ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF BIO - SCIENCES

(RSBSC)

Learning Outcomes based Curriculum Framework (LOCF) for BIOTECHNOLOGY Undergraduate Programme 2022-23

(Department of Biotechnology)

SYLLABUS

&

COURSE STRUCTURE

B.Sc. in Biotechnology

(In line with NEP-2020)

W.E.F. 2022-23

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1. Preamble:

Biotechnology is a branch of science that deals with the exploitation of biological processes for industrial and other purposes, especially the genetic manipulation of microorganisms for the production of antibiotics, hormones, etc. The discipline of Biotechnology has transcended boundaries and has incorporated diversified subjects to make it one of the most sought after programme to be pursued for UG/PG/ PhD degrees. The Choice Based Credit System (CBCS) curriculum for Biotechnology at the undergraduate level has now been developed into a new system called Learning Outcome Curriculum Framework (LOCF) under the recommendations and guidance of University Grants Commission (UGC). The LOCF approach first envisioned the programme learning outcomes of the B.Sc. (Hons) program in Biotechnology as well as the learning outcomes of the courses being taught under this programme, keeping in view the graduate attributes of the subject. It is envisaged that the students trained under this curriculum will have the required attributes of knowledge, skills, temperament and ethics related to the subject. Besides the contents of the curriculum, the teaching learning processes have also been designed to achieve these attributes.

The syllabus of the B.Sc. Biotechnology programme is designed with an array of courses *viz.* Core courses, Department Specific Electives (DSE), Generic Electives (GE), Skill Enhancement Elective Courses (SEC), Value Addition Course (VAC), Ability Enhancement Compulsory Courses (AECC), Internships and Research Projects.

The major objective of the programme is as follows:

- Impart theoretical and practical knowledge including skilled training.
- To instil confidence in the students for overall development of their professional expertise and traits.
- To instil the values of ethics and integrity.
- To enable graduates to become future leaders and innovators.

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. <u>Aim of the Bachelors Degree Programme in Biotechnology:</u>

The aim of the undergraduate 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 awaits graduates in Bio-Technology. Some such are as follows.

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

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

<u>5.Graduate attributes:</u>

A student graduating in Biotechnology shall acquire the knowledge, develop concept and the basic skills in Biology, Chemistry and Techniques. The fundamental course outline shall be delivered to the students to equip the students with the practical training in the different areas of the subject; *viz;* Molecular Biology, Biochemistry, Genetics, Cell Biology, Microbiology, Genetic Engineering etc

so as to enable them proceed for further higher study. Graduate attributes have been formulated with various qualification descriptors so as to improve upon the subject. These attributes are elaborated as below-

GA 1: Disciplinary Knowledge

a. Ability to understand the fundamental concepts in biology and technological applications related to biology.

b. To apply the basic principles of technology in solving biological problems

c. To have the ability to relate the various interrelated physiological and biochemical events.

d. Ability to analyse and evaluate the situation in solving practical problems.

GA 2: Communication Skills

a. The students must be able to follow the English language as the medium of instruction

b. Have the ability to listen and follow scientific viewpoints

GA 3: Critical Thinking

a. Ability to think and apply the knowledge of scientific texts, reports and updates.

b. Ability to place scientific statements and themes in context and evaluate the same.

GA 4: Problem Solving

a. Ability to solve the problems in complex situations.

b. Ability to understand the topics and solve the problems associated with it.

c. Ability to cooperate and solve the problems in collaboration with colleagues.

GA 5: Analytical Reasoning

a. Ability to observe the strength and weakness of scientific texts/ articles etc.

b. Ability to use critics and theorists to create a framework and to substantiate one's

argument in one's reading of scientific texts.

GA 6:Research Related Skills

a. Ability to formulate hypothesis and research questions.

b. Ability to identify and consult relevant sources to find answers.

c. Ability to plan and write a research paper

GA 7: Teamwork and Time Management

a. Ability to participate constructively in class room discussions.

b. Ability to contribute to group work.

c. Ability to meet a deadline.

GA 8: Scientific Reasoning

a. Ability to analyze texts, evaluate ideas and strategies for scientific research.

b. Ability to formulate logical and convincing arguments in favour of the knowledge shared.

GA 9: Digital Literacy

a. Ability to use various digital platforms/sources and apply the same to convey and explain the core

concepts of the discipline.

GA 10: Moral and Ethical Values

a. Ability to interrogate one's own ethical values, and be aware of ethical and environmental issues.

b. Ability to read the values inherited in society and criticism vis a vis, the environment, religion

and spirituality, as also structures of power.

GA 11: Leadership Readiness

a. Ability to lead group discussions, to formulate questions related to scientific and social

issues.

GA 12: Life-long Learning

a. Ability to retain and build on critical thinking skills, and use them to update scientific

knowledge and apply them in day to day business.

6. Qualification Descriptors:

The following are the important qualifying descriptors for a UG degree in Biotechnology.

6.1: Demonstrate the understanding of the academic field of Biotechnology, the various learning areas and applications and its relation with the related areas/ subjects. They must have the procedural knowledge leading to creation of different professionals related to Biotechnology including research and development, teaching and Govt service. They must also acquire the skills in areas related to specialization area of the sub fields and in the recent developments in the field.

6.2: Use the knowledge gained in understanding and gaining the skills required for identification of problems and issues related to the subject, application, analysis and evaluation of using different methodologies for formulation of evidence based solutions and arguments.

6.3: Communicate the results of studies accurately in a range of different contexts using the main concepts and techniques of the subject.

6.4: Meeting one's own learning needs, drawing on a range of current research and development work and professional materials.

6.5: Apply the knowledge of the subject and skills to new/ unfamiliar contexts for identification and analysis of problems and issues and provide solutions to complex problems.

6.6: Demonstrate subject related and transferable skills relevant to the subject area.

7. Programme Learning Outcome/ Program Outcomes (PLO/PO):

The problem learning outcomes related to the BSc degree in Biotechnology includes the following competencies to be acquired by the students during the course of their studies.

PO1: **Disciplinary Knowledge**

Understand the fundamental concepts in biology and technological applications related to biology and have the ability to analyse and evaluate the situation in solving practical problems.

PO 2: Communication Skills

Ability to communicate with peers and understand the delivery of the lectures given.

PO 3: Critical Thinking

Ability to think and apply the knowledge of scientific texts, reports and updates

PO 4: Problem Solving

Ability to solve the problems with a logical mind and also provide solutions to emerging problems.

PO 5: Analytical Reasoning

Understand the relate the scientific texts to reason the argument and observe the strength and weakness of scientific texts/ articles etc.

PO 6:Research Related Skills

Ability to identify and consult relevant sources to find answers related to formulation of hypothesis and other research questions.

PO 7: Teamwork and Time Management

Ability to participate constructively in class room discussions, work in combination and be able to meet deadlines.

PO 8: Scientific Reasoning

Ability to analyze texts, evaluate ideas and strategies for scientific research and formulate logical and convincing arguments

PO 9: Digital Literacy

Ability to use various digital platforms/sources and apply the same to convey and explain the core concepts of the discipline.

PO 10: Moral and Ethical Values

Ability to interrogate one's own ethical values, and be aware of ethical and environmental issues.

PO 11: Leadership Readiness

Ability to lead group discussions, to formulate questions related to scientific and socialissues.

PO 12: Life-long Learning

Ability to retain and build on critical thinking skills, and use them to update scientific knowledge and apply them in day to day business.

8. Programme Specific Outcome (PSO)

The programme specific outcome for a graduate student in Biotechnology are as follows

PSO1: Enable a student to be a better and effective communicator of the subject by applying the basic principles and skills.

PSO2: Ability to understand the principles of the core subject areas in Biotechnology including identifying crucial biological problems and handle basic, sophisticated and advanced instrumentation required to execute the solutions.

PSO3:To understand the various laws and ethics in Biotechnology.

PSO4:To launch start-ups and become entrepreneurs for novel biotechnology products.

9. Teaching and Learning Process

- Lectures: Regular class lectures shall be accompanied with teaching using ICT tools for interactive learning.
- Tutorial classes: The tutorials are conducted for students who are unable to achieve average grades in their weekly assessments.
- Remedial classes: The remedial classes are conducted for students who achieve average and above average grades in their weekly assessments. The focus is laid to equip the students to perform better in the exams/assessments.
- Dissertation/ Projects: Project based training are implemented to instill skill amongst the students and enhance their ability to apply and analyze the knowledge gained.

