ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF BIO - SCIENCES

(RSBSC)

Department of Biotechnology

SYLLABUS

&

COURSE STRUCTURE

M.Sc. in Biotechnology

W.E.F. 2022-23

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M.Sc. in BIOTECHNOLOGY UNDER CBCS

1. Preamble

The discipline of Biotechnology has transcended boundaries and has incorporated diversified subjects to make it one of the most sought after subjects to be pursued for UG/PG/ PhD degrees. The subject has made worthwhile contributions to the upliftment of the society through various means *viz* novel agricultural crops, vaccines against novel diseases, drug discovery against new emerging diseases, medical diagnostics, food security etc.

The M.Sc. programme in Bio-Technology is conceived with the idea of development of Human Resource for engagement in the society. The man power generated through the programme shall be engaged as resources for societal developments, industries and academia.

The major objective of the programme is as follows:

- Impart theoretical and practical knowledge in the area of modern biology to enable them to work in industries, research organizations etc.
- To develop healthy citizens who are competent in their chosen fields.
- To instil confidence in the students for overall development of their professional expertise and traits.
- To instillthe values of ethics and integrity.
- To enable graduates to become future leaders and innovators.

The two year degree course is for students who wish to broaden their knowledge about modern biology and its relation to the development of society. Students who wish to make a change in the society and contribute to its improvement are highly welcome.

2. Introduction:

Twenty First Century is known as the "Century of Biotechnology". Biotechnology is one of the multidisciplinary branches of Life Science, which amalgamates technology with biology to understand various biological phenomena and their applications in human welfare. Thus through knowledge of Biotechnology, helps in bridging the gap from labs to market driven research. The socio-economic potential of Biotechnology is well established which has almost become synonymous with modern development. Biotechnology has its applications in almost every field touching practically every human activity. The applied aspect of Biotechnology is now getting established with its applications in Industry, Agriculture, Health and Environment. Biotechnology demands a trained, skilled human resource to establish the Industry and Research sectors. The field is novel and still expanding which demands inputs in Infrastructure and Technology. The global and local focus is on developing new technological applications. Biotechnology sector in Research and Industry is expanding which is set to augur the next major revolution in the world.

3. Aim of the Post Graduate Degree Programme in Biotechnology:

The aim of the postgraduate degree in Biotechnology is to make the students gather knowledge and understand the various basic concepts in Biotechnology. The students are required to improve upon their skills in handling laboratory instruments and learn about the principles and mechanism of working of the instruments. The understanding, knowledge and skills in Biotechnology need to be developed through a well developed teaching learning processes in the class. Practical skills will be obtained through laboratory work and presentation and articulation skills through various seminars and internship exposure. The students will also be mentored and guided through research projects in their final year of study.

4. Career Opportunities: Various scopes of career opportunities in Bio-Technologyare as follows.

- Microbiologists
- QC Manager
- Pharmaceutical Industries
- Research and Development
- Academics
- Research
- Government Jobs

Students can also pursue higher studies such as Ph.D. programme in Biotechnology or other areas in biological sciences.

DEPARTMENT OF BIOTECHNOLOGY

VISION

To create biologists who have strong ethics, integrity and preparedness to tackle any emerging global problem.

MISSION

- **Impart quality education to students and make them globally competitive biotechnologists.**
- **To incorporate confidence in the students to prepare themselves for solutions to emerging globally threatening problems.**
- **To provide state of the art academic and laboratory facilities.**

CREDIT DISTRIBUTION

SEMESTER	CREDITS
I	22
II	24
III	27
IV	29
	TOTAL CREDITS=102

Assessment and Evaluation:

Scheme of Evaluation

The following suggestive table indicates the distribution of marks for various components in a semester

	Component of Evaluation	Marks	Frequency	Code	Weightage (%)
A	**Continuous Evaluation**				
i	Analysis/Class test	Combination of any three from (i) to (v) with 5 marks each	1-3	C	25%
ii	Home Assignment		1-3	H	
iii	Project		1	P	
iv	Seminar		1-2	S	
v	Viva-Voce/Presentation		1-2	V	
vi	Mid term examination	MSE shall be of 10 marks	1-3	Q/CT	
vii	Attendance	Attendance shall be of 5 marks	100%	A	5%
B	Semester End Examination		1	SEE	70%
	Project				**100%**

M.Sc. Biotechnology

Programme Structure

1st semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects *(Please Add rows, as required)*							
1	**BTC154C101**	**Biochemistry**	**3**	**1**	**0**	**4**	**4**
2	**BTC154C102**	**Genetics**	**3**	**1**	**0**	**4**	**4**
3	**BTC154C103**	**Microbiology**	**3**	**1**	**0**	**4**	**4**
5	**BTC154C114**	**Practical I**	**0**	**0**	**8**	**4**	**8**
Ability Enhancement Compulsory Courses (AECC)							
6	**CEN984A101**	**Communicative English – I**	**1**	**0**	**0**	**1**	**1**
7	**BHS984A103**	**Behavioural Science – I**	**1**	**0**	**0**	**1**	**1**
Elective: Discipline Specific DSE							
8	**BTC154D101**	**DSE – 1 (Analytical Techniques)**	**3**	**1**	**0**	**4**	**4**
		TOTAL CREDIT	**14**	**4**	**8**	**22**	**26**

2nd semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects *(Please Add rows, as required)*							
1	**BTC154C201**	**Biophysical Chemistry**	**3**	**1**	**0**	4	**4**
2	**BTC154C202**	**Cell Biology**	**3**	**1**	**0**	**4**	**4**
3	**BTC154C203**	**Molecular Biology**	**3**	**1**	**0**	**4**	**4**
4	**BTC154C214**	**Practical II**	**0**	**0**	**8**	**4**	**8**
Ability Enhancement Compulsory Courses (AECC)							
5	**CEN984A201**	**Communicative English – II**	**1**	**0**	**0**	**1**	**1**
6	**BHS984A123**	**Behavioural Science – II**	**1**	**0**	**0**	**1**	**1**
Elective: Discipline Specific DSE							
7		**AEEC/SEC/-1***	**2**	**0**	**0**	**2**	**2**
8	**BTC154D201**	**DSE – 2(Genomics and Proteomics)**	**3**	**1**	**0**	**4**	**4**
		TOTAL CREDIT	**16**	**4**	**8**	**24**	**28**

3rd semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects *(Please Add rows, as required)*							
1	**BTC154C301**	**Animal Biotechnology**	2	1	0	**3**	**3**
2	**BTC154C302**	**Plant Biotechnology**	2	**1**	0	**3**	**3**
3	**BTC154C313**	**Practical III**	**0**	**0**	4	**2**	**4**
Ability Enhancement Compulsory Courses (AECC)							
4	**CEN984A301**	**Communicative English – II**	**1**	**0**	**0**	**1**	**1**
Elective: Discipline Specific DSE							
5		**AEEC/SEC/-2***	**2**	**0**	**0**	**2**	**2**
6	**BTC154D301**	**DSE – 3 (Environmental Biotechnology)**	**3**	**1**	**0**	**4**	**4**
7	**BTC154D302**	**DSE – 4 (Bioprocess Technology)**	**3**	**1**	**0**	**4**	**4**
8	**BTC154D303**	**DSE – 5 (Biostatistics and Bioinformatics)**	**3**	**1**	**0**	**4**	**4**
9	**BTC154C324**	**Minor Project**	**0**	**0**	**10**	**4**	**10**
		TOTAL CREDIT	**18**	**3**	**14**	**27**	**35**

4th semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects *(Please Add rows, as required)*							
1	**BTC154C401**	**Immunology**	2	1	**0**	**3**	**4**
2	**BTC154C402**	**Genetic Engineering**	2	1	**0**	**3**	**4**
3	**BTC154C413**	**Practical IV**	**0**	**0**	**4**	**2**	**4**
Ability Enhancement Compulsory Courses (AECC)							
4	**CEN984A401**	**Comm. Eng**	**1**	**0**	**0**	**1**	**1**
Elective: Discipline Specific DSE (Any Three)							
5	**BTC154D401**	**DSE – 6 (IPR, Biosafety, Bioethics and Research Methodology)**	**3**	**1**	**0**	**4**	**4**
6	**BTC154D402**	**DSE – 7 (Medicinal Plants, Conservation andApplications)**	**3**	**1**	**0**	**4**	**4**
7	**BTC154D403**	**DSE – 8 (Industrial Microbiology)**	**3**	**1**	**0**	**4**	**4**
8	**BTC154D404**	**DSE- 9 (Developmental Biology)**	**3**	**1**	**0**	**4**	**4**
	Project Dissertation						
9	**BTC154C421**	**Major**	**0**	**0**	**10**	**8**	**10**
		TOTAL CREDIT	**16**	**3**	**14**	**29**	**35**

