assessment through remote sensing and GIS, Ecological Treatment process for environment clearance ,Institutional visits of WIHG, Dehradun.

ENVIRONMENTAL SYSTEM ENGINEERING AND ECOLOGY (BTT-333)

L:T:P::3:0:0 **Credits-3**

TEXT /REFERENCE BOOKS:

1. Sincero and Gregoria: 2020. Environmental Engineering: A Design Approach. PHI Learning, Lucknow
2. Tyley Miller. 2008. Environmental Science: advance approaches. Tata Mac Grow Hills, New Delhi
3. Edward J Komoondy.2010. Concepts of Ecology. PHI Learning, Lucknow

WASTE MANAGEMENT TECHNOLOGIES (BTT-336)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES:

1. To aware students about aspects of biological processes for waste management
2. To understand the principles of bioremediation for handling waste.
3. To identify suitable biotechnological processes for waste management

COURSE OUTCOMES:

1. Identify salient aspects of biological processes for waste management.
2. Design of bioreactors for waste treatment.
3. Apply principles of bioremediation for handling waste.
4. Develop suitable biotechnological processes for hazardous waste management

Syllabus:

UNIT-I (8 hours)

Solid waste: Introduction and classification, sources and types of Municipal solid wastes, solid waste characteristics, Effects of improper disposal of solid waste on Public health and environment, On site storage methods- Effect of storage, Segregation of solid waste, Case studies under Indian conditions- Source reduction of solid waste, Reuse and Recycling. Waste processing- Physical processing techniques and equipment,

UNIT-II (8 hours)

Introduction to waste management. Introduction to bioreactor, Microbial growth kinetics, Design of a bioreactors, Instrumentation and control, Aeration and agitation, Effluent treatment. Bio-industrial waste management. Strategies for sustainable waste management.

UNIT-III (8 hours)

Bioreactors for wastewater treatment: – Aerobic System Biological processes for domestic and industrial wastewater treatments; Aerobic systems - activated sludge process, trickling filters, biological filters, rotating biological contactors (RBC), Fluidized bed reactor (FBR), expanded bed reactor, inverse fluidized bed biofilm reactor (IFBBR) packed bed reactors air sparged reactors.

UNIT-IV (8 hours)

Bioremediation:- The characterization and bioremediation of contaminated sites, the superfund law, preliminary site assessment, site investigation techniques, and bioremediation technologies; and monitoring requirements. In-situ Bioremediation of Contaminated Ground Water; Phytoremediation of Contaminated Soil and Ground Water at Hazardous Waste Sites.

UNIT-V (8 hours)

Hazardous Waste Management: Introduction - Xenobiotic compounds, recalcitrance. Hazardous wastes - biodegradation of Xenobiotics. Biological detoxification - market for hazardous waste management, biotechnology application to hazardous waste management. Introduction to Solid, Hazardous, and Radioactive Waste Disposal and Containment. Design of Landfill, Municipal Solid Waste Landfills.

TEXT BOOKS:

1. Introduction to Hazardous Waste Management, Clifton Vanguilder, Mercury Learning & Information 2011, 1st Edition.
2. Microbial biodegradation and bioremediation, Surajit Das, Elsevier, 2014, 1st Edition.

ADVANCED ANALYTICAL TECHNIQUES (BTT-335)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVES

1. To understand protein crystallization techniques and its applications.
2. To understand chromatographic techniques for protein purification.
3. To understand advanced imaging techniques, electrophoresis techniques and other advanced techniques for analysis of biological samples.

COURSE OUTCOMES

On completion of the course, students will be able to:

1. Apply crystallography for protein samples.
2. Illustrate chromatography and electrophoresis techniques for protein purification.
3. Analyze biological samples using different microscopy and mass spectroscopy techniques.
4. Demonstrate flow cytometry and understand data generated.
5. Study nucleotide sequences through next generation sequencing methods

Syllabus:

UNIT-I **(8 hours)**

Protein Crystallography: Biological macromolecules, Principle and method of protein crystallization, X-ray diffraction: Introduction to x-ray and general theory and instrumentation, Bragg's law, various techniques and Computational tools to determine crystal structure, Generation of X-rays, interpretation of diffraction patterns and applications. Single crystal diffractions of biomolecules. Fiber diffraction.ORD Principle, Plain curves, curves with cotton effect, circular dichroism and its relation to ORD. Discussions with Case studies.

UNIT-II **(8 hours)**

Chromatographic methods for protein and peptide purification: Gas Chromatography with mass spectrometric detection(GC-MS), liquid chromatography with mass spectrometric detection (LC-MS), inductively coupled plasma with mass spectrometric detection (ICP-MS). Metal analysis by ICP-MS; Analysis of data: HPLC chromatograms, Case studies in HPLC, including troubleshooting– how to achieve good separation on HPLC; GC-MS data; LC-MS spectra.