- Quizzes: Quizzes shall be periodically organized to test the level of knowledge and learning and remembering ability of the students.
- Seminars/ Presentations: Will be organized to prepare the students for social speaking, making them more vocal and allowing them to understand their course and study accordingly.
- Practicals: Biotechnology being an applied subject, the practical component is incorporated for better skill development and training.
- ICT enabled learning: ICT enabled learning and training are incorporated in the syllabus for holistic development of the students.
- Library resources: To enhance the teaching learning process the library facility is provided with reference books and other subject related texts.
- Blended Learning: Blended learning has been developed as a part of learning through both online and offline mode.

DEPARMENT OF BIOTECHNOLOGY

VISION

To produce biologists with strong ethics, integrity, acumen, and preparedness to tackle any emerging problem of global concern by fostering curated opportunities in the course area to push themselves at the global platform.

MISSION

· To impart quality education to students through scientifically designed up-to-date course structure and make them globally competitive.

· To instill confidence in the students for developing analytical skills to find out solutions for current and emerging problems of global concern.

· To provide state of the art academic and laboratory facilities with skilled training and integration of interdisciplinary approach to foster entrepreneurial thinking.

CREDIT DISTRIBUTION

SEMESTER	CREDITS
I	24
II	24
III	24
Iv	24
V	26
VI	26
	TOTAL CREDITS=148

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%**

Programme Structure

B.Sc. in Biotechnology

1st semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects *(Please Add rows, as required)*							
1	BTC152C101	Cell Biology	3	1	0	4	4
2	BTC152C102	Genetics	3	1	0	4	4
3	BTC152C113	Practical on Cell Biology and Genetics	0	0	8	4	8
Discipline Specific Elective (DSE)							
	Skill Enhancement Elective Courses (SEC)						
4	BTC152S111	Vermicompost and Its Application	0	0	4	2	4
Value Addition Course							
5						2	
Ability Enhancement Compulsory Courses (AECC)							
6	CEN982A101	Communicative English-I	1	0	0	1	1
7	BHS982A104	Behavioral Science-I	1	0	0	1	1
Generic Elective							
8	BTC152G101	Basic Instrumentation in Biology	2	1	0	3	3
9	BTC152G102	Biofertilizer	2	1	0	3	3
		Total Credit	**12**	**4**	**12**	**24**	**28**
2nd semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects *(Please Add rows, as required)*							
1	BTC152C201	Biochemistry	3	1	0	4	4
2	BTC152C202	Microbiology	3	1	0	4	4
3	BTC152C213	Practical on Biochemistry and Microbiology	0	0	8	4	8
Discipline Specific Elective (DSE)							
	Skill Enhancement Elective Courses (SEC)						
4	BTC152S211	Biochemical Analysis of Food	0	0	4	2	4
Value Addition Course							
5						2	
Ability Enhancement Compulsory Courses (AECC)							
6	CEN982A201	Communicative English-I	1	0	0	1	1
7	BHS982A204	Behavioral Science-II	1	0	0	1	1
Generic Elective							
8	BTC152G201	Biotechnology and Human Welfare	2	1	0	3	3

9	BTC152G202	Ecosystem Degradation and Intervention	2	1	0	3	3
		Total Credit	**12**	**4**	**12**	**24**	**28**

3rd semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects *(Please Add rows, as required)*							
1	BTC152C301	Molecular Biology	3	1	0	4	4
2	BTC152C312	Practical on Molecular Biology, Bioinformatics and Biostatistics	0	0	8	4	8
Discipline Specific Elective (DSE)							
3	BTC152D301	Bioinformatics and Biostatistics	3	1	0	4	4
Internship							
5	BTC152C323	Internship (4 weeks Duration)	0	0	8	4	8
Ability Enhancement Compulsory Courses (AECC)							
6	CEN982A301	Communicative English-I	1	0	0	1	1
7	BHS982A303	BHS-3	1	0	0	1	1
Generic Elective							
8	BTC152G301	Entrepreneurship Development	2	1	0	3	3
9	BTC152G302	Biofertilizer	2	1	0	3	3
		Total Credit	**12**	**4**	**16**	**24**	**32**
4th semester							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects *(Please Add rows, as required)*							
1	BTC152C401	Immunology	3	1	0	4	4
2	BTC152C412	Practical on Immunology and Medical Biotechnology	0	0	8	4	8
Discipline Specific Elective (DSE)							
3	BTC152D401	Medical Biotechnology	3	1	0	4	4
Skill Enhancement Elective Courses (SEC)							
4	BTC152S411	Phytochemical Analysis and Drug Discovery	0	0	4	2	4
Value Addition Course (Basket Course)							
5		Select one course from a basket of course	0	0	4	2	0
Ability Enhancement Compulsory Courses (AECC)							
6	CEN982A201	Communicative English-I	1	0	0	1	1
7		Functional Language	1	0	0	1	1
Generic Elective							
8	BTC152G401	Bioethics & IPR	2	1	0	3	3
9	BTC152G402	Ecosystem Degradation and Intervention	2	1	0	3	3
		Total Credit	**12**	**4**	**12**	**24**	**28**

SYLLABUS (1ST SEMESTER)	
Subject Name: Cell Biology	**Subject Code: BTC152C101**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is to provide a detailed description of the organization of the cell, the structure and functions of various organelles. The course also focuses on cell-cell communication and the importance of cell division.

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 components of the cell and their function.	**BT 1**
CO 2	**Understand** the function of the cells and their roles.	**BT 2**
CO 3	**Apply** the knowledge gained in solving of problems associated with the topic.	**BT 3**
CO 4	**Analyze** the components of the cellular structure in prokaryotes, eukaryotes and archaea.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport. Extracellular matrix and its composition.	**12**
II.	Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of micro tubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.	**12**
III.	Lysosomes: Vacuoles and micro bodies: Structure and functions, Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure. Signal transduction.	**12**
IV	Structure and function of prokaryotic cell and its components. Cell wall of bacteria, outermembrane of Gram negative bacteria. Overview of the cell-cycle, Intracellular and extracellular control of cell division. Programme cell death, Cell cycle and cancer.	**12**

TOTAL	48
Pedagogy: Lectures, Assignments, Seminars	

Text Books:

1. Karp, G.,*Cell and Molecular Biology: Concepts and Experiments,* 6th Edition, 2010 John Wiley &Sons.Inc.

Reference Books

1. De Robertis, E.D.P. and De Robertis, E.M.F.,*Cell and Molecular Biology*,8th edition, 2006, Lippincott Williams and Wilkins, Philadelphia.
2. Cooper, G.M. & Hausman, R.E..*The Cell: A Molecular Approach*, 5th edition. 2009, ASM Press& Sunderland, Washington, D.C.; Sinauer Associates, MA.

Subject Name: Genetics	**Subject Code: BTC152C102**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is to understand the structure and function of genes and chromosomes as well as the harmful effects of mutations which can cause various genetic disorders

Course Outcomes:

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Memorize** the various laws of genetics	**BT 1**
CO 2	**Understand** the concepts of the core areas	**BT 2**
CO 3	**Apply** the knowledge gained in solving of genetic problems.	**BT 3**
CO 4	**Compare** and **analyze** the theoretical knowledge gained in solving inheritance pattern.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Historical developments in the field of genetics**. Organisms suitable for genetic experimentation and their genetic significance. **Mendelian genetics:** Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete	**12**

	dominance, co-dominance, semi-dominance, pleiotropy, multiple alleles, pseudo-allele, essential and lethal genes, penetrance, and expressivity.	
II.	**Non-allelic interactions**: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes. **Linkage & Crossing over** - Chromosome theory of Linkage, types of linkage, linkage groups, types of Crossing over, mechanism of Meiotic Crossing over.	**12**
III.	**Sex determination and sex linkage**: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, sex limited gene expression, sex linked inheritance. **Human Genetics:** Concept, Human chromosomes and chromosome abnormalities, Mendelian pedigree pattern.	**12**
IV	**Extra chromosomal inheritance**: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. **Evolution and population genetics**: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.	**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.

Reference Books

1. Gardner, E. J., Simmons, M. J. & Snustad, D. P. (2013). Principles of Genetics, 8th Edition, John Wiley and Sons.

2. Tamarin, R.H. (2002). Principles of Genetics, 7 th Edition, Tata McGraw-Hill Publishing Company Ltd.

Subject Name: Practical on Cell Biology and Genetics	**Subject Code: BTC152C113**
Credit Units: L-T-P-C – 0-0-8-4	**Scheme of Evaluation: (P)**

Course Objective: The main objective of the course is toperform the various experiments and understand the underlying principles of each experiment.