SYLLABUS (1ST SEMESTER)

Subject Name: Biochemistry **Scheme of Evaluation: (T)**

Subject Code: BTC154C101 **Credit Units: 3-1-0-4**

Course Objective: The course is designed to understand the basic characteristics of various biological macromolecules, their formation along with their association in various metabolic pathways.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the core concept of basic biochemistry, structure of various biological macromolecules.	**BT 1**
CO 2	**Understand**the basic biochemical processes occurring in the living system and involvement of various biological macromolecules in those processes.	**BT 2**
CO 3	**Apply** the knowledge gained during the course in the field of research and development.	**BT 3**
CO 4	**Analyse** theoretical knowledge in developing practical solutions in solving real life problems associated with biochemistry.	**BT 4**
CO 5	**Evaluate** their understanding in chemistry behind reactions occurring in living systems.	**BT 5**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I	**Chemical foundations of Biology:** Composition of living matter, Water-properties, pH, pKa, acids, bases, buffers; weak bonds, covalent bonds. **Protein:** physical and chemical properties of amino acids; Primary, secondary, tertiary and quaternary structure; Globular and fibrous proteins; Amino acid composition and primary structure analysis, Structure-function relationship in model proteins like ribonuclease A, myoglobin and haemoglobin, structure of collagen, Ramachandran Plot	**12**
II	**Carbohydrates**: mono, di and polysaccharides; Structural and functional role; Glycoprotein and Glycolipid. **Lipids:** Structure and properties of storage and membrane lipids; Lipoproteins; Structural organization of biological membrane.	**12**
III	**Nucleic acids:** Structure and properties of purines, pyrimidines, nucleosides, nucleotides, helical structure of DNA. Different forms of DNA. Denaturation and renaturation of DNA.	**12**

	Enzyme catalysis: General principles of catalysis; Quantitation of enzyme activity and efficiency;Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; single and bisubstrate enzyme reactions.	
IV	**Metabolic pathways**: Energy concepts and energy rich compounds; Glycolysis, glycogenolysis, gluconeogenesis, pentose phosphate pathway, citric acid cycle and oxidative phosphorylation; Fatty acid biosynthesis and oxidation (α and β) **Vitamins**: Types and biological properties	**12**
Total		**48**
Pedagogy: Lectures, Assignments, Seminars		

Textbooks:

1. Nelson, D.L., Cox, M.M.,*Lehninger Principles of Biochemistry*, 4th Edition, 2004, W.H. Freeman and Company, New York, USA
2. Satyanarayana, U. and Chakrapani, U, Biochemistry, 6th Edition, 2021, Elsevier.

Reference Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer. L., *Biochemistry*, 6th Edition, 2006, W.H. Freemanand Co.
2. Voet, D and Voet, J.G., Biochemistry, 4th Edition, 2012, Wiley
3. Berg, J.M., Tymoczko, J.L., Gatto, G.J. and Stryer, L, Biochemistry, 8th Edition, 2015, W.H. Freeman and Company

Subject Name: Genetics	**Scheme of Evaluation: (T)**
Subject Code: BTC154C102	**Credit Units: 3-1-0-4**

Course Objective: The course is designed with the following major objectives

The course is designed to understand the various laws governing inheritance and learn about chromosomal aberrations and structure of chromosomes

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concept of Mendelian principles of heredity and use those principles to analyze genetic data.	**BT 1**
CO 2	**Understanding** of how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc.	**BT 2**
CO 3	**Apply** to real life situations and one's life the principles of human heredity.	**BT 3**
CO 4	**Analyse** the historical and current knowledge regarding human heredity, and understand how such knowledge has influenced law, medicine, and society**.**	**BT 4**
CO 5	**Evaluate** the fundamentals of gene technology to understand how such technology impacts humans.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Mendelian genetics:** Brief survey of Mendelian Genetics, law of dominance, independent assortment, linkage and crossing over, interaction of genes, Extrachromosomal inheritance: mitochondrial & chloroplast inheritance.	**12**
II	**Microbial genetics:** Bacterial chromosome and plasmids, bacterial mutants, prototroph and auxotroph. Transformation, conjugation and transduction in bacteria. Bacteriophage and their genetic systems, Lytic and Lysogenic cycles in lamda(λ) phage: genetic recombination and heteroduplex DNA.	**12**
III	**Mutation:** types, rates and the agents that cause mutation, Molecular basis of mutation, Genome instability: chromosomal aberration; Cell division and errors in cell division. Assay of mutagenic agents (Ames test).	**12**
IV	**Concept of Human Genetics:** Human Chromosome and abnormalities, Mendelian pedigree pattern, polygenic and multifactorial inheritance, inborn errors of metabolism, Hardy-Weinberg equilibrium, genotype and allele frequency, sex determination, role of Y-chromosome and mechanism. Introduction to cancer genetics	**12**
Total		**48**
Pedagogy: Lectures, Assignments, Seminars		

Textbooks:

1. Gupta P.K., Genetics, ISBN-10 8171339328, ISBN-13 978-8171339328, Rastogi Publications, Meerut.
2. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., Molecular *Biology of the Gene*, 7th edition, 2012. Cold Spring Harbour Lab. Press, Pearson Pub.
3. Fairbanks, D.J.,Genetics: The Continuity of Life, Wadsworth Publishing, ISBN-10: 0534252796
4. Russel, P.J.,iGenetics, Pearsons Education India, ISBN-10: 9332571627, ISBN-13: 978-9332571624

Reference Books:

1. Karp, G..*Cell and Molecular Biology: Concepts and Experiments*, 6th edition, 2010. John Wiley & Sons. Inc.
2. Klug, W., Cummings, M., Spencer, C.A., Palladino, M.A., Concept of Genetics, ISBN-10: 9789332577466, ISBN-13: 978-9332577466, Pearsons Education India.

Subject Name: Microbiology	**Scheme of Evaluation: (T)**
Subject Code: BTC154C103	**Credit Units: 3-1-0-4**

Course Objective:

The course aims to give a holistic theoretical and practical knowledge in field of general microbiology, its core concept, scopes, applications and future prospects.

Course outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the core concept of basic microbiology, microbial structure, their taxonomic classification, microbial ecology and their applications.	**BT 1**
CO 2	**Understand** isolation, screening, characterization, and identification of important microbes from various sources.	**BT 2**
CO 3	**Apply** the knowledge gained during the course in the field of research and development.	**BT 3**
CO 4	**Analyse** theoretical knowledge in developing practical solutions in solving real life problems associated with microbiology.	**BT 4**
CO 5	**Evaluate** future prospects by pursuing entrepreneurial ventures in this field.	**BT 5**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I	**Microbial Diversity and Systematics:** Classical and modern methods and conceptsin classification of microorganisms. Bergey's manual of determinative Bacteriology, 16s rDNA sequencing and ribosomal database project.Microbial systematics, Molecular Taxonomy,	**12**
II	**Study of microorganisms**: General characteristics and salient features related to structure, function, physiology and significance of cyanobacteria, actinomycetes, fungi, yeast, viruses, rickettsia & mycoplasma. Ultrastructure of a bacterial cell: spore, cell wall, flagella, cell membrane, capsule, pili. Microbial growth.Virus structureand composition, virus replication andpathogenicity, Basic microbiological techniques: Microscopy, Pure culture, nutrition, enrichment, sterilization, disinfection, safety in the microbiological laboratory.microbial gene transfer: transformation, transduction, conjugation, plasmids, transposons.	**12**
III	Study of ecophysiological, biochemical and nutritional aspects of phylogenetically diverse representative groups of organisms: extremophiles - thermophiles, psychrofiles, halophiles, methanogens, archaebacteria, Nitrogen	**12**

	fixing organisms and nitrogen fixing genes, Mycorrhiza: types and its functions **Microbial Ecology:** interactions among microbial populations, microbial interaction with animals, microbial interaction with plants, quorum sensing **Diseases of humans:** Bacterial meningitis, botulism, poliomyletis, hepatitis and AIDS.	
IV	**Antibiotics:** types & mode of action, resistance to antibiotics. Prebiotics and Probiotics, Bacteriocins,vaccines and adjuvants, Bioprocess technology, bioprocess control and monitoring variables, Media formulations, sterilization, Thermal death kinetics, batch and continuous sterilization systems, extracellular enzymes, biotechnologically important intracellular products, exopolymers.	**12**
Total		**48**
Pedagogy: Lectures, Assignments, Seminars		

Textbooks:

1. Willey, J., Sherwood, L., Woolverton, C.J., Prescotts Microbiology, , ISBN-10: 9813151269, ISBN-13: 978-9813151260, McGraw Hill Edition, 10th edition.
2. Ananthanarayan and Paniker's Textbook of Microbiology, ISBN-10: 9789386235251, ISBN-13: 978-9386235251, Universities Press
3. Reed, G., Prescotts and Dunn Industrial Microbiology, ISBN-10: 8123910010, ISBN-13: 978-8123910017, CBS Publishers & Distributors

Reference Books:

1. Madigan, M.T.,Martinko, J.M., Bender, K. S., Buckley,D.H., Stahl, D.A.Brocks Biology of Microorganisms, ISBN-10: 9332586861, ISBN-13: 978-9332586864, Pearson's Education,
2. Bauman R.W., Microbiology with Diseases by Taxonomy, Pearson Education, ISBN-10: 9332587272, ISBN-13: 978-9332587274

Subject Name: Practical I	**Scheme of Evaluation:(P)**
Subject Code: BTC154C114	**Credit Units: 0-0-8-4**

Course Objective:

The course is designed with an objective to give the students a wholesome practical knowledge on Microbiology, Genetics and Biochemistry.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the practical skills associated with Microbiology, Genetics and Biochemistry.	**BT 1**

CO 2	**Understand** isolation, screening, characterization, and identification of important microbes from various sources.	**BT 2**
CO 3	**Apply** the knowledge gained during the course in the field of research and development.	**BT 3**
CO 4	**Analyse** theoretical knowledge in developing practical solutions in solving real life problems associated with microbiology.	**BT 4**
CO 5	**Create** an understanding in expanding the future prospects by pursuing entrepreneurial ventures in this field.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	1. Estimation of protein by Lowry's method. 2. Estimation of Carbohydrates by Anthrone method.	**24**
II	1. Detection of amino acids by ninhydrin method 2. Estimation of DNA by DPA method. 3. Estimation of RNA by Orcinol method	**24**
III	1. Study of meiosis from grasshopper testis. 2. Preparation of human karyotypes from well spread metaphase photographs. 3. Enzyme assay and activity assessment 4. Effect of pH and temperature on enzyme activity	**24**
IV	1. Preparation of common bacteriological media and sterilization 2. Isolation and enumeration of microorganisms from various sources. 3. Staining of microorganisms(Bacteria and Fungi) 4. Biochemical characterization of microorganisms (IMViC test, catalase test, gelatin liquefaction, antibiotic sensitivity assay). 5. Growth curve, measure of bacterial population by standard plate count.	**24**
Total		**96**
Pedagogy: Lectures, Experiments, Laboratory sessions		

Texts and Reference: As suggested under theory papers

Subject Name: DSE – 1 (Analytical Techniques)	**Scheme of Evaluation: (T)**
Subject Code: BTC154D101	**Credit Units: 3-1-0-4**

Course Objective: The course is designed with an objective to give students the technical know how of the working of analytical equipment used in Biotechnology

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**

CO 1	**Remember** the specific technique to be used for different analytical characterizations.	**BT 1**
CO 2	**Understand** the working principles of various equipment used in analysis.	**BT 2**
CO 3	Ability to **apply** the acquired knowledge to address research problems.	**BT 3**
CO 4	Ability ti **analyse** the data generated by using sophisticated equipment.	**BT 4**
CO 5	Ability to **evaluate** alternative and better methods of sample analysis to reduce time and increase throughput.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Basic techniques**: Buffer preparations; pH measurement; Cell disintegration; Dialysis and Ultra filtration. **Spectroscopy:** Principles and applications of UV-Visible, Fluorescence and Infrared spectroscopy. **Chromatography:** Principles and applications of Paper and Thin layer chromatography; Size exclusion, Ion exchange, Hydrophobic, Reverse phase and Affinity chromatography; HPLC and FPLC.	**12**
II	**Electrophoresis:** Theory and application of Polyacrylamide and Agarose gel electrophoresis; Different variants ofpolyacrylamide gel electrophoresis (PAGE) like native, SDS-PAGE, 2D-PAGE, Blotting Techniques: Southern, Western and Northern blotting, Immunoblotting, Immunoelectrophoresis,Immunofluorescence, ELISA.	**12**
III	**Centrifugation:** Sedimentation, Analytical ultra-centrifugation, Preparative ultra-centrifugation: zonal and equilibrium density gradient ultracentrifugation. **Radioactivity:** Concept of radioactivity; Radioactivity counting methods with principles of different types of counters; Autoradiography; Applications of radioactive tracers in biology.	**12**
IV	**Microscopy:** Principles and applications of Simple, Compound and Phase contrast microscope, Fluorescence microscope, confocal microscope, Electron microscopy: SEM & TEM, Cryo-Electron microscopy	**12**
Total		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text Books:

1. Wilson, K., and Walker, J.*Principles and Techniques of Practical Biochemistry*, 5th edition, 2000.
2. Freifelder, D.,*Physical Biochemistry, application to Biochemistry and Molecular Biology*, 2nd edition, 1982.

Reference Books:

1. Holme,D.,and Peck, H.*Analytical Biochemistry*, 3rd edition, 1998,
2. Scope, R. K.*Protein Purification: Principles and Practice*, 3rd edition, 1993.

SYLLABUS (2nd SEMESTER)

Subject Name: Biophysical Chemistry	**Scheme of Evaluation: (T)**
Subject Code: BTC154C201	**Credit Units: 3-1-0-4**

Course Objective:

The course aims to give a holistic theoretical and practical knowledge in field of basics of Biophysical Chemistry, its role in the life form, and techniques to understand various Biophysical phenomena in living system.

Course Outcome:

After completion of the course, the students are expected to

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the practical skills associated with Biophyscical Chemistry.	**BT 1**
CO 2	**Understand** molecular events associated with protein chemistry and basic principles associated with various instruments and techniques.	**BT 2**
CO 3	**Apply** the knowledge gained during the course in the field of research and development.	**BT 3**
CO 4	**Analyse** theoretical knowledge in developing practical solutions in solving real life problems associated with biophysical chemistry.	**BT 4**
CO 5	**Evaluate** their understanding in expanding their future prospects by pursuing entrepreneurial ventures in this field.	**BT 5**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I	**Interaction in biological systems:** Intra and inter molecular forces, electrostatic interactions, hydrogen bonding, van der Waal interactions, hydrophobic interactions, disulfide bond. **Biophysics of Water:** Physicochemical properties of water, Molecular structure, Nature of hydrophobic interactions, Water Structure. **Bioenergetics:** Concept of energy coupling in biological processors, Energy requirements in cell metabolism, structure and role of mitochondria, high energy phosphate bond, energy currency of cell, Biological oxidation, Electron-transport chain, Oxidative Phosphorylation including chemiosmotic hypothesis.	**12**

II	**Protein Structure:** Conformational properties of polypeptide, Ramachandran plot. Primary and secondary structure of proteins; alpha helix, beta sheet and random coil Tertiary structure; concept of domain and fold, Quaternary structure; Oligomeric proteins and cooperativity, Metalloproteins, Structural features of membrane proteins, Intrinsically disordered proteins. **Protein purification techniques:** Gel filtration assay.	**12**
III	**Multiple equilibrium:** Titration of proteins to evaluate total and net charge; Scatchard and hill plots; Protein stability, denaturation, unfolding equilibrium; Kinetics and thermodynamics of protein folding; Protein refolding and aggregation; Effect of solvent and temperatures on the protein stability and folding, Heat Shock Proteins (Hsp) and their role in protein folding, scrapie proteins, Differential scanning calorimetry.	**12**
IV	**Methods for the structure analysis:** Far-UV and near UV-Circular Dichroism (CD); Fluorescence, single molecule fluorescence spectroscopy, fluorescent probes; Hydrogen-Deuterium (H-D) exchange; Fourier-transform Infrared (FT-IR) spectroscopy; Mass spectrometry (ESI and MALDI-TOF); Nuclear magnetic resonance (NMR) spectroscopy; X-ray crystallography.	**12**
Total		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text Books:

1. Nelson, D.L., Cox, M.M.*Lehninger Principles of Biochemistry*, 4th Edition, 2004, W. H. Freeman and Co., New York, USA

Reference Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. *Biochemistry*, 6th Edition, 2006, W.H. Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. *Biochemistry and Molecular Biology of Plants*, 2nd Edition, 2015, American Society of Plant Biologists, USA.