UNIT-III **(8 hours)**

Advanced imaging techniques in microscopy: Live cell imaging, Confocal microscopy and sample preparation for fluorescence microscopy, High content/throughput screening: Basics of SEM and Specimen preparation for SEM, Basics of TEM and Specimen preparation for TEM, Atomic Absorption and IR Spectrophotometry: Principle, instrumentation details, and various applications.

UNIT-IV **(8 hours)**

Electrophoresis Techniques: Strategies, Separation proteins using 2D Gel electrophoresis, Electrophoresis method for purifying proteins, Field Ionization Mass Spectrometry (FIMS), Fast Atom Bombardment MS(FAB MS), Matrix Assisted laser desorption/ionization MS (MALDI), Separation of peptide mixture, Pulsed-field gel electrophoresis, Denaturing gradient gel electrophoresis.

UNIT-V **(8 hours)**

Flow Cytometer: Introduction to flow-cytometry, Fluorochromes and fluorescence spectroscopy, Experimental design and fluorescence quantitation, analysis of flow cytometry data, FACS, FRAP and FRET,: introduction to autoradiography and Real time PCR.

ADVANCED ANALYTICAL TECHNIQUES (BTT-335)

L:T:P::3:0:0 **Credits-3**

TEXT/REFERENCE BOOKS:

1. Williams, D. and Fleming, I. “Spectroscopic Methods in Organic Chemistry”, McGraw-Hill Higher Education, Maidenhead, UK.
2. Babine, R.E. and Abdel-Meguid, S.S., “Protein Crystallography in Drug Discovery”, Willy VCH Verlag Gmb H & Co.
3. Keith Wilson and John Walker, “Principles and Techniques of Practical Biochemistry”, Cambridge University Press.
4. Kwon, Young Min, Ricke, Steven C.(Eds), “High-Throughput Next Generation Sequencing Methods and Applications” Humana Press.
5. Bhowmik, G. and Bose, S.,“Analytical Techniques in Biotechnology”, Tata McGraw-Hill Publishers.
6. Chandler, D. and Roberso, R.W., “Bioimaging: Current Techniques in Light & Electron Microscopy”, Jones and Bartlett Publishers.

MEDICAL DIAGNOSTIC TECHNIQUES (BTT-334.)

L:T:P::3:0:0 **Credits-3**

COURSE OBJECTIVE:

1. Understand electrical and non-electrical physiological measurements
2. Learn about biomedical Recorders.
3. Understand the measurement of non-electrical parameters.
4. Learn biochemical measurement.
5. Understand the patient safety and electromedical equipments

COURSE OUTCOMES:

At the end of the course, the students should be able to:

1. Learn the concept of man instrumentation system
2. Explain the function of Biomedical Recorders
3. Perform electrical and non-electrical physiological measurements.
4. Analyze the working of biochemical measurement
5. Learn the about the patient care and monitoring

Syllabus:

UNIT -1 **(8 hours)**

Introduction to Biomedical Instrumentation: Components of the man- instrument system, Specifications of medical instrumentation systems, Problems encountered in measuring living systems, Basic transducers principles, Active and passive transducers, transducers for biomedical applications.

UNIT II **(8 hours)**

Biomedical Recorders: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes – Electrode-tissue interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes, Needle electrodes.

UNIT III **(8 hours)**

Measurement of non-electrical parameters: Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers - systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.

UNIT IV **(8 hours)**

Biochemical measurement: Biochemical sensors - pH, pO2 and pCO2, Ion select Field-effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors - Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description).

UNIT V

Patient safety and electromedical equipment: physiological effects of electrical currents, macroshock and microshock, preventive measures to reduce shock hazards, Leakage current, isolation of patient circuits, safety of electrically susceptible patients, radiation hazards and safety, shielding, open ground problem and earthing methods.

MEDICAL DIAGNOSTIC TECHNIQUES (BTT-334)

L:T:P::3:0:0 **Credits-3**

TEXT/REFERENCE BOOKS:

1. John G. Webster, “Medical Instrumentation Application and Design”, John Wiley and sons, New York, 2004.
2. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, New Delhi, 2003.
3. Leslie Cromwell, “Biomedical Instrumentation and measurement”, Prentice hall of India, New Delhi, 2007.
4. Myer Kutz, “Standard Handbook of Biomedical Engineering and Design”, McGraw Hill Publisher, 2003.
5. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, Pearson Education, 2004.
6. R.Anandanatarajan, “Biomedical Instrumentation”, PHI Learning, 2009