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 instruments used in a Biotechnology laboratory.	**BT 1**
CO 2	**Understand**the general laboratory safety measures and maintain the same.	**BT 2**
CO 3	**Apply** the knowledge for preparation of various chemicals.	**BT 3**
CO 4	**Analyze** and Examine the results and relate them to the experiments carried out	**BT 4**

Detailed Practicals:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	1. Study the effect of temperature and organic solvents on semi permeable membrane. 2. Demonstration of dialysis. 3. Study of plasmolysis and de-plasmolysis. 4. Cell fractionation and determination of enzyme activity in organelles using sprouted seedor any other suitable source.	**24**
II	1. Study of structure of any Prokaryotic and Eukaryotic cell. 2. Microtomy: Fixation, block making, section cutting, double staining of animal tissueslike liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes. 3. Cell division in onion root tip/ insect gonads. 4. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.	**24**
III	1. Permanent and temporary mount of mitosis. 2. Permanent and temporary mount of meiosis. 3. Mendelian deviations in dihybrid crosses 4. Demonstration of - Barr Body-*Rhoeo*translocation.	**24**
IV	1. Karyotyping with the help of photographs 2. Pedigree charts of some common characters like blood group, color blindness and PTC tasting. 3. Study of polyploidy in onion root tip by colchicine treatment.	**24**
		96
Pedagogy: Lectures, Experiments, Laboratory sessions		

Recommended Texts:

- As suggested under the theory papers.

Subject Name: Basic Instrumentation in Biology	**Subject Code: BTC152G101**
Credit Units: L-T-P-C – 2-1-0-3	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is toprovide the graduates with a strong foundation in the area of instrumentation's used in biology.

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 instruments that play a major role in the study of biology.	**BT 1**
CO 2	**Understand**the principles and applications of the instruments.	**BT 2**
CO 3	**Apply** the theoretical knowledge in practical applications.	**BT 3**
CO 4	**Analyze** the results of practicals carried out using the instruments	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	Microscopy and Imaging techniques: Principles and applications of Light microscopy, Phase contrast microscopy, fluorescence microscopy, electron microscopy- Scanning electron microscopy and Transmission electron microscopy	**9**
II	pH and Centrigugation: pH meter: Principles and application, Centrifugation: Principles, types of centrifuges, types of rotors, differential and density gradient centrifugation. Electrophoresis techniques: Gel electrophoresis, PAGE, Pulse field, 2DGE	**9**
III	Chromatography techniques: Principles and Application of Thin layer chromatography, Column chromatography, Gas Chromatography, High pressure liquid chromatography Preparation of Buffers, Molar solutions, Dilutions, Handling of chemicals, Good Laboratory Practices	**9**
IV	Spectroscopy and other techniques: UV-Vis spectroscopy, Infra-Red spectroscopy, Mass Spectroscopy Lyophilizer, Sonication, Freeze Drying, Micropipettes	**9**
		36
Pedagogy: Lectures, Experiments, Laboratory sessions		

Text Books:

1. Bajpai, P.K., Biological Instrumentation andmethodology, 2006, S. Chand & Co. Ltd.

Reference Books:

1. K. Wilson and J. Walker Eds. . Biochemistry andMolecular Biology, 2005, Cambridge University Press.

2. F. Partibhan and S. Felix, Biochemical Techniques and Instrumentation, 2020, Daya Publishing House.

Subject Name: Biofertilizer	**Subject Code: BTC152G102**
Credit Units: L-T-P-C – 2-1-0-3	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is toprovide the graduates with the knowledge of biofertilizers and their applications in agriculture.

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 techniques in production of biofertilizer	**BT 1**
CO 2	**Understand**the principles and applications biofertilizer	**BT 2**
CO 3	**Apply** the theoretical knowledge in practical applications.	**BT 3**
CO 4	**Analyze** the role of biofertilizers in agricultural production.	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	Soil Environment- microorganisms, soil structure, soil profile, physicochemical conditions,microbial composition, sampling techniques, role of microorganisms in organic matterdecomposition(cellulose,Hemicellulose,Lignins).Bio-geochemicalcycles:Carboncycle,Nitrogencycle	**9**
II	Biofertilizers-Introduction,biofertilizersusingnitrogenfixingmicrobes,phosphatesolubilization - Rhizobium, Azatobacter,Azospirillum, Azolla;AnabaenaSymbiosis,bluegreen algae and Ecto- and Endomychorizae. Cultivation, mass production and inoculationofRhizobium,Azotobacter,Azospirillum,Azollaandcyanobacteria,Carrier-	**9**

	basedinoculants,methodsofapplication,qualitycontrol,agronomicimportance.Application methodsfordifferent biofertilizers.	
III	Roleendophyticfungiintheproductionofbiofertilizer:symbioticandopportunisticassociations,coevolutionandlossofreproductivestructures,Secondarymetaboliteproduction,toxins-importance,toxicitytoherbivoresandinsects.Mycorrhizalassociations:endoandectomycorrhiza.Roleofalgaeandlichensasbiofertilizers:Anabaena,Nostoc,Aulosira, Calothrix,Plectonemaetc	**9**
IV	Solid wastes in the production of biofertilizers:Concept of solid waste; Industrial solidwaste;Domesticsolidwaste;Agriculturalsolidwaste;Municipalsolidwaste;Majorsourcesofsolidwastes;Technicalapproachforsolidwastemanagement;Disposal oforganic andmedicalwaste.	**9**
		36
Pedagogy: Lectures, Experiments, Laboratory sessions		

TextBook:

1. S. Kannaiyan, BiotechnologyofBiofertilizers,2002, Alpha Science International.

ReferenceBooks:

1. TheCompleteTechnologyBookOnBio-FertilizerAndOrganicFarming.2004, NiirBoard.
2. M. K. Rai.,HandbookofMicrobialBiofertilizers,2006, Food Products Press

Subject Name: Biocompost and its Applications	**Subject Code: BTC152S111**
Credit Units: L-T-P-C – 0-0-4-2	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is toprovide the graduates with the skill based knowledge of preparation of vermicompost from cow dung and other available food and agri waste for generation of skilled entrepreneurs.

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 theoretical and practical approaches in preparation of biocompost.	**BT 1**
CO 2	**Understand**the applications of biocompost in daily use.	**BT 2**
CO 3	**Apply** the knowledge of preparation of biocompost in solving	**BT 3**

	problems of agriculture.	
CO 4	**Analyze** the role of biocompost in industries and in establishment of entrepreneurship.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	1. Evaluation of various microbial species used in preparation of biocompost. 2. Assessment of earthworm species used in preparation of vermicompost 3. Determination of constituents in preparation of biocompost and vermicompost	**12**
II	1. Preparation of the soil structure used in vermicompost. 2. Analysis of composition of vermicompost bed. 3. Preparation of vermicompost shed	**12**
III	1. Assessment on the methods of preparation of biocompost. 2. Estimation on the organic constituents of compost 3. Evaluation on the growth patterns of of earthworms on different feeds.	**12**
IV	1. Assessment of the quality of biocompost and vermicompost. 2. Estimation of the NPK content. 3. Study of market potential of compost	**12**
		48
Pedagogy: Lectures, Experiments, Laboratory sessions		

TextBook:

1. Singh, K. A Textbook of Vermicompost: Vermiwash and Biopesticides, 2014, Biotech Books.

Reference Books:

1. Sreenivasan, E. Handbook of Vermicomposting Technology, 2018, The Western India Plywoods Ltd.

SYLLABUS (2nd SEMESTER)	
Subject Name: Biochemistry	**Subject Code: BTC152C201**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is to provide basic foundation on biomolecules of life with reference to their properties, and biological functions.

Course Outcome:

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Learn** and **remember**about the structure of atoms, biomolecules and chemical bonds	**BT 1**
CO 2	**Understand** concepts of enzyme kinetics, bio-polymers etc.	**BT 2**
CO 3	**Demonstrate** the knowledge gained in solving practical experiments.	**BT 3**
CO 4	**Relate** and **analyze** the metabolic processes.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Introduction to Biochemistry:** A historical prospective. **Amino acids & Proteins:** Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins. **Carbohydrates**: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions	**12**
II.	**Lipids**: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol. **Nucleic acids**: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines &pyrimidines, Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation andrenaturation of DNA.	**12**

III.	**Enzymes**: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric &oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilicarchaea and bacteria. Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxalphosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions	**12**
IV	**Carbohydrates Metabolism**: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids, glyoxylate cycle.	**12**
TOTAL		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text Books:

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

Reference Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer.,*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: Microbiology	**Subject Code: BTC152C202**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is to provide the basic understanding on the role of microbes and their diversity. The course will also throw light on the role of microbes in industries and research and their disease causing abilities

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Recall** the various types of microorganism and the roles played by them.	**BT 1**
CO 2	**Describe** the microbial world, their diversity and utilization.	**BT 2**