Subject Name: Cell Biology	**Scheme of Evaluation:(T)**
Subject Code: BTC154C202	**Credit Units: 3-1-0-4**

Course Objective: The course is designed with the following major objectives

The course aims to give a holistic theoretical and practical knowledge in field of general microbiology, its core concept, scopes, applications and future prospects.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Ability to**remember** how cellular components are used to generate and utilize energy in cells.	**BT 1**

CO 2	**Understand** the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles	**BT 2**
CO 3	**Apply** their knowledge of cell biology to selected examples of changes orlosses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.	**BT 3**
CO 4	**Analyse** the cell signalling and how it regulates cellular functions. Also how its disregulation leads to cancer and other diseases.	**BT 4**
CO 5	**Evaluate** the how cells grow, divide, and die and how these important processes are regulated.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Cell Structure and Methods in Cell Biology:** Cell: Difference between prokaryotes and eukaryotes, structural and functional organization of eukaryotes, difference between plant and animal cells, Cell wall and cell membrane,Cell motility, sub cellular organelle like Nucleus, Endoplasmic reticulum, Golgi, Mitochondria, Lysosomes; Fractionation of sub cellular organelles, Principles and applications of the microscopy, Cell counting.	**12**
II	**Bio-membrane structure and Function:**Plasma Membrane: organization and properties, Dynamics transport across membrane, Cell signaling: Types of receptors (Intracellular and cell surface), signal transduction by membrane bound, cytosolic and nuclear receptors via various pathways **Endo-membrane System and Cellular Motility:**General organization of protein transport within and outside the cell, Mechanisms of endocytosis and exocytosis, Protein sorting and secretion, Vesicular transport, Mechanism of intracellular digestion.	**12**
III	**Cell Dynamics:** Cell dynamics, cytoskeleton and cell surface, Microfilaments: Structural organization, cell motility and cell shape; Microtubule: Structural and functional organization, cilia, flagella, centriole; Intermediate filaments, Cell-cell interactions and cell matrix interaction **Cell Cycle & Cell Death:**Mitosis, Meiosis, Eukaryotic Cell cycle and its regulation, Apoptosis, Cancer biology - Mechanism of carcinogenesis, tumor suppressor genes and oncogene.	**12**
IV	**Cell Differentiation:**Cell differentiation, hormones and growth factors; Stem cell differentiation, Blood cell formation, Fibroblast and their differentiation, Mating cell type in yeast, Surface antigen changesin Trypanosomes.	**12**
Total		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text Books:

1. Gupta P.K., Genetics, ISBN-10 8171339328, ISBN-13 978-8171339328, Rastogi Publications, Meerut.
2. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R. *Molecular Biology of the Gene*, 6th edition, 2008. Cold Spring Harbour Lab. Press, Pearson Pub.
3. De Robertis, E.D.P. and De Robertis, E.M.F. *Cell and Molecular Biology*, 8th edition, 2006, Lippincott Williams and Wilkins, Philadelphia.

Reference Books:

1. Karp, G..*Cell and Molecular Biology: Concepts and Experiments*, 6th edition, 2010. John Wiley & Sons. Inc.
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P., *The World of the Cell*, 7th edition, 2009, Pearson Benjamin Cummings Publishing, San Francisco.

Subject Name: Molecular Biology	**Scheme of Evaluation: (T)**
Subject Code: BTC154C203	**Credit Units: 3-1-0-4**

Course Objective: The course is designed to understand the organization of the prokaryotic/eukaryotic eukaryotic genome and the various molecular processes taking place in the living system

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various molecular events associated with the growth and development of the cell.	**BT 1**
CO 2	**Understand** how replication, transcription and translation processes occur within the living cell.	**BT 2**
CO 3	**Apply** the knowledge gained during the course in the field of research and development.	**BT 3**
CO 4	**Analyse** the effetcs of various factors on molecular events including replication, transcription and translation.	**BT 4**
CO 5	**Evaluate** the knowledge to design experiments to manipulate cellular and molecular processes.	**BT 5**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I	**Genes and Chromosomes:** Organization of bacterial genome; DNA structure, Structure of eukaryotic chromosomes; Complexity of genome and its reassociation kinetics (Cot curve analysis); Clusters and repeats; Chromatin: Heterochromatin and Euchromatin; Nucleosome structure and its phasing: DNasesensitivity, DNA methylation and imprinting, Human genome project and its importance, Structural genomics, Sequence components, Satellite, microsattelite and minisatellite chromosome.	**12**
II	**Replication in prokaryotes & eukaryotes:** Initiation and its regulation, elongation and termination in prokaryotes and eukaryotes;Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA. **Repair:** Gene stability and Replication error repair, DNA repair enzymes: Photoreactivation, Nucleotide and base excision repair, Mismatch repair and SOS repair.	**12**

III	**Prokaryotic & Eukaryotic Transcription:** Promoters, Initiation, Elongation and Termination steps of prokaryotic transcription and its comparison with eukaryotic transcription. Enhancers, Transcription factors: TATA binding proteins (TBP) and TBP associated factors (TAF), Activators and repressors; Processing of primary transcripts; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; **Translation & Transport:** Translation machinery; Ribosomes; Steps of translation and its mechanism in prokaryotes and eukaryotes: Initiation, elongation and termination; Genetic codon and its properties; Co- and post translational modifications; Protein trafficking.	**12**
IV	**Regulation of gene expression:** Prokaryotic gene expression with reference to inducible and repressible operons, Concept of eukaryotic gene regulation, Chromatin remodelling, Epigenetics: Chromatin marking system; Regulatory RNA: Basic concepts of miRNA, siRNA and RNAi.	**12**
Total		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text Books:

1. Watson, J. D., Baker, T. A., Bell, S. T.,Gann,A.*Molecular Biology of the Gene*, Pearsons Education, 7th edition, ISBN 978-81-7758-181-2
2. Berk, A., Zipursky, S. L., Matsudaira, P.T., Baltimore, D., Darnell, J.,Lodhish,H. F.*Molecular Cell Biology*, W.H.Freeman& Co Ltd (Latest Edition), ISBN-10: 0716731363, ISBN-13: 978-0716731368

Reference Books:

1. Karp, G. *Cell and Molecular Biology: Concepts and Experiments*, 6th edition, 2010. John Wiley & Sons. Inc.
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. *The World of the Cell*, 7th edition, 2009, Pearson Benjamin Cummings Publishing, San Francisco.

Subject Name: Practical II	**Scheme of Evaluation: (P)**
Subject Code: BTC154C214	**Credit Units: 0-0-8-4**

Course Objective:

The course is designed with an objective to give the students a wholesome practical knowledge on Bio-instrumentation associated with Biophysical Chemistry, Molecular Biology and Cell Biology.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the practical skills associated with essential instrumentation and techniques, Molecular Biology and Cell Biology.	**BT 1**
CO 2	**Understand** the characterization and quantification of various biomolecules.	**BT 2**

CO 3	**Apply** the knowledge gained during the course in the field of research and development	**BT 3**
CO 4	**Analyse** theoretical knowledge in developing practical solutions in solving real life problems associated with microbiology.	**BT 4**
CO 5	**Evaluate** their understanding in expanding their future prospects by pursuing entrepreneurial ventures in this field.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	1. Microscopy: a) simple, b) compound c) phase contrast microscopes. 2. Study of mitosis and meiosis in dividing cells 3. WBC profiling by Giemsa stain	**24**
II	1. Identification of Barr body 2. Isolation of Mitochondria	**24**
III	1. Isolation of genomic DNA from plants/bacteria/animal cell. 2. Quantification and purity determination of isolated genomic DNA by UV-spectrophotometry and agarose gel electrophoresis. 3. Extraction of RNA	**24**
IV	1. Isolation of plasmid DNA by alkaline lysis and phenol method. 2. Restriction digestion of DNA 3. Polymerase chain reaction of genetic DNA	**24**
Total		**64**
Pedagogy: Lectures, Experiments, Laboratory sessions		

Texts: As prescribed under theory papers

Subject Name: DSE – 2 (Genomics and Proteomics)	**Scheme of Evaluation:(T)**
Subject Code: BTC154D201	**Credit Units: 3-1-0-4**

Course objectives: The course is designed to appraise the students to the vital concepts of technologies pertinent to Genomics and Proteomics, their applications and demonstrate skills to apply the knowledge in scientific queries.

