॥ सा विद्या या विमुक्तये ॥
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड
'ज्ञानतीर्थ', विष्णुपुरी, नांदेड – ४३१ ६०६ (महाराष्ट्र राज्य) भारत
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED
'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA
Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited 'B++' grade
स्वातंत्र्याचा अमृत महोत्सव

ACADEMIC (1 BOARD OF STUDIES) SECTION
Phone: (02462) 215542 **Website:** www.srtmun.ac.in **E-mail:** bos.srtmun@gmail.co

प्रस्तुत विद्यापीठाच्या जैवतंत्रज्ञान सकुंलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील M. Sc. Biotechnology II year पदव्यूत्तर स्तरावरील CBCS Pattern नुसारचा Revised अभ्यासक्रम शैक्षणिक वर्ष २०२२–२३ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक २३ मे २०२२ रोजीच्या विज्ञान व तंत्रज्ञान विद्याशाखेच्या बैठकीतील शिफारशी नुसार व मा विद्यापरिषदेच्या दिनांक २५ जून २०२२ रोजीच्या बैठकीतील विषय क्रमांक १६/५४–२०२२ च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या जैवतंत्रज्ञान संकुलातील **विज्ञान व तंत्रज्ञान विद्याशाखेतील M. Sc. Biotechnology II year या पदव्यूत्तर स्तरावरील C.B.C.S. (Choice Based Credit System) Pattern** नुसारचा **Revised** अभ्यासक्रम शैक्षणिक वर्ष २०२२–२३ पासून लागू करण्यास मान्यता देण्यात आली आहे.

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शैक्षणिक–१/परिपत्रक/पदवी–सीबीसीएस अभ्यासक्रम/
न्यू मॉडल डिग्री कालेज/ २०२२–२३/४४७
दिनांक : ०२.०८.२०२२.

स्वाक्षरित
सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :
१) मा. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) संचालक, जैवतंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
४) अधीक्षक, परिक्षा विभाग विज्ञान व तंत्रज्ञान विद्याशाखा प्रस्तुत विद्यापीठ.
५) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. यांना प्रत देवून कळविण्यात येते की, सदरील परिपत्रक व अभ्यासक्रम विद्यापीठ संकेतस्थळावर प्रसिध्द करण्यात यावे.

Swami Ramanand Teerth Marathwada University, Nanded

School of Life Sciences

Name of Programme: M.Sc. Biotechnology

III[rd] and IV[th] Semester Syllabus Effective From 2022-2023 onwards

Semester	Code	Title of theory/ practicals	No. of instructi onal hrs/ week	Type of course	Total credits	Marks		Total marks
						CIA	ESA	
Semester III	**Theory**							
	BTT-C-301	r-DNA Technology	04	CC	04	50	50	100
	BTT-C-302	Bioprocess Engineering and Technology	04	CC	04	50	50	100
	BTT-C-303	Enzyme Technology	04	CC	04	50	50	100
	BTT-C - 304	Research Methodology	02	CC	02	25	25	50
	***BTT-E-301 **OR** ***BTT-E-302 OR ***BTT-E-303 OR ***BTT-E-304	**Advanced Instrumentation OR Communication Skill in English OR Foreign Language French OR Foreign Language Spanish**	02	**SDC**	02	25	25	50
		****Open Elective**	02	**OE**	02	25	25	50
	Practical							
	BTL-C-301	Lab in r-DNA Technology	04	CC	02	25	25	50
	BTL-C-302	Lab in Bioprocess Engineering and Technology	04	CC	02	25	25	50
	BTL- C-303	Lab in Enzyme Technology	04	CC	02	25	25	50
		Total	**30**	**4-CC, 1-SDC, 1-OE**	**24**	**300**	**300**	**600**

	Theory							
	BTT- C-401	Pharmaceutical Biotechnology	04	CC	04	50	50	100
	BTT- C-402	Food Biotechnology	04	CC	04	50	50	100
Semester-IV	BTT-C-403	Genomics and Proteomics	04	CC	04	50	50	100
	*BTT-E-401 OR *BTT-E-402 OR *BTT–E-403	**Microbial Technology** **OR** **Plant Biotechnology** **OR** **Animal Biotechnology**	04	**DSE**	04	50	50	100
		****Open Elective**	02	**OE**	02	25	25	50
	Practical							
	BTL-C-401	Lab in Pharmaceutical Biotechnology and Food Biotechnology	04	CC	02	25	25	50
	BTL-C-402	Lab in Genomics and Proteomics and Microbial Technology/Plant Biotechnology/Animal Biotechnology	04	CC	02	25	25	50
	*BTL-C-403	**Project/ Review writing**	04	CC	04	-	100	100
		Total	**30**	3-CC, 1-DSE 1-OE	**26**	**275**	**375**	**650**

CC: Core course, OE: Open Elective, DSE: Discipline Specific Elective, SDC: Skill Development Course, CIA: Continuous Internal Assessment, ESA: End Semester Assessment, Credits of Four Semesters = 100.

- Total credits/ year = 50
- Total credits of all four semester = 100
- Total marks of all four semester = 2500
- CIA –
- For 4 credit course- Two internal exams of 15 marks each (MCQ/Theory)
    - Home assignment -10 marks per paper
    - Seminar -10 marks per paper.

- For 2 credit course- One internal exams of 15 marks (MCQ/Theory)
    - Home assignment -05 marks per paper
    - Seminar -05 marks per paper.

SEMESTER-III

r-DNA TECHNOLOGY

COURSE CODE: BTT-C- 301

CREDITS: 4

Course objectives:

The objective of this course is to familiarize the students with concept of rDNA, clone and gene cloning, cloning strategies, tools and techniques, applications and advantages and alternatives to transgenics etc.

COURSE CONTENT:

UNIT –I Fundamentals of Genetic Engineering

Introduction to concept of r-DNA, clone and gene cloning. Scope and Milestones in Genetic Engineering.

Strategies and Molecular Tools: Restriction and modifying enzymes. DNA and RNA markers.

Vectors: Cloning and expression vectors; vector components: Promoters, selectable markers, reporter genre, ori, URRs, codon optimization, Properties and Applications. Commonly used vectors: Plasmids, bacteriophages, Phagemids and cosmids. Artificial chromosomes.

UNIT –II Gene Cloning strategies and tools

Isolation and purification of chromosomal and plasmid DNA, Yield analysis, Nucleic acid amplification and its applications. Genomic and c-DNA library preparation and application.

Cloning Methods: Blunt end cloning, Sticky end and sticky end PCR cloning, TA cloning, PCR recombination, Integration PCR, In-Fusion™ Cloning, TOPO Cloning, Gateway cloning etc.