CO 3	**Demonstrate** the knowledge gained in understanding the causative agents of various diseases and maintenance of sterility.	**BT 3**
CO 4	**Analyze** and **relate** the co-evolutionary pattern and relationship between microbes and the environment.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**An introduction to microbiology**: History of microbiology, concepts of microbial diversity, scope and applications of microbiology. **Microscopy and specimen preparation**: Bright and dark field microscopy, TEM and SEM. Concepts of fixation and staining, Gram staining, acid fast staining, negative staining, capsule, flagellar and endospore staining. **Prokaryotic cellular architecture**: The cell wall and other constituents. Comparison between prokaryotic and eukaryotic organisms. Introduction to Eubacteria and Archaea, their major structural differences. General characteristics and classification of viruses, differences between bacteria and viruses. Bacteriophages; lytic and lysogenic cycles. Prions and viriods.	**12**
II.	**Eukaryotic microbial diversity**: Introduction to protists, bacteria, actinomycetes and fungi, Mycelia of fungi and Actinomycetes, cytoskeleton filament, heterocysts and akinets of Cyanobacteria. **Microbial growth and nutrition**: Principles of growth and growth curve, methods of growth determination and factors affecting growth. Mode of nutrition, growth mediums and pure culture techniques; isolation, preservation and maintenance of cultures, sterilization techniques.	**12**
III.	**Microbial taxonomy**: Concept of microbial species and strains, classification of bacteria based on-morphology (shape flagella), staining reaction, mutation and extreme environment. **Microbial Reproduction and recombination**: Transformation, conjugation (cointegrate Formation and Hfr Cells, F-Plasmid) and transduction (generalized and specialized).	**12**
IV	**Microbial Metabolism**: Bacterial Photosynthesis, photophosphorylation, assimilation of inorganic nitrogen, phosphorus and sulphur, ED Pathway **Microorganisms and health:** Basics of host pathogen interaction, commensalism, colonization, infection and disease. Infections caused by Enterobacteriaceae, Mycobacteriaceae*, Candida, Aspergillus, Variola, Varicella-Zoster, HPV, EBV* **Plant microbe interactions**: Plant microbe interaction in the rhizosphere. Carbon and Nitrogen cycle, Biological nitrogen fixation – symbiotic and non-symbiotic Plant Growth Promoting Rhizobacteria (PGPR) - Mycorrhizae -Blue Green Algae (BGA)	**12**
TOTAL		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text Books:

1. Willey, J.,Sherwood,L.,Woolverton, C.,(2013) *Prescott's Microbiology*,;10th edition McGraw HillScience/Engineering/Math.
2. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

Reference Books

1. Pelczar, *Microbiology*, 5th edition, McGraw-Hill Inc,US.
2. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5thedition. McMillan.

Subject Name: Practical on Biochemistry and Microbiology	**Subject Code: BTC152C213**
Credit Units: L-T-P-C – 0-0-8-4	**Scheme of Evaluation: (P)**

Course Objective: The main objective of the course is toperform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Learn** and **remember** about the process of preparation of buffers and calculate the same.	**BT 1**
CO 2	**Understand** about pH and its importance, enzyme kinetics.	**BT 2**
CO 3	**Apply** the knowledge about the role of media in microbial growth.	**BT 3**
CO 4	**Identify** the equipment's used and the underlying safety measures in a laboratory	**BT 4**

Detailed Practical:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	1. Safety measures in microbiology laboratory. 2. Cleaning and sterilization of glassware. 3. Study of instruments: Compound microscope, Autoclave, Hot air oven, pH meter, laminar air flow and centrifuge. 4. Staining Techniques Simples, Negative staining, Gram Staining and Endospore staining.	**24**
II.	1. Preparation of mediatypes. 2. Isolation of bacteria from different sources. 3. Estimation of microorganisms-Total Count. 4. Extraction of microbial DNA	**24**
III.	1. Principles of Colorimetry andVerification of Beer's law 2. Preparation of buffers. **3.** Separation of Amino acids by paper chromatography. **4.** Qualitative tests for Carbohydrates, lipids and proteins- Mollisch test,	**24**

	Benedicts test and Soxhlet test	
IV	**1.** Effect of α-amylase on starch **2.** Effect of pH and temperature onα-amylaseactivity **3.** Determination of Km and Vmax of α-amylase activity	**24**
TOTAL		**96**
Pedagogy: Lectures, Experiments, Laboratory sessions		

Reference Books:

As suggested under the theory papers.

Subject Name: Biotechnology and Human Welfare	**Subject Code: BTC152G201**
Credit Units: L-T-P-C – 2-1-0-3	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is toput forward the basic objective of the study of Biotechnology and its relation to overall welfare of the human society.

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 roles played by Biotechnology.	**BT 1**
CO 2	**Understand**the role of Biotechnology in solving environmental issues.	**BT 2**
CO 3	**Employ** the theoretical knowledge in future studies.	**BT 3**
CO 4	**Analyze** the role of the techniques learnt in development of society	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	BiotechnologyinIndustries:Developmentofproteinproducts,developmentofrecombinant proteins, modification and application of enzymes, antibiotic production,alcoholproduction. BiotechnologyinAgriculture:Productionofnewcrops,geneticallymodifiedcrops,development of stress/flood/drought tolerant crops. Better production of resistant crops.Improvementoflivestock.	**9**

II	Biotechnology in Environment: Development of products which can degrade organic andnonorganic pollutant, degradation of hydrocarbons and agriculture wastes, developmentofbiodegradable polymers.	**9**
III	Biotechnology in Food: Development of better quality food products, development ofinnovative food products, development of new microbial strains, new beverages, qualitypreservationinfoods,developmentof nutraceuticalsandtheir role in health.	**9**
IV	BiotechnologyinForensics:Biotechnologicalinterventionsinsolvingcrimes,DNAfingerprinting-Principlesandapplications,serologytoolsandroleinsolvingcrimes,biologicalsolutions tosolving crimes. Biotechnology in Pharmaceutical and Health: Development of new therapeutic agents,vaccines,genetherapytechniques,newdiagnostictechniquesfordetectionofviraldisease,eg-Covid-19,HIVetc,RoleofHumanGenomeProject.	**9**
		36
Pedagogy: Lectures, Experiments, Laboratory sessions		

TextBooks:

1. S.M.Reddy,S.R. Reddy,G.N. Babu,BasicindustrialBiotechnology, 2012,NewAgePublishers.

ReferenceBooks:

1. Ratledge,C.,Kristiansen,B.,BasicBiotechnology,3rdedition,2006, Cambridge University Press;
2. Das,H.K.,TextbookofBiotechnology,5thedition,2017, WileyPublishers.

Subject Name: Ecosystem Degradation and Intervention	**Subject Code: BTC152G202**
Credit Units: L-T-P-C – 2-1-0-3	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is toprovide the knowledge of functioning of ecosystem, their degradation and the interventions required.

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 concepts of ecosystem and ecology.	**BT 1**
CO 2	**Understand** the role of ecosystem and ecology in degradation of environment.	**BT 2**

CO 3	**Apply** the theoretical knowledge of ecosystem in understanding environmental issues.	**BT 3**
CO 4	**Analyze** the impact of ecosystem degradation upon environment	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Environment:** Definitions, Components and Inter-relationships, Parts of the environment, Ecology and Ecosystems, examples of interconnections in nature. **Ecology and ecosystem:** Structure and boundaries of ecosystem, evolution of an ecosystem, value of ecosystem and ecosystem services. **Biogeochemical cycles:** Cycling elements, water cycle, carbon cycle, nitrogen cycle, phosphorus cycle, sulphur cycle. Impact of human activity on the cycling elements.	**9**
II	**Environmental degradation:** Impact of anthropogenic activities on biotic and abiotic components of ecosystem. Causes of biodiversity loss. Ecological balance and footprint; United Nations Millennium ecosystem assessment. **Environmental toxicology:** Toxic chemicals in the environment (air and water) – their effects and biochemical interactions; Pesticides, Heavy metals, etc.	**9**
III	**Global environmental issues:** Ozone layer depletion (Montreal protocol), El Nino, Acid rain - causes and effects, Green House Gases(GHG) and greenhouse effect, global climate change, global warming – effect on oceans, coastline and marine ecosystem, impact of global warming on India. Response to global warming – Kyoto protocol and its outcome. **Environmental laws:** The Environment Protection Act, 1986; The Water (Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981; The Forest Conservation Act, 1980, Cartagena protocol, COP27,	**9**
IV	**Biotechnological interventions for pollution control:** Biofilters, Bioremediation, Biotransformation, Biodegradation, and Phytoremediation: In situ and Ex situ bioremediation; Evaluating Bioremediation; Bioremediation of VOCs. Factors affecting process of biodegradation; Contaminant availability for biodegradation; Use of microbes (bacteria and fungi) and plants in biodegradation and Biotransformation; Phytoremediation: Waste water treatment using aquatic plants, sustainable agriculture, waste to energy and waste management	**9**
		36
Pedagogy: Lectures, Experiments, Laboratory sessions		