Course outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various techniques involved in the study of genomics and proteomics.	**BT 1**

CO 2	**Understand** the basic principle of all the techniques associated with genomics and proteomics study.	**BT 2**
CO 3	**Apply** the knowledge in the study of genomics and proteomics of a cell under specific conditions.	**BT 3**
CO 4	**Analyse** the effect of various intrinsic and extrinsic factors in the genome and proteome of a cell under certain conditions	**BT 4**
CO 5	**Evaluate** better and alternative methods to analyse the sample in cost effective manner.	**BT 5**

Detailed syllabus:

Modules	Topics / Course content	Periods
I	**Genomics:** DNA markers - SNP; STR; QTLs, RFLP; RAPD, cDNA and genomic librariesPhysical mapping of DNA by building genomic libraries, Clone contigs, YAC, BAC and PAC, Functional Genomics, DNA microarray, Functonal analysis by gene knockouts	**12**
II	**PCR and Its Applications:** Primer design; Fidelity of thermostable enzymes; DNA polymerases, Types of PCR - multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; Basic concepts of genome sequencing, Next generation sequencing strategies, brief study about 3rd and 4th generation of sequencing	**12**
III	**Basics of proteomics:** Protein folding and modification, Types of proteomics,Protein sequencing, Protein structure determinations and Structural proteomics, Proteomic interactions (Y2H approaches, Co-IP); Concepts of protein engineering.	**12**
IV	**Proteomic technologies:**Microarray technology; Analytical proteomics tools (1-D & 2-D gel electrophoresis); Chromatography, in gel digestion, Mass spectrometry and analysis (ESI, MALDI), LC/MS-MS; Peptide mass fingerprinting.	**12**
Total		**48**

Text Books:

1. Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Campbell AM & Heyer LJ, Benjamin Cummings 2007; CSH Press, NY. ISBN-10: 8131715590
2. Principles of Proteomics. R.M Twyman (2004) (BIOS Scientific publishers). ISBN-10: 1859962734
3. Genome III – T.A. Brown Garland Science Publ. June 08, 2006. ISBN-10: 0815341385

Reference Books:

1. Principles of Gene Manipulation and Genomics- Primrose S & Twyman R, 7th Edition, Blackwell, 2006. ISBN-10: 1405135441
2. Principles of Genome Analysis and Genomics. Primrose SB & Twyman RM. 2007. Blackwell. ISBN-10: 1405101202
3. Introduction to Genomics. A.M Lesk, Oxford University press, 2007. ISBN-10: 0199557489
4. A Primer of Genome Science. Greg Gibson and Spencer V. Muse. 2nd ed. 2004. SINAUER Associates Inc. ISBN-10: 0878932364

SYLLABUS (3rdSEMESTER)

Subject Name: Animal Biotechnology **Scheme of Evaluation: (T)**

Subject Code: BTC154C301 **Credit Units: 2-1-0-3**

Course Objective:

The course is designed to appraise the students to the vital concepts in animal cell culture, animal genomics and transgenic animals and their process of characterization of animal genomes.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the principles, practices, and application of animal biotechnology in Tissue Engineering, Vaccines and biopharmaceuticals.	**BT 1**
CO 2	**Understand** the principles of animal culture and media preparation.	**BT 2**
CO 3	**Apply** the animal tissue culture techniques and animal products, production & improvement of them	**BT 3**
CO 4	**Analyse** the cell and molecular techniques to in vitro situations.	**BT 4**
CO 5	**Evaluate** the importance of engineering animal cells to produce therapeutic proteins	**BT 5**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I	***Animal Cell Culture****:* History of animal cell culture; Basic requirement for animal cell culture; Cell culture media and reagents; Animal cell; Tissue and organ cultures; Primary culture and establishedcell lines;Basic technique of mammalian cell culture, cell synchronization, Scaling of animal cell culture, Transfection and transformation of cells, Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity for environmental pollutants in cell culture; Stem cells and their application, in-vitro fertilization; culture of embryos; cryopreservation of embryos; embryo transfer; embryo splitting	**9**
II	**Animal health Biotechnology:** History of development of vaccines; Introduction to the concept of vaccines; Conventional methods and Recombinant approaches to vaccine production; Hybridoma technology; Application of cell culture technology in vaccine production and pharmaceutical proteins. Introduction of DNA fingerprinting. Scope and application of DNA forensics: animal species identification; identificationof adulteration of meat by DNA based techniques.	**9**

III	**Animal genomics:** Different methods of characterization of animal genomes; SNP; STR; RFLP; Proteomics; Metabolomics; Genetic basis for disease resistance; gene knock out technology and animal models for human genetic disorders,;Targetted gene replacement, gene therapy.	**9**
IV	Reproductive Biotechnology: History, importance of assisted reproductive biotechnology in animals, introduction to embryo biotechnology, endocrine therapeutics, Biotechnological approaches to reproduction. Semen sexing, sperm encapsulation, seminal biomarkers, ovum pickup.	**9**
Total		**36**
Pedagogy: Lectures, Assignments, Seminars		

Text books:

1. Animal cell biotechnology Portner, 2nd edition, Humana Press,2007.
2. Pinkert, Transgenic animal technology, Academic Press,2006.

Reference books:

1. Gordon, Reproductive technologies in farm animals, CAB Intl,2005.
2. Ed. John R.W. Masters, Animal cell culture- Practical approach, 3rd edition, Oxford University Press, 2000.

Subject Name: Plant Biotechnology	**Scheme of Evaluation: (T)**
Subject Code: BTC154C302	**Credit Units: 2-1-0-3**

Course Objective:

The course is designed to understand the various processes involved in plants tissue culture and how the techniques learnt can help in the creation of new transgenics.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** about tissue culture, callus culture, suspension cell culture of plant tissues.	**BT 1**
CO 2	**Understand** the processes of creation of tissue cultured plants.	**BT 2**
CO 3	**Apply** the knowledge of plant tissue culture in conservation.	**BT 3**
CO 4	**Analyze** the theoretical knowledge in the generation of new plants.	**BT 4**
CO 5	**Evaluate** the knowledge gained in compiling the same for proposing solutions to plant diseases.	**BT 5**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**

I	**Plant tissue and cell cultures**; callus, meristem culture etc, secondary metabolites in plant tissue cultures; protoplast culture and somatic hybridization; haploid plants and somaclonal variation.	**9**
II	**Methods for Plant Conservation**, Germplasm conservation- *in situ, ex situ* conservation and in vitro conservation; cryopreservation- techniques, storage, thawing, re-culture and plant regeneration; cold storage, low pressure and low oxygen storage and applications of germplasm storage. **Genetic engineering of crop plants**; Agrobacterium-mediated gene transfer, direct gene transfer to protoplasts; Biolistic gene transfer, alternative approaches of gene transfer - microinjection, micro- targeting and electroporation.	**9**
III	**Plant gene expression signal and genetic markers** - constitutive promoters, tissue specific and inducible promoters, expression vectors, selectable marker genes and reporter genes.Plant genome organization, Organization and expression of chloroplast genome and mitochondrial genome.	**9**
IV	**Transgenic crop plants** - Review of transgenic plants (Bt-cotton and other Bt-plants, Golden rice etc), development of pathogen resistant cultivars using resistant lines. **Metabolite production** - Production of secondary metabolites, culture conditions, elicitations, immobilization of cells, hairy root culture, biotransformation, permeabilization of cells, removal of secreted products. **Bioreactor**s- Stirred tank, Bubble column, Air lift, Rotating drum and immobilized plant cell reactor.	**9**
Total		**36**
Pedagogy: Lectures, Assignments, Seminars		

Text books

1. Satyanarayana,U.Biotechnology (Books and Allied (P) Ltd.2005).
2. Slater, A., Scott, N. W., Fowler, M. R Plant Biotechnology: The Genetic Manipulation of Plants (Oxford University Press, USA; 2ND edition, 2008).

Reference Books

1. Adrian, S. Plant Biotechnology: The Genetic Manipulation Of Plants (Oxford University Press,2008)
2. Bohnert, H. J. et al Bioengineering and Molecular Biology of Plant Pathways, Volume 1 (Elsevier, USA,2008)
3. Davey,M.R. Plant Cell Culture: Essential Methods (Wiley-Blackwell Publishing, 2010)

Subject Name: Practical III	**Scheme of Evaluation: (P)**
Subject Code: BTC154C313	**Credit Units: 0-0-4-2**

Course Objective:

The course is designed with an objective to give the students a wholesome practical knowledge on Bioprocess Technology, plant tissue culture, and the basics of animal cell culture.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the practical skills associated with essential instrumentation and techniques involved in fermentation, plant and animal tissue culture.	**BT 1**

CO 2	**Understand** the basic principles involved in the production of various fermented products.	**BT 2**
CO 3	**Apply** the knowledge gained during the course in the field of research and development.	**BT 3**
CO 4	**Analyse** theoretical knowledge in developing practical solutions in solving real life problems associated with microbiology.	**BT 4**
CO 5	**Evaluate** their understanding in expanding their future prospects by pursuing entrepreneurial ventures in this field.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	1. Preparation of media for plant tissue culture. 2. Micropropagation using apical/nodal explants. 3. Callus culture using apical meristem, embryo/cotyledon.	**12**
II	1. Establishment of suspension culture. 2. Assessment of plant polyphenol content using biochemical assay 3. Isolation of protoplasts.	**12**
III	1. Study of equipment's and materials for animal cell culture. 2. Demonstration of the process and techniques of animal cell culture. 3. Study on the laboratory setup for animal cell culture and animal house.	**12**
IV	1. Preparation of wine from fruit juice. 2. Preparation of synthetic seeds. 3. Production of edible mushrooms. 4. MBRT test for quality assessment of milk.	**12**
Total		**48**
Pedagogy: Lectures, Experiments, Laboratory sessions		

- Texts: As suggested under the theory papers.