Methods of screening: Selection by complementation, antibiotic resistance, colony PCR etc. Expression analysis: Phenotype, RNA and Protein level. Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays, RT-PCR and Real time q- PCR, Nucleic acid microarray,Transcriptome sequencing, Western blotting.

UNIT –III Applications of r DNA Technology

Heterologous expression of proteins. Vector engineering and codon optimization, host engineering, Expression in bacteria, expression in mammalian and plant cells, Processing of Recombinant proteins:

Purification and refolding, characterization of recombinant proteins, stabilization of proteins. Process and applications of Phage Display.

GMO (Microorganisms, Plants and animals) with traits having applications in different sectors:

A. Health, B. Agriculture, C. Environment and D. Industrial

UNIT- IV

Gene silencing: Strategies, applications and advantages. Genome editing: Strategies, applications and advantages.

Gene therapy: Principles of Gene therapy: Vector engineering. Strategies of gene delivery. Gene replacement/augmentation therapy, success and limitations of gene therapy.

Genetic engineering guidelines, Regulatory bodies, GEAC, RCGM and IBSC.

BTL-C 301
Laboratory Course in r-DNA technology

1) Genetic recombination (conjugation, transformation, transduction) in bacteria.
2) Gene cloning: Restriction, digestion and ligation, DNA Cloning in plasmid vectors and analysis of gene products.
3) Preparation of competent cells and transformation by $CaCl_2$ method.
4) DNA amplification.
5) DNA fingerprinting: RFLP, RAPD
6) Blotting and hybridization techniques: Western, Southern & Northern hybridization.
7) Gene expression in *E. coli*
8) Agarose gel electrophoresis by using DNA markers for molecular weight determination

Learning Outcomes (LO):
Students will be GM literate i.e. aware about rDNA technology, its advantages and disadvantages in addition to tools and techniques. It will help in avoiding spread of misconception about GMO in society.

References:

1. Molecular Cloning: A Laboratory Manual, J. Sambrook, E. F. Fritisch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. DNA Cloning: a Practical Approach, D. M. Glover and B. D. Hames, IRL, Press, Oxford, 1995.
3. Molecular and Cellular Methods in Biology and Medicine, P. B. Kaufman, W. Wu, D, Kim and L. J. Cseke, CRC Press, Florida, 1995.
4. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques, S. L. Berger and A. r. Kimmel, Academic Press, Inc. San Diego, 1998.
5. Methods in Enzymology Vol 185, Gene Expression Technology, D. V. Goeddel, AcademicPress, Inc., San Diegoo, 1990.
6. DNA Science. A First Course in Recombinant Technology, D. A. Mickloss and G. A. Freyer, Cold Spring Harbor Laboratory Press, New York, 1990.
7. Molecular Biotechnology (2^{nd} edition), S. B. Primrose, Blackwell Scientific Publishers, Oxford,1994.
8. Milestones in Biotechnology. Classic papers on Genetic Engineering, J. A. Davies and W. S.

Raznikoff, Butterworth-Heinemann, Boston, 1992.

9. Route Maps in Gene Technology, M. R. Walker and R. Rapley, Blackwell Science Ltd., Oxford,1997.
10. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes, S. M. Kingsman and A. J. Kingsman, Blackwell Scientific Publications, Oxford,1998.
11. Molecular Biotechnology – Glick.

BIOPROCESS ENGINEERING AND TECHNOLOGY
COURSE CODE: BTT-C- 302

CREDITS; 4

Course Objectives:

The objective of this course is to apply fundamental principles and concepts of chemical engineering to biological systems. This will provide a comprehensive understanding of media formulations, microbial growth kinetics, bioreactor selection, upstream & fermentation processes, and its role in manufacturing bio-products.

COURSE CONTENT:

UNIT-I

Introduction: Interaction of two disciplines: biology and bio-chemical engineering, historical advancement in fermentation processes, current status of biochemical engineering in fermentationindustry, range of microbial diversity in fermentative processes.

Microbial Growth Kinetics: Growth, growth measurement, media formulation, stoichiometry of cell growth and product formation, factors influencing product formation on varying carbon & nitrogen source, batch culture, Monod's kinetics, modeling of batch growth kinetics, environmental factors affecting microbial growth, continuous culture, an ideal Chemostat, advantages and limitations of continuous over batch culture, fed-batch culture and its applications.

UNIT-II

Aeration and Agitation: Fick's law, theories of mass transfer, mass transfer between two phases, role of aeration and agitation in a bioprocess, oxygen transfer methodology in a fermentation process, significance of volumetric transfer coefficient (KLa) and its determination, factors affecting KLa values in a bioreactor, power requirements in gassed and ungassed bioreactors, rheological characteristics of fermentation fluids.

UNIT-III

Bioreactor Selection and Design: Selection criteria for bioreactor, body construction of fermenter and its components *i.e.*, impellers, stirred glands and bearings, seal assemblies, baffles, sparger and valves, solid state and submerged fermentation, design aspects of bubble column bioreactor, air-lift fermenter, plug-flow and packed bed bioreactor, scaling up of bioreactor.

UNIT-IV

Sterilization, Instrumentation and Process Control: Need of sterilization, media sterilization, Del factor, design of batch and continuous sterilization, air sterilization, log penetration theory, scale up of sterilization process, filter design, control systems in a bioprocess, methods of measuring process variables i.e., temperature, pressure, flow, dissolved oxygen, pH, role of computers in fermentation process analysis

BTL-C-302

Laboratory Course in **Bioprocess Engineering and Technology**

1 Bacterial growth kinetics
2 Effect of varying carbon substrate on specific growth rate
3 Production of citric acid and lactic acid
4 Production of Alcohol (Ethanol)
5 Comparative study on rate of product formation using immobilized and suspension cells
6 KLa determination using non-fermentative and fermentative methods
7 Effect of mixing and agitation rate on KLa

Learning Outcomes (LO):

Students will be able to

1 Explain how microorganisms and biochemical processes can be applied in engineered systems.
2 Distinguish among batch, continuous and fed-batch culture systems for the production of Biochemical products.
3 Describe microbial growth & cultivation, various bioreactor components, and types of Bioreactor used in biotechnology industries.
4 Design media sterilization and design of air filter in a bioprocess.
5 Apply various concepts to improve bioreactor performance and evaluate process variables to analyze a bioprocess.