Text Book:

1. Kumar H. D., Modern Concepts Of Ecology, 2018, 8th edition, Vikas Publishing House
2. Tyler Miller, G. Living in the Environment: Principles, Connections, and Solution, 16th

edition, 2009,Cengage Publications

Reference Book:

1. Nebel, B.J. & Wright, R. Environmental Science: Toward a Sustainable Future. Pearsons, Latest edition.
2. Cunningham, W.P., Cunningham, M.A. & Saigo, B. Environmental Science, a Global Concern. (16th edition). 2021, McGraw-Hill (Boston)

Subject Name:Biochemical Analysis of Food	**Subject Code: BTC152S211**
Credit Units: L-T-P-C – 0-0-4-2	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is toprovide the graduates with the skill based knowledge in analysis of the biochemical constituents of food.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Recall** the various theories taught and relate them to the analysis of food materials	**BT 1**
CO 2	**Compare** the various theories and the practicals in analysis of different food components.	**BT 2**
CO 3	**Apply** the knowledge of instruments in analysis of food products	**BT 3**
CO 4	**Analyze** the components of food and relate them to health and wellness.	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	1. Preparation of buffers and chemicals required in analysis of food 2. Isolation and separation of food components by Paper chromatography and TLC. 3. Isolation and estimation of starch and sugar present in food.	**12**
II	1. Biochemical analysis of different food components 2. Analysis of proteins and fats of cereals 3. Analysis of lipids and lactose from milk and milk products	**12**
III	1. Assessment of microbial contamination in food products and water 2. Estimation of glucose in food products 3. Estimation of starch in food samples	**12**
IV	1. Estimation of caesin from milk 2. Estimation of cholesterol from egg yolk. 3. Estimation of vitamins in fruits and vegetables	**12**

	48
Pedagogy: Lectures, Experiments, Laboratory sessions	

TextBook:

1. Pearson, D. Chemical Analysis of Foods, 1970, (6th Ed), London: T.A. Churchill.

Reference Books:

1. Plummer, D. T. Introduction to Practical Biochemistry. Bombay:1979, Tata McGraw Hill Pub. Co. Ltd.

2. S. Sadasivan and A. Manickam, Biochemical Methods, 2nd ed., 2003, New Age International (P) Ltd.. Publishers.

SYLLABUS (3rdSEMESTER)

Subject Name: Molecular Biology	**Subject Code: BTC152C301**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is to allow the students to perceive the structure of the DNA molecule, understand the various mechanisms of molecular events and relate the role played in maintaining the biological 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 basic concepts in molecular biology.	**BT 1**
CO 2	**Demonstrate** the concepts in understanding the formation of various molecular events in life forms.	**BT 2**
CO 3	**Apply** the theoretical knowledge in carrying out practicals assigned.	**BT 3**
CO 4	**Analyze** and **categorize** the various molecular reactions involved in mutations and DNA repair	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	Introduction to Molecular Biology, Types of genetic materials- Experiments of Griffith, Avery, MacLeod and McCarty, Hershey and chase, Lederberg and Tatum, Central dogma of life. Replication of DNA, Models of DNA replication, Mechanism of DNA replication in prokaryotes (initiation, elongation, replication fork, replication machinery, termination), Enzymes and proteins involved in DNA replication (nucleases, DNA polymerases, DNA helicases, gyrases, SSCP, topoisomerase, primase).	**12**
II.	Mechanism of transcription in prokaryotes and eukaryotes. Enzymes and proteins involved in transcription, post transcriptional modification. Inhibitors of transcription. Translation initiation and elongation.	**12**
III.	Genetic code - characteristics and properties, Wobble hypothesis. Post translational modification, protein degradation, Inhibitors of protein synthesis. Regulation of gene expression (lac, trp and gal operons).	**12**
IV	Mutation and its types- spontaneous, induced, reverse, suppressor mutations; chemical mutagens- alkylating agent, nitrous acid, hydroxylamine; physical mutagen- radiation. DNA repair- mismatch repair, excision repair, direct repair and SOS repair.	**12**
TOTAL		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text books:

1. Watson, J.D., Molecular Biology of the Gene, Pearsons, 8th edition

Reference books:

1. Lodish. H, Berk. A, Lawrence, A, Matsudaira. A, Baltimore. D and Dernell. J. Molecular Cell Biology (Fourth Edition). Media Connected – W.H.Freeman and Company. 2009
2. Cell and Molecular Biology by De Robertis E.D.P and De Robertis E.M.F, 1987. Leaand Febiger International Edition, USA. 8 th ed 2010.

Subject Name: Practical on Molecular Biology, Bioinformatics and Biostatistics	**Subject Code: BTC152C312**
Credit Units: L-T-P-C – 0-0-8-4	**Scheme of Evaluation: (P)**

Course Objective: The main objective of the course is toperform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Learn** and **remember** about the process of preparation of chemicals and calculate the same.	**BT 1**
CO 2	**Understand** about the various molecular mechanisms.	**BT 2**
CO 3	**Apply** the knowledge about thestructure of DNA, its isolation and use of electrophoresis in isolation.	**BT 3**
CO 4	**Analyse** the role of bioinformatics and biostatistics in solving biological problems.	**BT 4**

Detailed Practical:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	1.Isolation of genomic DNA from plants/ microorganisms/ animal cells 2.Isolation of plasmid DNA by alkaline lysis and phenol method 3.To perform restriction digestion of DNA 4.Quantification and purity determination of isolated genomic DNA by UV-Spectrophotometry.	**24**
II.	1.To perform ligation of foreign DNA into cloning/ expression vector 2.To carry out polymerase chain reaction of genomic DNA 3.RFLP analysis of genomic DNA	**24**
III.	1.Introduction to bioinformatics softwares 2.Database search and sequence download 3.BLAST, FASTA: Search and analysis of data 4.Protein structure download and structural analysis	**24**

	5.ADMET – drug properties analysis and toxicology study	
IV	1. Students T-Test 2. Calculation of Standard deviation, Regression value and Mean Value in MS Excel 3. Construction of Bars/ Lines / Graphs using MS Excel 4.Univariate and Multivariate analysis 5.Analysis of Variance (ANOVA)	**24**
TOTAL		**96**
Pedagogy: Lectures, Experiments, Laboratory sessions		

Reference Books:

As suggested under the theory papers.

Subject Name: Bioinformatics and Biostatistics	**Subject Code: BTC152D301**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (T)**

Course Objective: The course aims to give a holistic theoretical and practical knowledge in field of bioinformatics and biostatistics to relate the role of computational biology and statistics in biotechnology.

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 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 computational tools.	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	**Basics of bioinformatics**: Definition, Scope and Goal, Application in Computational Biology, Limitations; **Biological Database**: Types of databases, biological database: GenBank, EMBL, DDBJ, Uniprot-KB: SWISS-PROT, PDB, AceDBs, literature databases, PubMed;	**12**

	Webtools: ExPASy server **Sequence Analysis and Sequence Alignment:**Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues and paralogues, 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 **Structural bioinformatics**: proteins and its structure, Determination of protein 3-Dimensional structure, Protein structure visualization, comparison, Secondary and tertiary structure prediction	
II.	**Molecular Phylogenetics:**Basic concepts, Methods in evaluation of phylogeny and steps in constructing alignments and phylogenetic Trees, Types of phylogenetic tree. **Chemoinformatic and Computer Aided Drug Designing (CADD):**Introduction to cheminformatics, Use of cheminformatics, Prospectus of cheminformatics, Basics of medicinal chemistry. Prodrugs and soft drugs, Drug targets, Drug solubility, Natural resources of lead compounds, Pharmacokinetics & drug metabolism.	**12**
III.	**Statistical tools:** Measures of central tendencies and dispersion, concept of probability and theoretical distributions (Binomial, Poisson and normal distribution), Correlation and Regression; Random numbers, sampling methods, 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**
Pedagogy: Lectures, Assignments, Seminars		

Text books:

1. Lesk, A. (2019). Introduction to bioinformatics. Oxford university press.
2. Xiong, J. (2006). Essential bioinformatics. Cambridge University Press.

Reference books:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis, Published CSHL Press
2. Des Higgins, Willie R. Taylor. Bioinformatics: Sequence, Structure and Databanks: A Practical, Approach, Oxford University Press.