Subject Name: DSE – 3 (Environmental Biotechnology) **Scheme of Evaluation:(T)**

Subject Code: BTC154D301 Credit Units:3-1-0-4

Course Objective:

This course is offered with the objective of familiarizing students with the current and pertinent environmental issues and possible approaches to mitigate them.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** and identify area and time-specific environmental issues.	**BT 1**

CO 2	**Understand** the significance of environmental problems persisting in a place.	**BT 2**
CO 3	**Apply** the knowledge to relate cause and effect of major issues pertaining to the environment.	**BT 3**
CO 4	**Analyse** the scientific basis of the negative effects of pollutants on the environment.	**BT 4**
CO 5	**Evaluate** a detailed information system, starting from cause, effect, and solution to better prepare oneself to mitigate environmental concerns.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Environmental Pollution:**Concept of Environmental Pollution; Origin of pollution; Classification and nature of Environmental Pollutants; Major sources; Impacts of Environmental Pollution at local regional and global level.	**12**
II	**Air pollution:** Concept of air Pollution; Major air pollutants and their sources; Meteorological aspects of air pollution; Oxides of nitrogen and sulphur; Particulate matter; Air pollution standards; Indoor and outdoor air pollution; Air pollution episodes and disasters; Effects of air pollution on human health, animals, plants, material and climate; Formation of fog and photochemical smog and acid rain; Monitoring of air pollution; Control on release of smoke.	**12**
III	**Soil Pollution:** Concept of soil pollution; Causes of soil salinity; Different causes of soil degradation; Chemical and metallic pollution of agricultural soil; Mining and soil pollution; Control of soil pollution. **Solid Waste:** Concept of solid waste; Industrial solid waste; Domestic solid waste; Agricultural solid waste; Municipal solid waste; Major sources of solid wastes; Effects of solid waste generation on quality of air, water and public health; Technical approach for solid waste management; Disposal of organic and medical waste; Recovery and recycling of metallic waste; Disposal of plastic waste and hazardous wastes.	**12**
IV	**Environmental Quality Assessment and Monitoring:** What is environmental quality? Quality of environment for life on earth and man; Deterioration of environmental quality with reference to anthropogenic impact; Methods of assessment of environmental quality; Short term studies/surveys; Rapid assessment; Continuous short and long term monitoring **Environmental Impact Assessment (EIA):**Need of EIA; Scope and objectives; Types of environmental impacts; Steps involved in conducting the EIA Studies; Environmental Impact Assessment techniques; Merits and Demerits of EIA studies.	**12**
Total		**48**

Text Books:

1. Wang, L. et al. (2010). Environmental Biotechnology, Humana Press. (available at UTS Library, either in hard copy or electronic version)
2. Wang, L. et al. (2010). Environmental Engineering, Humana Press. (available at UTS Library, either in hard copy or electronic version)

Reference Books:

1. Vallero, D. A. (2010). Environmental Biotechnology: A Biosystems Approach, Elsevier. (available at UTS Library)
2. Evans, G. M. and Furlong, J. C. (2011). Environmental Biotechnology: Theory and Application, Wiley-Blackwell. (available at UTS Library)
3. Jördening, H. J. and Winter, J. (2005). Environmental Biotechnology: Concepts and Applications, Wiley-VCH. (available at UTS Library E-book)

Subject Name: DSE – 4 (Bioprocess Technology)	**Scheme of Evaluation: (T)**
Subject Code: BTC154D302	**Credit Units: 3-1-0-4**

Course Objectives:

The course aims to give a holistic theoretical and practical knowledge in field of general microbiology, its core concept, scopes, applications and future prospects.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the core concept of modern biotechnology and its application in food, pharma- and petroleum industries.	**BT 1**
CO 2	**Understand** the production procedure of alcoholic beverages, antibiotics and drugs.	**BT 2**
CO 3	**Apply** the knowledge gained during the course in the field of research and development.	**BT 3**
CO 4	**Analyse** theoretical knowledge in developing practical solutions in solving real life problems associated with microbiology.	**BT 4**
CO 5	**Evaluate** their understanding in expanding their future prospects by pursuing entrepreneurial ventures in this field.	**BT 5**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**

I	Basic principle of Biochemical engineering: Isolation screening and maintenance of industrially important microbes, microbial growth and death kinetics (particularly with reference to industrially useful microorganisms), strain improvement for increased yield and other desirable characteristics	**12**
II	Detailed study of the design and operation of different types of fermenters, Mode of fermentation processes: Bioreactor designs, types of fermentations and fermenters: Upstream processing: scale up and scale down process. Fermentation process kinetics: Reaction kinetics: effect of temperature on reaction rate, activated complexes, catalysed reactions, thermal death of micro-organisms, enzyme inhibition, Fermentation kinetics: advantages and limitations, Downstream processing: Bioseparation: drying, crystallization, storage and packaging, treatment of effluent and its disposal	**12**
III	Applications of enzymes in food processing: enzymatic bioconversions e.g. starch and sugar conversion processes, High-Fructose Corn Syrup, and their downstream processing, backing by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing, cheese making by proteases. Application of microbes in food process operations and production: Fermented foods microbes and their use in pickling, producting colours and flavours, and process of wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins: production and applications.	**12**
IV	Biodegradation of xenobiotic compounds and toxic wastes, removal of spilled oil & grease deposits, Biosurfactants, Bioremediation of soil & water, solid waste & waste water treatment, use of microorganism for the production of energy: Biogas (production of methane and hydrogen), fuel alcohol production & hydrocarbon production	**12**
Total		**48**

Text Books:

1. Fermentation and Biochemical Engineering Handbook, Principles, Process Design, and Equipment; Edited by Henry C. Vogel; Noyes Publications, New Jersey, U.S.A. ISBN: 0-8 155-1407-7.
2. Biotechnology- Volume 3- Bioprocessing; VCH VerlagsgesellschaftmbH. Weinheim, ISBN 3-527-28313-7 (Weinheim); ISBN 1-56081-153-6 (New York).

Reference Books:

1. Principles of Fermentation Technology, P. E. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heinemann, ISBN: 07506 45016.
2. Practical Fermentation Technology, B. Mcneil and L. M. Harvey, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, ISBN 978-0470-014349

Subject Name: DSE – 5 (Bioinformatics and Biostatistics)	**Scheme of Evaluation:(T)**
Subject Code: BTC154D303	**Credit Units:3-1-0-4**

Course Objectives: The course aims to give a holistic theoretical and practical knowledge in field of bioinformatics and biostatistics to understand the various cellular activities.

Course outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various softwares and biological databases and their application in the analysis of various biological experiments.	**BT 1**
CO 2	**Understand** the various softwares and their use in the analysis of various biological results.	**BT 2**
CO 3	**Apply** the knowledge to analyse the results of biological experiments statistically using various computational tools	**BT 3**
CO 4	**Analyse** the various biological events and their probable outcome using computationaltools .	**BT 4**
CO 5	**Evaluate** various databases and softwares for the experiments/ analysis of the results of biological experiments.	**BT 5**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I	**Basics of bioinformatics:** Definition, Scope and Goal, Application in Computational Biology, Limitations; **Biological Database:** Types of database, biological database: GenBank, EMBL, DDBJ, Uniprot-KB: SWISS-PROT, PDB, AceDBs, literature databasesPubMed; Webtools: ExPASy server **Sequence Analysis and Sequence Alignment:**Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues, Basic concepts of sequence alignment, Uses of Sequence Alignment, Pairwise, multiple, Database Similarity search, **Scoring matrices:** Basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, matrix derivation methods and principles **Sequence similarity search:** BLAST and FASTA	**12**
II	**Molecular Phylogenetics:**Basic concepts, Methods in evaluation of phylogeny and steps in constructing alignments and phylogenetic Trees, Types of phylogenetic tree. **Structural bioinformatics:** proteins and its structure, Determination of protein 3Dstructure, Protein structure visualization, comparision, Secondary and tertiary structure prediction,	**12**

	Chemiinformatics and Computer Aided Drug Designing (CADD): Introduction to cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Basics of medicinal chemistry. Prodrugs and soft drugs, Drug targets, Drug solubility, Natural resources of lead compounds, Pharmacokinetics & drug metabolism.	
III	**Statistical tools:** Measures of central tendencies and dispersion, concept of probability and theoretical distributions (Binomial, Poisson and normal distribution), Correlation and Regression; Univariate and multivariate multiple regression. Random numbers, samplingmethods, random plot design. Basics of testing of hypothesis. Analysis of variance (one way and two way), Students t test, Chi-square test, F-test and Z-test.	**12**
IV	**Statistical Science and biological assays:** Importance, nature and planning of bioassays;Direct and indirect bioassays; Design of experiments by Analysis of variance and Dose-response analysis. **Analysis of biochemical data:** Application of multiple regressions in epidemiologic and clinical data; Study of association between disease and risk factors. Application of odds ratio, Logistic regression with dichotomous response variable.	**12**
Total		**48**

Text Books:

1. Zar, J. H. 2000. Biostatistical Analysis. Pearson Education, India.
2. Kothari, C. R. Research Methodology: methods and techniques. New Age International Publishers, India.