Reference Books

1 P.F. Stanbury and A. Whitaker-Principle of Fermentation Technology; Pergamon Press(1988).
2 M. L. Shuler and F. Kargi- Bioprocess Engineering: Basic Concepts" by, 2nd Edition, PearsonEducation (2001).
3 P. M. Doran-Bioprocess Engineering Principles Academic Press (2012).
4 J. E. Bailey and D.F. Ollis-Biochemical Engineering Fundamentals, McGraw-Hill Book Co., New York (1986)
5 S. Aiba, A. E. Humphrey, N. F. Millis-Biochemical Engineering, Academic Press, New York 2nd Edition (1973)

ENZYME TECHNOLOGY
COURSE CODE: BTT-C-303

CREDITS: 4

Course Objectives: To make Students learn structural and functional relationships in enzymes and altering their structure in order to function 'better'. To provide basic knowledge of enzyme technology and use of enzymes as tools in industry, agriculture and medicine.

COURSE CONTENT:

UNIT-I:

General characteristics of enzymes, activation energy, active site & its importance, nomenclature and classification of enzymes, enzyme activity units, specific activity, coenzymes and cofactors. Sources of enzyme, isolation & purification of enzymes, enzymes catalysis, Michaelis-Menten equation and forms of Michaelis-Menten equation, significance of Vmax & Km.Effect of physiochemical parameters on enzyme activity

UNIT-II:

Types of enzyme inhibition, kinetics of competitive, non-competitive & uncompetitive inhibition, Allosteric inhibition- Positive and negative cooperativity, sigmoidal kinetics and allosteric enzymes. Models accounting cooperativity – Hill, Adair, MWC and KNF models. Cooperative binding of oxygen to haemoglobin – significance of sigmoidal behaviour. Aspartate transcarbamoylase as allosteric enzyme. Importance of enzyme regulation, enzyme induction & repression, covalent modification & feedback inhibition. Abzymes, synzymes & ribozymes.

UNIT-III:

Techniques of enzyme Immobilization, stability of immobilize enzymes. Analytical, therapeutic, environmental and industrial applications of immobilized enzyme. Enzyme engineering- Objectives of Protein Engineering, basic strategy of enzyme engineering. Techniques of Enzyme Engineering, Chemical modification and Site directed mutagenesis to study the structure- function relationship of industrially important enzymes. Properties of enzymes modified by enzyme engineering and their examples.

UNIT-IV:

Enzymes in food & leather industry, enzymes in disease diagnosis, enzymes in cancer therapy, enzymes as thrombolytic & anti-inflammatory agents. biosensors & their applications, enzyme probe.

BTL-C-303

Laboratory Course in Enzyme Technology

1. Isolation of microbial strains for the production of commercially important enzymes.
2. Production of commercially important enzymes from microbial source.
3. Standardization of medium, composition for the optimum production of enzymes
4. Partial purification of isolated enzymes
5. Determination of enzyme activity and specific activity
6. Study of Maltose calibration curve
7. Characterization of enzymes effect of pH, temperature and inhibitors on enzyme activity.
8. Study of kinetic parameters Km, Vmax and Kcat
9. Molecular weight determination of enzyme by gel filtration method
10. Method of checking the purity of the enzymes SDS PAGE
11. Immobilization of enzymes

Learning Outcomes (LO):

Students will be able to

1. Learn kinetics of enzyme catalyzed reactions & enzyme inhibitory and regulatory process.
2. Perform immobilization of enzymes
3. Get exposure of wide applications of enzymes and their future potential

Reference Books:

1. Dixon, M. and E.C Webb. "Enzyme inhibition and activation" Enzymes 3 (1979): 126-136
2. Palmer, T. Understanding enzymes, 4th ed. Prentice Halls/Ellis Horwood, London (1995)
3. Price, Nicholas C., and lewis Stevens. Fundamentals of Enzymology. Oxford science publications. 2nd ed. New York, 2001
4. Buchholz, Klaus, Volker Kasche and Uwe Theo Bornscheuer. Biocatalysts and enzyme technology, John Wiley & Sons, 2012
5. Copeland, Robert A. Enzymes: a practical introduction to structure, mechanism and data analysis, John Wiley & Sons, 2004
6. Balasubramanian D, Bryce CFA, Dharmalingam K, Green J, and Jayaraman R, Concepts in Biotechnology, Universities Press (2007).
7. Rastogi SC, Mendiratta N and Rastogi P, Bioinformatics - Methods and Applications, PHI(2006).
8. Satyanarayana, U, Biotechnology, Books and Allied (P) Ltd. (2005).
9. Smith JE, Biotechnology, Cambridge University Press (2006).

10. Berg JM, Tymoczko JL and Stryer L, Biochemistry, W H Freeman and Company (2002).
11. Creighton TE, Protein-Structure and Molecular Properties, W.H. Freeman and Co. (1997).
12. Primrose SB and Twyman RM, Principles of Gene Manipulation and Genomics, Blackwell
13. Publishing (2006) 7th ed.
14. Sambrook J, Fritsch EF, Maniatis T, Molecular Cloning: A Laboratory Manual, Cold SpringHarboLaboratory (1999)

RESEARCH METHODOLOGY
COURSE CODE: BTT-C-304

CREDITS: 2

Course Objectives: The students will know how to access new facts using systematic thinking, analyzing phenomena, problems and seeking solutions to them based on reliable facts. The analysis of a phenomenon and trace its basics and refute its cause. The prediction based on scientific evidence, documented methodology and consecutive logical steps. Provide logical solution to the problem. To reach new and innovative results based on the latest facts and research.

COURSE CONTENT:

Unit I: Introduction and scope

Science, Scientific Field and Biological research. Role of a researcher in different stages of a project, Routes to research funding (academic and commercial)

Research, Definition, Importance of research, Characteristics of research, Types and steps in research, Identification, Selection and formulation of research problem, Research questions, Research design – Formulation of Hypothesis, Review of Literature.

Unit II: Types of research articles

Type of Articles (review, letters etc). Scientific paper format (Abstract, Introduction, Materials and Methods, Results, Discussion). Writing (ethical Vs unethical), evaluating, presenting and publishing the results of scientific research in the academic press (journals, conferences etc). Choosing the appropriate journal (Sources, Information, Instructions to authors, peer review system, journal evaluation), Case studies of areas of current research. Formulating a research plan and its presentation.

Learning Outcomes (LO):

Students will be able to

1. Understand basic concepts of research and its methodologies
2. Identify appropriate research topics
3. Select and define appropriate research problem and parameters
4. Present a research report and paper
5. Write a research proposal for grant

Text book & References:

3. Research Methodology Methods and Techniques by C.R. Kothari
4. Research Methodology Methods and statistical Techniques by Santosh Gupta

ADVANCED INSTRUMENTATION
COURSE CODE: BTT-E-301

CREDITS: 2

Course Objectives: To familiarize students with the basic principle, working of advanced microscopic techniques. Ability to extract important biomolecules from organisms and analyze their structure and to measure thermostability of polymeric molecules.