Subject Name: Entrepreneurship Development	**Subject Code: BTC152G301**
Credit Units: L-T-P-C – 2-1-0-3	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is toprovidethebasicunderstandinginentrepreneurshipanditsimportanceindailylife

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 role of entrepreneurship in daily life.	**BT 1**
CO 2	**Understand** the role of development of entrepreneurship and its activities in sustaining a life.	**BT 2**
CO 3	**Interpret** the knowledge in generating entrepreneurship avenues.	**BT 3**
CO 4	**Outline** the role of entrepreneurship in solving unemployment problem.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	Entrepreneurship:Meaninganditsneedsandimportance.Promotionofentrepreneurship,factorsinfluencingentrepreneurship,Featuresofsuccessfulentrepreneurship	**9**
II	Establishmentofenterprise:Formsofbusinessorganization,projectidentification,formulationand feasibility,selectionof product. Entrepreneurship and International Business: Meaning of International business, selectionofproductandmarket,financinginbusinessandexport, institutionalsupportforexports.	**9**
III	Enterprisefinancing:Importanceof finance/loansandrepayments,characteristics ofbusiness finance, sources of fixed capital, working capital and its sources, application forloans.Inventories, rawmaterials anditsmanagement	**9**
IV	Marketing Management: Meaning and importance, marketing mix, product management,marketingresearch,surveyanditsimportance,physicaldistributionandstockmanagement.	**9**
		36
Pedagogy: Lectures, Experiments, Laboratory sessions		

TextBooks:

1.Entrepreneurshipand SmallBusinessManagement:C.B.Gupta,S.S.Khanka,2017, SultanChandand Sons.

ReferenceBooks:

1. D.H.Holt,Entrepreneurship:NewVentureCreation. 2016, Pearson Education India.

Subject Name: Biofertilizer	**Subject Code: BTC152G102**
Credit Units: L-T-P-C – 2-1-0-3	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is toprovide the graduates with the knowledge of biofertilizers and their applications in agriculture.

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 techniques in production of biofertilizer	**BT 1**
CO 2	**Understand**the principles and applications biofertilizer	**BT 2**
CO 3	**Apply** the theoretical knowledge in practical applications.	**BT 3**
CO 4	**Analyze** the role of solid waste in the production of biofertilizers.	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	Soil Environment- microorganisms, soil structure, soil profile, physicochemical conditions,microbial composition, sampling techniques, role of microorganisms in organic matterdecomposition(cellulose,Hemicellulose,Lignins).Bio-geochemicalcycles:Carboncycle,Nitrogencycle	**9**
II	Biofertilizers-Introduction,biofertilizersusingnitrogenfixingmicrobes,phosphatesolubilization - Rhizobium, Azatobacter,Azospirillum, Azolla;AnabaenaSymbiosis,bluegreen algae and Ecto- and Endomychorizae. Cultivation, mass production and inoculationofRhizobium,Azotobacter,Azospirillum,Azollaandcyanobacteria,Carrier-basedinoculants,methodsofapplication,qualitycontrol,agronomicimportance.Applicationmethodsfordifferent biofertilizers.	**9**
III	Roleendophyticfungiintheproductionofbiofertilizer:symbioticandopportunisticassociations,coevolutionandlossofreproductivestructures,Secondarymetaboliteproduction,toxins-importance,toxicitytoherbivoresandinsects.Mycorrhizalassociations:endoandectomycorrhiza.Roleofalgaeandlichensasbiofertilizers:Anabaena,Nostoc,Aulosira, Calothrix,Plectonemaetc	**9**
IV	Solid wastes in the production of biofertilizers:Concept of solid waste; Industrial solidwaste;Domesticsolidwaste;Agriculturalsolidwaste;Municipalsolidwaste;Majorsourcesofsolidwastes;Technicalapproachforsolidwastemanagement;Disposal	**9**

	oforganic andmedicalwaste.	
		36
Pedagogy: Lectures, Experiments, Laboratory sessions		

TextBook:

1. S. Kannaiyan, BiotechnologyofBiofertilizers,2002, Alpha Science International.

ReferenceBooks:

1. TheCompleteTechnologyBookOnBio-FertilizerAndOrganicFarming.2004, NiirBoard.
2. M. K. Rai.,HandbookofMicrobialBiofertilizers,2006, Food Products Press

SYLLABUS (4thSEMESTER)

Subject Name: Immunology **Subject Code: BTC152C401**

Credit Units: L-T-P-C – 3-1-0-4 **Scheme of Evaluation: (T)**

Course Objective: The course aims to provide knowledge in field of immunology and demonstrate the various forms in relation to their purpose of defending 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 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**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	Immunology - History & Milestones, Microbial infections and host resistance. Immune response: Innate & Adaptive responses, Humoral and cell mediated Immune Responses. Structures, composition and functions of cells and organs of immune system.	**12**
II.	Antigens & Immunogenicity. Antigens - Types, properties, Haptens, Adjuvants, Toxoids, Immunoglobulins- structure, types and properties, Theories of antibody formation, Structural and genetic basis of antibody formation. Antigen and antibody reactions, Immunodiagnostic methods - Agglutination, precipitations, complement fixation, RIA, ELISA and its types, Immunofluorescence, Production of Monoclonal Antibodies and Hybridoma technique.	**12**
III.	Cytokines &Chemokines - Classification, types and its functions, Complement system:- structure, properties, functions of complement components and its pathways. Hypersensitivity reactions: Type I, II, III and IV.	**12**
IV	Immunity and tumors: Types of tumors, tumor antigens, immune response to tumors. Immunodeficiency and Auto immune diseases, MHC - Structure and function of class I and class II MHC molecules, Transplantation immunology - types and mechanisms involved.	**12**
TOTAL		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text books:

1. Kuby, J., Immunology by (7th edition) W.H. Freeman and Company, New York, 2013

Reference books:

1. Khan. F.H. The Elements of Immunology, Pearson Education India, 2009

Subject Name: Practical on Immunology and Medical Biotechnology	**Subject Code: BTC152C412**
Credit Units: L-T-P-C – 0-0-8-4	**Scheme of Evaluation: (P)**

Course Objective: The main objective of the course is tothe basic principles fo Immunology and defence of the living system.

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Learn** and **remember** about the process of preparation of chemicals and calculate the same.	**BT 1**
CO 2	**Understand** about the various immunological cells and tissues.	**BT 2**
CO 3	**Apply** the knowledge about the role of immune molecules in organism defence.	**BT 3**
CO 4	**Analyse** the role of the instruments and techniques used in immunology and medical biotechnology.	**BT 4**

Detailed Practical:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	1. Isolation of lymphocytes from blood / spleen. 2. Demonstration of Western Blotting 3. Assays based on agglutination reactions - Blood typing (active) and passive Agglutination	**24**
II.	1. Blood film preparation and identification of cells 2. SGOT/SGPT assay 3. Demonstration of ELISA	**24**
III.	1. Antibiotic sensitivity assay 2. Haemolytic assay 3. Urine culture assay	**24**
IV	1.Blood Grouping assay 2. Estimation of blood glucose sugar 3. Determination of coagulation time of blood	**24**
TOTAL		**96**
Pedagogy: Lectures, Experiments, Laboratory sessions		

Reference Books:
As suggested under the theory papers.

Subject Name: Medical Biotechnology	**Subject Code: BTC152D401**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (T)**

Course Objective: The course aims to give a holistic theoretical and practical knowledge in field of medical biotechnology, learn about the various disease and identification of assays in understanding the diseases.

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 disorders of the chromosomes.	**BT 1**
CO 2	**Understand** the mechanisms of various diseases	**BT 2**
CO 3	**Apply** the knowledge learnt in carrying out pedigree analysis.	**BT 3**
CO 4	**Analyse** the various strategies for treatment of diseases.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	**Introduction:** History and scope of medical biotechnology, current status and future prospects. **Classification of genetic diseases:** Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders.	**12**
II.	**Molecular basis of human diseases:** - Pathogenic mutations Gain of function mutations: Oncogenes, Huntingtons Disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function - Tumour Suppressor. Genomic. Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy. Mitochondrial diseases	**12**
III.	**Gene therapy:** Ex-vivo, In vivo, In situ gene therapy, Strategies of gene therapy: gene augmentation Vectors used in gene therapy Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer. Gene therapy trials – Familial Hypercholesterolemia, ADA, AIDS, Cystic Fibrosis, Solid tumors. epigenetic inheritance, problems & ethics. Gene therapy Models – Liver diseases, Lung diseases, Hematopoietic diseases, & Auto-immune diseases. SARS-CoV-2 (Severe acute respiratory syndrome coronavirus 2)	**12**
IV	**Recombinant & Immunotherapy;** Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors, Monoclonal antibodies and their role in cancer;	**12**

	Role of recombinant interferons; Immunostimulants; Immunosupressors in organ transplants; Role of cytokine therapy in cancers;	
TOTAL		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text Books:

1. A. J.T. George, C.E. Urch, Diagnostic and Therapeutic Antibodies : Humana Press; edition (Latest Edition)

Reference books:

1. J. Decker, U. Reischl, Molecular Diagnosis of Infectious Diseases, Springer (Latest Edition)
2. T. Strachan, A. Read, Human Molecular Genetics, Garland Science (Latest Edition)

Subject Name: Phytochemical Analysis and Drug Discovery	**Subject Code: BTC152S411**
Credit Units: L-T-P-C – 0-0-4-2	**Scheme of Evaluation: (T)**

Course Objective: The main objective of the course is toprovide the graduates with the skill based knowledge in analysis of phytochemical constituents from plants and discovery of new drug molecules using*in silico* analysis.