Reference Books:

1. Quinn, G. P. & Keough, M. J. 2002. Experimental design and data analysis for biologists. CambridgeUniversityPress, UK.
2. Gould. 2002. BioStats Basics. W H Freeman & Co, USA.

SYLLABUS (4thSEMESTER)	
Subject Name: Immunology	**Scheme of Evaluation: (T)**
Subject Code: BTC154C401	**Credit Units: 2-1-0-3**

Course Objective:

The course aims to give detailed concept in the core areas of immunology and understand the various forms of immunity and also the diseases associated with immune disorders.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic forms of immune system present in the body.	**BT 1**
CO 2	**Understand** the mechanism of the immune system.	**BT 2**
CO 3	**Apply** the knowledge learnt in relating the same to the defence of the body during diseases.	**BT 3**
CO 4	**Analyse** the importance of the various molecules that play an important role in immune function.	**BT 4**
CO 5	**Evaluate** the various diseases that occurs in the system to the forms of immune disorders.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Immunology- fundamental concepts and anatomy of the immune system:** Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue (MALT&CALT); Mucosal Immunity; Antigens - immunogens,haptens.	**9**
II	**Immune responses generated by B and T lymphocytes:** Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily;Antibody diversity, somatic hypermutation and class switching; Basis of self– and non-selfdiscrimination; MHC antigens and their role inimmune respnses, Kinetics of immune response, memory; B cell maturation, activation and differentiation; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation-	**9**

	endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell- cell co-operation, Hapten-carrier system.	
III	**Antigen – Antibody Interactions:** Precipitation, Agglutination; Advanced immunological techniques- RIA, ELISA, Western blotting, ELISPOT assay and Immunoflourescence. Complementsystem and complement fixation test. **Clinical Immunology:**Immunity to Infection:Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases.	**9**
IV	**Transplantation and tumor immunology:**Transplantation– Immunological basis of graft rejection; Tumor immunology – Tumor antigens; Immune response to tumors and immune evasion by the tumor, Immunodeficiency-Primary and acquired immunodeficiency.Vaccines: History, development, types and process of preparation and delivery	**9**
Total		**36**
Pedagogy: Lectures, Assignments, Seminars		

Text books:

1. Kuby,J.,Thomas,J.K., Barbara,A.O.Immunology,6thEdition, W. H. Freeman,2002.
2. Janeway et al., Immunobiology, 4th Edition, Current Biology publications.,1999.

Reference books:

1. Brostoff, J., Seaddin, J.K., Male,D., Roitt, I.M., Clinical Immunology, 6thEdition, Gower Medical Publishing,2002.
2. Paul, R., Fundamental of Immunology, 4thedition, Lippencott,1999.
3. Goding, Monoclonal antibodies, Academic Press.1985.

Subject Name: Genetic Engineering	**Scheme of Evaluation: (P)**
Subject Code: BTC154C402	**Credit Units: 2-1-0-3**

Course Objective:

The course aims to give in depth knowledge in field of genes and genetic engineering, the mechanism of creation of recombinant products and the role of instrumentation and sequencing process in genetic engineering.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the core concept of Genetic Engineering, DNA modifying enzymes and cloning vectors *etc*.	**BT 1**
CO 2	**Understand** the production procedure of recombinant products by molecular cloning.	**BT 2**
CO 3	**Apply** the knowledge gained during the course in the field of research and development.	**BT 3**
CO 4	**Analyse** theoretical knowledge in developing biotechnological solutions in solving various problems.	**BT 4**
CO 5	**Evaluate** their understanding in expanding their future prospects by pursuing entrepreneurial ventures in this field.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Basics Concepts:** DNA modifying enzymes; Cohesive and blunt end ligation; Linkers; Adaptors Homopolymerictailing; Labelling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseIfootprinting;	**9**
II	**Cloning Vectors:** Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo& retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors.	**9**
III	**Cloning Methodologies:** Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression	**9**
IV	**Application and study of gene regulation:** DNA transfection, reporter assay, expression strategies for heterologus genes in bacteria, mammalian cells and plants. Targeted gene replacement. **PCR and Its Applications**: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR.	**9**

	Sequencing methods: Enzymatic DNA sequencing; Chemical sequencing of DNA; highthroughputDNA sequencing.	
Total		**36**
Pedagogy: Lectures, Assignments, Seminars		

Text books

1. Primrose, S.B., Twyman, R.M., and Old, R.W. *Principles of Gene Manipulation*. 6th Edition, S.B. University Press, 2001.
2. Brown, T.A., Genomes 3, 3rd ed. Garland Science, 2006.

Reference books

1. Sambrook,J.,and Russel,D.W., Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
2. Selected papers from scientificjournals.
3. Technical Literature from Stratagene, Promega, Novagen, New England Biolabetc.

Subject Name: Practical IV	**Scheme of Evaluation: (P)**
Subject Code: BTC154C413	**Credit Units: 0-0-4-2**

Course Objective:

The course is designed with an objective to give the students a wholesome practical knowledge on Genetic Engineering, Immunology, and Industrial Microbiology.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the practical skills associated with Genetic Engineering and Immunology.	**BT 1**
CO 2	**Understand** the characterization and quantification of DNA from various sources.	**BT 2**
CO 3	**Apply** the knowledge gained during the course in the field of research and development.	**BT 3**
CO 4	**Analyse** theoretical knowledge in developing and optimizing protocols for various experiments.	**BT 4**
CO 5	**Evaluate** their understanding in expanding their future prospects by pursuing entrepreneurial ventures in this field.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	1. Blood film preparation, staining and identification of blood cells. 2. Preparation of antigen. 3. Immunizationof mice, serum collection and preservation. 4. Purification of IgG from serum.	**12**
II	1. SGOT – PT test; agglutination. 2. Immuno-electrophoresis, Immuno-peroxidase test; Immuno-fluorescence test, ELISA. 3. Isolation of lymphoid cells (mouse) from spleen. 4. Separation of mononuclear cells.	**12**
III	1. Isolation and purification of genomic DNA from plants, animals and bacterial sources. 2. Isolation and purification of bacterial plasmids. 3. Spectrophotometric qualitative assessment of DNA. 4. Agarose gel electrophoresis of DNA.	**12**
IV	1. PCR Amplification of DNA. 2. Construction of restriction map. 3. Cloning of DNA fragments in plasmid vector (Kit Based)	**12**
Total		**48**
Pedagogy: Lectures, Experiments, Laboratory sessions		

- Texts: As suggested under the theory papers.

Subject: DSE-6 (IPR, Biosafety, Bioethics and Research Methodology) Scheme of Evaluation: (T)

Subject Code: BTC154D401 Credit Units: 3-1-0-4

Course Objectives:

This subject aims to introduce students to Intellectual Property Rights and apprise them of ethical issues in the biological sciences and the laws pertaining to these in both the global and national context and also to aware the students with ethical practices appropriate for various scientific disciplines at all times and to adopt safe working practices relevant to the different biotech industries & fields of research.