COURSE CONTENT:

UNIT I:

Principle, working and applications of scanning and transmission electron microscopy, confocal microscopy, atomic force microscopy and fluorescence microscopy. General principle & procedure involved in solid phase extraction and liquid-liquid extraction, LC-MS/MS and GC-MS/MS techniques, MALDI-TOF.

UNIT II:

Principle, instrumentation and applications of Thermogravinometric analysis (TGA), Differential thermal analysis (DTA) & Differential scanning colorimetry. X-ray crystallography- single crystal diffraction & powder diffraction.

Learning Outcomes (LO):

Students will be able to

1. Understand the advanced instruments used and its application in drug analysis
2. Understand the chromatographic separation and analysis of drugs
3. Understand the calibration of various analytical instruments
4. Know analysis of drugs using various analytical instruments.

References:

1. Instrumental methods of chemical analysis by B.K Sharma
2. Organic spectroscopy by Y.R Sharma
3. Text book of pharmaceutical analysis by Kenneth A. Connors
4. Vogles text book of quantitative chemical analysis by A.I Vogel
5. Practical pharmaceutical chemistry by A.H Beckett and J.V Stenlake
6. Organic chemistry by I.L Finar
7. Organic spectroscopy by William Kemp
8. Quantitative analysis of drugs by D.C Garrett
9. Quantitative analysis of drugs in pharmaceutical formulations by E.D Sethi
10. Spectrophotometric identification of organic compound by Silverstein

COMMUNICATION SKILL IN ENGLISH
COURSE CODE: BTT-E- 302

CREDITS: 2

Course Objectives: To provide the students with the essential skills required for effective communication and to provide a comprehensive view of business communication and its role in the corporate environment.

COURSE CONTENT:

UNIT-I

Essentials of Communication: Meaning, Definition, process, feedback, emergence of communication as a key concept in the corporate and global world, impact of technological advancements on communication.
Channels of Communication: Formal and Informal: Vertical, horizontal, diagonal, and grapevine.

UNIT-II

Methods and Modes of Communication: Verbal and nonverbal, Verbal Communication: Characteristics of verbal communication, Non-verbal Communication: Characteristics of non-verbal communication, kinesics, proxemics and chronemics.
Barriers to Communication: Physical, semantic, language, socio-cultural, psychological barriers, Ways to overcome these barriers.

UNIT-III

Listening: Importance of listening skills, cultivating good listening skills.
Written Communication: Business letters, memos, minutes of meeting, notices, e-mails, agendas and circulars.
Technical Report Writing: Types of Reports, contents of reports. Formatting, writing styles and documentation.

UNIT-IV

Presentations: Principles of effective presentation, power-point presentation, video and satellite conferencing.
Interviews and Group Activities Personal interviews, group discussion and panel discussion
Creative writing: Paragraph and Essay writing, Book reviews, Movie Reviews, Editorials and articles.
Self-Learning: Paper writing: Styles of paper writing: Short Communication, Review papers and Research papers, referencing styles: MLA, Chicago Style and APA.

Learning Outcome (LO):

Students will be able to:

1. Understand and demonstrate the use proper writing techniques relevant to the present day technological demands, including anticipating audience reaction.
2. Write effective and concise letters and memos, prepare informal and formal reports, proofread

and edit copies of business correspondence.
3. Develop interpersonal skills that contribute to effective personal social and professional relationships.

Text & Reference Books:

1. Lehman C. M., DuFrene D.D., & Walker. B-BCOM-An Innovative Approach to Learning and Teaching Business Communication. Cengage Learning New Delhi
2. McMurrey A. M & Buckley J., Handbook for Technical Writing. Cengage Learning, New Delhi.
3. Lesikar R.V & Flately M.E., Basic Business Communication-Skills for Empowering the Internet Generation. Tata McGraw-Hill Publishing Company Limited. New Delhi.

FOREIGN LANGUAGE- FRENCH

COURSE CODE: BTT-E-303

CREDITS: 2

Course objectives:

1. To acquire the phonology of French language.
2. To present and talk about one self and others.
3. Introduction to Grammar.
4. To learn about France.

COURSE CONTENT:

UNIT- I Communicative and linguistic components

Communicative: Formal and informal greetings- To Introduce oneself and to introduce others- Ask and give details of personal information: age, profession, nationality, address, e-mail etc.- To give and ask for time and date – to describe persons and things.

Grammar and Structure: Alphabet and pronunciation- Subject personal pronouns- Indicative Simple Present: Conjugation of -er, - ir, -re ending verbs (Regular verbs, selected irregular verbs)- Basic Negative and interrogative constructions- Gender and number- Question Words -Definite, Indefinite Articles–-Qu'est-ce que c'est?, C'est/ce sont, Il y a.

Vocabulary: Classroom communication - Nationalities, countries and languages- Parts of the day, days of the week and months- Numbers- Adjectives of Quality -Professions –Internet.

UNIT -II Cultural components

Introduction to France - institutions, symbols, history, culture, physical features, polity.

Learning Outcomes (LO): Students should be able:

1. To master the sounds of French language and its alphabet.
2. To talk about oneself and others briefly.
3. To have a notion of basic grammatical structures of French.
4. To communicate effectively in oral and written format in simple personal and professional situations in French using the linguistic and extra-linguistic skills gained during the course.

References:

1. Select units from Connexions Niveau 1, (Text book and Work book) by Régine Mérieux and Yves Loiseau, Didier, Paris, 2004.
2. Other select print, illustrated, audio and video material from books, CDs, DVDs and online sources.
3. CLE Grammaire 450 nouveaux Exercices –Débutant (Livre + corriges).
4. DELF/DALF practice books available in the University Library.
5. Haine, Scott W., The History of France, Greenwood Publishing, 2000.
6. Northcutt, Wayne, The Regions of France: A Reference Guide to History and Culture, Greenwood Press, 1996.
7. Dictionaries and reference books available in the University Library.

FOREIGN LANGUAGE- SPANISH

COURSE CODE: BTT-E- 304

CREDITS: 2
Course objectives:

1. To develop the skills of listening, speaking, reading & writing.
2. To read and understand simple texts.
3. To be able to write brief texts.
4. To be able to listen to simple texts and answering questions on them.
5. To have conversations based on visual texts.

COURSE CONTENT:

UNIT –I: Communicative functions & cultural components

Formal and informal greetings. To introduce oneself and to introduce others.To ask and give details of personal information: name, age, profession, nationality, address, email etc. To give and ask for time and date. To describe every day activities and habits with frequency. To talk of relations with other persons. To talk about one's family. Life and culture of the people where the language is spoken. Diversity of the countries where the language is used. Spanish speaking countries. Spanish songs, music and dance.