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 theories taught related to phytochemical analysis and drug discovery	**BT 1**
CO 2	**Compare** the various theories and the practicals in understanding the relation between a drug and the target.	**BT 2**
CO 3	**Apply** the knowledge of various softwares used in drug design and target identification.	**BT 3**
CO 4	**Analyze** the results and compare the various properties of drug molecules in yielding a lead drug.	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	1. Collection of plant samples, drying methods and extraction 2. Determination of qualitative constituents of plant metabolites- alkaloids, tanins, saponins etc. 3. Estimation of plant quantitative constituents- alkaloids, tanins, saponins etc.	**12**
II	1. Isolation of essential oil from plants using cleavangers method 2. Isolation of essential oil from plants using soxhlet apparatus 3. Determination of antioxidant properties of plants using DPPH radical scavenging, ABTS method.	**12**

III	1. Introduction to molecular modelling 2. Study the various softwares used in drug design. 3. Study on the virtual screening of drug molecules from databases.	**12**
IV	1. *In silico* docking of ligands with targets 2. ADMET study of natural product molecules 3. Study on the process of identification of new drug targets	**12**
		48
Pedagogy: Lectures, Experiments, Laboratory sessions		

TextBook:

1. Leach, A.R., Molecular Modelling: Principles and Applications (Paperback), Pearson Higher Education, USA, 2001 (ISBN 0582382106).

2. Harbourne, J.B., Phytochemical Methods, A Guide to Modern Techniques of Plant Analysis, 1984, Springer Dordrecht, 978-94-010-8956-2

Reference Books:

1. S. Sadasivan and A. Manickam, Biochemical Methods, 2nd ed., 2003, New Age International (P) Ltd.. Publishers.

SYLLABUS: FIFTH (5th) SEMESTER

Subject Name: Plant and Animal Biotechnology **Subject Code: BTC152C501**

Credit Units: L-T-P-C – 3-1-0-4 **Scheme of Evaluation: (T)**

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 tissue cultured plants.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** about the process of tissue culture, callus culture, suspension cell culture of plant tissues.	**BT 1**
CO 2	**Understand** the processes and techniques 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**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	Plant tissue cultures: callus, meristem culture etc, secondary metabolites in plant tissue cultures; protoplast culture and somatic hybridization; haploid plants and somaclonal variation. Methods for Plant Conservation: Germplasm conservation- in situ, ex situ conservations and in vitro conservation; cryopreservation, Transgenic crop plants - Review of transgenic plants (Bt-cotton and other Bt- plants, Golden rice etc), development of pathogen resistant cultivars using resistant lines.	**12**
II.	Genetic engineering of crop plants: Agrobacterium-mediated gene transfer, direct gene transfer; Biolistic gene transfer, alternative approaches of gene transfer - microinjectionand elctroporation.Bioreactors- Stirred tank, Bubble column, Air lift, Rotating drum and immobilized plant cell reactor.	**12**
III.	**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	**12**
IV	**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.	**12**

TOTAL	48
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; 2NDedition, 2008).
3. Animal cell biotechnology Portner, 2nd edition, Humana Press,2007.
4. Pinkert, Transgenic animal technology, Academic Press,2006.

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

Subject Name: Practical in Plant and Animal Biotechnology & Fermentation Technology **Subject Code: BTC152C512**

Credit Units: L-T-P-C – 0-0-8-4 **Scheme of Evaluation: (P)**

Course Objective: The course is designed to learn about the various experiments used in plant and animal tissue culture and their role in the generation of new plants, animals and their products.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** about the procedures of tissue culture and maintenance of plant culture laboratory. The students will also be aware of the process of fermentation and preparation of various fermented food products.	**BT 1**
CO 2	**Understand** the role of various instruments and setups in the tissue culture laboratory and in bioprocess industry.	**BT 2**
CO 3	**Apply** the knowledge of plant tissue culture in conservation and fermentation in food preservation and processing.	**BT 3**
CO 4	**Analyze** the theoretical knowledge in the generation of new plants and innovative food products	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	1. Overview of setup in a plant tissue culture laboratory 2. Preparation of media for plant tissue culture. 3. Micropropagation using apical/nodal explants.	**12**
II.	1. Assessment of plant polyphenol content using biochemical assay 2. Isolation of protoplasts. 3. Study of equipment's and materials for animal cell culture. 4. Demonstration of the process and techniques of animal cell culture.	**12**
III.	1. Overview of a fermenter used in fermentation. 2. Formulation of culture media for fermentation 3.Isolation and screening of Lactobacilli from various fermented food sources.	**12**
IV	1. Preparation of red wine from grape juice 2. Preparation of beverages from cereals by fermentation. 3. Preparation of fermented food products	**12**
TOTAL		**48**
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; 2NDedition, 2008).

Reference Books

1. Davey,M.R. Plant Cell Culture: Essential Methods (Wiley-Blackwell Publishing, 2010)

Subject Name: Instrumentation and Techniques **Subject Code: BTC152D501**

Credit Units: L-T-P-C – 3-1-0-4 **Scheme of Evaluation: (T)**

Course Objective: The course is designed to understand the role of different instruments used in the study of the broad field of Biotechnology. The course covers the details of the instruments, their principles and applications.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** about the working principles of the various instruments used in biological science.	**BT 1**
CO 2	**Understand** the theory of the instruments and their applications.	**BT 2**
CO 3	**Apply** the knowledge of the instruments in the experiments to be conducted	**BT 3**

CO 4	**Analyze** the theoretical knowledge in the experiments to be carried out using various instruments	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	General introduction to analytical equipment. Maintenance, operation and safety measures in laboratory. Spectroscopic techniques: Theory & application of- UV-VIS and IR spectroscopy, GCMS, MS, NMR, XRD.	**12**
II.	Electrophoresis: Basic principles and application of SDS-PAGE, agarose, agar cellulose (horizontal and vertical) electrophoresis; submerged electrophoresis, Isoelectricfocussing: Pulse Field Gel Electrophoresis (PFGE); Field inversion electrophoresis, Capillary and Immuno-electrophoresis	**12**
III.	Chromatographic techniques: Partition, ion exchange, gel filtration and affinity chromatography. Chromatographic methods such as TLC, GLC, HPLC, FPLC.Hyphenated chromatography systems and their applications of LC-MS, GC-MS, Centrifugation techniques: principles and applications. Types of centrifuges. Ultracentrifugation and density gradient centrifugation.	**12**
IV	Microscopy: light, dark field, phase contrast, fluorescent microscopy, SEM and TEM. Confocal Microscopy, Basic concept of X-ray microprobe analysis and EM Tomography. Radioactive isotopes: Basic principle and application of tracer techniques, gamma counters, liquid scintillation counter, Measurement of radioactivity. Autoradiography.	**12**
TOTAL		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text books

1.Modern Analytical Chemistry, David Harvey, McGraw-Hill, 1st ed, 2000, ISBN: 0–07– 237547–7

2.Chemical Analysis: Modern Instrumentation Methods and Techniques, Francis Rouessac, AnnickRouessac, John Wiley & Sons, 2nd ed, 2007. ISBN: 0470859040, 9780470859049

Reference Books

1. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler, S.R. Crouch, Brooks Cole; 6th edition (Dec 6 2006) , ISBN: 0495012017 , 978-0495012016

2.Physical Biochemistry by David Freifelder, W H Freeman and Co, ISBN: 9780716705598, 0716705591 (Latest Edition)

Subject Name: Fermentation Technology	**Subject Code: BTC152D502**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (T)**

Course Objective: The course is designed to learn about the process of fermentation and the applications of the techniques in the preparation of reactors and beverages.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** aboutthe basics of fermentation and the mechanisms involved.	**BT 1**
CO 2	**Understand** the principles of fermentation and utilize their role in societal applications	**BT 2**
CO 3	**Apply** the knowledge gained in real life situations such as in the preparation of various food items.	**BT 3**
CO 4	**Analyze** the basics in the design of fermenters and their applications.	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	Basic principle of fermentation technology: Isolation, screening and maintenance of industrially important microbes, microbial growth and death kinetics, 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. Thermal death of microorganisms, 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: Fermentated foods, use of microbes in pickling, productingcolours and flavours, and process of wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products.	**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.	**12**
TOTAL		**48**
Pedagogy: Lectures, Assignments, Seminars		

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 Verlagsgesellschaftmb H. 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: Biophysical Chemistry	**Subject Code: BTC152D503**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (T)**

Course Objective: The course is designed to learn about the process of biophysical chemistry and understand the underlying phenomenons involved in protein structure and its composition.