Course outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** intellectual property laws/principles (including copyright, patents, designs and trademarks) to real problems and to analyse the social	**BT 1**
CO 2	**Understand**, recognize and distinguish an ethical issues from other issues	**BT 2**

CO 3	**Apply** the knowledge gained during the course in spreading IPR related awareness.	**BT 3**
CO 4	**Analyse** experimental results for their potential to file suitable IPR.	**BT 4**
CO 5	**Evaluate** their understanding in expanding their future prospects by pursuing entrepreneurial ventures in this field.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Concept of Property:** Tangible and Intangible Property, Intellectual Property-Origin Development and Objectives, Classification of Intellectual Property-Patents, Copyright, Trademark, Industrial Design, Geographical Indications, Protection of Plant Varieties and Traditional Knowledge, Relevance of Intellectual Property Rights for Science and Technology; Patentability Criterion-Discovery and Invention, Patentable Subject Matters; Novelty, Utility (Industrial Applicability), Non-Obviousness (Inventive Step) and Written Description, Product Patents vis-à-vis Process Patents; Patentability of Biotechnology Inventions; Patent Laws in Indian and International Perspective; Indian Patent Act 1970 (Patent Amendment Acts-1999, 2002 and 2005); International Conventions relating to Intellectual Property; General Agreement on Trade and Tariff (GATT); Trade Related Aspects of Intellectual Property Rights (TRIPS)	**12**
II	**Biosafety:** Definition and requirement; Important symbols and their meaning, Biosafety in relation to human health, environment, transgenic research and applications; International Legal Instruments on Biosafety Cartagena Protocol on Biosafety, Nagoya Protocol Laws relating to Biosafety in India: The Biological Diversity Act, 2002, Biosafety procedures, rules and guidelines under Environment (Protection) Act 1986 and Rules 1989; Biosafety Regulation: Principles and Practices in Microbial and Biomedical Labs; Guidelines for research involving genes; Regulatory bodies at National and International level	**12**
III	Nature, Concept and Relevance of Bioethics; Basic Principles of Bioethics; Legal, Social and Economic Impacts of the Products and Techniques in Biotechnology; Bioethics in Plants, Animals and Microbial Genetic Engineering; Ethical issues in Healthcare; Biopiracy and Bioethics: Application of IPR regime to Biological Resources and Biopiracy, Access to Biological Resources, Benefit Sharing and Informed Consent	**12**

IV	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations. Effective literature study approaches, analysis Plagiarism, Research ethics. Effective technical writing, how to write report, Developing a Research Proposal, Format of research proposal, presentation and assessment by a review committee.	**12**
Total		**48**

Text books:

1. Cornish, W. R., Intellectual Property (Latest Edition)
2. Intellectual Property Rights by Paul Goldstein
3. Intellectual Property Rights by K. R. G. Nair, Ashok Kumar, K. R. G. Nair
4. Kilner, John, et.al, eds., Cutting-Edge Bioethics. Eerdmans 2002.

Reference Books:

1. B.L. Wadera, Patents, Trademarks, Copyright, Designs and Geographical Indications
2. S. Ignacimuthu, Bioethics, Alpha Science International, Limited (2009)
3. Matthew Rimmer, Intellectual Property and Biotechnology: Biological Inventions (2008)
4. Arthur L. Caplan, Robert Arp, Contemporary Issues in Bioethics (2014)

CourseObjectives:

The objective of the course is to gatherinformationabouttherichheritageofmedicinalplantspresentintheregion and to gain knowledge onhowtoconservemedicinalplantsandpreservethem and learn the ways of application of the medicinal plants

CourseOutcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various types of plants used in traditional folk medicines and in the pharma industry.	**BT 1**
CO 2	**Understand** theprocess of isolation of natural products	**BT 2**
CO 3	**Apply**the knowledge in quality checking of natural products and in generation of entrepreneural avenues	**BT 3**

CO 4	**Analyse**the process of conservation of medicinal plants and try to propagate and preserve them.	**BT 4**
CO 5	**Evaluate** the importance of medicinal plants in preparation of various products for the cosmetics, pharmaceutical and food industry	**BT 5**

DetailedSyllabus:

Modules	Topics/Coursecontent	Periods
I	Introduction to Medicinal and Aromatic plants: MAPs: definition, history, importance and future prospects. Medicinal Plants – past and present status in world and India. MAPs as industrial crops - constraints and remedial measures.	**12**
II	Medicinal plant conservation – issues and approaches. Medicinal plant conservation areas (MPCA), Non-timber forest products (NTFP), Good Agriculture Practices (GAP). Indian Himalayan region (IHR). Laws governing conservationofplants. NationalandInternationalorganizationsresponsiblefor conservation of plants.	**12**
III	Introduction, definition, factors influencing the choice of extraction, principles of extraction methods, types of extraction and their merits and demerits. Selection and Purification of Solvents for Extraction. Methods of isolation, purification and characterization of natural products	**12**
IV	Important aromatic plants of India: systematics, geographical distribution and uses. Aromatic and cosmetic products. Raw material for perfumes etc. Cosmetic Industries. Major, minor and less known aromatic plants of India. Taxonomic descriptionsandusesofimportantaromaticplants –citronella,davana,damask rose, geranium, khus grass, large cardamom, lavender, lemon grass, mentha, holybasil,patchouli,rosemaryPalmarosa,vetiver,artemisia,eucalyptus,thyme, marjoram and oreganum. Aromatic spices - clove, cinnamon, nutmeg, ajwain, dill, celery, tamarind, garcinia, curryleaf and saffron.	**12**
Total		**48**

TextBooks:

1. HarboneJ.B.PhytochemicalMethods,3rdEdition-1998ChampanandHallLondon

Reference Books:

1. Tyler,Brady,Robberts-Pharmacognosy,8thEdition-1981,K.M.VargheseCompany, Mumbai
1. PeterB.Kaufman,NaturalProductsfromPlants,CRCPress,NewYork,Latestedition.

Subject Name: DSE-8 (Industrial Microbiology)	Scheme of Evaluation: (T)
Subject Code: BTC154D403	Credit Units: 3-1-0-4

Course Objectives:

The course is designed to provide knowledge in the field of industrially important microorganisms, their isolation and culture and development of new strains.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the utility of different industrial approaches to improvise microbial production.	**BT 1**
CO 2	**Understand** the principles of the various techniques used in food processing and fermentation technology.	**BT 2**
CO 3	**Apply** modern biotechnology in the food and pharma industries, for example, in the production of alcoholic beverages, antibiotics and other drugs.	**BT 3**
CO 4	**Analyse** experimental data generated using different processes.	**BT 4**
CO 5	Evaluate the design of fermenters and bioreactors to improve industrial production processes currently in use.	**BT 5**

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Concepts of Microbiology:** History of Microbiology, biogenesis versus abiogenesis theory, germ theory of fermentation, disease, Koch's postulates, contribution of various researchers to the field of Microbiology, Scope of Microbiology, General structure, distinctive characteristics of protozoa, algae, bacteria, fungi, viruses, bacteriophages-lytic and lysogenic, Microbiology as a Science.	**12**
II	Microbial growth (physical characters - gaseous atmosphere, pH, other conditions andnutritional classification. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential and enrichment media. Detailed study of the design and operation of different types of fermenters, Mode of fermentation processes: Bioreactor designs, types of fermentations and fermenters: Upstream processing: scale up and scale down process. Downstream processing: Bioseparation: drying, crystallization, storage and packaging, treatment of effluent and its disposal	**12**

III	Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates. Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations. Economics of a fermentation process, determination of cost and its recovery, cost cutting strategies, cell and enzyme immobilization, biological waste treatment, hygiene and safety in fermentation industries.	**12**
IV	Application of microbes in food process operations and production: Fermented foods microbes and their use in pickling, producing,colours and flavours, and process of wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins: production and applications. Applications of enzymes in food processing: enzymatic bioconversions e.g. starch and sugar conversion processes, High-Fructose Corn Syrup, and their downstream processing, backing by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing, cheese making by proteases.	**12**
Total		**48**

Text Books:

1. Fermentation and Biochemical Engineering Handbook, Principles, Process Design, and Equipment; Edited by Henry C. Vogel; Noyes Publications, New Jersey, U.S.A. ISBN: 0-8 155-1407-7.
2. Biotechnology- Volume 3- Bioprocessing; VCH VerlagsgesellschaftmbH. Weinheim, ISBN 3-527-28313-7 (Weinheim); ISBN 1-56081-153-6 (New York).

Reference Books:

1. Principles of Fermentation Technology, P. E. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heinemann, ISBN: 07506 45016.
2. Practical Fermentation Technology, B. Mcneil and L. M. Harvey, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, ISBN 978-0470-014349

Subject Name: DSE – 9 (Developmental Biology) **Scheme of Evaluation:(T)**

Subject Code: BTC154D404 **Credit Units: 3-1-0-4**

Course Objectives:

The main objective of the course is to gather information about the rich heritage of medicinal plants present in the region, gain knowledge on the the process of conservation of medicinal plants, their

preservation and their applications.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Ability to **remember** the important developmental stages in organisms	**BT 1**
CO 2	Ability to **understand** the role of various genes involved in development.	**BT 2**
CO 3	Ability to **apply** the knowledge gained in carrying out studies on development.	**BT 3**
CO 4	Ability to **analyze** the importance of various processes involved in development of an organism	**BT 4**
CO 5	Ability to **evaluate** the role of germ layers, oogeneisis, gametogenesis and spermatogenesis	**BT 5**

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I	Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division	**12**
II	Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizer	**12**
III	Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)	**12**
IV	Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and TheoriesTeratogenesis: Teratogenic agents and their effects on embryonic development; Amniocentesis	**12**
Total		**48**

Text Books:

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press

Reference Books:

1. Carlson, R. F. Patten's Foundations of Embryology
2. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
3. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press