UNIT –II: Functional grammar and vocabulary

Alphabet and pronunciation.Subject personal pronouns.Indicative simple present: conjugation of *-ar, -er, -ir* ending verbs (regular verbs, reflexive verbs and selected irregular verbs).Negative and interrogative constructions.Gender and number.Articles and contractions.Interrogative pronouns: *qué, cuál, quién, cómo, dónde, cuándo, cuánto, etc.* Classroom communication. Greetings. Parts of the day. Days of the week. Months of the year. Seasons. Colours. Numbers (0 to 100). Family relations. Languages.

Learning Outcomes (LO):

Learners should be able to -

1. Participate in simple conversations in various day to day situations.
2. Organize ideas and communicate both in the written as well as oral form.
3. Know different aspects of life and culture of the people who speak the language.
4. Know basic concepts of grammar as well as functional and notional questions of language use/registers.

References:

1. J. Corpas, Aula Internacional- I, Inicial. (Libro de alumno, cuaderno de ejercicios, CD). Madrid,2010.
2. Virgilio Borobio, Nuevo ele inicial 1 (Libro del alumno, cuaderno de ejercicios, casete), EdicionesSM, Madrid, 2005.
3. 450 Ejercicios Gramaticales, Aquilino Sánchez, SGEL, Spain, 2007.
4. Cuadernos de Gramática Española, Emilia Conejo, CIPD, Barcelona, 2008.
5. Dictionaries available in the university library.
6. Other print, audio and video material from various books, CDs, DVDs and the internet.

SEMESTER-IV

PHARMACEUTICAL BIOTECHNOLOGY
COURSE CODE: BTT-C-401

CREDITS: 4

Course objectives:

The objective of this course is to apply the basic concepts in the specific field of pharmaceutical biotechnology. The student will gain insights into identification and design of drugs that could be potentially useful in the identification of candidate drug which have efficacy in cell culture or animal models and thus the most effective compound could be employed based on the above results to put into clinical trials.

COURSE CONTENT:

UNIT- I: **Antibiotics and Synthetic antimicrobial agents**

Concept of bioassay, therapeutic index, MIC and LD50 Mechanism of action, microbial resistance, therapeutic, prophylactic usage and adverse reactions of antibiotic and synthetic antimicrobial agents: β-lactam, aminoglycosides, tetracyclines, ansamycins, macrolides, peptide antibiotics, synthetic antibiotics: Sulphonamides, Chloramphenicol, Quinolone. Antifungal antibiotics: Amphotericin B, Griseofulvin and Fluconazole. Antiviral drugs: Acyclovir, Zidovudine, Amantadine. Antitumor drugs: Bleomycin, Dactinomycin

UNIT- II: Drug discovery methods

Drug Discovery Process, biological activity directed and other types of screening, natural products, combinatorial chemistry; General overview of validation techniques, Methods of Drug Discovery and development, QSAR and SAR. Concepts of Bioavailability, Process of drug absorption, Pharmacokinetic processes, Timing for optimal therapy, Drug delivery considerations for the new biotherapeutics.

UNIT –III: Pharmacology of drugs

Physicochemical properties in relation to biological action, Effects of route of administration, Drug Targets, Validation techniques of Pharmaceutical targets, Pharmacokinetics and pharmacodynamics of drugs, Drug Toxicity. Basic terminologies in drug delivery and drug targeting, Doses forms, Various routes of administration of drugs, Strategies for enhanced therapeutic efficacies. DNA vaccines, Vaccines & Monoclonal antibody-based pharmaceuticals and other pharmaceutical products: Streptokinase, streptodornase

UNIT- IV: Formulations and Regulations of drug

Formulation of Biotechnological Products, Drug Delivery, Examples of some Biotechnological products in clinical development. Role of FDA, ICH Guidelines, The Regulation of Pharmaceutical Biotechnological Products and Ethical Issues.

BTL-C 401
Laboratory Course in Pharmaceutical Biotechnology

1. Quality control of antibiotic and non-antibiotic formulations using titrimetric, spectrophotometric, chromatographic methods as per IP/US Pharmacopoeia.
2. Microbiological assays of antibiotics.
3. Sterility testing and stability testing of parenteral formulations.
4. Sterility testing of pharmaceutical products (intra-venous injections, antibiotics and vitamins),
5. Assays for screening antimicrobial/antifungal agents from plants and other natural sources.
6. Test for disinfectants (phenol coefficient / RWC method).
7. Determination of antibacterial spectrum for drugs/antibiotics.
8. Testing for antibiotic / drug sensitivity /resistance.
10. Determination of MIC value for antimicrobial chemicals.

Learning Outcomes (LO):

Students will be able to

1 Explain the strategies and various steps of new drug discovery process.
2 Explain the concept of pharmacodynamics and pharmacokinetics
3 Apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals like antibiotics, vaccines, proteins and hormones
4 Carry out the quality control procedures in the production of various biopharmaceuticals
5 Explain the regulatory aspects in the development of pharmaceuticals.

Reference Books

1. Pharmaceutical Microbiology- Edited by W. B. Hugo & A.R. Russel Sixth Edition. Blackwell Scientific Publications.
2. Principles of medicinal chemistry Vol. 1 by Kadam S.S., Mahadik K.R., Bothra K.G. Edition: 18, Nirali Publication.
3. Pharmacognosy by Gokhale S.D., KoKate C.K..Edition:18, Nirali publication
4. Biotechnology – Expanding Horizon by B.D. Singh., First Edition, Kalyani Publication, Delhi.
5. Pharmaceutical Biotechnology by S. P. Vyas & V.K. Dixit. CBS publishers & distributors, New Delhi.
6. Quniolinone antimicrobial agents- Edited by David C. Hooper, John S. Wolfson. ASM Washington DC.
7. Quality control in the Pharmaceutical industry - Edited by Murray S. Cooper Vol. 2, Academic Press New York.
8. Biotechnology- Edited by H.J. Rhem & Reed, vol 4 VCH publications, Federal Republic of Germany.

9. Drug carriers in biology & medicine Edited by Gregory Gregoriadis. Academic Press New York.
10. Drug Delivery and Targeting, A.M. Hillery, A.W. Lloyd and J. Swarbrick, Harwood Academic Publisher
11. Pharmaceutical Dosage Forms and Drug Delivery Systems, H.C. Ansel, L.V. allen and N.G. Popovich, Lippincott Williams and Wilkins Publisher
12. Applications of Targeted Nano Drugs and Delivery Systems, Shyam Mohapatra, Shivendu Ranjan, Nandita Dasgupta, Raghvendra Mishra and Sabu Thomas (EDs.), Elsevier, 2019.