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 basics of biophysical chemistry	**BT 1**
CO 2	**Understand** the principles of and processes of biophysical chemistry and its application in solving protein structure	**BT 2**
CO 3	**Apply** the basics in understanding the role of bioenergetics.	**BT 3**
CO 4	**Analyze** the role of equilibrium and study the properties of protein folding and refolding.	**BT 4**

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**Periods**
I.	**Structure and Bonding:** Structure of atoms, molecules and chemical bonds(Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, Co-valent bonding, etc.)..Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).	**12**
II.	**Conformation and configuration of proteins: R**amachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds. Conformation of nucleic acids (A, B, Z-DNAforms), t-RNA structure, micro-RNA etc).	**12**
III.	**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**
IV	**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	**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.

SYLLABUS: SIXTH (6th) SEMESTER

Subject Name: Genetic Engineering **Subject Code: BTC152C601**

Credit Units: L-T-P-C – 3-1-0-4 **Scheme of Evaluation: (T)**

Course Objective: The course is designed to provide the basic concepts in the area of genetic engineering and provide knowledge in the area of new strain development.

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 concepts in genetic engineering	BT 1
CO 2	Understand the role of the various enzymes used in genetic engineering	BT 2
CO 3	Apply the knowledge in the creation of better microbiological strains for development of better food products	BT 3
CO 4	Analyze the techniques learnt in generation of new biological products.	BT 4

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	Basics Concepts: DNA modifying enzymes; Restriction enzymes and their types, restriction cuts, Cohesive and blunt end ligation; Linkers; Adaptors; Radioactiveand non-radioactive probes, RNaseH, H1 nuclease; gene transfer techniques.	**12**
II.	Cloning Vectors: Plasmids; PBR322, pUC18/19, Phagemids; Bacteriophages; M13 mp vectors; Insertion and Replacement vectors; Cosmids; Highcapacity vectors: Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo& retroviral vectors; Expression vectors; pMalPlant based vectors, Ti and Ri as vectors, Yeast vectors.	**12**
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; Southern, Northern and Western blotting; DNA foot printing; Site directed mutagenesis	**12**
IV	PCR and its Applications: Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR; Primer design; Taq polymerases; cloning of PCR products; Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Transgenics.	**12**
TOTAL		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text Books:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6 t h Edition, S.B.University Press,2001.
2. Brown TA, Genomes, 3rd ed. Garland Science2006

Reference Books:

1.J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vol 1-3, CSHL, 2001.
2.Scientific research articles from Science Direct.com

Subject Name: Practical in Genetic Engineering	**Subject Code: BTC152C612**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (P)**

Course Objective: The course is designed to provide in-depth knowledge of genetic engineering. The understanding of the process can lead to the creation of new organisms and products.

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 concepts in genetic engineering and its applications.	**BT 1**
CO 2	**Understand** the processes and techniques used in genetic engineering	**BT 2**
CO 3	**Apply** the knowledge of the subject learnt and use	**BT 3**
CO 4	**Analyze** the theoretical knowledge and expression of genes	**BT 4**

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	1.Identification of instruments and their mechanism required in Genetic engineering. 2. Preparation of reagents for PCR experiments. 3. Preparation of reagents for electrophoresis.	**12**
II.	1. Digestion of DNA using restriction enzymes and its analysis 2. Demonstration of Agarose gel electrophoresis 3. Amplification of DNA by PCR.	**12**
III.	1. Isolation of DNA from plant/ microbe/ tissue 2. Estimation of purity of DNA using spectrophotometer 3. Vertical gel electrophoresis	**12**
IV	1. Analysis of gels using Gel Doc/ Transilluminator instrument 2. Isolation and purification of bacterial plasmids. 3. Cloning of DNA fragments in plasmid vector (Kit Based)	**12**
TOTAL		**48**
Pedagogy: Lectures, Assignments, Seminars		

Text books: As prescribed for the Theory Course

Subject Name: Genomics and Proteomics **Subject Code: BTC152D601**

Credit Units: L-T-P-C – 3-1-0-4 **Scheme of Evaluation: (T)**

Course Objective: 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 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 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

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I.	Genome Projects approaches for whole genome sequencing and genome projects; Nucleotide data acquisition, annotation, chromosome mapping, Prokaryote Genome anatomy, Eukaryotic nuclear genome, eukaryotic organelles genomes (Mitochondria and Chloroplast), Repetitive DNA. Comparative genomics; Introduction to functional genomics: transcriptomics, proteomics, metabolomics	**12**
II.	Transcriptomics: Microarray, RNA sequencing, methods to study differential gene expression: differential display PCR Tools for genome analysis- PCR and automated DNA sequencing, RFLP, DNA footprinting, DNA finger printing, RAPD, AFLP, SNP detection techniques, Applications of DNA markers	**12**
III.	Introduction to Proteome Concept and nature of proteome, overview of the tools to study proteome, and categories of current proteomic studies, Application of Proteomic studies in (Gene Expression, Protein, Biomarker discovery in disease diagnosis and drug designing); Proteomic interactions (Y2H approaches, Co-IP); Sequencing of proteins, Concepts of protein engineering, protein microarray.	**12**
IV	Analytical proteomic tools: SDS-PAGE, Native PAGE, western blotting and immune-detection, 2D-gel electrophoresis., in gel digestion, Purification of proteins using various chromatographic techniques. Mass spectrometry: Principle and practices.	**12**
	TOTAL	**48**
Pedagogy: Lectures, Assignments, Seminars		

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

Subject Name: Developmental Biology	**Subject Code: BTC152D602**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (T)**

Course Objective: 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 Outcome:

On successful completion of the course the students will be able to:		
Sl No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the important developmental stages in organisms	BT 1
CO 2	**Understand** the role of various genes involved in development.	BT 2
CO 3	**Apply** the knowledge gained in carrying out studies on development.	BT 3
CO 4	**Analyze** the importance of various processes involved in development of an organism	BT 4

Detailed Syllabus:

Modules	**Topics (if applicable) & Course Contents**	**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
Pedagogy: Lectures, Assignments, Seminars	

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

Subject Name: Research Methodology and IPR **Subject Code: BTC152D603**

Credit Units: L-T-P-C – 3-1-0-4 **Scheme of Evaluation: (T)**

Course Objective: This subject aims to introduce students to Intellectual Property Rights and apprise them of ethical issues and practices.

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 relate the social impacts of intellectual property law and policy.	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

Modules	Topics (if applicable) & Course Contents	Periods

I.	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.	**12**
II.	Publication ethics: Effective literature studies approaches, analysis Plagiarism, Research ethics; COPE and its role. Effective technical writing, how to write report, Developing a Research Proposal, Format of research proposal, presentation and assessment by a review committee. Biopiracy and Bioethics: Application of IPR regime to Biological Resources and Biopiracy, Access to Biological Resources, Benefit Sharing and Informed Consent.	**12**
III.	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	**12**
IV	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; Salient features of Indian Patent Act 1970 and their amendments.	**12**
TOTAL		**48**
Pedagogy: Lectures, Assignments, Seminars		

Detailed Syllabus:

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

Reference Books:

1. Kilner, John, et.al, eds., Cutting-Edge Bioethics. Eerdmans 2002.
2. Arthur L. Caplan, Robert Arp, Contemporary Issues in Bioethics (2014)

Subject Name: Project	**Subject Code: BTC152D624**
Credit Units: L-T-P-C – 3-1-0-4	**Scheme of Evaluation: (T)**

Course Objective: The course is designed to provide the students with the knowledge of a particular area/ theme of research and its outcome. The students shall be given a problem to which they shall carry out the objectives, utilizing the knowledge they have gathered during their respective course.

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 concepts learnt in solving the problems.	BT 1
CO 2	Understand the objectives and solve the same using various instruments an d techniques	BT 2
CO 3	Apply the techniques learnt in the course of the project duration in dealing with new problems.	BT 3
CO 4	Analyze the techniques learnt and the way to solve the same.	BT 4