FOOD BIOTECHNOLOGY

COURSE CODE: BTT-C-402

CREDITS: 4

Course objectives: To provide basic knowledge about food biotechnology and preliminary preparation of food before actual processing steps. To know the effect of microorganisms on food and to make the clear understanding about chemical and microbiological properties of food etc. To understand the concept of food born infections and to aware about laws and standards in food biotechnology.

COURSE CONTENT:

UNIT-I

Characteristics of Microorganisms in Food, Types of microorganisms associated with food, Factors affecting the growth of micro-organisms in food, Microbial Food Spoilage, Sources of Microorganisms in foods, Some important food spoilage microorganisms, Spoilage of specific food groups- Milk and dairy products, Meat, poultry and seafood's, Cereal and cereal products, Fruits, vegetables and Canned food products.

UNIT-II

Food Fermentations – Definition and types of fermented food, Microorganisms used in food fermentations, Dairy Fermentations- starter cultures and their types, concept of probiotics, biotechnological process for food fortification, prebiotics and oligosaccharides, fermented foods-types, methods of manufacture for vinegar, sauerkraut, tempeh, miso, soya sauce, beer, wine and traditional Indian fermented foods.

UNIT-III

Foodborne Diseases, Types – Food borne infections, food borne intoxications and toxin infections, with common and recent examples. Control of microorganisms in foods, Principles and methods of preservation, Physical Methods of Food Preservation- Dehydration, Freezing, Cold storage, Heat Treatment, Irradiation, Bio-preservatives i.e Bacteriocins and other natural products, Role of lactic acid bacteria in preservation of food items.

UNIT-IV

Food safety Laws and Standards: Food quality & analysis: Pre and Post-harvest factors in food quality, Physical, Chemical and Microbiological factors of quality, proximate analysis of foods, sample and sample preparation in foods. food laws: voluntary and mandatory food laws in India. Food certification agencies.

BTL-C-401

Laboratory course in Food Biotechnology

1. Isolation of microorganism from spoiled food (Dairy products, Meat products, Vegetables & Fruits)

2. Isolation of microorganism from traditional Indian fermented foods

3. Production and characterization of bacteriocin from probiotic microorganisms.

4. Antimicrobial activity of spices and oils against food spoilage causing microorganism

5. Microbiological Analysis of Milk: Raw and Pasteurized Milk - MBRT, SPC, Coliform, Sterilized Milk / LHT Milk - Spore Count.

6. Microbiological analysis of Milk Products: Analysis of butter, ice cream, Paneer, Standard plate count, coliform count, yeast and mold count.

7. Proximate analysis of dairy & fermented foods

Learning Outcomes (LO): Students will be able to

1 Comprehend the different microorganisms roles involved in food biotechnology with different food items.
2 Define and explain different preliminary steps before and after food fermentation.
3 Comprehend phenomenon of food degradation and spoilage by microorganisms with change in the properties of food.
4 To create awareness about different laws and standards in food biotechnology.

Reference Books

1. Norman N. Potter and Joseph H. Hotchkiss - Food Science, 5th ed. (2007)
2. M. Shafiur Rahman Handbook of Food Processing, 2nd Edition, CRC Press Taylor and Francis group (2007)
3. Frazier William C and Westhoff, Dennis C.)- Food Microbiology, TMH, New Delhi.(2004)
4. B. Sivasankar (Food Preservation, PHI Learning (2002)
5. Avantina Sharma Textbook of Food Science & Technology (Vol-I & II), International Book Distributing Company, Ist ed. (2006)
6. Cheung, Peter C. K., Mehta, Bhavbhuti M. Handbook of Food Chemistry, Springer-Verlag Berlin Heidelberg, Ist Edition. (2015)
7. Jay, James M. 2000 Modern Food Microbiology, CBS Publication, New Delhi,
8. Garbutt, John.1997 Essentials of Food Microbiology, Arnold, London,
9. Pelczar MJ, Chan E.C.S and Krieg, Noel R 1993 Microbiology, 5th Ed., TMH, New Delhi
10. Lawley, R., Curtis L. and Davis,J. , 2004 The Food Safety Hazard Guidebook , RSC publishing.

GENOMICS AND PROTEOMICS

COURSE CODE: BTT-C-403

CREDITS: 4

Course objectives: To understand the concept of proteomics and their applications. In addition, they will learn about methods of studying genetic materials obtained from various environmental samples. They will also provide understanding of basic concepts of sequences, structural alignment, database searching, protein structure prediction and computer-based drug designing.

COURSE CONTENT:

UNIT I: Genomics

Introduction, Methods of preparing DNA (isolation and *in-vitro* chemical synthesis), DNA separation techniques and DNA sequence analysis: Introduction, methods, sanger and dideoxy method, Automated sequencing, fluorescence method, Genome mapping: Introduction, methods, construction, use of onlinetools for genome map construction.

UNIT- II: Genome Engineering

Microarray technology: Introduction, methods and application, Combinational genomics: Introduction and application, synthetic chromosome/ synthetic life pharmacogenomics and proteomics.

UNIT III: Proteomics

Introduction and scope, polyacrylamide gel electrophoresis, Isoelectric focusing, Two dimensional PAGE for proteome analysis and image analysis of 2D gel, Mass spectrometry for protein identification.

UNIT IV: Protein structure prediction

Introduction, principle, tools, application for structure prediction of primary to quaternary structure of proteins, Protein engineering: Introduction, protein chips and functional proteomics, protein modeling, introduction, methods and tools, assigning secondary structure.

BTL-C-402

Laboratory course in Genomics and Proteomics

1 Proteomics tools,
2 Structural and functional predictions,
3 Phylogenetic Analysis, Phylogenetic tree construction
4 DNA and protein sequence and PDB file formats,
5 Local and global sequence alignment of protein and DNA sequences,
6 Needleman Wunsch and Smith-Waterman algorithm,
7 BLAST, Multiple sequence alignment
8. MS Excel and Graph pad Prism software, data entry and graphical representation, equation formulation and analysis for sample testing, nonparametric tests, correlation and

regression,

9. ANOVA, multiple comparisons.

Learning Outcomes (LO):

Students will be able to

1 Perform alignment of sequences and construct the matrix for alignment based on dynamic programming
2 Construct the phylogenetics of different sequences.
3 Analyze sequence and structure of bio-macromolecule data
4 Edit the three dimensional structure of protein using structural bioinformatics tools
5 Explain the properties of genetic materials and storage and processing of genetic information.
6 Analyze genomic data.
7 Explain biological phenomena based on comparative genomics
8 Design transcriptomics and proteomics experiments for studying differential gene expression and related analysis
9 Use metagenomics approach for studying phenomena associated with microbial communities.

Reference Books

1 Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006) 7th ed. ISBN 1-4051-3544-1
2 Lesk, A. M., Introduction to Genomics, Oxford University Press (2008), ISBN 978-0-19-955748-6
3 Lesk, A. M., Introduction to Bioinformatics (3rd Edition), Oxford University Press (2011), ISBN 978-0-19-958079-8
4 Ghosh, Z. and Mallick, B., Bioinformatics Principles and Applications(2008) Oxford University PressISBN 9780195692303
5 Lewin, B., Genes VIII, International Edition, Pearson Education International (2004), ISBN0131238264

MICROBIAL TECHNOLOGY
COURSE CODE: BTT-E-401

CREDITS: 4

Course objectives: The aim of this course is to impart knowledge about biological & biochemical technologies with focus on biological products, design & operation of industrial practices.

COURSE CONTENT:

UNIT I: Microbial production of therapeutic agents

- Antibiotics; Griseofulvin, Rifamycin
- Antiviral & anticancer agents
- Vaccines, insulin and siderophore
- Biotransformation of steroids and antibiotics.

UNIT II: Microbial production of solvents, beverages and biofuels

- Solvents: Ethanol, acetone-butanol.
- Beverages:Wine and beer.
- Biofuels- H_2 gas and bio-disel.

UNIT III: Modern trends in Microbial Production

- Biopolymers & Bioplastics: Dextran, Alginate, Xanthan, Pullulan, PHA & PHB.
- Bioferilizers: Nitrogens fixers, Phosphate solubilizers.
- Biomass: Mushroom and probiotics.
- Biosurfactants & Biopigments: Glycolipids, beta-carotene.
- Bio – insecticides & Bioweedicides.

UNIT IV: IPR and IPR Practices

- Introduction to IPR & patents: composition of patents, patent practices and problems, patent, Trademarks and copyrights.
- Patenting of biological materials: Microbial products, transgenic organisms and isolated genes
- Patent regulation bodies at national and international level.

BTL-E-401

Laboratory Course in Microbial Technology

1. Production, extraction & recovery of amylase using *A.niger / A.oryzae.*
2. Production, extraction & recovery of citric acid using *A.niger.*
3. Production of Glutamic acid using C. glutamium
4. Production of penicillin using *Pencillium notatum.*
5. Production of ethanol using tree & immobilized cause & *S. cerevisiae.*
6. Microbial production of biosurfactants.

7. Production of biofertilizers & testing of efficacy.
8. Production of siderophore using *Pseudomonas aeruginosa.*

Learning Outcomes (LO):

Students will be able to

1. Demonstrate production of antibiotics, solvents, biopolymer by using microorganisms at lab scale level.
2. Acquire knowledge of biofertilizer, mushroom, biosurfectant and bioinsecticide production as per society need.
3. Familiarize students about patents of microbiological products

Reference books

1. Biotechnological innovations in Chemical Synthesis. BITOL. Publishers / Butterworth-Heinemann.
Industrial Microbiology by G.Reed (Ed,) CBS publishers (AVI publishing Co.)
2. Biology of industrial Microorganisms by A.L. Demain
3. Genetics and Biotechnology of Industrial Microorganism by C.I. Hershnergy, S.W. Queener and Q. Hegeman. Publisher.ASM Ewesis ET.AL 1998 Bioremediation Principles, Mac GrawHill.
4. Biotechnology, A textbook of industrial Microbiology by Creuger and Creuger
5. Manual of industrial microbiology and Biotechnology 2nd edition by Davis J.E. and Demain A.L. ASM publications.
6. Mukhopadhayay, S.N. (2004) Process Biotechnology Fundamentals , 2ndedn., Viva Books Pvt. Ltd, Mumbai(ISBN:81-7649-496-8)
7. Rehm, H.J. and Reed, G, (1983) Biotechnology, Vol. 3 Dellweg, H. (ed.), VerlagChemie, Basel(ISBN:3-527-25765-9)
8. Martin, A.M. (1998) Bioconversion of Waste Materials to industrial products, 2nd ed,. Blackie Academic and professional, London((ISBN:0-7514-0423-4)
9. Chincholkar, S.B. and Mukherji ,K. G.(2007)Biological Control of Plant Diseases, Hawarth Food and Agricultural Products Press, Oxford, UK (ISBN:1-56022-328-6)

PLANT BIOTECHNOLOGY

COURSE CODE: BTT-E-402

CREDITS: 4

Course objectives:

1. To acquaint the students with basic principles and various methods of Tissue Culture.
2. To impart knowledge about varied methods of gene transfer and transgenic plant development.
3. To underhand basics of secondary metabolites and their engineering.
4. To acquire knowledge about molecular markers and their use in plant breeding.

COURSE CONTENT:

UNIT- I

History:Important events in the history of plant tissue culture ; Laboratory Requirements and General Techniques;Cellular Totipotency ; Tissue Culture Media:Introduction, media constituents, media selection, media preparation ;Callus Culture;Micropropagation:Introduction, techniques, applications, production of pathogen free plants;Somatic Embryogenesis ; Haploid Production:Introduction, techniques, factor affecting androgenesis, ontogeny of androgenic haploids, plant regeneration from pollen embryos, homozygous diploids, applications, limitations;Triploid production.

UNIT- II

Somaclonal & gametoclonal variations; Protoplast Culture:Protoplast isolation, fusion and regeneration, Cybrids;Embryo Culture and embryo rescue:Introduction, techniques ; Synthetic Seeds;Cell and Suspension Culture:Introduction, isolation of single cells, suspension cultures, culture of single cells, plant cell reactors, applications of cell culture;Production of secondary metabolites:Introduction, strategies used to optimize product yield, commercial aspects.

UNIT- III

Introduction to transgenic technology: Conventional breeding versus Transgenesis;Introduction to *Agrobacterium tumefaciens* and *A. rhizogenes,* Features of Ti and Ri Plasmids and their use as vectors, Binary and co-integrate vectors, *Agrobacterium* mediated transformation, Direct DNA transfer to plants , Detection, characterization and expression of Transformants

Applications of plant transformation for productivity and performance: GM technology for:Conferring resistance to biotic stresses (pests, viruses and fungi) and abiotic stresses (draught and salt), Herbicide resistance**,** Increasing shelf life of fruits and flowers**,** Enhancing the nutritional quality (pro-vitamin A), Chloroplast Transformation.

UNIT- IV

Metabolic engineering and industrial products: Plant secondary metabolites: alkaloids, industrial enzymes, biodegradable plastic: polyhydroxybutyrate, therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, oleosin partitioning technology etc, Aspects related to commercial release of transgenic crops.

Molecular marker aided breeding**:** RFLP, RAPD, Microsatelites, AFLP etc.

BTL-E-402

Laboratory Course in Plant Biotechnology

1. Preparation of MS medium
2. Surface sterilization
3. Micro propagation of plant through multiplication of pre-existing meristems.
4. Hardening of *in vitro* raised plants
5. Encapsulation of somatic embryos
6. Embryo culture and embryo rescue.
7. Protoplast isolation, fusion and culture.
8. *In vitro* production of fast growing normal root culture for production of secondary metabolites
9. Elicitation of plant cells for secondary metabolites
10. Agrobacterium Ti plasmid based vector mediated transformation, selection of transformants, reporter gene assay.
11. Transformation of plant tissues using *Agrobacterium rhizogenes* for hairy root production
12. Transformation and expression of GFP gene in suitable host.
13. Developing RFLP maps, Developing RAPD maps

Learning Outcomes (LO):

On completion of this course, the students shall:

1. Demonstrate the knowledge about the techniques of Plant Tissue Culture and acquire comprehensive knowledge on GM technology for quality characteristics and their role in crop improvement.
2. Acquire knowledge in metabolic engineering and industrial products.
3. Develop skills in molecular markers studies and their use in plant breeding.
4. Shall develop scientific skills to work in Plant tissue culture, Pharmaceutical and Research laboratories.

References:

1. Razdan M. K. (2002) Introduction to Plant Tissue Culture; Oxford and IHB publishing Co. Pvt.Ltd.
2. Kumar U, (1999): Methods in Plant Tissue Culture, Bikaner, Agro Botanica.
3. Misawa Masanaru (1994) Plant tissue culture; an alternative for production of useful metabolites, Daya Publishing House, New Delhi.
4. Bhojwani S. S. and Razdan M. K. (1996) Plant tissue culture, theory and practice a revisededition, Elsevier India Ltd.
5. Ignacimuthu SJ, Applied Plant Biotechnology, Tata McGrew Publishing Company, New Delhi.

6. Flower M. W. and Wasven E. S. (1992). Plant Biotechnology comprehensive Biotechnologysupplement, Oxford Pergaman press.
7. Hammand J; McGarvey P and Yusibov V (2000): Plant B:iotechnology, New Products andapplications; Springer, New Delhi.
8. Mantell S. H; Matthews J. A.: Makee R A (1985) Principles of Plant Biotechnology; an introduction to genetic Engineering in plants; Oxford, Blackwell- Scientific publication.
9. Chawla Harvinder Singh (1998): Biotechnology in crop improvement: International Book distribution company, Lucknow.
10. Gupta P. K. (1996) Elements of Biotechnology: Rastogi and Company Meerut.
11. Pareek L. K. (1997): Trends in Plant tissue culture and Biotechnology; Agro Botanica publishers.
12. Esra Galum: Adina Breiman (1997) Transgenic plants: Imperial College Press.
13. B. D. Singh (1998), Biotechnology; Kalyani Publishers.
14. Narayanswami, Plant tissue culture.
15. J. Hammond, P. McGarvey and V. Yusibov (Eds.): Plant Biotechnology, Springer Veriag, 2000.
16. T. J. Fu, G. Singh, and W.R. Curist (Eds.): Plant Cell and Tissue Culture for the production ofFood Ingredients. Kluwer Academic/Plenum press, 1999.
17. H. S. Chawla: Biotechnology in Crop Improvement. International Book Distribution Company,1998.

ANIMAL BIOTECHNOLOGY
COURSE CODE: BTT-E- 403

CREDITS: 4

Course objectives: The objective of this course is to enable students to develop basic skills for vertebrate cell culture, maintenance of cell lines and *in vitro* application of cell and molecular techniques and also to understand the principles of animal cloning and its applications.

COURSE CONTENT:

UNIT -I

Structure and organization of animal cell. Equipments and materials for animal cell culture technology.Primary and established cell line cultures. Introduction to the balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements. Serum and protein free defined media and their applications. Application of animal cell culture.

UNIT- II

Primary and secondary culture of animal cells: types of primary cell cultures, isolation of tissue and primary culture.

Subcultured propogation, criteria for subculture and propogation, split ratio, subculture in suspension.

Basic techniques of mammalian cell culture *in vitro*, disaggregation of tissue and primary culture; maintenance of cell culture; cell separation.

Scaling- up of animal cell culture.

UNIT -III

Culture and maintenance of cell lines, Biology and characterization of the cultured cells, Measurement of viability,

Model animals in animal biotechnology

DNA transfer techniques in to mammalian cells, Microinjection, electroporation, Stem cell etc.

Artificial insemunisation, IVF, somatic cell nuclear transfer and stem cell technology.

UNIT -IV

Principle, Concept and application of animal cloning, embryonic stem cells and their applications.

Cell culture based vaccines, viral vectors, Gene therapy, animal ethics and bio safety, Principle of tissue engineering,

BTL-E-403

Laboratory course in Animal Biotechnology

1. Enumeration of Red Blood cells (RBCs) from sheep and human blood
2. Isolation of Cells from Liver tissue and its Quantification
3. Cell Viability assay using dye-exclusion method
4. Micronucleus Assay
5. Hemolytic test for *Staphylococcus aureus*
6. Con-A induced Hemagglutination Assay
7. Anchorage independent cell culture(Lymphocyte culture)
8. Anchorage dependent cell culture (chick embryo cell culture)
9. Epithelial cell culture
10. Anti-angiogenic activity using chick chorio-allantoic membrane(CAM) assay
11. Preparation of culture media.

Learning Outcomes (LO):

Students will be able to

1 Explain the fundamental scientific principles that underlie cell culture
2 Acquire knowledge for isolation, maintaince and growth of cells.
3 Develop proficiency in establishing and maintaining of cell lines.
4 Acquire knowledge in animal cloning and its applications

Reference Books

1 R. Ian Freshney Culture of Animal Cells: A Manual of Basic Technique, 4th Edition" 2000.
2 Ranga, M.M., Animal Biotechnology, Agrobios (2007) 2nd ed.
3 Masters, J. R.W., Animal Cell Culture, Oxford (2000) 3rd ed.
4 Marshak L, Stem Cell Biology, Cold Spring Harbor Publication, (2001).

*BTL-C-403 PROJECT/ REVIEW WRITING

CREDITS: 04

To be under taken by the students under the guidance of advisor allotted.

COURSE GUIDELINES:

- Each student has to undertake a project work/review writing under the guidance of school faculty.
- Students will be alloted to the concern guide at the end of IInd semester & students can select co-guide from other institutes or from industry with consultation of guide and school director.
- Students may be permitted to work in other institutes or industry during summer and winter vacations
- The outcome will be intellectual property of the student and faculty guide/Co-guide which cannot be published without written permission of the faculty guide/ Co-guide.